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CHAPTER

26

Green spaces resume their importance in cities after the COVID-19 pandemic

A case of study from Mexico City

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26.1 Introduction

The new coronavirus pandemic that began in Wuhan, China in December 2019, has prompted countries around the world to implement unprecedented social distancing measures to slow the spread of COVID-19. The result of sudden and massive interruptions in daily life is likely to affect well-being, particularly among urban populations living in dense environments with limited public space (Samuelsson et al., 2020). This disease came to change the daily development of cities and its citizens significantly, so this can be seen as a moment to redesign the way urban areas are planned (Lai et al., 2020). Aside of this, we must consider another element that has been present for a long time now, this is climate change, but international efforts are being made to transform the dominant development paradigm takes us on an inclusive, long-term vision path of sustainable development in cities.

The path to achieving sustainable urban areas is with the implementation of the 2030 Agenda for Sustainable Development approved in September 2015 by the General Assembly of the United Nations. This Agenda establishes a transformative vision towards the economic, social and environmental sustainability of the 193 Member States that signed it and is a reference guide for institution's work towards this vision during the next 15 years (Comisión Económica para América Latina y el Caribe, 2002). Among the Sustainable Development Goals (SDGs) associated with this Agenda, this work will reference Objective 3: Health and Well-being and Objective 11: Sustainable Cities and Communities as they both mention the importance of cities to adapt climate change with diverse mitigation activities such as the increase of green urban spaces for its capacity to retain polluted particles, improve air quality and prevent respiratory diseases.

26.1.1 Right to the city

The notion "right to the city", has been restored in recent years in the international debate on the urban question, refers to Henry Lefebvre's book that deals with the implications of urban life, where the practices a kind of domination was displayed correctly through the exploitation of people as producers and consumers of products and space (Ugalde, 2015). The Right to the City is the right of all inhabitants to inhabit, use, occupy, produce, transform, govern and enjoy fair, inclusive, safe, sustainable, and democratic cities, towns, and urban settlements, defined as common goods for a dignified life (United Nations Habitat, 2018). In the present work, we assume the Right to the City from

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the point of revaluing public goods, such as the case of public spaces dedicated to coexistence, recreation, and social welfare, which face an imbalance evidenced in recent years compared to the overproduction of private spaces such as centers. The Right to the City appears at an international level of organizations since December 2005 in UNESCO, which undertakes various initiatives in this regard. In 2010, the Government of Mexico City and several civil organizations signed the document Letter of Mexico City for the Right to the City, where it conceives as a collective right and gives its inhabitants the legitimacy of action and organization to demand the full exercise of the right to self-determination and an adequate standard of living (Ugalde, 2015).

26.1.2 Measures for COVID-19 in Mexico City

The appearance of 44 cases of pneumonia from unknown causes in China, detected by the epidemiological system of Mexico and the communication system with the Pan American Health Organization (PAHO) and the World Health Organization (WHO), guidelines, manuals, and guides were developed (WHO & PAHO, 2020). In Mexico since February 28th, the press conferences are held daily at 6:00 p.m. (Mexico City time), notifying all information regarding the pandemic, declaring on March 23rd 2020, the start of the National Day of Healthy Distance and mitigation; which comprehend the temporary suspension of school, work, recreational, cultural and leisure activities in public spaces. The objective of this measure was to reduce the proximity between people, where day by day contact between people was less so that those who are carriers of the virus, do not infect those who are susceptible. An estimate of eighty million people abandoned streets and roads, the Government of Mexico documented this value, and this lasted for the entire "National Healthy Distance Day" until May 30th, 2020 (Secretaría de Gobierno (SEGOB), 2020).

Mexico City in coordination with 16 municipalities that integrate the city, followed by national policy of #StayAtYourHouse (#QuédateEnCasa) and #YourHealthyDistance (#SuSanaDistancia) which they announced on March 23rd, 2020. It was an agreement for different activities and establishments to close temporarily until April 16th with the purpose to avoid infections caused by the Coronavirus (Gobierno de la Ciudad de México, 2020a). On June 15th, the city government established the return to "New Normality" ("Nueva Normalidad"), where Mexico City ends the particular program named "Today you cannot drive" ("Hoy no circula"), a restrictive measure of vehicular traffic, applied jointly with the surrounding municipalities and the reopening the Metro and Metrobus Collective Transportation System (SCT) was also done the same day. On June 16th, activities in the manufacturing industry began (Monday to Thursday), at least 340,000 employees returned to work. On June 18th, some activities were permitted, and small business was started in neighbourhoods. On June 19th, the exercise of professional scientific and technical services is allowed (linked to the industries that operate during the red and orange epidemiological risk traffic light (Gobierno de la Ciudad de México, 2020b).

The Epidemiological Risk Traffic Light to move towards a new normal is a monitoring system for public space regulation used by the risk to spread COVID-19, the four colors of the traffic light are described below.

