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Planning and Quality of Green Areas in Ciudad Juárez, Chihuahua

Planeación y calidad de áreas verdes en Ciudad Juárez, Chihuahua

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ABSTRACT

In Mexico, urban green areas are usually viewed as a recreational space, however, little attention is paid to their quality. In Ciudad Juárez, Chihuahua there is a deficit of these spaces, and only a few are maintained. Therefore, the objective of this paper is to analyze the number, spatial distribution, and quality of urban green areas in relation to territorial planning using the Physical Activity Resource Assessment Instrument, and the Community Park Audit Tool. The findings show that the lack of planning for green areas results in a lack of equipment, poor quality of service, high levels of insecurity and incivility, as well as a lag for certain sectors of the population. Based on these results, the goal is to provide quality elements for planning in order to have an impact beyond considering the green areas as just a number.

Keywords: 1. planning, 2. equipment, 3. green areas, 4. northern border, 5. Mexico.

RESUMEN

En México las áreas verdes urbanas generalmente son consideradas como espacios de recreación, sin embargo, no siempre se presta atención a su calidad. En Ciudad Juárez, Chihuahua, estos espacios escasean y solo algunos reciben mantenimiento. Por ello, el objetivo de este artículo es analizar el número, la distribución espacial y la calidad de las áreas verdes urbanas en relación con la planeación territorial utilizando los instrumentos Physical Activity Resource Assessment y Community Park Audit Tool. Los hallazgos muestran que la falta de planeación de las áreas verdes se traduce en carencia de equipamiento, mala calidad del servicio, elevados niveles de inseguridad e incivilidad, así como el rezago de ciertos sectores de la población. Con base en estos resultados, se busca contribuir a la planeación con elementos de calidad para incidir más allá de considerar el ámbito de las áreas verdes solo como un número.

Palabras clave: 1. planeación, 2. equipamiento, 3. áreas verdes, 4. frontera norte, 5. México.

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INTRODUCTION

As the global population grows and urbanization accelerates, the need for cities to adopt sustainable practices becomes increasingly urgent. Urban green spaces (UGS) and the ecosystem services they provide play a crucial role in enhancing urban sustainability (Morgenroth et al., 2016). These services include provisioning (water provided by the hydrological cycle), regulating (air and water pollution control, stormwater management), cultural (recreation, physical and mental health benefits), and supporting services (wildlife habitats) (Jennings et al., 2017). However, the current shortage of UGS has triggered environmental and social challenges, limiting cities' ability to harness these essential ecosystem benefits (Flores-Xolocotzi & González Guillén, 2010).

Moreover, UGS are generally regarded as a type of public space characterized by collective use, as they are accessible for multiple purposes, facilitate social interaction, and promote identity formation (De la Torre, 2015). In Mexico, urban development plans (UDP) often use the term "public space" interchangeably with "green space." However, while certain green spaces may function as public spaces, others are privately owned, and not all public spaces necessarily contain vegetation (Ojeda-Revah et al., 2020).

Similarly, UGS, as public spaces, provide an ideal setting for societal development by fostering diverse forms of interaction and promoting inclusivity—that is, ensuring equitable access for all individuals to gather, walk, and engage in an environment that supports both public and private health (Restrepo Vélez, 2016). Given their critical role in facilitating social, commercial, artistic, recreational, entertainment, and sports activities, as well as religious practices and the expression of social movements in Latin American cities, UGS are increasingly being managed to enhance residents' quality of life through the creation of new spaces and the rehabilitation of neglected ones (Páramo et al., 2016).

In the context of sustainable development, the quantity and quality of UGS are essential components of urban planning (Yao et al., 2014; Vélez Restrepo, 2009). According to Boulton et al. (2018), cities typically prioritize aspects related to quantity—such as area, percentage of urban space, and square meters per inhabitant—and of functionality based on their location and distribution (accessibility). In contrast, quality-related considerations are often given less attention (Gómez et al., 2011; Haq, 2011).

According to the Instituto Municipal de Investigación y Planeación[4] (IMIP), in 2016, Ciudad Juárez, Chihuahua, had 7 478 012.67 m² of UGS, equivalent to 5.88 m² per inhabitant (IMIP, 2016). By 2022, these figures had risen to 9 268 937.92 m² and 6.17 m² per inhabitant (IMIP, 2024). One of the challenges faced by the city is that residential areas have been developed in locations unsuitable for the establishment and provision of UGS (IMIP, 2010). Furthermore, prior to the enactment of the Ley General de Asentamientos Humanos, Ordenamiento Territorial y Desarrollo Urbano[5] (LGAHOTDU, 2016), the UGS areas designated by developers were often located on residual plots that could not be subdivided for housing due to their size and layout (typically in the

[4] Municipal Institute of Research and Planning (unofficial translation).

[5] General Law on Human Settlements, Land Planning, and Urban Development (unofficial translation).

shape of a blade).[6] As a result, the majority of UGS developed before this law were fragmented and concentrated in the central and eastern parts of the city, where pocket parks (100 to 400 m²) and public gardens (401 to 5 000 m²) prevailed, while neighborhood parks (10 001 to 40 000 m²) and urban parks (40 001 m² or more) were relatively scarce.

In this regard, UGS have primarily been treated as quantifiable elements in planning, only focusing on identifying the number of these spaces and summing UGS areas, without integrating quality criteria. Considering the significance of UGS and the challenges at hand, this article seeks to analyze the quantity, distribution, and quality of UGS in Ciudad Juárez, Chihuahua, in the context of urban planning.[7]

THEORETICAL-CONCEPTUAL FRAMEWORK

Urban green spaces are essential elements for enhancing the well-being of the population, particularly in large cities, as they provide ecological, material, and social benefits (Morgenroth et al., 2016). These benefits positively impact users' health and generate economic advantages by reducing pollution-related costs, increasing property values in surrounding areas, and boosting a city's appeal, thereby fostering tourism and job creation (Flores-Xolocotzi, 2012).

Despite their importance, UGS remain scarce in Latin American cities, largely due to the history of rapid and often precarious urbanization since the second half of the 20th century (Reyes & Figueroa, 2010). According to Flores-Xolocotzi and González-Guillén (2010), common challenges such as limited green space, social exclusion, and insecurity are prevalent in the green space and public park systems of cities like Curitiba (Brazil), Mexico City (Mexico), Madrid (Spain), New York (United States), and Santiago (Chile).

The theoretical framework related to UGS encompasses the concepts of sustainable development and governance, as outlined in the United Nations Sustainable Development Goal 11. One of its key targets is to ensure universal access to public, safe, inclusive, and accessible UGS (target 11.7), to make cities resilient and sustainable (United Nations General Assembly, 2015). This is closely linked to the principle of environmental justice, which Hervé Espejo (2010) defines as "the equitable distribution of environmental burdens and benefits among all members of society" (p. 17).

