STUDIA ECOLOGIAE ET BIOETHICAE

2023, 21, 1: 69-88
p-ISSN 1733-1218; e-ISSN 2719-826X
DOI: http://doi.org/10.21697/seb.2023.06

Urban Green Spaces in Brazil: Challenges and Opportunities in the Context of the COVID-19 Pandemic

Miejskie tereny zielone w Brazylii: wyzwania i szanse w kontekście pandemii COVID-19

Romero Gomes Pereira da Silva[*1], **Cláudia Lins Lima**[1], **Sterling D. Quinn**[2], **Aneta Afelt**[*3,4], **Anne-Elisabeth Laques**[4], **Carlos Hiroo Saito**[*1]

[1] University of Brasilia, Brazil

[2] Central Washington University, USA

[3] University of Warsaw, Poland

[4] IRD – Institut de Recherche pour le Développement, UMR ESPACE-DEV, France

ORCID RGPS https://orcid.org/0000-0002-4553-3498; CLL https://orcid.org/0000-0003-2684-8459; SDQ https://orcid.org/0000-0002-4900-8885; AA https://orcid.org/0000-0001-8744-2992; A-EL https://orcid.org/0000-0003-4469-270X; CHS https://orcid.org/0000-0002-5757-9629 • romerogomes1@gmail.com; akafelt@uw.edu.pl; carlos.h.saito@hotmail.com

Received: 08 Jan 2023; Revised: 31 Jan, 2023; Accepted: 01 Feb, 2023

Abstract: During the COVID-19 pandemic, urban green spaces were considered less prone to contagion, and thus people adopted them as alternative sites for improving mental health. The One Health concept advocated by health organizations worldwide supports the idea that the well-being of urban residents is strongly linked with physical activity in green areas. As the world grapples with the physical and mental health consequences of the COVID-19 pandemic, it becomes clearer that access to urban green spaces is a human rights issue. This study compared previously-mapped urban green spaces in five metropolitan regions in Brazil with the results of an extensive survey of municipal managers concerning possible increase in demand of population for green spaces. Urban green spaces of over 625 m^2 were mapped in 117 municipalities, the total area of 4170 km^2 representing 37.4% of the urban spaces analyzed in the five metropolitan regions. Out of these 117 municipalities, 49 had data available concerning demands of green spaces in the pandemic context. Overall, 20 municipalities (representing all five metropolitan regions) stated that there was an increase in visitation in urban green spaces, and 13 more indirectly suggested possible demands. When sustainability transitions are understood as geographical processes that happen in concrete places, urban green spaces then represent real locations where sustainable transitions can begin. The unequal distribution of these spaces also brings into consideration a social justice perspective, as well as aspects of public health that involve climate change resilience and epidemiological risk (SDG 11).

Keywords: green spaces, social justice, sustainable transition, pandemic, One health, SDG 11

Streszczenie: Wyniki wielu badań wskazują, że dobre samopoczucie mieszkańców miast jest silnie związane z aktywnością fizyczną na terenach zielonych. Podczas pandemii COVID-19 miejskie tereny zielone były uważane za mniej podatne na ekspozycję na zakażenie, dlatego były wykorzystywane jako alternatywne miejsca dla poprawy zdrowia psychicznego. Ponieważ zmagamy się z fizycznymi i psychicznymi konsekwencjami pandemii COVID-19, staje się jasne, że dostęp do miejskich terenów zielonych jest kwestią praw człowieka. Jeśli zmiany w zakresie zrównoważonego rozwoju są rozumiane jako procesy geograficzne, które zachodzą w konkretnych miejscach, miejskie przestrzenie zielone reprezentują rzeczywiste

obszary, w których mogą rozpocząć się zrównoważone zmiany, uwzględniające m.in. dobrostan zdrowotny populacji (zgodnie z koncepcją One Health). W badaniu porównano miejskie tereny zielone w pięciu regionach metropolitalnych w Brazylii z wynikami szeroko zakrojonej ankiety przeprowadzonej wśród zarządców miejskich, dotyczącej możliwego wzrostu zapotrzebowania ludności na tereny zielone. Miejskie tereny zielone o powierzchni od 625 m^2 zostały zmapowane w 117 gminach, ich łączna powierzchnia 4170 km^2 reprezentuje 37,4% przestrzeni miejskich w analizowanych regionach metropolitalnych. Spośród 117 gmin, 49 miało dostępne dane dotyczące zapotrzebowania na tereny zielone w kontekście pandemii. W sumie 20 gmin (reprezentujących wszystkie pięć regionów metropolitalnych) stwierdziło, że nastąpił wzrost odwiedzalności miejskich terenów zielonych, a 13 kolejnych pośrednio zasugerowało możliwe zapotrzebowanie. Nierówna dystrybucja tych przestrzeni uwzględnia perspektywę sprawiedliwości społecznej, jak również aspekty zdrowia publicznego, które obejmują odporność na zmiany klimatu i ryzyko epidemiologiczne (SDG 11).

Słowa kluczowe: tereny zielone, sprawiedliwość społeczna, zrównoważona transformacja, pandemia, One Health, SDG 11

Introduction

Rapid spread of the virus SARS-CoV-2 brought societies face-to-face with their vulnerabilities. We all were pushed to adapt to a new—and globally similar—lifestyle. The isolation and social distancing required by the COVID-19 pandemic have led the population to change daily movement and lifestyle patterns to fit a "new normal." These public health measures aim to prevent the spread of the SARS-CoV-2 virus from person to person (Wilder-Smith and Freedman 2020). Although necessary, isolation and social distancing presented negative effects on physical and mental health (Banerjee and Rai 2020; Bland et al. 2022; Hwang et al. 2020; Maury-Mora et al. 2022). Urban green spaces have become an option to mitigate these harmful effects (Nieuwenhuijsen 2021).

Urban green spaces are less prone to the contagion of SARS-CoV-2 because they are open and ventilated places. Such spaces have become an alternative for the practice of sports and leisure activities, since they allow socialization with minimal risk. In addition to outdoor escape during the COVID-19 pandemic, urban green spaces are associated with higher levels of physical activity, social interaction, and stress reduction, which reflect a better quality of life (Van Den Berg et al. 2016). Moreover, green spaces provide ecosystem services by mitigating air pollution, noise, and the urban heat island effect (Nieuwenhuijsen 2021). The importance of green spaces concerning public health in general, and the pandemic in particular, is evidenced by their protective role against wheezing in people exposed to these areas, also resulting in less atopic sensitization in children and adolescents up to 20 years old (Tischer et al. 2017). The One Health approach strongly links urban resident health and well-being with physical activity in the green areas (Rüegg et al. 2018).

People's desire to live near to and enjoy open spaces is reflected in the increase in demand for these places during the pandemic. The analysis performed by Bland et al. (2022) in 48 countries (distributed on all continents) through Google community mobility reports and the Oxford Coronavirus Government Response Tracker confirms a significant increase in urban park visitation. These parks' critical role in supporting physical and mental wellbeing clearly emerged in those cities where access was allowed during lockdowns (for example, in Oslo, outdoor activities increased by 291%) (Geneletti et al. 2022).

While these evidences leave little room for doubt about the positive impact of urban green spaces on quality of life, the COVID-19 pandemic demands consideration of the green spaces' spatial function, as

well as access to these spaces as a human right. While in European countries, spatial planning is by principle inclusive and considers the green space city infrastructure, globally there are still regions of low presence of green areas, or unequal access to them. This is linked with the history of the society, economic gaps, and in general local political movements and their associated legal frameworks.

Urban inequalities can function to stabilize a particular mode of production, but they are also a locus of accumulated contradictions and the birthplace of new modes of social and productive organization (Harvey 1993). From this perspective, the COVID-19 pandemic offers an opportunity to discuss urban spatial planning issues surrounding access to green areas globally, as a part of human right (Cole et al. 2020; Haase 2020; Mendes 2020).

In the case of Brazil, a country of continental dimensions and a large number of urban green areas, now is the ideal time to plan a just and sustainable transition to a post-COVID-19 future based on the United Nations Sustainable Development Goals (SDGs), specifically SDG 11, Sustainable Cities and Communities. From 3 January 2020 to 13 May 2022, Brazil reported to the World Health Organization (WHO) a total of 30,617,786 confirmed cases of COVID-19 and 664,516 deaths. Spatiotemporal patterns of the virus's spread in Brazil are given by Castro et al. (2021). As of 6 May 2022, a total of 416 055 006 vaccine doses have been administered[1].

Considering this situation and the high degree of socioeconomic inequality in Brazilian cities, planning a just and sustainable transition requires starting with a diagnosis of existing urban green spaces, focused on areas of greater social vulnerability.

It is also necessary to consider that urban green spaces that lack accompanying urban infrastructure can become areas that may present risk to people in Brazil. In this context of green spaces in infrastructure-poor areas, Juntti et al. (2021) describe that people's ability to interact with green spaces is conditioned by insecurity in access and the right to housing, risk of crime, poor provision of urban services, and environmental degradation. Thus, urban inequality related to green spaces can be due to both unequal distribution (presence) of urban green spaces, as well as differentiated investments and care of those spaces by local governments.

The focus of this discussion will be the importance of urban green spaces as urban facilities capable of meeting people's basic demands for a variety of activities such as leisure, sport, cultural activities, and so forth, while simultaneously offering ecosystem services such as microclimate regulations, landscape beauty, and biodiversity support, for all (Aydin and Çukur 2012). Did the pandemic conditions lead to a "tipping point" in public expectations about the need to increase the comfort of living in Brazilian cities? This inquiry is especially necessary in places with low socioeconomic indices, whose unequal level of access to general urban facilities became more evident during the COVID-19 pandemic. This article will employ data from the mapping of urban green spaces, as well as the calculating of geostatistical correlations with socioeconomic data, prepared by Silva (2018) in Brazil. In addition, we will present data from interviews with local managers made available by the National Confederation of Municipalities (CNM, Brazilian acronym) that confirm the increase in demand for green spaces in Brazil during the pandemic and highlight the potential of these spaces as one of the elements for a fair and sustainable transition for a better world (CNM 2021).