- Red: Only essential economic activities will be allowed and for people to go for a walk around their homes during the day.
- Orange: In addition to essential economic activities, companies of non-essential economic activities will be allowed to work with 30% of the staff for their operation, always taking into account the maximum care measures for people with a higher risk of presenting a severe picture of COVID-19, open public spaces opened with a reduced capacity of people.
- Yellow: All work activities are allowed, taking care of people with a higher risk of presenting a severe picture of COVID-19. Open public space is opened regularly, and closed public spaces can be opened with reduced capacity. The development of these activities must be developed with prevention measures and utmost care for the people in the risk population.
- Green (All activities are allowed, including academic ones).

At the time of writing this paper, Mexico City is at an Orange traffic light with a Red alert (Gobierno de la Ciudad de México, 2020b).

Climate change, territorial inequalities, poor health infrastructure, social, economic, and age characteristics of the population in Mexico, in general, all structural problems, potentiate the impact of suffering lethal effects from COVID-19, in the present work we will focus on the urban population and the green urban spaces evolution of Mexico City in relation with the current disease. Privatization and commercialization of green areas have happened and continue to, adding the environmental part to the inequality that already exists in Mexico City (Pérez-Paredes, et al., 2015).

26.2 Cities as epicentres for the spread of the coronavirus

Social distancing is a different strategy from physical distancing behavior, as mentioned above, it can be an intervention and mitigation strategy, is a term that is used during the pandemic to reduce the viral impact on society through personal contact limited. As communities are reopening and people are in public more frequently, the term physical distancing (at least 2 meters or 6 feet from others to avoid the disease spread) is used to emphasize the importance of maintaining space physically in public areas (Lockerd, 2020; Sergent, et al., 2020).

The modern urban lifestyle is associated with chronic stress, insufficient physical activity, and exposure to anthropogenic environmental hazards. Urban green spaces, such as parks, playgrounds, and residential green areas, can promote physical and mental health, also can reduce morbidity and mortality in urban residents by providing psychological relaxation together with stress relief, stimulating social cohesion, supporting physical activity as well as reduce exposure to air pollutants, noise, and excessive heat (Braubach et al., 2017). Moreover, urban areas have become points of a high spread of the coronavirus, attention has focused on protecting the elderly and people with acute diseases, defined as those at highest risk, but the reality is more complex, with the combination of social, economic, and demographic factors together with the urban environment probably explains many of the observed infection patterns.

The vulnerable population of cities lives in the lowest quality areas and housing of a city, they live in the highest densities. In the narrowest accommodation, these areas have higher levels of air pollution and low quality or inaccessible public services; they often have the smallest areas of open public spaces. The population with low incomes lives in confined spaces, social distancing is nearly impossible (Simon, 2020). The attention must be in of social and primarily urban fundamentals about the transmission of COVID-19, and not only to the biological characteristics of the virus itself. The current COVID-19 pandemic has been considered an urban incident; this is the reason to put urban management and planning at the center of the debate. The high population density in the metropolitan area, as well as the massive level of public transport in large cities, the wastewater discharged, the solid urban waste can be a sort of "multiplier effect" for the virus transmission; urban settings can be the place to resolve both challenges and opportunities regarding the current epidemic (Liu, 2020).

26.2.1 Importance of green urban space availability

The smaller the area of green space, the higher the number of confirmed infections, cities with larger open spaces may be less vulnerable to infection by the virus. Liu's study (2020) provides information to urban planners on the role of public green spaces in the pandemic, in this research is highlighted that even biological and medical academics realize the challenges and opportunities concerning the current pandemic can be solved in urban settings. The public spaces are figurative and expressive elements of the cities in which they exist; in themselves and any territory, the availability, existence, quality, and characteristics of public spaces provide information and are witnesses to the urban memory that expresses the conditions in which its inhabitants live, not only from the spatial sphere but also from the social, political, economic and environmental.

In the same way, the state in which the public spaces are in a city allows us to infer the nature of the existing relationships between the various agents that influence the destiny of cities, or the degree of power that its inhabitants have to decide on their environment (Pérez-Paredes et al., 2015). The cities are shaped by the public spaces they have such as their squares, parks, gardens, play areas, green areas, sports centers, libraries or streets; these define the city image and the vocation that is a reflection of local public policies, which not only deal with actions but also omissions. Urban public space is a public benefit that needs with attention, surveillance, and care from the citizens and government. It is, after all, a scenario that enhances social cohesion, recreation, coexistence, and urban environmental development in a population. It also promotes the protection of ecosystems considered as substantial elements to aspire to have inclusive, democratic, sustainable, and equitable cities. Green spaces like parks are recognized as vital to human health. However, the people who need those spaces the most, are the ones without private gardens, they have less access moreover the parks that serve these people have also come under significant pressure during closures. Closing them down instead of ensuring that the people who use them follow social distancing guidelines compounds the problem of the pandemic.