It is important to emphasize that environmental justice extends goes beyond socio-spatial distribution. According to Kuehn (2000), it encompasses several forms of justice: distributive, participatory, procedural, corrective, and social. These justice types should be integrated into planning when designing management tools and public policies, as well as in urban development plans, where citizen participation (Rigolon, 2016) and the legal and political processes that shape

[6] It refers to an urban plot with an isosceles triangle shape, typically situated at the intersection of streets that meet at an acute angle. Due to its narrow vertex, the plot resembles the shape of a blade.

[7] The number, distribution, and quality of green spaces are key aspects of the findings from the project "Espacios públicos y actividad física en ciudades del norte de México," conducted by Bojórquez, I., Romo M. de L., Ojeda-Revah, L., Lara-Valencia, F., García, H., Díaz, R., and Aranda P. at El Colegio de la Frontera Norte (Conacyt PDCPN 2015-482).

them (Schlosberg, 2004). However, in the management and planning of UGS, the focus has primarily been on economic, environmental, and social indicators (Flores-Xolocotzi, 2012).

The most commonly used indicator to assess public UGS is the total area in relation to the total population (m² per inhabitant). However, this measure fails to provide information on the distribution, accessibility, or quality of these spaces (De la Barrera et al., 2016). This limitation stems partly because urban planning in many countries assumes that all UGS are comparable and prioritizes the quantity of UGS over other considerations, based on the assumption that more green space is inherently better (Ibes, 2015). However, not all UGS are equal, as the quality of each space can influence its use (McCormack et al., 2010) and, consequently, affect the health of individuals who access them or live nearby (Wheeler et al., 2015).

Beyond this, the assessment of the structure and functionality of UGS focuses on attributes that influence their use—such as size, quantity, diversity of facilities and services, as well as their level of maintenance and security (Gidlow et al., 2018; Kraemer & Kabisch, 2021; McCormack et al., 2010; Viinikka et al., 2023). These attributes can be objectively measured using systematic observation tools (Rigolon et al., 2018). In terms of structural considerations, location plays a crucial role, as it defines the physical accessibility of spaces and enables the assessment of the distance between households and the nearest UGS (via Euclidean network or streets), as well as the area or amount of UGS per resident (Rigolon, 2016). Studies, such as Fernández-Álvarez (2017), also show a direct correlation between the socioeconomic conditions of the population and the distribution of UGS. Furthermore, the management, organization, and governance of UGS are assessed through the analysis of public policies (Andersson et al., 2019).

A considerable body of research worldwide has examined disparities in the accessibility, size, and quality of UGS. However, the findings are mixed and vary depending on the specific context. In this regard, Hoffimann et al. (2017) identify four types of outcomes concerning the accessibility and quality of UGS: *1)* both are fairly distributed, regardless of socioeconomic group; *2)* accessibility is fairly distributed, but size and quality are worse for lower-income groups; *3)* both accessibility and quality are worse for lower-income groups; and *4)* distribution favors lower-income groups.

The study of equity in access to UGS has gained increased attention in Mexico in recent years, with most studies identifying inequities in the provision and access to UGS (Ojeda-Revah, 2021). However, few researchers have analyzed the quality of UGS using objective tools for systematic observation (Ojeda-Revah, 2021), and those who have typically rely on presence-absence scores of various elements without considering differences in size or quality (Kraemer & Kabisch, 2021). This is a significant issue, as the lack of information on the quality of UGS may lead to an overestimation of the accessibility and abundance of those spaces that are truly usable (Viinikka et al., 2023).

The literature review reveals that the vast majority of studies focus on issues of equity and accessibility, with only a minority examining aspects of quality based on presence-absence indicators of specific elements within the green space. However, there has been limited exploration of the factors that contribute to the existence of UGS, including their location and characteristics, essentially, urban planning.

The design and creation of UGS should be guided by planning that prioritizes their value based on the services they provide (Meza & Moncada, 2010) and integrates them effectively, considering their quality beyond the simple presence or absence of elements that support population growth or contribute to the well-being of residents (Bascuñán Walker et al., 2007).

It is important to note that the theoretical, methodological, and conceptual discussions on planning have evolved significantly. In the 1980s, planning was primarily viewed as an instrumental procedure focused on basic urban and architectural design aspects.[8] Today, however, framed by global trends, planning emphasizes principles of integral, systemic, and relational analysis that prioritize social well-being and place people at the center. Despite these global trends influencing methodologies for developing urban development plans (García Moctezuma, 2010; Gutiérrez Chaparro, 2015; Peña Medina, 2015; Romo Aguilar, 2015; Bollo et al., 2018), the approach followed in the country remains largely rational and technical. It primarily considers the number and area of UGS per inhabitant, without addressing quality, ecosystem services, or incorporating a theoretical framework in its regulatory policies.

Among the legal foundations related to urban development and UGS is the Ley General de Planeación,[9] enacted in 1930, which is primarily administrative in nature and has not undergone substantial modifications to date. Additionally, the LGAHOTDU of 2016 aims to integrate the planning of population centers with their surrounding territory in an orderly manner, addressing the legal gaps that existed in the separate interpretation of previous legislation, including the LGAHOTDU, the Ley General del Equilibrio Ecológico y la Protección al Ambiente,[10] and the Reglamento del Ordenamiento Territorial.[11] Furthermore, the Norma Oficial Mexicana[12] NOM-SEDATU-001-2021 concerning public spaces in human settlements was recently published. This standard seeks to influence national territorial planning processes to create more inclusive, safe, resilient, and sustainable spaces (Secretaría de Desarrollo Agrario, Territorial y Urbano [SEDATU], 2022a).

In this regard, Ojeda-Revah et al. (2020) observe that the legal framework for planning UGS is fragmented across various regulations at different levels of government, framed within distinct policies, which complicates its application and creates ambiguity. They also note that the human settlements and environmental protection laws grant states and municipalities the authority to establish UGS. Within this context, municipalities have relied on the Urban Equipment Normative System for classification and provision, though it is only indicative and not legally binding

[8] Planning is an anticipatory process of policy formulation for land use and resource allocation aimed at achieving a specific collective purpose. In Mexico, it has mainly followed the comprehensive rational model, which seeks to coordinate system objectives by formulating strategies in an exhaustive and systematic manner, grounded in technical and scientific criteria (Peña Medina, 2016).

[9] General Planning Law (unofficial translation).

[10] General Ecological Balance and Environmental Protection Law (unofficial translation).

[11] Territorial Planning Regulation (unofficial translation).

[12] Official Mexican Standard (unofficial translation).

(Secretaría de Desarrollo Social [SEDESOL], 1999). As a result, each municipality determines UGS provision (through subdivisions) based on the percentage of developed area, meaning the same land area is designated regardless of population size, leading to inequity (Ojeda-Revah et al., 2020).