1. Materials and methods

1.1. Definition of urban green spaces

Urban green spaces have large areas of vegetation, with little or no land cover and few

1 WHO (World Health Organization). 2022. The current COVID-19 situation-Brazil. https://www.who.int/countries/bra/.

built-up areas, where natural or seminatural ecosystems are converted into urban space (Bilgili and Gökyer 2012; Silva et al. 2020) and they are thus different from the mere presence of trees alongside streets. In Silva's (2018) study, the only way of classifying some of these spaces in terms of use was by referencing the boundaries of protected areas, made available by the managing body of these areas at the federal level, the Chico Mendes Institute for Biodiversity (ICMBio 2013). A more nuanced classification could be achieved by considering the types of activities occurring in the green space and the infrastructure available for supporting those activities; for such analysis, secondary data distinguishing these spaces according to their use (park, square, urban forest, etc.) are needed. Silva (2018) did not distinguish them according to their use. It is therefore important, for the present analysis, to consider the potential incorporated in green spaces to offer environmental services and, when possible, to implement adequate infrastructure for the enjoyment of the population for leisure, sport, culture, and socialization. Here, the definition of urban green space is linked with the physical and mental health impact for society, as well as its positive role for local climate stabilization in terms of climate change impact and the UN's SDG 11 goal.

1.2. Urban green space identification

Silva's (2018) mapping of green spaces in the indicated urban areas was carried out using an automatic classification, via cluster analysis (Richards 1986), for the five spectral bands of the RapidEye image (5 m resolution, as a base for drawing maps of the green spaces). Aiming at greater precision, only areas larger than 625 m^2 were mapped and analyzed. This unit size is analogous to other studies (De Vries et al. 2003; Maas et al. 2006; Van Dillen et al. 2012) that analyzed urban green spaces.

A total of 11 120 km^2 of urban areas were mapped, covering 117 Brazilian municipalities in addition to Brasília (Federal District, capital of Brazil). Thirty-one million people reside this study area, or about 20% of the Brazilian urban population.

1.3. Social and economical data

We combined additional sources of data to study the relationship between urban green space in Brazil and its surrounding urban society under varying conditions. One of these sources was survey data from the CNM. This non-profit entity seeks to develop municipal technical capacities and, as a result, create a strong political network with influence and reach throughout the country. The capillary nature of the CNM allows a careful diagnosis of the on-the-ground reality in Brazil's municipalities, since its interviews are conducted directly with local managers. For instance, from March 2021 to March 2022, the CNM did weekly surveys with mayors to learn the themes and issues that most concern local entities about how to cope with the COVID-19 pandemic. The surveys were carried out by the CNM itself, through its call center.

In this case, we will analyze the Edition number 23 of the surveys, conducted in August 2021 (CNM 2021), which covered topics such as restriction measures, the distribution and application of vaccines, the increase in cases of infection and deaths by COVID-19, the advance of vaccination, and issues regarding urban green spaces. The survey obtained responses from 2 022 municipal managers, which represent 36.3% of Brazilian municipalities in all regions of the country.

1.4. Quantification the spatial distribution of urban green spaces and the social vulnerability index

Taking 2010 as the base year of analysis, Silva (2018) presented a methodology that measured the correlation of urban green spaces with socioeconomic indices on the intra-urban scale. The main data were satellite images (RapidEye), urban census tracts (IBGE 2011), and a social vulnerability index (IPEA 2015). This index is a result

of three sub-indices (urban infrastructure, human capital, and income and work) obtained from the demographic census of Brazil (the last one being carried out in 2010) (IPEA 2015).

After mapping the urban green spaces, Silva (2018) correlated these spaces with socioeconomic data through exploratory spatial data analysis (ESDA) (Anselin 1994). This method allowed the possibility to map, visualize and quantify the spatial distribution of urban green spaces correlated with the social vulnerability index (IPEA 2015). Notably, ESDA allowed the identification of different spatial patterns, such as groups with similar values (clusters) or divergent values (outliers), through local indicators of spatial association (LISA). In this case, it generated four spatial associations from a set of census tracts. These combinations were named in the analysis by Silva (2018) as scenarios, with colors being assigned in the mapped results. The scenarios are described below:

- scenario 1 (high-high): high social vulnerability and high percentage of urban green space system (orange)
- scenario 2 (low-high): low social vulnerability and high percentage of urban green space system (green)
- scenario 3 (low-low): low social vulnerability and low percentage of urban green space system (yellow)
- scenario 4 (high-low): high social vulnerability and low percentage urban green space system (red).

This analysis of different spatial patterns and their associations makes it possible to understand and identify the socio-environmental demands on the population, in order to plan more assertive public policies. As countries seek to recover from the COVID-19 pandemic, this methodology can be replicated and can contribute to achieving the SDGs, once these international objectives are already strongly linked to the competencies of Brazilian municipalities.

The maps of urban green spaces by Silva (2018) encompass urban areas in five metropolitan regions (MR) in Brazil: Brasília (Federal District, Midwest), Manaus (Amazon state, North), Porto Alegre (Rio Grande do Sul state, South), Recife-(Pernambuco state, Northeast), and São Paulo (São Paulo state, Southeast). This sample was made by determining which state capital city exhibited the greatest income inequality (as determined by Gini coefficient) in each geopolitical region of the country (Midwest, North, South, Northeast, and Southeast). All neighboring municipalities that make up these metropolitan regions were included in the analysis, since the capitals have large population densities whose socio-environmental problems extend beyond local political boundaries.

2. Results and discussion

2.1. Urban green spaces in five metropolitan regions in Brazil

The mapped data cover an area of 4 170 km² of urban green space, which represents 37.4% of the urban spaces analyzed in five metropolitan regions. Table 1 describes the urban areas analyzed (in km²), their resident populations, and percentage of mapped urban green spaces (Silva 2018). In all analyzed cases, the amount of green spaces is substantial, ranging from values close to 30% in the metropolitan regions of Brasília and Porto Alegre, 40% in Recife and São Paulo, and 60% in Manaus.

In terms of location, Silva (2018) highlights that the largest portions of urban green spaces are located in the peri-urban areas of the analyzed metropolitan regions (Figure 1), in other words, at the edges of the urban fabric. These are places of urban expansion. In Brazilian cities, peri-urban areas are historical places of socio-environmental problems, such as precarious and predatory occupations without adequate urban planning (Maricato 1999).

Table 1. Areas analyzed (km²), population, percentage of green spaces in metropolitan regions (source: Silva 2018)

Metropolitan region	Urban area (km²)	Population (milion)	% Green espaces
Brasília	2104.47	3.5	30.2
Manaus	1023.97	1.9	59.4
Porto Alegre	2538.75	4.0	29.3
Recife	885.54	3.3	38.9
São Paulo	4565.07	19.9	40.2
Total	11117.8	32.6	37.4

Silva (2018) was also able to identify from the georeferenced base of Brazilian protected areas (ICMBio 2010) that the largest blocks of urban green spaces located in peri-urban areas are protected areas. In this case, three situations stand out.

The first is Manaus, located in the middle of the Amazon rainforest, which has extensive fragments of this rainforest on the edges of the urban fabric (Figure 1b). The extensive hydrography implies a large area destined for the preservation of riparian forests. There is also a large conservation area for scientific research (Ducke reserve) and a military training area. However, near or within the green spaces, numerous socio-environmental problems occur, reflecting the high degradation of urban watersheds and lack of urban planning (Silva and Scudeller 2022). These authors report that in the last 50 years, there has been an enormous expansion of communities in extreme poverty in areas close to rivers and forests, with inadequate housing and basic sanitation.

The second situation, in the Metropolitan Region of São Paulo (the largest analyzed area in terms of area and population), presented one of the highest percentages of urban green spaces (40.2%) (Figure 1e). Most of these spaces are concentrated in the peri-urban area, where a large number of protected areas coexist with an aggressive and disorderly urban expansion. Mello-Théry (2011) reports that this pressure in the peri-urban area is exacerbated by the high population density. In addition, it appears that old farms were transformed into leisure areas and spaces for the advancement of peripheral housing (Mello-Théry 2011).

The third situation is Recife, the only case of a coastal city, which contained a considerable amount of urban green space (38.92%) (Figure 1d). Most of the spaces are in the inland portion (west), where there is a strong presence of protected areas and no real consolidation of the urban fabric. Azevêdo (2015) reports that the majority of these protected areas are located in the relief of the hills, covered by large fragments of native vegetation.

The metropolitan regions of Brasília (Figure 1a) and Porto Alegre (Figure 1c) had the lowest percentage of green spaces, indicating that these urban fabrics are more consolidated, with fewer peri-urban areas than the others. However, in these two cases, there are also significant portions of protected areas in the urban space. In the specific case of Brasília, 83% of the territory of the federal capital is considered a protected area, but in a category that allows urbanization in a controlled manner, which is not always effective (Peluso 2003). What could in theory be a positive factor toward achieving the goals of the SDGs is, in practice, only a set of rigid norms affecting the types of permitted activities and enterprises. There is no permission to install some industries and other high-impact activities in this region, but there is also urban expansion without environmental planning. This results in communities lacking adequate services, sanitation, and other urban infrastructure, generating inequality and social injustice.