We also start from its multifunctionality; public space plays a role in articulating the urban city development; the habitability and urban well-being conditions evaluation "is inseparable from the supply, availability, quality, and safety of public space" (Programa de la Naciones Unidas para los Asentamientos Humanos [ONU-Hábitat], 2012). Accordingly, an international consensus reached that public spaces are places of coexistence and social interaction and, also performs a social, institutional, environmental, mobility and recreation functions which constitutes the

articulating axes of a city and its services. Particularly in the urban environmental public agenda at the national level, identified that public spaces in cities have a second-degree priority and we could even mention the vulnerability in economic interests and profitability promoted by real estate agencies and companies. Also, local governments for having commercial land use either used for housing or shopping centers, which threatens the existence and multiplication of urban public spaces.

The World Health Organization recommends between 9 and 12 square meters of green space per inhabitant and that all residents live within a 15-minute walk of the green zone (Naciones Unidas, 2015; Gómez-Baggethum et al., 2013). In the same way, UN-Habitat established as a goal for 2030 that the percentage occupied by public spaces has to be 45% for cities with a population density of 150 inhabitants per hectare, and considers 15% for open spaces, green spaces and public facilities (Programa de la Naciones Unidas para los Asentamientos Humanos [ONU-Hábitat], 2015).

In recognition that the next Century will see is a substantial majority of the world's population living in urban areas, where the World Health Organization and the United Nations have developed policy frameworks and guidance that promote the increased provision of urban green spaces for the people health. However, these commitments do not provide specific policy guidance in terms of designing attributes needed to address lifestyle diseases and promote the well-being of urban populations. Besides, the treatment of green spaces is as a type of homogeneous environment. In general, the literature supports the view that urban green spaces, as part of the broader environmental context, promote health and well-being throughout life (Douglas et al., 2017). Taking into consideration the physical function that public spaces fulfill, these are defined as meeting places where anyone has the right to circulate and are characterized by being an open environment to be occupied as areas for social gatherings, exercise, recreation for children, all these activities contribute to the lives of citizens Thus, they represent an ideal place for sports development, recreational, artistic-cultural, leisure activities, in general, for the use and enjoyment of the community (Secretaría de Desarrollo Social, 2010).

The approach that highlights the environmental function of public spaces is based on sustainable and healthy cities paradigm in which the planning of urban green areas is urgent, to ensure populations environmental and social well-being (Chiesura, 2004; Edwards and Tsouros, 2006; Escobar, 2006; Flores-Xolocotzi and González-Guillén, 2019), in this sense life quality has been interrelated with the environment, considering it as a necessary condition for individuals and societies well-being (Kilbourne, 2006). Different reports (Nikula, 2017; ONU-Hábitat, 2012; Secretaría de Desarrollo Social, 2010) indicate that most Latin American cities are characterized by having scarce public spaces, with low quality and inequitable distribution. The land use for public spaces in cities promotes coexistence between neighbors, being the first step for greater participation of communities, local development, and sustainability.

26.2.2 Epidemiological studies

Many epidemiological studies have shown various positive health effects of urban green spaces, including improved mental health, reduced depression, decreased cardiovascular morbidity and mortality, improved pregnancy outcomes, and more of reduced rates of obesity and diabetes. Therefore, providing urban green spaces is a nature-based solution with a variety of general health and wellness benefits (Braubach et al., 2017). In the last 15 years, there has been a resurgence in examining the impact of the environment on human health, with a considerable number of theoretical and empirical studies. Although there is research on health issues related with poor air quality and various forms of pollution distribution, recently more attention has been paid to the positive influence on the health of "environmental goods" in urban areas such as access to nature, biodiversity and the distribution of urban green spaces on well-designed and passable cities. "Lifestyle diseases" such as heart disease, obesity, diabetes, hypertension, osteoporosis, mental illness and some cancers are being attributed to low environmental quality in Mexico cities; the literature generally supports the view that urban green spaces, as part of the broader environmental context, promote health and well-being in cities and provide health services as part of a broader range of ecosystem services (Douglas et al., 2017).

26.2.3 Human health and green spaces

A growing body of research has shown that frequent interactions with natural areas or green spaces are associated with positive measures of health and well-being among a variety of populations. For example, indicators of health and life quality are higher among those who live in the proximity to parks or forests, inhabitants of buildings with expansive views of the natural environment from windows, and people who frequently spend time relaxing or being physically active in natural conditions (Holt et al., 2019). Urbanization and the associated increase in obesogenic settings are creating health and wellness challenges for planning and designing urban settings. At the same

time, green spaces in cities are starting to be seen as places for 'restorative' contact with nature, physical activity and social engagement, which according to evidence positively influence well-being and trigger behaviour change towards a lifestyle (Douglas et al., 2017).