In urban planning instruments, it is essential to move beyond the general assumption that all UGS share similar characteristics and conditions. It is important to consider not only the quantity of these spaces but also other relevant factors, such as their quality, which can significantly impact their use (McCormack et al., 2010; Giles-Corti et al., 2005).

Thus, UGS with a diverse range of features and services can attract a wider variety of users. Aspects such as the size, number, and types of facilities and services can draw visitors (Kaczynski et al., 2008; Giles-Corti et al., 2005). Therefore, the use of UGS can be influenced by the presence or absence of elements like sports fields (Cohen et al., 2007), trees, trails, paths, and sidewalks (Kaczynski et al., 2008), playgrounds, restrooms, lighting, shade, and drinking fountains (Cohen et al., 2007), among others. Additionally, factors such as safety, maintenance, and cleanliness play a crucial role in determining the use of UGS (McCormack et al., 2010). Poor maintenance, vandalism, and the absence of restrooms can discourage users (Gobster, 2002; Boone-Heinonen et al., 2010).

To assess the quality of UGS, variables such as maintenance, safety, the availability of services, and the absence of litter have been evaluated (McCormack et al., 2010). The services considered include the number and types of facilities (e.g., playgrounds, sports fields, trails), as well as tree coverage (Zhou & Kim, 2013). Some studies also examine the land use surrounding UGS as a factor influencing its use (Byrne & Wolch, 2009).

When planning cities, it is crucial not only to allocate space for recreation and UGS but also to establish guidelines and regulations that ensure the proper design of these spaces. These should consider the climatic conditions of each city as well as the physical characteristics of the urban area where they are located (Salas-Esparza & Herrera-Sosa, 2017).

The analysis and discussion of green planning within the context of sustainable development highlight that local governments in Latin America (including Mexico) must establish strategies to incorporate it effectively (Vélez Restrepo, 2009). Achieving this goal will require strengthening the technical and administrative capacities of these governments (Flores-Xolocotzi, 2012).

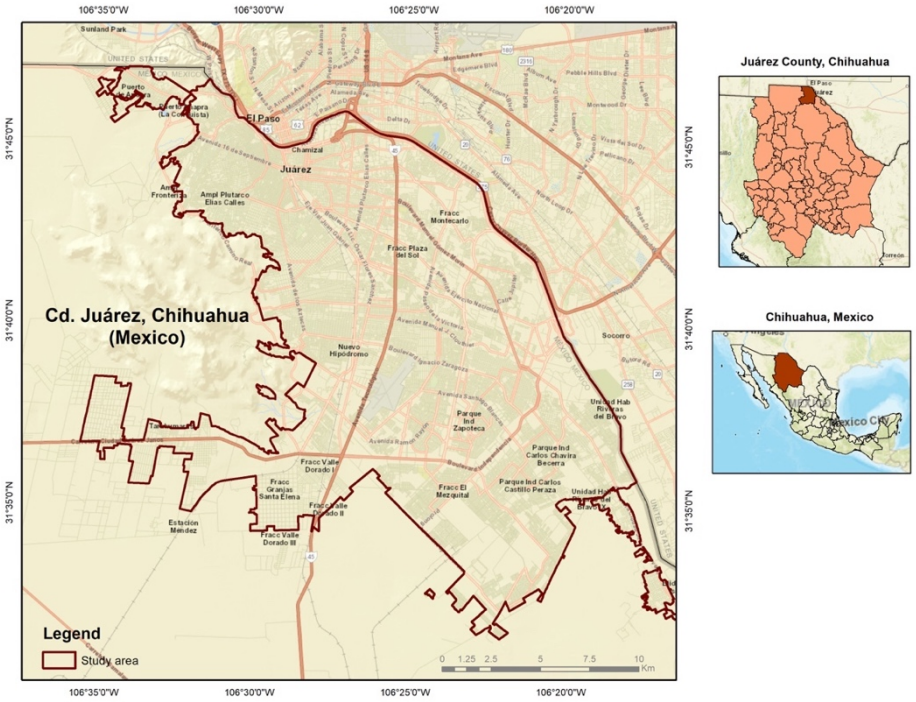
In this regard, Flores-Xolocotzi (2017) suggests the use of UGS standards that address key aspects such as social, environmental, recreational, aesthetic, and public health needs. These standards should also consider whether spaces are publicly accessible, restricted (private), or difficult to reach, as well as factors like geographic and environmental context, size, diversity, population density, and the potential for multiple uses.

METHODOLOGY

Study Area

Ciudad Juárez is located on the northern border of the state of Chihuahua, Mexico, adjacent to the city of El Paso, Texas, in the United States (Map 1). It is bordered to the north by the Rio Bravo, to the west by a mountain range, and to the south by a desert. In 2016, the urban area spanned 32 119.57 hectares and had a population of 1 391 180 inhabitants, with a population density of 41.82 inhabitants per hectare. The city exhibits a pattern of dispersed and disorganized growth, with vacant land and residential areas disconnected from the city center (IMIP, 2016). This pattern has remained largely unchanged, though by 2020, the population had increased to 1 501 551, raising the population density to 43.34 inhabitants per hectare.

Map 1. Location of the Study Area



Source: Author's elaboration based on information from the National Institute of Statistics and Geography (Instituto Nacional de Estadística y Geografía [INEGI], 2019).

Materials and Methods

The methodology employed consisted of four phases: *1)* analysis of UGS inclusion in the planning instruments from 2003 to 2016; *2)* inventory of the number and distribution of UGS; *3)* classification of UGS suitable for the city and selection of the "public parks" category; and *4)* evaluation of the quality of the selected UGS through the application of the Instrumento de Evaluación y Recurso de Actividad Física (IERAF) (Physical Activity Assessment Tool and Resource). The IERAF includes identification elements and general aspects of the space and its surroundings, as well as an assessment of services, facilities, and the presence of incivilities, among other factors.

First, the legal framework was analyzed, and three urban development plans (UDP) for Ciudad Juárez (2003, 2010, and 2016) were reviewed to assess how UGS were integrated. In the second phase, for the spatial analysis of the number and distribution of UGS, the geospatial public spaces database from the Municipal Institute of Research and Planning (IMIP, 2017) was used with the Sistemas de Información Geográfica (Geographic Information Systems) tool. This vector data includes stadiums, public squares, municipal gyms, sports facilities, and parks, all projected in the WGS_1984 UTM_13-Norte coordinate system. Subsequently, the UGS were classified, focusing the analysis on the "public parks" category, as these constitute the majority of UGS. Table 1 presents the various types of parks and their coverage radius based on Romo Aguilar's (2008) categorization.[13]

Table 1. Classification of Green Areas and Coverage Radius

Designation	Surface area ranges (m²)	Coverage radius (m)
Public garden	0-300	50
	301-600	100
	601-1 000	150
Neighborhood park	1 001-2 500	350
Community park	2 501-10 000	700
District park	1 to 3 ha	1 500
Urban park	3 to 10 ha	City

Source: Author's elaboration based on Romo Aguilar (2008).