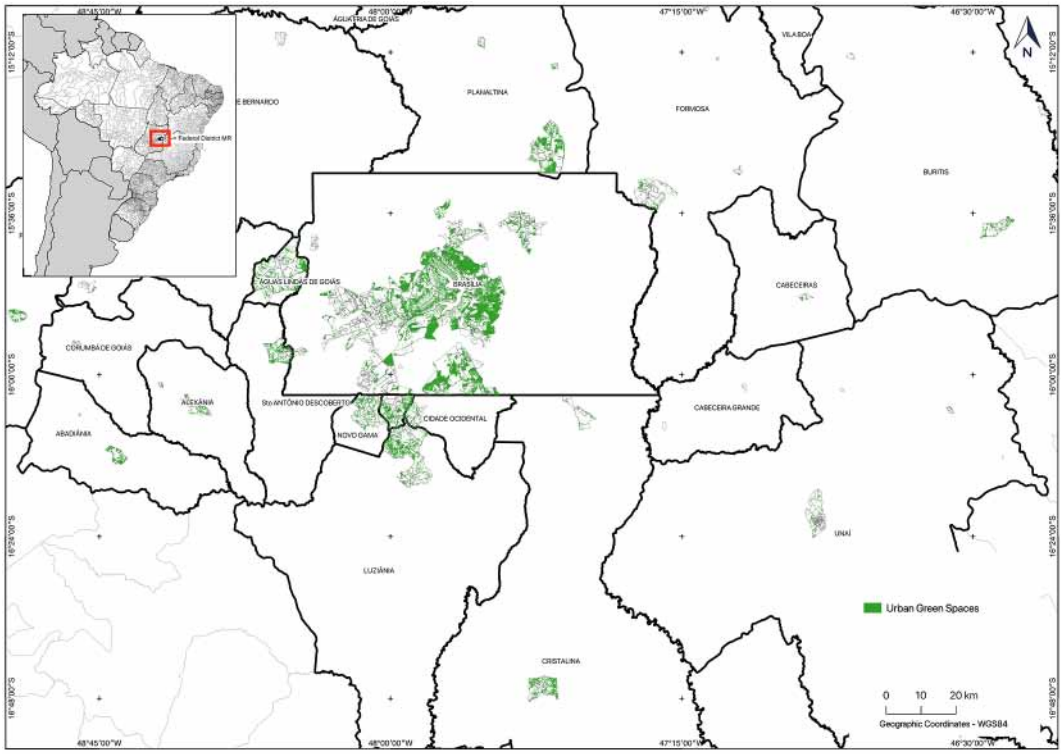

Figure 1, a

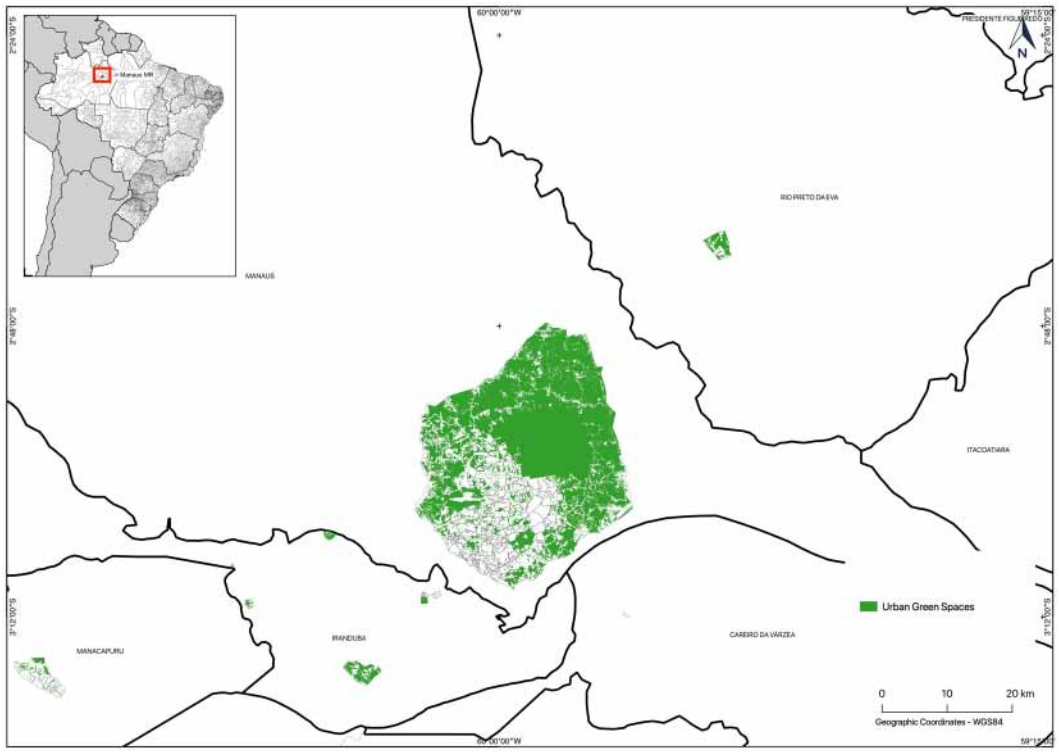

Figure 1, b

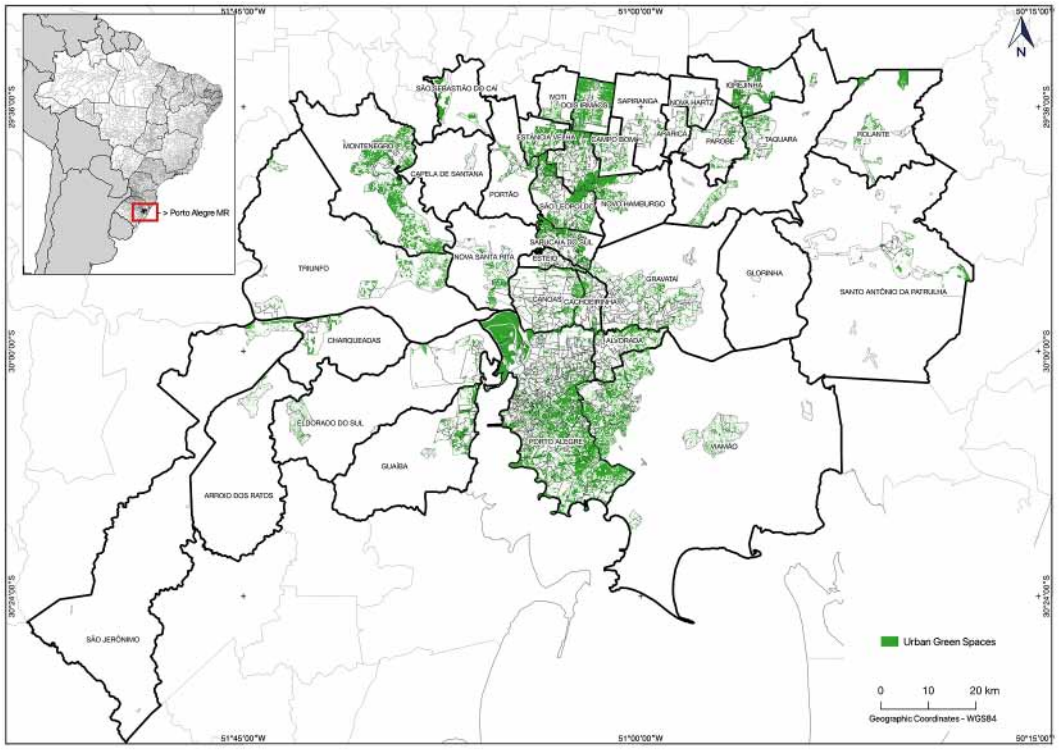

Figure 1, c

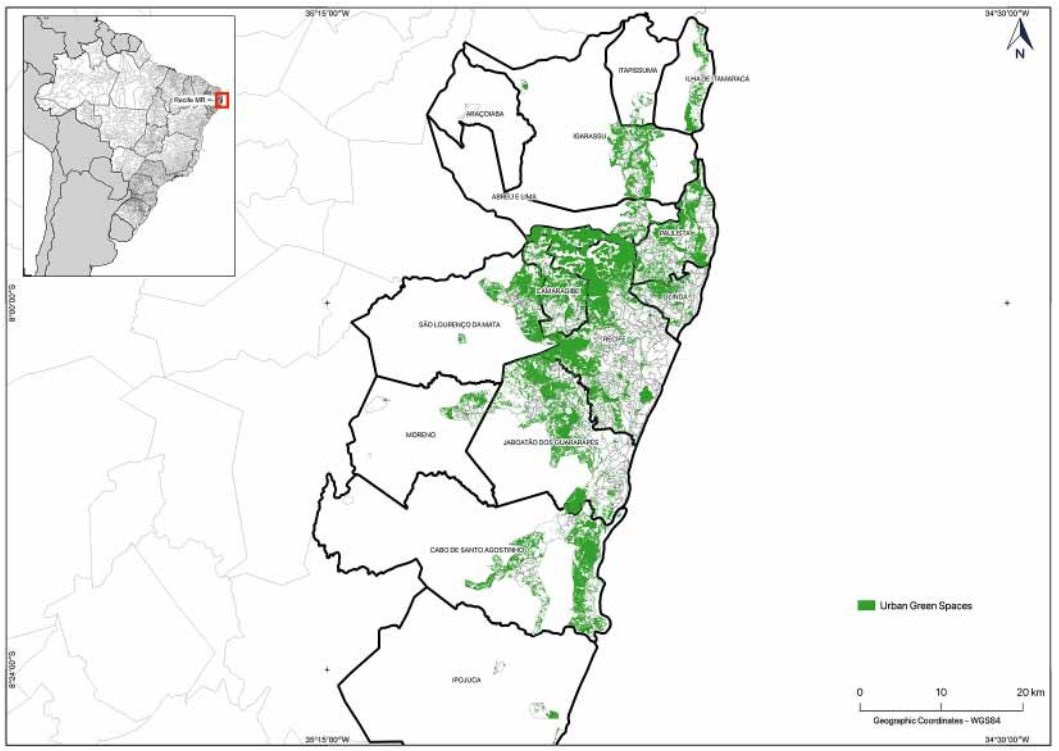

Figure 1, d

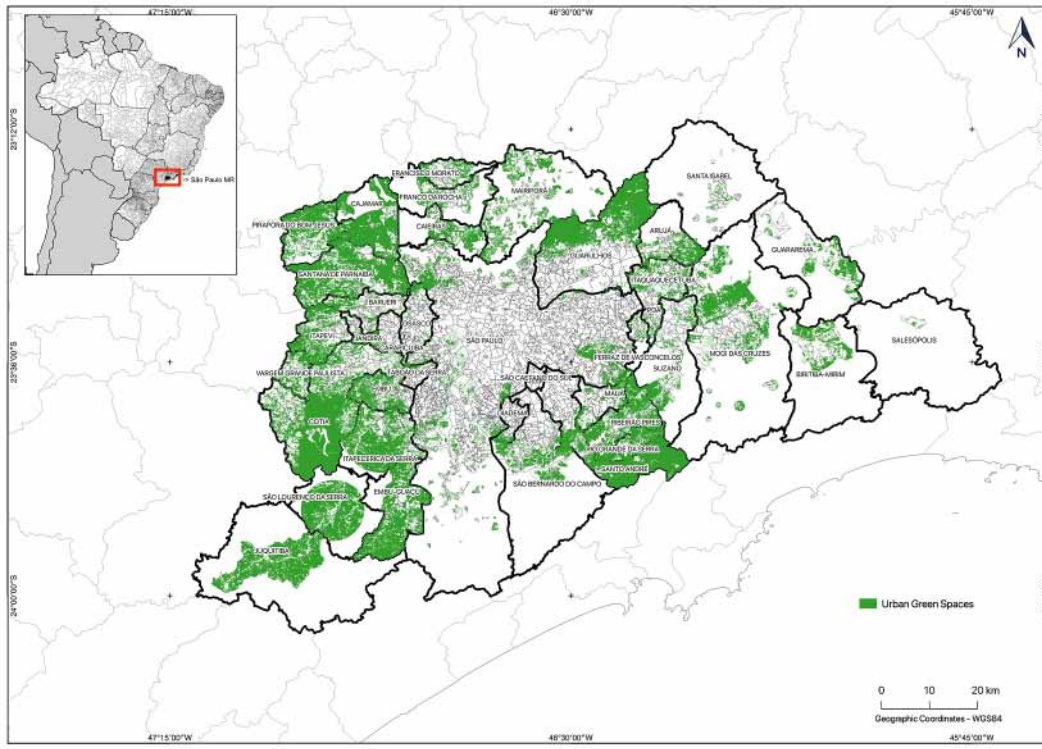

Figure 1, e

Figure 1. Urban green spaces in the analyzed metropolitan regions: a. Brasilia MR; b. Manaus MR; c. Porto Alegre MR; d. Recife MR; e. São Paulo MR – adapted from Silva (2018)

2.2. The correlation of urban green spaces with the social vulnerability index

By correlating the social vulnerability index with the amount of urban green spaces, the analysis by Silva (2018) indicated that the largest metropolitan region analyzed, São Paulo, presented the highest degree of correlation. In terms of population, 60% of people in this metropolitan region live in places where there was significance in the proposed correlation. Most notable for public policy managers and green space advocates is the fact that 38.23% of the population of the largest metropolis in Brazil resides in census tracts with very few green spaces (red and yellow scenarios) (Silva et al. 2019).

Across all study areas analyzed by Silva (2018), about 50% of the population analyzed resides in census tracts where there was no correlation between the variables (gray color on the maps in Figure 2). This means that in these census tracts, there are no extreme values for the number of green spaces and socioeconomic levels. The other half is divided into 25% residing in low social vulnerability scenarios (green and yellow colors), and 25% residing in high social vulnerability scenarios (red and orange colors).

In this way, Silva's (2018) analysis located and quantified (in terms of area and population) the set of priority census tracts for directing public policies related to urban green spaces (Figure 2). In the 2030 Agenda (UN 2015) context, which established the SDGs as a global commitment, and considering that pre-existing urban inequalities shaped the spread of COVID-19 and that the pandemic's effects are long-lasting, it is important to focus on areas of greater social vulnerability, where

poverty and inequality tend to be worse (Oliveira and Emídio 2021). Specifically, the red-colored census tracts in Figure 2 (2a, 2b, 2c, 2d, 2e), representing a high social vulnerability and low green space, should be the highest priority locations for articulating the inclusion of new green spaces.

In the case of the census tracts located in the orange areas in Figure 2 (high social vulnerability and high amounts of green spaces), these spaces must be carefully maintained to ensure the continuation of essential environmental services. When use is allowed, it is important to institute integrative and cross-sectoral policies that will promote quality of life and well-being, with a focus on SDG 11 to plan a transition to inclusive, safe, resilient, and sustainable cities. This way, we can take the first steps to promote a long-term, multi-dimensional, and fundamental transformation process based on a socio-technical systems shift to more sustainable modes of production and consumption (Markard et al. 2012).