Green spaces can often reap psychological benefits through a more direct route: working from the field of Environmental Psychology suggesting that immersion in a natural environment reduces the exposure to the vital elements of everyday life and also promotes the restoration or recovery of the cognitive fatigue that arises from daily stressors. Thus, natural environments can serve to cushion physiological and emotional stress and restore attention and focus. Finally, those who use green spaces regularly for physical activity can benefit from the many positive impacts that exercise can have on physical and mental health. When performed physical activity in a natural environment (green exercise), there may be additional restorative benefits conferred. Given the wide range of ways those who use the green space, it could benefit one's health, well-being and the exposure assessments should be incorporated on the different types of green space interactions, as well as the dose (frequency and duration) of exposure (Holt et al., 2019). It is also important to note that disadvantaged population groups often live in neighborhoods with reduced availability of green space. Studies have shown that poor people tend to benefit more from improved access to urban vegetation. Thus, reducing socioeconomic disparities in the availability of urban green space can help reduce health inequalities related to income, minority status, disability, and other socioeconomic and demographic factors (Braubach et al., 2017).

Braubach et al. (2017) present a series of studies on the positive effects of contact with nature / green spaces such as a decrease in stress level, change of emotional state to more positive, restoration the well-being feeling in people who suffer from mental fatigue. Other positive effects can be the relieve symptoms of depression and chronic stress and obesity decrease. It shows that people who live in urban areas with more green spaces have a reduced level of stress and better well-being compared to those who have less availability of green spaces; more vegetation in the neighborhood was associated with lower levels of depression, anxiety and stress. Different studies have shown that green spaces are not equally available or accessible for all population groups; low-income communities often have less accessibility to green spaces. In case of communities that have green spaces in their areas can be vandalized and become unsafe areas; this indicates that socioeconomic inequalities determine access to green spaces and therefore health benefits (Braubach et al., 2017; Marmot, 2010; Pérez-Paredes et al., 2015).

According to Douglas et al. (2017) across the world, urban policymakers are exploring the links between planning and public health, as concerns rise about the impacts of urban settings on health outcomes and healthy lifestyles as a result to this are the official papers made by the WHO in 2010, 2012 and 2013, mention in this order below:

a) Environment and Health Risks: A Review of the Influence and Effects of Social Inequalities.
b) European policy framework supporting action across government and society for health and well-being.
c) Global action plan for the prevention and control of noncommunicable diseases.

Moreover, "Transforming our world: the 2030 Agenda for Sustainable Development" elaborated by UN General Assembly in 2015; add to this the creation of the Habitat III Agenda in 2016, promotes human health and well-being as a critical urban goal for the 21st Century.

26.3 Agenda 2030 and the sustainable development goals

In 2015, the UN approved the 2030 Agenda on Sustainable Development (Naciones Unidas, 2018), an opportunity for countries and their societies to embark on a new path to improve the lives of all, leaving no one behind. The Agenda has 17 Sustainable Development Goals, ranging from the elimination of poverty to the fight against climate change, education, and equality for women, the defence of the environment or the design of our cities. In this work, we are going to refer to objectives number 3 and 11.

26.3.1 Goal 3: Ensure healthy lives and promote well-being for all at all ages

Ensuring healthy lives and promoting well-being at all ages is essential for sustainable development. Today, the world is facing an unprecedented global health crisis; COVID-19 is spreading human suffering, destabilizing the global economy, and dramatically changing the lives of billions of people around the world. Health emergencies such as COVID-19 pose a global risk and have shown that preparedness is vital. The United Nations Development Program noted considerable differences in countries' capacities to deal with and recover from the COVID-19 crisis. The pandemic is a turning point when it comes to preparing for health emergencies and investing in vital public services of the 21st Century.

The World Health Organization (WHO) has been leading the global effort to tackle COVID-19. The Strategic Preparedness and Response Plan, developed by WHO and partners, outlines the public health actions that countries should take to prepare for and respond to COVID-19. The April 2020 strategy update provides additional guidance for public health response to COVID-19 at the national and sub-national levels and underscores the coordinated support that is needed from the international community to rise to the challenge that supposes COVID-19. WHO, together with partners, also provides guidance and advice to people to take care of their mental health during the COVID-19 pandemic, especially health workers, health centre managers, people who care for children, the elderly, lonely people and society, more generally. The pandemic is much more than a health crisis. It requires a response from governments and society as a whole equivalent to the determination and sacrifice of health workers on the front line.