In the fourth phase, 127 Basic Geostatistical Areas (Áreas Geoestadísticas Básicas [AGEB]) from the INEGI (2010) were selected based on a representative, multi-stage, probabilistic, and stratified sample of the adult population (18-65 years). Through spatial analysis, the UGS present

[13] This classification was based on the modification of the equipment standards from SEDESOL (1999), which, for park categories, establishes broad surface area and coverage radius ranges that overlap in size and do not apply to the polygons identified in Ciudad Juárez, where there is a significant number of small spaces. The urban park category (>3 ha) was not considered in this study, as its influence radius extends to the city level.

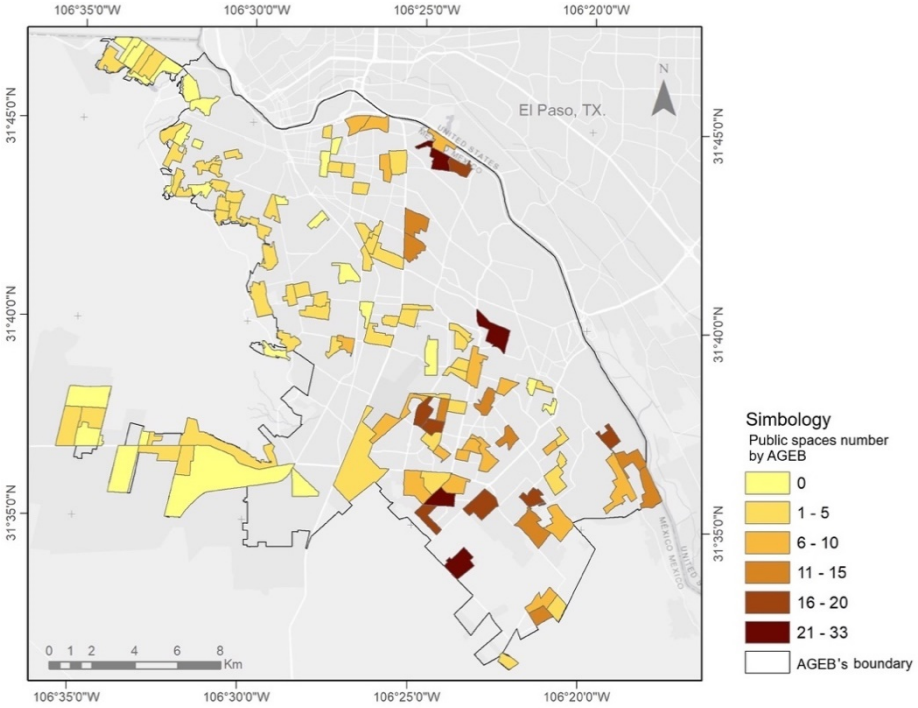
in the randomly selected AGEBs were identified according to the calculated sample[14] (Table 2). The spatial distribution of the UGS by AGEB is illustrated on Map 2.

Table 2. Urban Green Spaces in the Selected AGEBs

IMIP Data	Number of Polygons	Number of Selected Polygons/AGEB
UGS	2 430	459
UGS/Sports units		147
Sports units	128	27

Source: Author's elaboration based on IMIP data (2017).

Map 2. Concentration of Urban Green Spaces in the Selected Basic Geostatistical Areas



Source: Author's elaboration based on information from INEGI (2010) and IMIP (2017).

Among the UGS located in the selected AGEBs, 160 spaces[15] were randomly selected. Ultimately, 156 polygons were considered, and the IERAF was applied to them during April and May of 2018. Of these, 132 are UGS, and 24 are UGS/sports units.

[14] During the fieldwork, it was observed that some UGS overlap with certain sports units, leading to the addition of the category "UGS/sports units."

[15] Four spaces were excluded due to duplication from a database error or because they were vacant lots.

To assess the quality of the selected UGS, the Instrumento de Evaluación y Recurso de Actividad Física (IERAF) (Physical Activity Assessment Tool and Resource) was applied. It was based on the Physical Activity Resource Assessment Instrument (PARA) (Lee et al., 2005) and supplemented with questions from the Community Park Audit Tool (CPAT) (Kaczynski et al., 2012), as well as additional questions designed by the research project's technical team. The IERAF includes elements for identifying and evaluating general aspects of the space and its surroundings, as well as assessing services, equipment, and the presence of incivilities, among other factors. A manual for using the instrument and collecting data was developed, based on the PARA and CPAT manuals, with added instructions for the modified and/or newly designed questions specific to the project.[16]

A pilot test was conducted using the instrument in four UGS. Two members of the research team visited each selected space and conducted a walk-through according to the procedure outlined in the manual to inventory the elements listed in the instrument. Afterward, a responsible person was contacted to provide additional information about the space to complete any missing data for the IERAF. Once the data were collected, the research team discussed the findings to minimize subjectivity and correct any perceptual discrepancies where necessary.

The inventories were completed on paper and collected following an established procedure. For quality control, a double-entry process was used, and a random review of 10% of the inventories was conducted. Additionally, photographs were taken of the selected UGS where the instrument was applied. A protocol was developed for this, which included guidelines for timing to ensure proper lighting, framing the shot to cover relevant IERAF topics, and addressing safety considerations, such as avoiding photographing people, or leaving the location if suspicious activity was observed (Table 3).

Table 3. Evaluation Instrument (IERAF)
Adapted for the City

Evaluated element	Format	Evaluated element	Format
1. Date	dd/mm/yy	2. Name of the evaluator	Text
3. Space ID	Code	4. Start time	24 h
5. Type of public space a. Park b. Plaza c. Sports unit d. University campus e. Natural areas	Option selection	6. Traffic signs	Yes / No
		7. Adjacent land use a. Residential b. Commercial c. Institutional d. Industrial e. Natural	Option selection

(continues)

[16] The IERAF consists of 69 evaluation elements, with 48 (69.56%) derived from the PARA instrument, 11 (15.94%) from the CPAT, and 10 (14.5%) created by the project team.