In terms of area (km²), the orange scenario was the most representative of the four metropolitan regions. The exception was Brasília, which is the only analyzed example of a city built in a planned way under the concept of a park city. In this case, the green scenario (low vulnerability and high amounts of green space) was the most representative in terms of area and population (Figure 2a); however, the green colored areas on the map are restricted to only a part of the territory, with the red scenario affecting a substantial proportion of the residential population (15.35%) living inside a relatively small space (4.92% of the analyzed area).

Silva (2018) highlights the frequent occurrence of urban green spaces that have their largest blocks established as protected areas in peri-urban landscapes of low socioeconomic index (orange color in Figure 2). These results show that an abundance of urban green spaces, especially in peri-urban areas, does not necessarily imply a particular quality of life, although it brings well-proven environmental benefits.

Even before the COVID-19 pandemic, Silva (2018) stressed that the presence of green spaces in peri-urban areas is an opportunity to institute policies aimed at improving quality of life combined with environmental preservation. In the same sense, Haase et al. (2017) emphasize that in the context of urban planning and management, it is necessary to focus on the protection, management, and use of green spaces that already exist. In the case when they areplaced as urban facilities, green spaces end up serving the less favored population, promoting greater social inclusion and even attenuating social inequality. This can be a starting point for the transition to a better world, with other SDGs as a goal.

2.3. The increase in demand for urban green spaces in the COVID-19 pandemic, and implications for the just and sustainable transition

Among all the SDGs related to urban green spaces, there is no doubt that SDG 11 is the one that directly requires attention from local managers. Promoting public green spaces and enhancing inclusive and sustainable urbanization is a target that directly calls on mayors. In Brazil, more than 80% of the population lives in urban areas, hence the importance of a diagnosis of urban green spaces from the perspective of social vulnerability for sustainable planning.

The data presented above by Silva (2018) highlights that it is necessary to get past the scenario where urban green spaces are unintegrated into people's daily lives. Assuming environmental benefits as the main impetus for the permanence of these spaces helps create a positive relationship and bond between people and nature. This awareness can lead to the development of forms of controlled and sustainable use by the population, thus contributing to the preservation of these green spaces in the urban area (Rodgers 2020). After all, considering the lack of recognized