26.3.2 Goal 11: Make cities inclusive, safe, resilient, and sustainable

The world is becoming more and more urban. Since 2007, more of the half world's population has been living in cities; this number is projected to rise to 60% by 2030. Cities and metropolitan areas are powerhouses of economic growth, contributing around 60% of global GDP. However, they also account for around 70% of global carbon emissions and more than 60% of resource use. Rapid urbanization is leading to growing numbers of slum dwellers, inadequate and overloaded infrastructure, and services (such as waste collection and water and sanitation systems, roads, and transportation), worsening air pollution, and unplanned urban sprawl.

The impact of COVID-19 will be most devastating in poor and densely populated urban areas, especially for 1 billion people living in informal settlements and slums around the world, where overcrowding also makes it challenging to adhere to recommended measures such as the social distancing and self-isolation (Abu-Rayash and Dincer, 2020; Sharifi and Khavarian-Garmsir, 2020). Cities are on the front line in dealing with the pandemic and its lasting impacts. Around the world, COVID-19 is threatening cities and communities, endangering not only public health but also the economy and the social fabric.

UN-Habitat, is the international agency for housing and urban development, is working with national and local governments to help them prepare for, prevent, respond, and recover from the COVID-19 pandemic; with documents such as the methodologic guide to socioeconomic recuperation in the COVID-19 context and a policy brief of the urban world (Programa de la Naciones Unidas para los Asentamientos Humanos (ONU-Hábitat) 2020; United Nations, 2020) which aims to guide action at the global, regional, and national levels

Since 2015 with the adoption of the 2030 Agenda for sustainable development, the first UN world summit was held by UN-Habitat in Quito, Ecuador with the Conference on Housing and Sustainable Urban Development, this assembly provides opportunities to discuss the significant challenges of how to plan and manage cities, towns and villages in order to fulfil their role as drivers of sustainable development, and how they can cooperate in to apply the Agenda Goals and the Paris Agreement on climate change. In Quito, world leaders adopted the New Urban Agenda that sets global standards of achievement in sustainable urban development, rethinking the way we build, manage and live in cities by cooperating with committed partners, relevant stakeholders and urban actors in all levels of both government and civil society and the private sector.

26.4 Mexico City: A case study

Mexico City is the capital of the United Mexican States; it is in the south-central part of the country, it occupies the second place nationally for its number of inhabitants, it has 8,918,653 inhabitants, 4,687,003 women and 4,231,650 men, 7.5% of the country's total, with a population density of 5,967 people per square kilometre, see Fig. 26.1 to visualize green spaces in the city. The Mexico City area is 1,485 square kilometres, representing 0.08% of the national territory and is politically divided into 16 municipalities and in Table 26.1 we can see the number of inhabitants per municipality (Instituto Nacional de Estadística y Geografía [INEGI], 2005). The Commerce sector is the activity that contributes the most percentage to GDP in the state with 16.5%.

We can see that Iztalapa is the municipality have the highest number of inhabitants with 1,827,868, and Milpa Alta is the least one with 137,927 but is the largest city hall. Iztacalco is the smallest and has the least number of inhabitants; so, its population density is the highest with 16,953. The lowest population density is Tláhuac with 4,032. The previous allows us to see the lack of direct relationship between the municipality area with the number of inhabitants since the municipality with the highest density is the one with the smallest area, while the municipality with the lowest population density is the longest. In Table 26.2 we placed the green areas by a municipality and

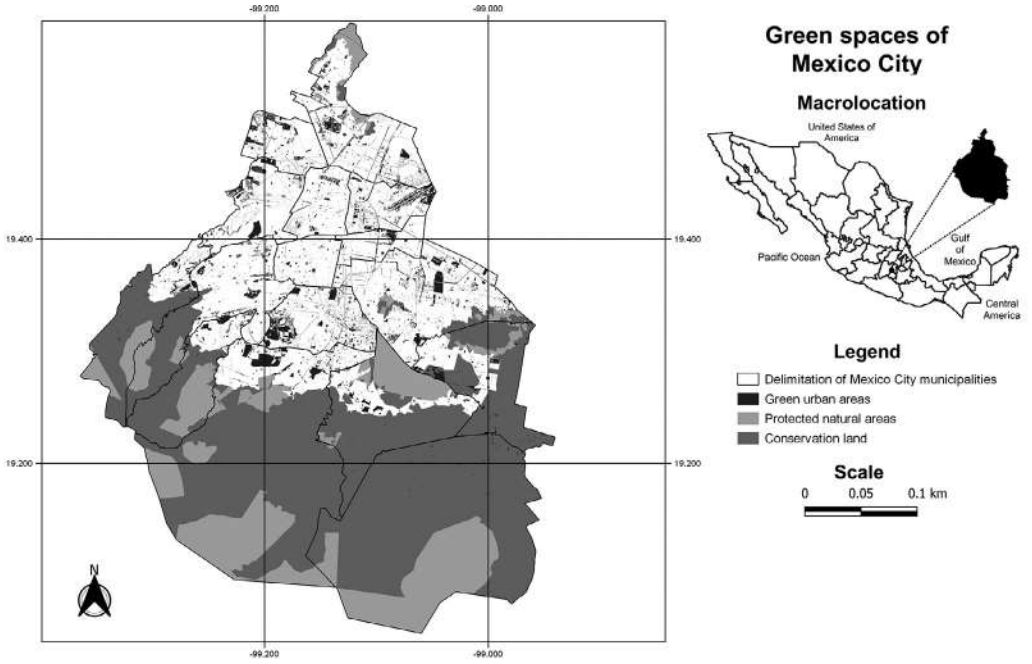

FIG. 26.1 **Green spaces of Mexico City.**

TABLE 26.1 Distribution of the population by municipalities in Mexico City.