Evaluated element	Format	Evaluated element	Format
(continuation)			
8. Parking within the public space	Yes / No	9. Street parking	Yes / No
10. Public transport stop	Yes / No	11. Number of access points a. Open b. More than 5 c. 2 to 5 d. Only 1	Option selection
12. Neighborhood safety and appearance a. Insufficient lighting b. Graffiti c. Vandalism d. Excessive litter e. Heavy vehicular traffic f. Excessive noise g. Desolate/isolated h. Buildings in poor condition i. Properties lacking maintenance j. Threatening individuals k. Other	Selection of option(s)	13. Hours of operation a. Opens b. Closes 14. Cost a. Free b. Fee upon entry c. Fee for specific activities or spaces d. Unknown 15. Sign with opening hours 16. Sign with rules	24 h Unknown Option selection Yes / No Yes / No
17. Maintenance a. Neighbors b. Organized neighbors c. Civil society organization d. Municipality e. Private company f. Unknown g. Other	Option selection	18. Surveillance 19. Emergency devices 20. Visibility from the center of the public space to the neighborhood a. Total b. Partial c. None	Yes / No / Unknown Yes / No Option selection
21. Baseball field	Not present / Poor / Fair / Good	22. Basketball court	Not present / Poor / Fair / Good
23. Soccer field		24. Futsal court	
25. Volleyball court		26. Tennis court	
27. Sandpit		28. Sidewalk	
29. Running or biking trails		30. Bicycle parking	
31. Exercise stations		32. Playground equipment	
33. Children's pool		34. Adult pool	
35. First aid		36. Wall or fence	
37. Access points		38. Benches	

(continues)

Evaluated element	Format	Evaluated element	Format
(continuation)			
39. Drinking fountains		40. Landscaping efforts	
41. Lighting		42. Picnic tables with shade	
43. Picnic tables without shade		44. Restrooms	
45. Fountains		46. Shelters or shade	
47. Showers/lockers		48. Trash bins	
49. Structure for hanging piñatas		50. Grills	
51. Installed irrigation system		52. Noise	Not present / Poor / Fair / Good
53. Broken glass	Not present / Poor / Fair / Good	54. Dog feces	
55. Loose dogs		56. Lack of grass	
57. Overgrown grass		58. Evidence of alcohol use	
59. Evidence of drug use		60. Graffiti	
61. Trash		62. Sexual paraphernalia	
63. Vandalism			
64. Tree distribution a. No trees b. Only on the perimeter c. Only in one section d. Throughout the area	Option selection	65. Tree coverage (%) a. 0 b. 1-24 c. 25-49 d. 50-74 e. 75-100	Option selection
66. Grass coverage (%) a. 0 b. 1-24 c. 25-49 d. 50-74 e. 75-100	Option selection	67. Surface of other vegetation coverage (%) a. 0 b. 1-24 c. 25-49 d. 50-74 e. 75-100	Option selection
68. End time	24 h	69. Comments	Text

Source: Author's elaboration based on the PARA and CPAT instruments (Lee et al., 2005; Kaczynski et al., 2012).

Some advantages of using this tool include the comprehensive information it provides to assess not only the quality of UGS but also their surrounding environment. Additionally, as an international instrument, it allows for comparative analysis with other cities in Latin America. However, one of its disadvantages is that, due to its level of detail, it requires significant resources for implementation, including trained personnel, funding, and time.

RESULTS

Incorporation of UGS in Planning Instruments

At the state level, the regulatory framework in Ciudad Juárez includes the Ley de Desarrollo Urbano Sostenible del Estado de Chihuahua[17] (2017), which mandates that at least 30% of the total surface area of developments exceeding one hectare must be allocated for UGS. At the municipal level, the Reglamento de Desarrollo Urbano Sostenible del Municipio de Juárez[18] (Agreement 139 of 2016) stipulates that the donation area for UGS will be determined by the developer and handed over to the municipality. It also outlines that UGS will be defined in the active UDPs; however, if this is not specified, 40% of the donation area will be allocated to UGS in residential zones, and 35% in commercial and industrial zones, leaving 12% for provision areas. Additionally, a minimum of 4 000 m² is required for subdivisions with affordable housing and 1 200 m² for middle-income and residential housing.

Recent changes introduced by NOM-001-SEDATU-2021 (SEDATU, 2022a) have further unified the concepts related to UGS and now provide a standardized framework for the methodological development of urban development programs (SEDATU, 2022b). This document proposes the use of UGS indicators based on population size and proximity, categorized by function, administration, and service scale.[19] Moreover, these changes are significant as they have promoted greater equity.

Prior to the implementation of this law, the planning instruments in Ciudad Juárez addressed the topic of UGS in various UDPs, mainly as a procedural element, identifying and tallying areas (Table 4) without considering their potential as multifunctional spaces.

Table 4. Urban Green Space Area in Ciudad Juárez, 2001-2022

Year	UGS area (m²)	Types of UGS included	m^2/hab.	UGS area / urban area (%)
2001	6 050 000	Parks, recreational UGS	5	2.73
2003	5 700 000	Parks, outdoor spaces, private recreational UGS	4.47	1.65
2010	4 115 697	Different types of public gardens, neighborhood parks, district parks, civic squares	3.16	1.37
2016	7 478 012.67	Different types of public gardens, neighborhood parks, district parks, civic squares, and outdoor spaces	5.66	2.08
2040	9 268 937.92	Landscaped areas, pocket parks, public gardens, neighborhood parks, district parks, urban parks	6.6	2.35

Source: Author's elaboration based on data from the IMIP (2003, 2010, 2016, 2024).

[17] Sustainable Urban Development Law of the State of Chihuahua (unofficial translation).

[18] Sustainable Urban Development Regulations of the Municipality of Juárez (unofficial translation).

[19] In the previous version of the methodological guide, a desired minimum standard of 10 m² per inhabitant and access within 500 meters was specified (Marambio Castillo et al., 2017).

The treatment of UGS as a purely accounting matter is evident in the analysis of the primary urban planning instruments in Ciudad Juárez, from the 2003 plan to the recently approved 2024 plan, as discussed in the following paragraphs. According to the 2003 UDP data, Ciudad Juárez had 5 700 000 m² of UGS (4.47 m² per capita), including private recreational UGS. The main issue identified in this UDP was that the city's growth was closely linked to industrialization, resulting in a monocentric urban structure. This hindered diversification and the development of a regulatory system focused on balanced urban growth. The provision of open spaces was not prioritized and was postponed in favor of urgent housing construction to accommodate population growth and the establishment of industrial parks to sustain economic activity (IMIP, 2003).

On the other hand, the 2010 UDP notes that open spaces decreased significantly due to the expansion of the urban area, dropping from 2.73% to 0.56%. By 2005, the provision of UGS (neighborhood and district parks) was limited, with only 3.16 m² per capita, and these spaces lacked both landscaping and urban furniture (IMIP, 2010). Additionally, the 2010 UDP introduced a classification of recreational areas, including categories such as public gardens, neighborhood parks, district parks, urban parks, and civic plazas. This document states that parks at different scales are designed to meet the needs for leisure, recreation, and physical and mental health through contact with nature.

The 2016 Sustainable UDP maintains the same UGS categorization as the 2010 version; however, the areas for the different types of UGS have been expanded. The public garden is designated for areas between 600 and 5,000 m²; the neighborhood park covers areas between 5 001 and 10 000 m²; the district park spans areas from 10 001 to 40 000 m²; and the urban park includes any area larger than 40 000 m² (IMIP, 2016).