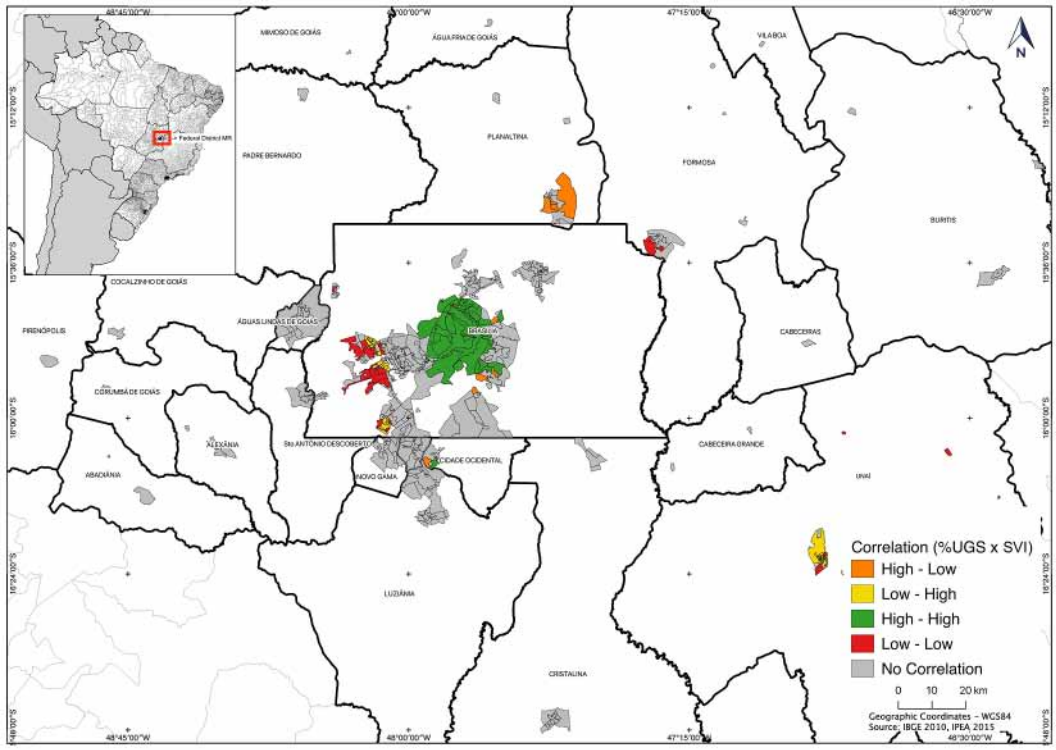

Figure 2, a

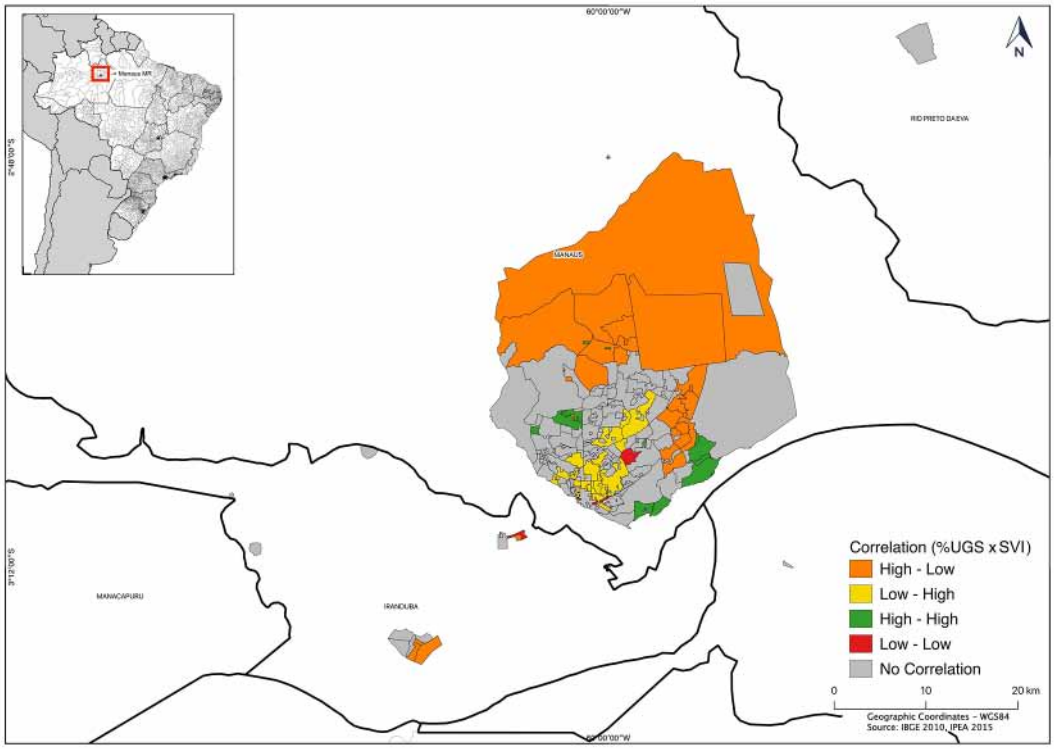

Figure 2, b

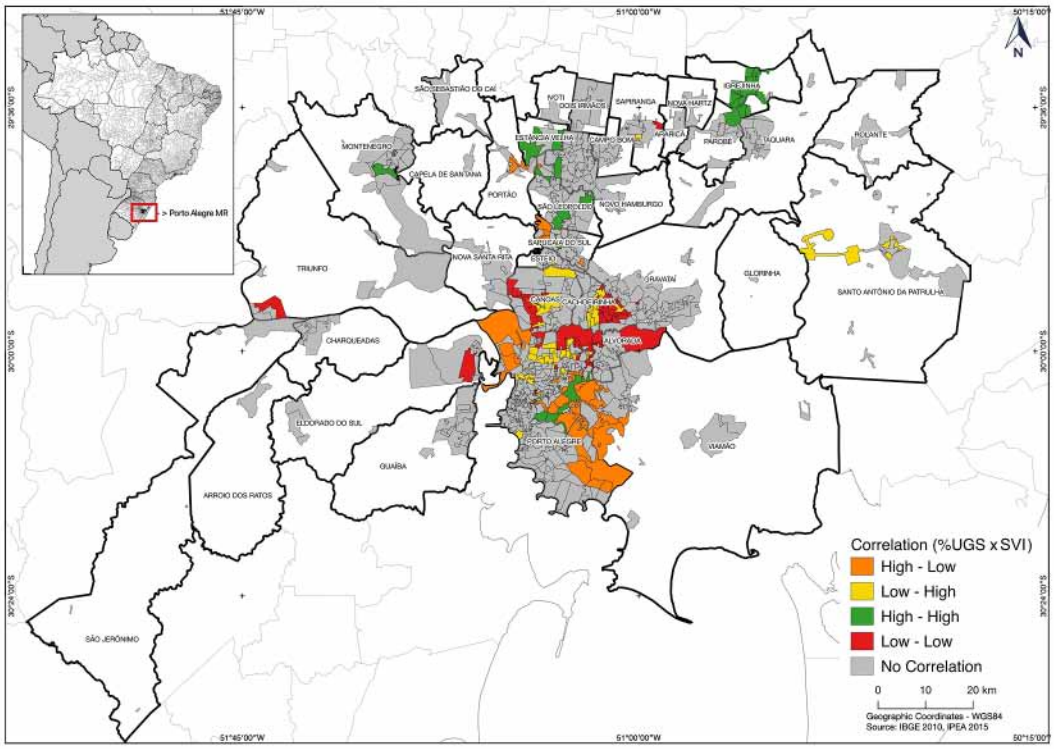

Figure 2, c

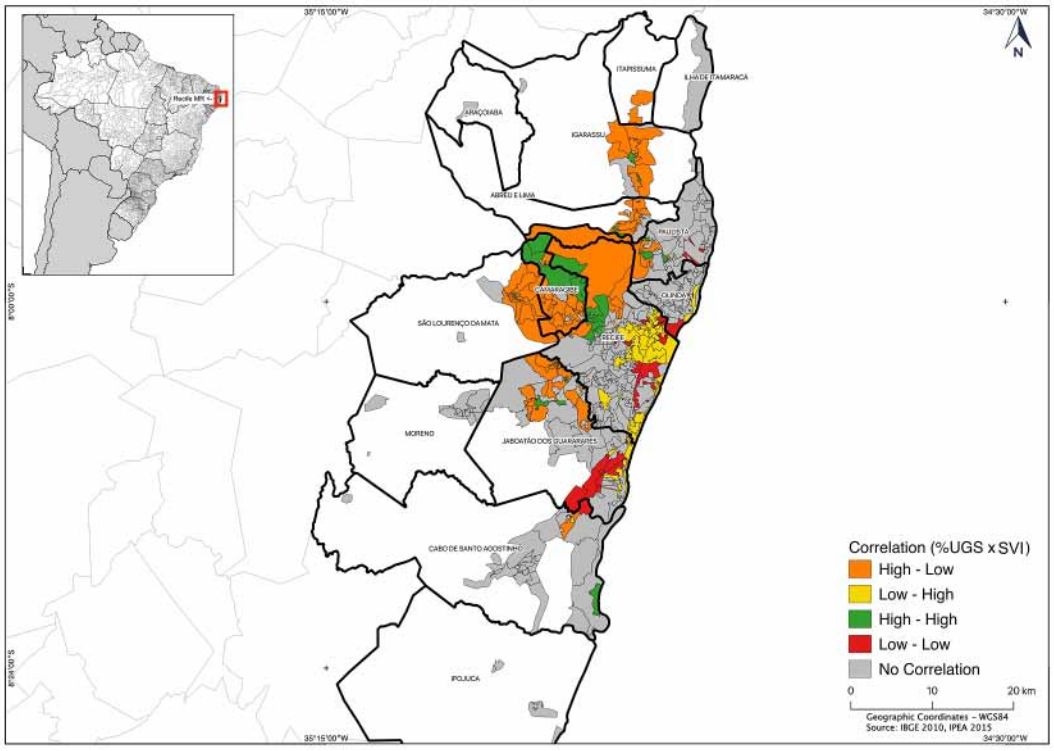

Figure 2, d

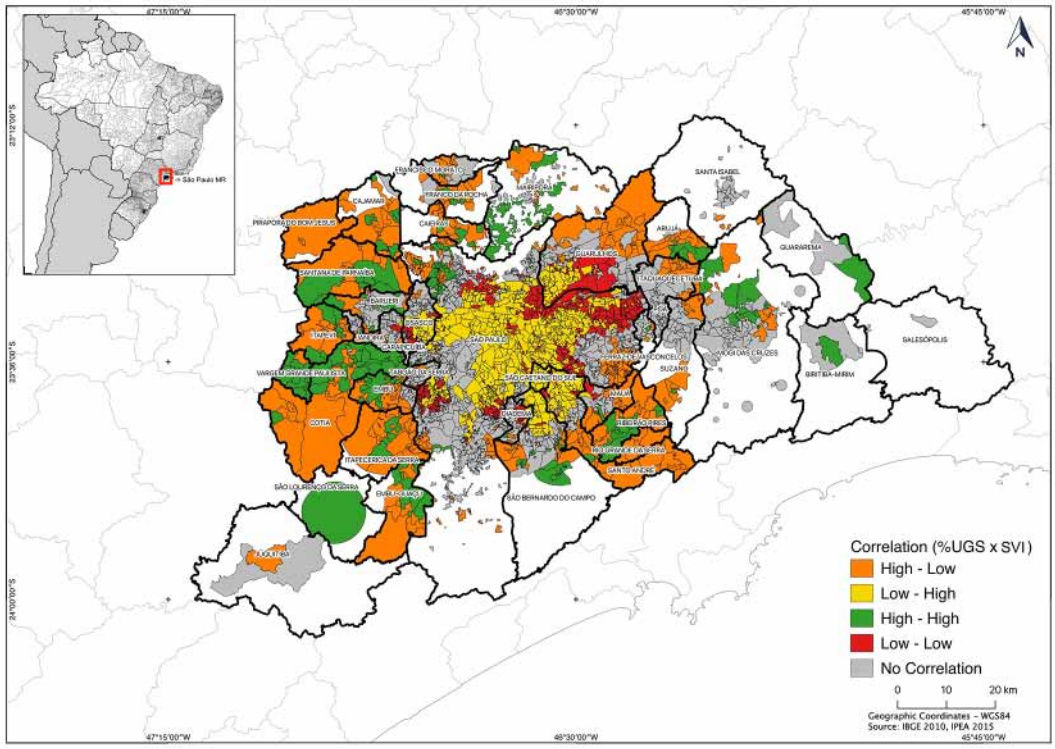

Figure 2, e

Figure 2. Scenarios corresponding to the correlation between green spaces and social vulnerability: a. Brasilia MR; b. Manaus MR; c. Porto Alegre MR; d. Recife MR; e. São Paulo MR (adapted from Silva 2018)

importance of the environmental benefits of urban green spaces by a large part of the city population (Marques et al. 2021), it is necessary to provide means for this population to feel the benefits of these green spaces in some way. Enabling a relationship and connection between the population and these urban green spaces through their use paves the way for this same population to recognize the importance of defending these spaces in the face of possible threats of area reduction (Kleinschroth and Kowarik 2020).