Municipality	Number of inhabitants	Area (km^2)	Population density (hab/km^2)
Álvaro Obregón	749,982	95.89	7820.9
Azcapotzalco	400,161	33.52	11936.9
Benito Juárez	417,416	26.70	15632.8
Coyoacán	608,479	53.92	11284.3
Cuajimalpa de Morelos	199,224	71.47	2787.6
Cuauhtémoc	532,553	32.52	16373.7
Gustavo A. Madero	1,164,477	87.91	13246.8
Iztacalco	390,348	23.10	16901.5
Iztapalapa	1,827,868	113.16	16152.3
La Magdalena Contreras	243,886	63.42	3845.6
Miguel Hidalgo	364,439	46.39	7855.7
Milpa Alta	137,927	298.22	462.5
Tláhuac	361,593	85.85	4211.9
Tlalpan	677,104	314.49	2153
Venustiano Carranza	427,263	33.86	12617.3
Xochimilco	415,933	114.12	3644.8

Modified based on data from INEGI (2015).

its evolution in a period of 10 years from 1999 to 2009 in Mexico City, here we show the variation in the surface area based on km^2.

Table 26.2 shows us in 1999 that the greenest mayor's office is Álvaro Obregon with 8.05 km^2 and the least green Cuajimalpa with 0.57 km^2; in 2003, the greenest mayor continued to be Alvaro Obregon and the least green Benito Juarez; in 2009 the greenest was still Alvaro Obregon with 17.41, and the least green was Iztacalco with 1.74. We

TABLE 26.2 Evolution and variations in the quantity km^2 of green areas in Mexico City from 1999 to 2009.

	Green areas (km^2)					
Municipality	**1999**	**2003**	**2009**	**Var. 1999–2009**	**Var. 1999–2003**	**Var. 2003–2009**
Álvaro Obregón	8,05	24,59	17,41	9,36	16,54	-7,18
Azcapotzalco	1,44	4,28	4,45	3,01	2,84	0,17
Benito Juárez	1,51	1,19	2,95	1,44	-0.32	1,76
Coyoacán	4,98	20,13	14,88	9,90	15,15	-5,25
Cuajimalpa de Morelos	0,57	5,55	3,34	2,77	4,98	-2,21
Cuauhtémoc	0,89	1,81	3,66	2,77	0,92	1,85
Gustavo A. Madero	6,56	14,26	5,66	-0.9	7,70	-8,60
Iztacalco	0,89	2,25	1,74	0,85	1,36	-0,51
Iztapalapa	3,04	18,32	12,23	9,19	15,28	-6,09
La Magdalena Contreras	0,18	1,82	2,43	2,25	1,64	0,61
Miguel Hidalgo	6,88	8,89	12,43	5,55	2,01	3,54
Milpa Alta	-	-	-	-	-	-
Tláhuac	1,73	2,27	1,95	0,22	0,54	-0,32
Tlalpan	4,56	11,8	11,07	6,51	7,24	-0,73
Venustiano Carranza	2,36	5,23	6,04	3,68	2,87	0,81
Xochimilco	5,1	5,89	4,74	-0,36	0,79	-1,15
Ciudad de México	49,51	128,28	112,899	63,39	78,77	-15,38

Modified based on data from Checa-Artasu, (2016).

can observe that in 2003 there was an increase in green areas; however, this did not last to 2009 where there was significant green areas reduction. From 1999 to 2009, the delegation with the most significant variation was Álvaro Obregón, which increased its surface area of green areas by 9.90 km^2, and the mayor's office that reduced the green areas was Gustavo A. Madero with –0.9 km^2. It is essential to mention that we remove Milpa Alta data from these statistics because it is a municipality which green surface status corresponds in more quantity to conservation land, and this could influence into the results, so we achieve a more precise analysis. The trend that we observe in Table 26.2 is a green surface loss, and we can exemplify it with Gustavo A. Madero, losing in three years almost 10 km^2 of green space. Also, we must mention that is Mexico City second most populated municipality this may be a reason for this reduction.

Finally, Table 26.3 that shows and helps to compare the latest data recorded in 2017 for green areas per inhabitant of each municipality of Mexico City as well as the number of confirmed cases of COVID-19 in June 2020.