The same Sustainable UDP specifies that 3-5% of UGS are designated for single-family housing and 6 to 6.75% for multi-family housing. In both cases, the variations depend on density, with up to 43 dwellings per hectare. For higher densities, 20 and 22.5 m² per dwelling are established for single-family and multi-family housing, respectively (IMIP, 2016). This UDP also makes efforts to align with the Reglamento de Desarrollo Urbano Sostenible del Municipio de Juárez (Agreement 139 of 2016), which, in Article 142, states that in areas without a UDP, donation areas for equipment and UGS must range from 10 to 12% of the subdivision's surface area, depending on the type and density. However, it does not specify how much should be allocated for equipment and how much for UGS. Additionally, Article 145 establishes that UGS in small, scattered fragments will not be accepted; instead, these spaces must have a minimum of 4 000 m² in social, popular, and economic housing developments, and 1 200 m² in medium and residential housing.

In terms of infrastructure, Article 145 of the Reglamento de Desarrollo Urbano Sostenible del Municipio de Juárez establishes that UGS must be delivered with connections to potable or treated water, an automatic irrigation system, sidewalks, curbs, urban furniture, vegetation, and tree planting in accordance with the regulations (Agreement 139 of 2016).

In the 2016 version of the UDP, the provision of UGS is 5.66 m² per capita, which represents a very small area. Furthermore, many UGS are in poor conditions, with sparse vegetation, a lack of

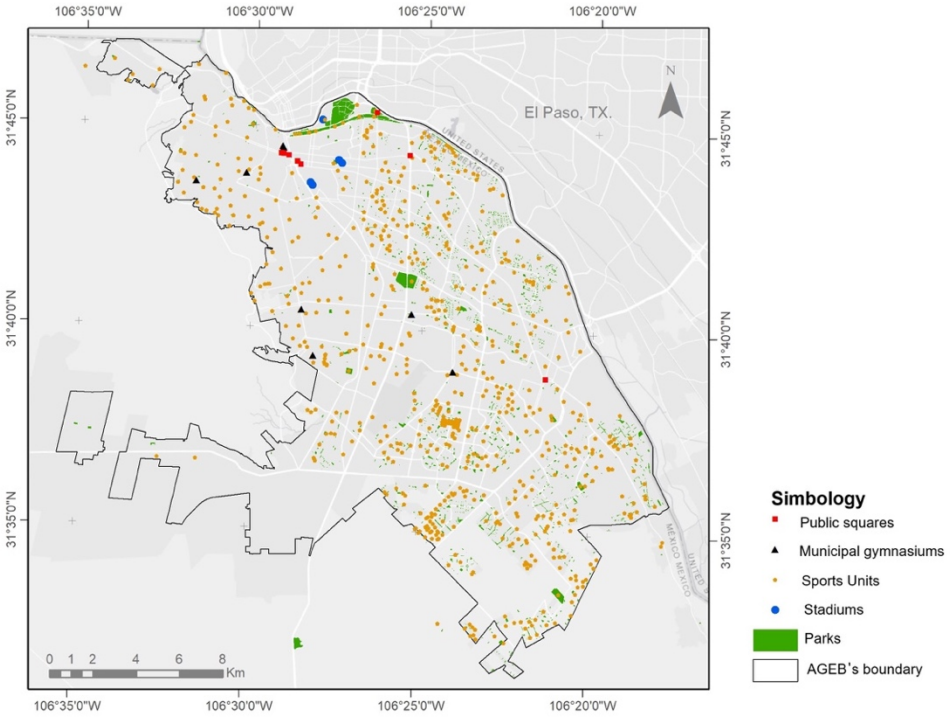
walkways, urban furniture, and other issues, particularly in the northwestern, western, central, southern, and southwestern areas, where the shortage of UGS is most noticeable (IMIP, 2016).

The Plan de Desarrollo Urbano Sostenible del Centro de Población de la Cabecera Municipal de Juárez, Chihuahua (PDUS 2040)[20] approved in August 2024, reports that as of February 2022, the city had an average of 6.6 m² of green space per inhabitant (IMIP, 2024). Its diagnostic report presents the percentage of UGS area by AGEB in the city, highlighting the urban areas where the unequal distribution of these spaces is most apparent. The document also assesses the conditions of vegetation, infrastructure, and urban furniture in these spaces, categorizing them as poor, fair, good, or vacant lots.

Number, Distribution, and Classification of UGS

According to the IMIP database (2017), Ciudad Juárez has 2,428 registered UGS. These spaces are predominantly concentrated in the eastern part of the city, while the western and southwestern areas face the greatest scarcity of such spaces (Map 3).

Map 3. Distribution and Type of Urban Green Spaces in Ciudad Juárez



Source: Author's elaboration based on IMIP data (2017).

Based on the classification proposed by Romo Aguilar (2008), the data in Table 5 shows that neighborhood parks are the most prevalent (34.93%), followed by district parks, which cover the

[20] Sustainable Urban Development Plan for the Population Center of the Municipal Head of Juárez, Chihuahua (PDUS 2040) (unofficial translation).

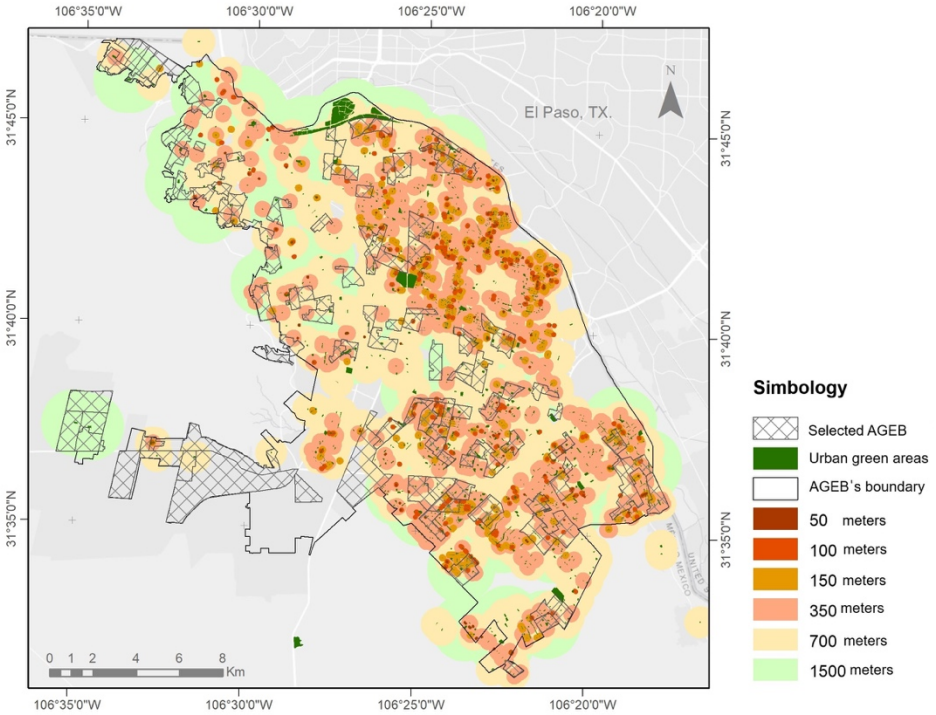
largest area percentage (35.29%). Urban parks come next, while public gardens occupy the smallest percentage of surface area (4.77%). Additionally, Map 4 illustrates that the district UGS in the selected AGEBs have greater coverage according to their influence areas.