However, for this to occur, these green spaces must be included at spatial planning as urban infrastructure that can meet the basic demands of the population for leisure, sport, and cultural activities, among others. Silva (2018) showed that it is necessary to go beyond the environmental benefits of green spaces when aiming for urban sustainability based on the SDGs. Within the scope of the 2030 Agenda for Sustainable Development (UN 2015), urban green spaces are essential for achieving goal SDG 11 (sustainable cities and communities) and indirectly SDG 3 (good health and well-being). In the case of urban settlements with great socioeconomic inequality, there is also the possibility of using green spaces as a means of articulating policies aimed at SDGs 15 (life on land) and SDG 10 (reduced inequality). In the context of the COVID-19 pandemic, this became even clearer with the increase in demand for urban green spaces in several countries as a way to minimize the negative effects of restrictive measures and social isolation (Okech and Nyadera 2021; Quezada et al. 2022). A holistic view of the pandemic should consider a vulnerability framework encompassing an exposure-sensitivity-capacity of response in which the human-environment relationship should be

evaluated in tandem with inner societal inequalities (Saito et al. 2020). Green space availability should be considered when determining these societal inequalities. The fact that the origin of the COVID-19 pandemic is the result of ecological imbalances indicates how environmental health (SDG 15) is strongly linked to human health (SDG 3).

The situation faced by local managers in August 2021 in Brazil was less serious compared to the periods before the arrival of the vaccine. In Edition nº 23 of the CNM survey (CNM 2021), of the 2 022 municipalities responding, only 16.4% declared that there was an increase in infected people; the vast majority of municipalities no longer faced an increase in cases. Each municipality was also asked if they had an increase in deaths that week. In 68.2% of the surveyed municipalities, there were no deaths due to COVID-19 and only 5.9% declared an increase, confirming the reduction of the severity of the situation in the country.

The above data reflect a strong mobilization by mayors around COVID-19 vaccines and isolation measures. When asked what percentage of the population already received the first dose of the vaccine, 44.3% indicated that it was between 70– 90%, and in 14.5% of the municipalities this figure was above 90%. Regarding the percentage of the population that already received the complete vaccination schedule (first and second dose or single dose), 50.9% indicated that it was from 30–50%, and 23.2% reported it being between 10– 30%. Social isolation measures, such as closing non-essential services and other actions, were still being applied by 49.3% of the municipalities at that time; this figure has continued to decrease in the following weeks, according to the latest CNM surveys.

CNM also asked whether 2021 saw an increase in visitation to the municipality's urban green spaces. The main goal was to verify if there were any changes in the behavior of the population in these urban green spaces, perhaps reflecting a need to have more contact with nature or perform outdoor activities. Notably, 39.3% of the municipalities reported an increase in use and visitation of urban green spaces. The remaining municipalities presented no answer or indicated no change in use. No one reported a decrease in demand.

Additionally, the CNM survey investigated whether adaptations were made to these areas to resume activities, taking into account COVID-19 protocols. According to 48.9% of the municipalities, adaptations took place in these areas for the return of activities under appropriate health precautions. Even when the severity of the pandemic was declining and the vaccinated population was increasing, municipal managers still stated that there was an increase in the use of urban green spaces by the population, even requiring the adaptation of these spaces to meet health standards for safe use. We therefore believe that this increase in demand for urban green spaces is not temporary, and that the COVID-19 pandemic has changed the habits of the population.

Interestingly, among the Brazilian municipalities that were included in both Silva's territorial sample (2018) and the CNM survey, the trends were similar. A total of 49 municipalities are present in both databases, representing all five sampled Brazilian geopolitical regions. Twenty of these 49 stated that there was an increase in visitation in urban green spaces, which is approximately 40%. Additionally, the 13 municipalities (16%) present in both databases reported that they made investments to adapt these areas to resume activities taking into account the COVID protocols, even though they did not answer about an increase of demands for green spaces, or they answered they have no conclusive data on this issue. Thus, out of this sample of municipalities, 33 of them (67%) highlight the relevance of these spaces for local managers as urban facilities for collective uses.

From a formal point of view, the management of urban green spaces in Brazil is the responsibility of the municipalities, since

the Brazilian Federal Constitution of 1988 determined that topics of local interest are the exclusive competence of the municipalities. Before that, the Urban Land Installment Law itself (Law n. 9785/1979) gave the municipalities the authority to define the permitted uses and urban rates of land subdivision and occupation, including green spaces. In this context, it is at the municipal level, based on the urban master plan or municipal legislation, that the amount allocated to green spaces for preservation, leisure, and public use can be defined.

The literature review points out that the increased use of urban green spaces was a worldwide phenomenon, and several studies prove the physical and mental health benefits of these spaces during the COVID-19 pandemic (Banerjee and Rai 2020; Zhu and Xu 2021). With the increase in demand for green spaces during the COVID-19 pandemic, it must be considered that the possibility of using and accessing urban green spaces is unequal (Li et al. 2015; Mushangwe et al. 2021; Schüle et al. 2017; You 2016; Marques et al. 2021).

One of the real lessons learned from this pandemic is that the mere existence of urban green spaces is not enough if people in cannot enjoy these spaces to improve their quality of life. Even when the green space exists, sometimes it may not be easily accessible due to the lack of gates, parking or transportation facilities, trails, etc. This is particularly true in countries with a high degree of socioeconomic inequality; therefore, green spaces need to be evenly distributed in the urban space to ensure that all inhabitants not only have equal access, but also equal benefits, reflecting the sustainability of cities combined with social inclusion (Haase et al. 2017). This can be the path to a just and sustainable transition in Brazil.

In Brazil, the creation and management of urban green spaces is a municipal responsibility and must be provided for in local legislation on territorial planning and urban zoning. This legislation should aim to provide areas for recreation, leisure, improvement of urban environmental quality, protection of water resources, maintenance or landscape improvement, and protection of cultural assets and manifestations. However, the reality of municipal environmental management in Brazil reveals several challenges that prevent the expansion of urban green spaces with adequate infrastructure, especially the need for technical and financial support for the implementation of parks. Federal investment in programs that support local management is the transition path that would allow cities to become more just and sustainable.

These reflections match the statement from Hansen and Coenen (2015) that sustainability transitions are geographical processes that happen in concrete places, with actual geographical locations and the materiality associated with them. Urban green spaces are thus real locations where sustainable and socially just transitions can begin.

2.4. Urban green spaces as a social issue

We wish to emphasize urban green areas as "participatory spaces" representing a core element of urban life that reflects and develops cultures, beliefs and values. To turn urban green spaces into instruments that can improve the quality of life in their surroundings, it is necessary to treat them as urban facilities. This is because green spaces also have a social function related to leisure, recreation, socialization, and promotion of cultural and educational activities that implies high quality of life and social inclusiveness (Bargos and Matias 2011).

There is a long history of social struggle surrounding urban green spaces and their maintenance. This has been closely related to the topic of appropriation of public spaces as common goods, usually within a project of collective emancipation striving for increased access to urban facilities (Harvey 1993). The popular fights for public common goods and urban facilities are part

of the contradictions and the birthplace of the new. In Turkey, on 27 May 2013, the government tried to destroy Gezi Park, located in the city center, with the objective of creating a commercial center and a large mosque, in the context of an urban development project. The Gezi movement of resistance exposed the precariousness of individual life and the fragmentation of social life, and offered new challenges for the reconstruction of a social life (Farro and Demirhisar 2014).

Similarly in Brazil, popular protest in 2012 in Brasilia aimed to guarantee an expansion of the Olhos D'Água Park to encompass an additional area containing water sources and springs, and stopped the construction of commercial buildings in that place (Pereira and Pato 2015). Many years before the COVID-19 pandemic, during the 1980s in Rio de Janeiro city, popular mobilizations related to the equal distribution of green spaces were carried on by the residents' associations, claiming with graffiti on the walls: "one neighborhood, one square" (Silva 2018).

One of the real lessons learned from this pandemic is that the mere existence of urban green spaces is not enough if society cannot equally enjoy these spaces to improve their quality of life. Benefiting requires the visitor to have a degree of free time and transportation that lower-income residents may lack (Mell and Whitten 2021). Other barriers to access include the lack of infrastructure such as trails, entrances, signage, restrooms, security measures, transit stops, parking areas, and resources for disabled persons. Government-administered green spaces must also be endowed with sufficient funding to be maintained over time (Ximenes et al. 2020). Presently, the overall awareness is that the green spaces are unequally distributed in urban areas, and thus they represent another way that environmental injustice can be manifested.

Furthermore, as discussed above, in Brazil some areas that appear as green space are in practice restricted from public access due to being located on private land or being subject to government regulations that restrict human entry. Green spaces with adequate infrastructure need to be evenly distributed across the urban landscape to ensure that all inhabitants not only have equal access, but also equal benefits. Focusing on urban sustainability and social inclusion in tandem (Haase et al. 2017) can represent a path toward a just and sustainable transition in Brazil.

Conclusions

Data analysis confirmed unequal distribution of urban green spaces in five large metropolitan regions of Brazil, and the majority of municipal managers in these regions reported increased concern about the value of these urban green spaces during pandemics. This increased concern was identified through a rise in demand by the population for urban green spaces post-pandemic, as well as measures adopted by municipalities to adapt these areas for the resumption of activities even in cases where an increase in demand for green spaces was not explicitly registered.

In the times of the COVID pandemic, urban green spaces have rightfully garnered much attention for their ability to interconnect several SDGs towards a just and sustainable transition. Thus, the creation and management of urban green space in Brazil which is now a municipal responsibility, must be provided for in local legislation on territorial planning, with strong emphasis on inclusiveness and public participation during the planning process. We expect that this will decrease societal vulnerability during future health crises, and generally improve individual and public health levels. Benefits of green spaces are directly linked with The One Health principles, and over the long term, they can offer resistance against climate change.