From the above table, it is worth mentioning that on the inventory of green areas carried out in 2017 (SEDEMA, 2017), Milpa Alta, urban green spaces such as public, academic institutions, pantheons, vacant lots among others, were considered giving a total of 2.2 m^2 per inhabitant of green area. The territories of the mayoralties are variable, despite this there are small areas that concentrate large populations such as Iztacalco or Cuauhtémoc whose territories are small, regarding this the green spaces are insufficient to provide the ecosystem services that the citizens require. In Table 26.3, regarding COVID-19 confirmed cases, Iztapalapa has 15,801 making it the municipality with the highest number and Milpa Alta has the lowest number of cases, neither of this municipalities has the 9m^2 per inhabitant that is needed and stipulated in the Environmental Law for the Protection of Land (ELPL) in Mexico City (Procuraduría Ambiental y del Ordenamiento Territorial del DF [PAOT], 2017). But if we noticed Miguel Hidalgo that has the greater green area with 15.4 m^2 per inhabitant with 4,449 confirmed cases it is three times lower than Iztapalapa.

According to the linear regression performed where confirmed COVID-19 cases are considered as the dependent value (y) and the independent value defined as "x1" is m^2 per inhabitant, the probability is equal to 0.975, which confirms that there is a correlation between these variables. However, a third variable was considered, the

TABLE 26.3 Correlation of green areas per inhabitant in 2017 and cases of COVID-19.

Municipality	2017 (green space m^2 / inhabitant)	Confirmed cases of COVID-19 (2020-09-09)
Álvaro Obregón	6.6	8,556
Azcapotzalco	9.9	6,085
Benito Juárez	2.2	3,709
Coyoacán	15	7,507
Cuajimalpa de Morelos	10.3	3,046
Cuauhtémoc	3.6	5,808
Gustavo A. Madero	6.7	12,939
Iztacalco	5	4,914
Iztapalapa	5.4	15,801
La Magdalena Contreras	5.5	4,128
Miguel Hidalgo	15.4	4,449
Milpa Alta	2.2	2,998
Tláhuac	8.4	5,500
Tlalpan	9.6	9,107
Venustiano Carranza	13.6	5,736
Xochimilco	5	6,484

Modified based on data from Gobierno de la Ciudad de México, (2020c) and Secretaría del Medio Ambiente de la Ciudad de México [SEDEMA], (2017).

municipality area, when including this independent variable defined as "x2" with those already described in multiple linear regression, a probability of 0.699 is obtained which means that there is a relationship between the three variables. However, the correlation coefficient of 0.232 indicates that the territorial extension of the municipalities and their green areas have no significant relationship with the disease.

26.5 Reflections

In recent years, Mexico City has shown a reduction in the square kilometers of green areas per inhabitant, this phenomenon, as we can see, is divided between the municipalities that have greater purchasing power, which maintain an area above $9m^2$ per inhabitant defined by the ELPL with those with lower purchasing power and whose green spaces are below this value. Except for Milpa Alta, which was excluded from the analysis because conservation land predominates and that this data would deviate the analysis from green areas per inhabitant. The municipalities history has been different, so their urban development has consequences on the amount of urban green areas. The reasons for the green areas decrease are multiple, among them the excessive urbanization manifested in the construction of housing units by the public and private sectors. However, the production of scientific evidence in this aspect is low, the invasion of green areas with irregular urban settlements. There are different realities regarding the urban green areas in Mexico City, and it is also related to the number of inhabitants and the municipality area. The inequality creates differences for those who have more significant green spaces can have more opportunities for outdoor activities such as exercise, recreation, social coexistence which is related to reduce the risk of health problems like anxiety, depression, obesity, and respiratory diseases. In Mexico City, we are witnessing a disappearance of the green public space which is reflected in the last two green spaces inventories, in the year 2010 with a total of 150.65 km^2 green area per inhabitant and with a drastic reduction in the year 2017 with a total of 67.31 km^2 green area per inhabitant (PAOT, 2010; SEDEMA, 2017).

Although it was thought that the greater of green urban spaces, the fewer reported cases of COVID-19 could be, such as the results shown for Wuhan and Hong Kong (Abu-Rayash and Dincer, 2020; You et al., 2020), but as we observed this is not the case. This is because Mexico City is a multifactorial area, so in future research, we must

consider other factors that can contribute to transmitting the disease such as climate (J. Liu et al., 2020), economy or even built space. We also must consider the citizens necessity to be close to green space and to use them for exercise, relaxation and to be in contact with nature (Ugolini et al., 2020). Even with isolation measures at home these places could be a safe space for the physical and mental health of citizens, this can be used to promote the increase of green public spaces and can be considered as another factor.