Table 5. Total Distribution and Surface Area of Parks in Ciudad Juárez, 2017

Type of park	No.	%	Area (m^2)	Percentage of area	Cumulative percentage of area
Public garden					
A) 0 to 300 m^2	80	3.29	17 707.66	0.19	0.19
B) 300.01 to 600 m^2	253	10.4	115 345.61	1.22	1.41
C) 600.01 to 1000 m^2	393	16.2	316 441.27	3.36	4.77
Neighborhood park					
1 000.01 to 2 500 m^2	848	34.93	1 368 255.02	14.51	19.28
Community park					
2 500.01 to 10 000.01 m^2	724	29.8	3 327 050.82	35.29	54.57
District park					
1 to 3 ha	94	3.87	1 375 365.99	14.59	69.16
Urban park					
A) 3 to 10 ha		1.28	1 721 988.39	18.27	87.43
B) 10 to 45 ha		0.21	1 185 059.57	12.57	100
Total	2 428	100	9 427 214.33	100	

Source: Author's elaboration based on IMIP data (2017).

Map 4. Influence radius of green areas in the selected AGEBs in Ciudad Juárez

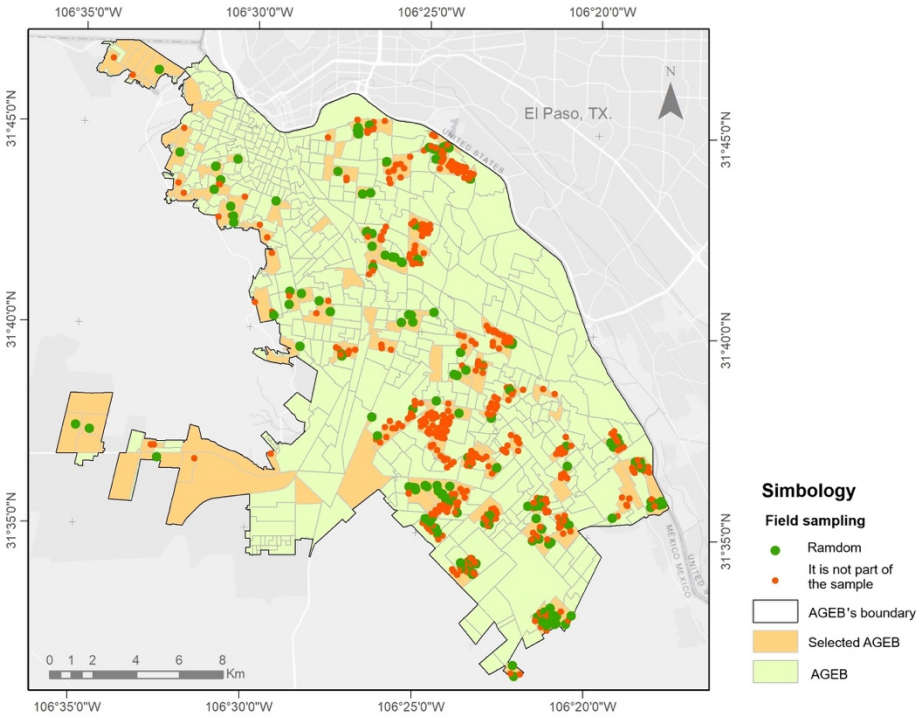


Source: Author's elaboration based on the project by Bojórquez et al. (2015-2019).

Evaluation of the Quality of UGS

The UGS selected for the application of the IERAF instrument aim to cover most urban sectors, with the exception of the northeast and the historic center of the city (Map 5). Regarding the quality analysis results, the findings show that 79.5% of the selected spaces have some form of traffic signage at pedestrian crossings.

Map 5. Existing Spaces and Selected Areas for the Application of the IERAF Instrument



Source: Author's elaboration based on the project by Bojórquez et al. (2015-2019).

Regarding adjacent UGS land use, 98.7% are residential areas, 31.4% commercial areas, and 25.6% institutional areas. Only 2.6% are industrial areas, such as warehouses or factories, while 17.9% are natural areas, such as bodies of water, rivers, or desert regions.

Regarding the appearance and safety of the neighborhoods surrounding the studied green spaces, that 33.3% had insufficient public lighting, 70.5% had graffiti on walls or buildings, 35.9% showed signs of vandalism, and 59% had significant amounts of trash on the streets, sidewalks, or surrounding properties. Additionally, 19.9% of the spaces experienced heavy vehicular traffic nearby, 25.6% had noise from the surroundings, and 3.8% were found to be desolate and isolated. On the other hand, 54.5% had buildings in poor condition or abandoned, and 63.5% were surrounded by properties in disrepair (e.g., peeling paint, overgrown weeds, untrimmed grass, broken windows, etc.). During the evaluation, no threatening individuals were encountered in the area, nor was there any evidence of drug use, alcohol, or sexual paraphernalia.

Among the UGS features, the data indicated that very few have on-site parking or a nearby public transportation stop (bus or taxi), visible from any point within the space. In terms of access points, nearly all spaces are fully open (87.2%) or have more than five access points (1.9%). The remaining spaces are limited to either a single access point (5.8%) or between two and five access points (5.1%).

Regarding usage hours, based on information provided by the person in charge or indicated on available signs, it was found that 92.9% are open 24 hours, while only five spaces have set hours, typically from 7 AM to 10 PM.[21]

As for admission fees, 97.4% of the spaces are free. However, two municipal gyms charge fees for specific activities, and for the remaining spaces, it was unclear whether a fee is required. Only 4% of the spaces have signage displaying usage rules.

In terms of maintenance, 17 spaces are maintained by individual neighbors, 14 by organized groups of neighbors, three by civil society organizations, two by private companies, nine by other unspecified means, and 25 by the municipality. For the remaining spaces, the responsible party is unclear. Additionally, 9.6% of the spaces are not maintained and are abandoned.

Very few spaces have any form of surveillance (15.4%), although there is some uncertainty about this aspect in certain cases (10.3%). The majority (97.4%) lack emergency devices such as public phones, emergency buttons, or instructions on how to act in case of an incident. In terms of visibility from the center of the park to the surrounding neighborhood, 77.6% have full visibility, 19.9% partial visibility, and 2.6% no visibility.