Author Contributions: Conceptualization, RGPS, CLL, SDQ, AA, A-EL, CHS; Research, RGPS, CLL, CHS; Methodology, RGPS, CLL, SDQ, AA, A-EL, CHS; Validation, RGPS, CLL, SDQ, AA, CHS; Formal Analysis, RGPS, CLL, SDQ, AA, A-EL, CHS; Writing – Original Draft Preparation, RGPS, CLL, SDQ, AA, A-EL, CHS; Writing – Review & Editing, RGPS, CLL, SDQ, AA, A-EL, CHS; Visualization, RGPS, CLL, SDQ, AA, A-EL, CHS; Supervision, CHS, AA. All authors have read and agreed to the published version of the manuscript.

Funding: This research was supported by the Center for Sustainable Development and Department of Geography, Institute of Humanities, University of Brasilia, Brazil.

Institutional Review Board Statement: Not applicable.

Conflicts of Interest: The founding sponsors had no role in the study's design, in the collection, analyses, or interpretation of data, in the writing of the manuscript, and in the decision to publish the results.

Acknowledgements: The authors are grateful to the INCT-ODISSEIA Project, "Observatory of Socio-environmental Dynamics" at Brasília University (UnB) for their technical support. We also thank Coordination for the Improvement of Higher Education Personnel (Capes), the National Council for Scientific and Technological Development (CNPq), and the Research Support Foundation of the Federal District (FAP-DF) for their financial support.

References

Anselin, Luc. 1994. "Exploratory spatial data analysis and geographic information systems." *New tools for spatial analysis*. Eurostat: pp. 45–54.

Azevêdo, Jéssika Karla Castro de. 2015. *Percep*ção dos Proprietários sobre a Biodiversidade de suas Florestas e a Necessidade de Incentivos Econômicos para sua Conservação na APA Aldeia-Beberibe, Pernambuco [Owners' Perception of the Biodiversity of their Forests and the Need for Economic Incentives for their Conservation in APA Aldeia-Beberibe, Pernambuco], Master degree dissertation, Universidade Federal de Pernambuco – Centro de Filosofia e Ciências Humanas]. https://attena.ufpe.br/handle/123456789/16610.

Aydin, Mediha Burcu Silaydin, Duygu Çukur. 2012. "Maintaining the carbon–oxygen balance in residential areas: A method proposal for land use planning." *Urban forestry & urban greening* 11(1): 87–94. https://doi.org/10.1016/j.ufug.2011.09.008.

Banerjee, Debanjan, Mayank Rai. 2020. "Social isolation in Covid-19: The impact of loneliness." *International Journal of Social Psychiatry* 66(6): 525–527. https://doi.org/10.1177/0020764020922269.

Bargos, Danúbia Caporusso, Lindon Fonseca Matias. 2011. "Áreas verdes urbanas: um estudo de revisão e proposta conceitual" [Urban green areas: a review study and conceptual proposal]. *Revista da Sociedade Brasileira de Arborização Urbana* 6(3): 172–188. http://dx.doi.org/10.5380/revsbau.v6i3.66481.

Bilgili, Bayram Cemil, Ercan Gökyer. 2012. "Urban Green Space System Planning." In *Landscape Planning*, edited by Mrat Ozyavuz, 107-122. Rijeka, Croatia: InTech. https://doi.org/10.5772/45877.

Bland, Amy Rachel, Jonathan Paul Roiser, Mitul Ashok Mehta, Barbara Jacquelyn Sahakian, Trevor William Robbins, Rebecca Elliott. 2022. "The impact of COVID-19 social isolation on aspects of emotional and social cognition." *Cognition and Emotion* 36(1): 49–58. https://doi.org/10.1080/02699931.2021.1892593.

Castro, Marcia, Sun Kim, Lorena Barberia, Ana Freitas Ribeiro, Susie Gurzenda, Karina Braga Ribeiro, Erin Abbott, Jeffrey Blossom, Beatriz Rache, Burton Singe. 2021. "Spatiotemporal pattern of COVID-19 spread in Brazil." *Science* 372(6544): 821-826. https://doi.org/10.1126/science.abh1558.

Cole, Helen V.S., Isabelle Anguelovski, Francesc Baró, Melissa García-Lamarca, Panagiota Kotsila, Carmen Pérez del Pulgar, Galia Shokry, Margarita Triguero-Mas. 2020. "The COVID-19 pandemic: power and privilege, gentrification, and urban environmental justice in the global north." *Cities & Health* 5(S1): S71-S75.

CNM. 2021. "Áreas verdes—A criação e gestão desses espaços vitais para a população" [Green areas—The creation and management of these vital spaces for the population]. In *Desafios do Saneamento* (p. 17). Confederação Nacional de Municípios. https://www.cnm.org.br/biblioteca/exibe/15232.

de Vries, Sjerp, Robert Verheij, Peter P. Groenewegen, Peter Spreeuwenberg. 2003. "Natural environments—Healthy environments? An exploratory analysis of the relationship between greenspace and health." *Environment and Planning A* 35(10): 1717–1731.

Farro, Antimo L., Deniz Gunce Demirhisar. 2014. "The Gezi Park movement: a Turkish experience of the twenty-first-century collective movements."

International Review of Sociology 24(1): 176-189. https://doi.org/10.1080/03906701.2014.894338.

Geneletti, Davide, Chiara Cortinovis, Linda Zardo. 2022. "Simulating crowding of urban green areas to manage access during lockdowns." *Landscape and Urban Planning* 219: 104319. https://doi.org/10.1016/j.landurbplan.2021.104319.

Haase, Annegret. 2020. "Covid-19 as a Social Crisis and Justice Challenge for Cities." *Frontiers in Sociology* 5: 583638. https://doi.org/10.3389/fsoc.2020.583638.

Haase, Dagmar, Sigrun Kabisch, Annegret Haase, Erik Andersson, Ellen Banzhaf, Francesc Baró, Miriam Brenck, Leonie K. Fischer, Niki Frantzeskaki, Nadja Kabisch, Kerstin Krellenberg, Peleg Kremer, Jakub Kronenberg, Neele Larondelle, Juliane Mathey, Stephan Pauleit, Irene Ring, Dieter Rink, Nina Schwarz, Manuel Wolff. 2017. "Greening cities – To be socially inclusive? About the alleged paradox of society and ecology in cities." *Habitat International* 64: 41–48. https://doi.org/10.1016/j.habitatint.2017.04.005.

Hansen, Teis, Lars Coenen. 2015. "The geography of sustainability transitions: Review, synthesis and reflections on an emergent research field." *Environmental Innovation and Societal Transitions* 17: 92–109. https://doi.org/10.1016/j.eist.2014.11.001.

Harvey, David. 1993. *Social Justice and the City*. Oxford: Blackwell Publishers.

Hwang, Tzung-Jeng, Kiran Rabheru, Carmelle Peisah, William Reichman, Manabu Ikeda. 2020. "Loneliness and social isolation during the COVID-19 pandemic." *International Psychogeriatrics* 32(10): 1217–1220. Cambridge Core. https://doi.org/10.1017/S1041610220000988.

IBGE. 2011. "*Base de informações do Censo Demográfico de 2010: Resultados do Universo por setor censitário" [2010 Population Census database: Universe results by census sector]*. Ministério de Planejamento, Orçamento e Gestão / Instituto Brasileiro de Geografia e Estatística – Centro de Documentação e Disseminação de Informações. http://www.ipea.gov.br/redeipea/images/pdfs/base_de_informacoess_por_setor_censitario_universo_censo_2010.pdf.

ICMBio. 2013. "Instituto Chico Mendes de Conservação da Biodiversidade/MMA. Categorias de Unidades de Conservação da Natureza (UC)" [Chico Mendes Institute for Biodiversity Conservation/MMA. Categories of Nature Conservation Units (CU)]. http://www.icmbio.gov.br/portal/biodiversidade/unidades-de-conservacao.

IPEA. 2015. *Atlas da Vulnerabilidade Social nas Regiões Metropolitanas Brasileiras* [Atlas of Social Vulnerability in Brazilian Metropolitan Regions]. Instituto de Pesquisa Econômica e Aplicada. http://ivs.ipea.gov.br/.

Juntti, Meri, Heloisa Costa, Nilo Nascimento. 2021. "Urban environmental quality and wellbeing in the context of incomplete urbanisation in Brazil: Integrating directly experienced ecosystem services into planning." *Progress in Planning* 143: 100433. https://doi.org/10.1016/j.progress.2019.04.003.

Kleinschroth, Fritz, Ingo Kowarik. 2020. "COVID-19 crisis demonstrates the urgent need for urban greenspaces." *Frontiers in Ecology and the Environment* 18(6): 318–319. https://doi.org/10.1002/fee.2230.

Li, Xiaojiang, Chuanrong Zhang, Weidong Li, Yulia A. Kuzovkina, Daniel Weiner. 2015. "Who lives in greener neighborhoods? The distribution of street greenery and its association with residents' socioeconomic conditions in Hartford, Connecticut, USA." *Urban Forestry & Urban Greening* 14(4): 751–759. https://doi.org/10.1016/j.ufug.2015.07.006.

Maas, Jolanda, Robert Verheij, Peter Groenewegen, Sjerp De Vries, Peter Spreeuwenberg. 2006. "Green space, urbanity, and health: How strong is the relation?" *Journal of Epidemiology & Community Health* 60(7): 587–592. https://doi.org/10.1136/jech.2005.043125.

Maricato, Erminia. 1999. *Metr*ópole *na periferia do capitalismo. Ilegalidade, desigualdade e violência* [Metropolis on the periphery of capitalism. Illegality, inequality and violence]. São Paulo: Hucitec.

Markard, Jochen, Rob Raven, Bernhard Truffer. 2012. "Sustainability transitions: An emerging field of research and its prospects." *Research Policy* 41(6): 955–967. https://doi.org/10.1016/j.respol.2012.02.013.