26.6 Conclusions

Managing this pandemic generated by COVID-19 requires controlling multiple factors of the urban environment in Mexico City, but one of the most important factors detected in this work is the equal availability of urban green areas. Mexico City barely has an average surface area below the WHO recommendations. Therefore, it is necessary to improve the availability of green spaces in Mexico City so that it can help reduce inequalities in health problems. Green areas or urban nature can provide people with opportunities to get out of the confinement and enjoy the positive effects on health and well-being while conserving physical space. The lack of urban public policies related to the planning of green areas is evident, the urgent need that arises from the pandemic due to the benefits shown leads us to analyze not only the lack of green spaces but also the quality and accessibility of the existing population.

The evidence of the benefits of green areas regardless of physical activity, for reducing stress and other psychological illnesses has been demonstrated by the different studies carried out. As we have seen, cities function as epicentres where coronavirus can be spread. Social isolation and physical distancing can induce feelings of loneliness, aggressiveness, confusion, anger, anxiety, depression, and premature mortality. Access to nature, in addition to helping people to stay physically healthy by having direct contact with nature, also helps to the mental health; Mexico City decision-makers need to work harder to increase green public spaces and to preserve those that already exist.

According to the World Health Organization, pandemics that can affect the way the society lives will be increasingly recurrent, therefore rethinking planning urban green spaces should be a priority, maintaining and promoting these areas also help to fulfil SDG 3 and 11.

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ENVIRONMENTAL RESILIENCE AND TRANSFORMATION IN TIMES OF COVID-19

Climate Change Effects on Environmental Functionality

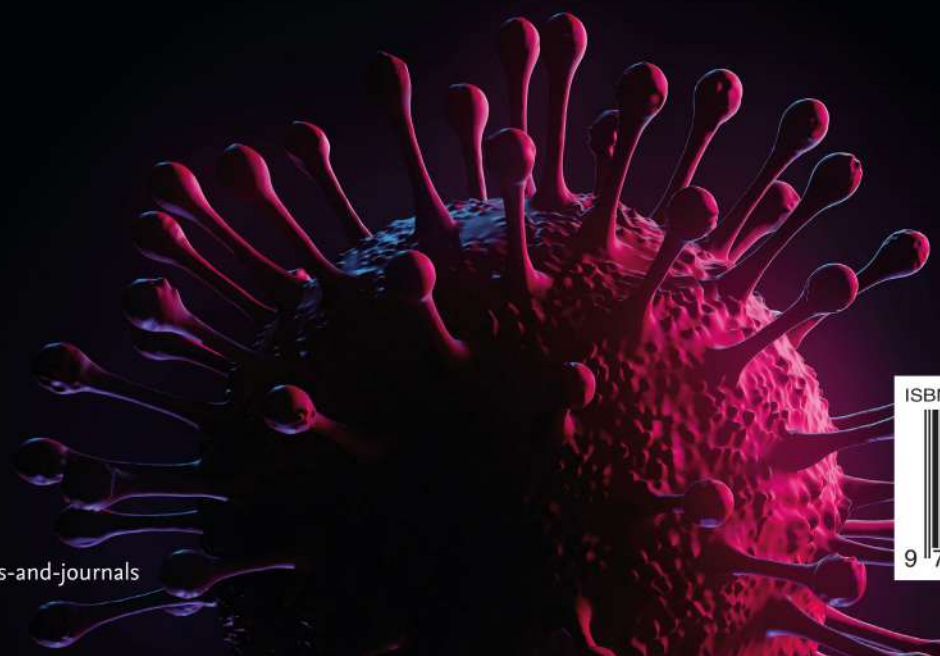
AL. Ramanathan, S. Chidambaram, M.P. Jonathan,
M.V. Prasanna, Pankaj Kumar and Francisco Muñoz Arriola

Environmental Resilience and Transformation in Times of COVID-19: Climate Change Effects on Environmental Functionality is a timely reference to better understand environmental changes amid the COVID-19 pandemic and the associated lockdowns. The book is organized into five themes: (1) environmental modifications, degradation, and human health risks; (2) water resources—planning, management, and governance; (3) air quality—monitoring, fate, transport, and drivers of socioenvironmental change; (4) marine and lacustrine environment; and (5) sustainable development goals and environmental justice. These themes provide an insight into the impact of COVID-19 on the environment and vice versa, which will help improve environmental management and planning, as well as influence future policies.

Featuring many case studies from around the globe, this book offers a crucial examination of the intersectionality between climate, sustainability, the environment, and public health for researchers, practitioners, and policymakers in environmental science.

Key features

- Features global case studies to illustrate themes and address issues to support environmental management.
- Offers fundamental and practical understanding of ways to improve and validate predictive abilities and tools in addition to response.
- Examines climate-related trends in the spread of the pandemic.
- Present different ways forward in order to achieve global goals with a specific focus on SDGs.



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