Marques, Piatã, Andrey Santos Silva, Yane Quaresma, Luisa Resende Manna, Newton de Magalhães Neto, Rosana Mazzoni. 2021. "Home gardens can be more important than other urban green

infrastructure for mental well-being during COVID-19 pandemics." *Urban forestry & urban greening* 64: 127268. https://doi.org/10.1016/j.ufug.2021.127268.

Maury-Mora, Marcela, María Teresa Gómez-Villarino, Carmen Varela-Martínez. 2022. "Urban green spaces and stress during COVID-19 lockdown: A case study for the city of Madrid." *Urban Forestry & Urban Greening* Volume 69: 127492. https://doi.org/10.1016/j.ufug.2022.127492.

Mell, Ian, Meredith Whitten. 2021. "Access to nature in a post Covid-19 world: Opportunities for green infrastructure financing, distribution and equitability in urban planning." *International Journal of Environmental Research and Public Health* 18(4): 1527.

Mello-Théry, Neli Aparecida de. 2011. "Conservação de áreas naturais em São Paulo." [Conservation of natural areas in São Paulo]. *Estudos Avançados* 25(71): 175–188. https://doi.org/10.1590/S0103-40142011000100012.

Mendes, Luis. 2020. "How Can We Quarantine Without a Home? Responses of Activism and Urban Social Movements in Times of COVID-19 Pandemic Crisis in Lisbon." *Tijdschrift Voor Economische En Sociale Geografie* 111(3): 318–332. https://doi.org/10.1111/tesg.12450.

Mushangwe, Shumirai, Thomas Astell-Burt, David Steel, Xiaoqi Feng, X. 2021. "Ethnic inequalities in green space availability: Evidence from Australia." *Urban Forestry & Urban Greening* 64: 127235. https://doi.org/10.1016/j.ufug.2021.127235.

Nieuwenhuijsen, Mark. 2021. "New urban models for more sustainable, liveable and healthier cities post covid19; reducing air pollution, noise and heat island effects and increasing green space and physical activity." *Environment International* 157: 106850. https://doi.org/10.1016/j.envint.2021.106850.

Nieuwenhuijsen, Mark, Haneen Khreis, Margarita Triguero-Mas, Mireia Gascon, Payam Dadvand. 2017. "Fifty Shades of Green: Pathway to Healthy Urban Living." *Epidemiology* 28(1). https://journals.lww.com/epidem/Fulltext/2017/01000/Fifty_Shades_of_Green__Pathway_to_Healthy_Urban.11.aspx.

Okech, Elizabeth Ayuma, Israel Nyaburi Nyadera. 2021. "Urban green spaces in the wake of Covid-19 pandemic: reflections from Nairobi, Kenya." *GeoJournal*: 1–15. https://doi.org/10.1007/s10708-021-10540-0.

Oliveira, Ana Luíza Matos de, Ana Paula Emídio. 2021. "The Great Equalizer"? The Long-Term Effects of the COVID-19 Pandemic on Poverty, Inequality, and the 2030 Agenda in Latin America." In, *COVID-19 and Cities: Experiences, Responses, and Uncertainties,* edited by M.A. Montoya, A. Krstikj, J. Rehner, and D. Lemus-Delgado, 109–125. https://doi.org/10.1007/978-3-030-84134-8_7.

Peluso, Marilia Luiza. 2003. "Brasília: Do mito ao plano, da cidade sonhada à cidade administrativa" [Brasília: from the myth to the plan, from the dreamed city to the administrative city]. *Revista Espaço e Geografia* 6(2): 1–29.

Pereira, Danielle Abud, Claudia Pato. 2015. "Valores e comportamento ecológico: dimensões para Educação Ambiental em Parques Urbanos." [Values and ecological behavior: dimensions for Environmental Education in Urban Parks]. *Ambiente & Educação-Revista de Educação Ambiental* 20(2): 81–101.

Quezada, Carolina Rojas, Felipe Aguilera-Sáez, Giovanni Vecchio, Stefan Steiniger. 2022. "Perception of Green Spaces Preparedness and Accessibility During COVID-19: An Exploratory Survey in Two Mid-Sized Chilean Cities." *Frontiers in Sustainable Cities* 4, 08 April 2022. https://doi.org/10.3389/frsc.2022.816688.

Richards, John. 1986. *Remote sensing digital image analysis* (Vol. 3). Springer.

Rodgers, Christopher. 2020. Nourishing and protecting our urban 'green' space in a post-pandemic world. *Environmental Law Review*, 22(3), 165–169. https://doi.org/10.1177/1461452920934667.

Rüegg Simon, Barbara Häsler, Jakob Zinsstag (ed.). 2018. *Integrated approaches to health: A handbook for the evaluation of One Health*. Wageningen: Wageningen Academic Publishers. https://doi.org/10.3920/978-90-8686-875-9.

Saito, Carlos Hiroo, Anne-Elisabeth Laques, Aneta Afelt. 2020. "The world after Covid-19: vulnerabilities, uncertainties and socio-environmental challenges." *Justiça do Direito* 34(2): 52–104. https://doi.org/10.5335/rjd.v34i2.11009.

Schüle, Steffen Andreas, Katharina M.A. Gabriel, Gabriele Bolte. 2017. "Relationship between neighbourhood socioeconomic position and

neighbourhood public green space availability: An environmental inequality analysis in a large German city applying generalized linear models." *International Journal of Hygiene and Environmental Health* 220(4): 711–718. https://doi.org/10.1016/j.ijheh.2017.02.006.

Silva, José Roselito Carmelo da, Veridiana Vizoni Scudeller. 2022. "Os ciclos econômicos da borracha e a Zona Franca de Manaus: Expansão urbana e degradação das microbacias." [The amazon rubber booms and the Free Trade Zone of Manaus: urban expansion and watersheds degradation]. *Research, Society and Development* 11(6): e33611629103. https://doi.org/10.33448/rsd-v11i6.29103.

Silva, Romero Gomes Pereira da. 2018. *Cen*ário *dos Espaços Verdes Urbanos no Brasil [Scenario of Urban Green Spaces in Brazil]*. PhD Thesis. Universidade de Brasília – Centro de Desenvolvimento Sustentável. https://repositorio.unb.br/handle/10482/32155.

Silva, Romero Gomes Pereira da, Cláudia Lins Lima, Carlos Hiroo Saito. 2019. "Análise Per Capita dos Espaços Verdes Urbanos na Região Metropolitana de São Paulo-Brasil." [Per Capita Analysis of Urban Green Spaces in the São Paulo Metropolitan Region – Brazil]. *Revista Do Departamento De Geografia* 38(2): 31–41. https://doi.org/10.11606/rdg.v38i1.156105.

Silva, Romero Gomes Pereira da, Cláudia Lins Lima, Carlos Hiroo Saito. 2020. "Espaços verdes urbanos: Revendo paradigmas" [Urban green spaces: reviewing paradigms]. *Geosul 35*(74): 86–105. https://doi.org/10.5007/1982-5153.2020v35n74p86.

Tischer, Christina, Mireia Gascon, Ana Fernández-Somoano, Adonina Tardón, Aitana Lertxundi Materola, Jesus Ibarluzea, Amparo Ferrero, Marisa Estarlich, Marta Cirach, Martine Vrijheid, Elaine Fuertes, Albert Dalmau Bueno, Mark Nieuwenhuijsen, Josep Antó, Jordi Sunyer, Payam Dadvand. 2017. "Urban green and grey space in relation to respiratory health in children." *European Respiratory Journal* 49(6): 1502112. https://doi.org/10.1183/13993003.02112-2015.

UN, U.N. 2015. *The Millennium Development Goals Report 2015*. eSocialSciences. https://EconPapers.repec.org/RePEc:ess:wpaper:id:7222.

van den Berg, Magdalena, Mireille van Poppel, Irene van Kamp, Sandra Andrusaityte, Birute Balseviciene, Marta Cirach, Asta Danileviciute, Naomi Ellis, Gemma Hurst, Daniel Masterson, Graham Smith, Margarita Triguero-Mas, Inga Uzdanaviciute, Ouck de Wit, Willem van Mechelen, Christopher Gidlow, Regina Grazuleviciene, Mark Nieuwenhuijsen, Hanneke Kruize, Jolanda Maas. 2016. "Visiting green space is associated with mental health and vitality: A cross-sectional study in four european cities." *Health & Place* 38: 8–15. https://doi.org/10.1016/j.healthplace.2016.01.003.

Van Dillen, Sonja, Sjerp de Vries, Peter Groenewegen, Peter Spreeuwenberg. 2012. "Greenspace in urban neighbourhoods and residents' health: Adding quality to quantity." *J Epidemiol Community Health* 66(6): e8–e8. https://doi.org/10.1136/jech.2009.104695.

Wilder-Smith, Annelies, David Freedman. 2020. "Isolation, quarantine, social distancing and community containment: Pivotal role for old-style public health measures in the novel coronavirus (2019-nCoV) outbreak." *Journal of Travel Medicine* 27(2): taaa020. https://doi.org/10.1093/jtm/taaa020.

World Health Organization. 2022. *COVID-19 weekly epidemiological update, Global overview, 11 May 2022. 91.* https://www.who.int/publications/m/item/weekly-epidemiological-update-on-covid-19---11-may-2022.

Ximenes, Deize Sanches, Ivan Maglio, Maria de Assunção Ribeiro Franco. 2020. "A infraestrutura verde nos espaços públicos como elemento de resiliência socioambiental pós-pandemia." [Green infrastructure in public spaces as an element of post-pandemic socio-environmental resilience]. *Labor e Engenho* 14: e020011-e020011. https://doi.org/10.20396/labore.v14i0.8660779.

You, Heyuan. 2016. "Characterizing the inequalities in urban public green space provision in Shenzhen, China." *Habitat International* 56: 176–180. https://doi.org/10.1016/j.habitatint.2016.05.006.

Zhu, Jiyou, Xu, Chengyang. 2021. "Sina microblog sentiment in Beijing city parks as measure of demand for urban green space during the COVID-19." *Urban Forestry & Urban Greening* 58: 126913. https://doi.org/10.1016/j.ufug.2020.126913.