Table 6 shows the major service deficiencies within the spaces. For example, while sidewalks and walking paths are present in almost all spaces, they are in poor condition in some cases, and in some spaces, they are nonexistent. Likewise, sports courts and sandpits are generally absent, but when present, most are in poor condition. The most common courts are for soccer and basketball.

On the other hand, although the majority of the spaces have playgrounds (66%), more than one-third of them show some degree of deterioration. Only one space has a pool for both children and adults. The most common types of equipment are lighting, followed by benches, landscaping efforts, and irrigation systems, many of which show low or regular maintenance, particularly the latter. Most of the other equipment analyzed is absent in the majority of cases. It is also worth noting that all types of incivilities are observed, particularly excrement, broken glass, graffiti, and various forms of vandalism.

[21] Only one space had a visible sign displaying the operating hours, while in six other spaces, this information was unavailable.

Table 6. Results of the IERAF Instrument for the Studied Spaces

		Not present (%)	Poor (%)	Fair (%)	Good (%)
Services	Baseball field	98.7	0.6	0.0	0.6
	Basketball court	70.5	17.9	5.8	5.8
	Soccer field	90.4	9	0	0.6
	Futsal court	69.2	25.6	3.2	1.9
	Volleyball court	91.7	5.8	1.3	1.3
	Tennis court	100	0	0	0
	Sandpit	74.4	9.0	9.6	7.1
	Sidewalk	20.5	8.3	26.9	44.2
	Running or biking trails	39.7	7.1	16.7	36.5
	Bicycle parking	98.7	0	0	1.3
	Exercise stations	92.9	0	2.6	4.5
	Playground equipment	34	5.8	30.1	30.1
	Children's pool	99.4	0.6	0	0
	Adult pool	99.4	0.6	0	0
	First aid	99.4	0	0.6	0
Equipment	Wall or fence	58.3	7.1	14.7	19.9
	Access points	1.9	12.2	35.3	50.6
	Benches	25.6	6.4	15.4	52.6
	Drinking fountains	95.5	1.9	0.6	1.9
	Landscaping efforts	42.3	27.6	14.1	16
	Lightning	19.2	14.7	24.4	41.7
	Picnic tables with shade	96.8	0	1.3	1.9
	Picnic tables without shade	97.4	0	0	2.6
	Restrooms*	92.9	1.3	0.6	2.6
	Fountains	100	0	0	0
	Shelters or shade	86.5	1.9	1.9	9.6
	Showers, lockers	98.1	0.6	0	1.3
	Trash bins	76.9	7.1	5.1	10.9
	Structure for hanging piñatas	98.1	0.6	1.3	0
	Grills	98.1	1.3	0	0.6
	Irrigation system	61.5	25.6	3.8	9
	Noise	82.7	14.1	1.9	1.3
	Broken glass	25	23.7	11.5	39.7

(continues)

		Not present (%)	Poor (%)	Fair (%)	Good (%)
(continuation)					
Incivilities	Dog feces	23.1	17.9	14.1	44.9
	Loose dogs	55.8	20.5	19.9	3.8
	Lack of grass	9	9	21.2	60.9
	Overgrown grass	76.9	7.7	8.3	7.1
	Evidence of alcohol use	46.8	22.4	14.1	16.7
	Evidence of drug use	100	0	0	0
	Graffiti	37.2	17.9	15.4	29.5
	Trash	7.7	9	11.5	71.8
	Sexual paraphernalia	98.7	1.3	0	0
	Vandalism	42.3	33.3	71	173

* The conditions of four public spaces are unknown due to their closure.

Source: Author's elaboration based on the project by Bojórquez et al. (2015-2019).

Concerning tree cover, 14 spaces have no trees, 69 have tree cover ranging from 1% to 24%, 45 fall within the 25% to 49% range, 15 have 50% to 74%, and 13 have 75% to 100%. In terms of grass cover, 86 spaces have none, 38 have 1% to 24%, eight have 25% to 49%, nine have 50% to 74%, and 15 have more than 75%. Additionally, 84 spaces have no vegetation other than trees and grass; 70 have 1% to 24% additional vegetation, one has 25% to 49%, and another has 50% to 75%.

DISCUSSION

Among the key issues related to the planning process of UGS in Mexico, the following stand out: the legal framework is fragmented across various federal, state, and municipal laws and regulations; planning is not linked to sustainable development or ecosystem services; there is no long-term integrated planning, and existing plans are not adequately implemented; there is a lack of professionalization among stakeholders and insufficient coordination; data availability is scarce, especially regarding quality; there are no budgetary allocations for their maintenance, and they lack political support (Ojeda-Revah et al., 2020; Ojeda-Revah, 2021). These challenges have also been reported in other parts of the world in relation to UGS planning (Haaland & Van den Bosch, 2015; Boulton et al., 2018).

In urban development strategies, as a result of UGS planning, these spaces are not always provided with the required quantity and quality. In many cities, a standardized, non-integrated planning approach is primarily used (Flores-Xolocotzi & González-Guillén, 2010; Boulton et al., 2018). This lack of integrated planning is evident in the reduced number of UGS, insecurity, and social exclusion, as is the case in Ciudad Juárez. In line with the findings of Hoffimann et al. (2017), the results of the analysis of UGS in Ciudad Juárez show that both the quality and accessibility of the spaces are inequitable.

Among the analyzed UDPs of Juárez, the parameters for counting UGS vary, with some including spaces within gated communities while others exclude them. This leads to an apparent decrease in the UGS area during certain periods, particularly because the information is not updated regularly. According to Ojeda-Revah et al. (2020), this discrepancy arises from the lack of a clear and unified definition of UGS, as well as the absence of consistent data or data derived from different classifications, sources, sampling methods, and scales. The apparent decrease is also attributed to municipalities selling UGS land, a practice prohibited by the LGAHOTDU of 2016.

An important element of UGS is their size, as a larger surface area allows for various activities and facilitates the simultaneous presence of different population groups (children, adults, young people, etc.). To encourage their use, it is also recommended that the UGS have to be accessible within a 10 to 15-minute walk (Reyes & Figueroa, 2010). However, in Ciudad Juárez, 30% of UGS are smaller than 1,000 m², and another 35% are smaller than 2 500 m². In Mexico, this issue stems from the legislative framework for UGS (Ojeda-Revah et al., 2020), a problem also reported in the case of Chile (Reyes & Figueroa, 2010).

In terms of the quality of UGS, according to Ojeda-Revah et al. (2020), of the UDP corresponding to the 30 most populated municipalities in Mexico (including Ciudad Juárez), 63% do not consider quality as an indicator, while 73% emphasize maintenance as the key issue and attribute it to a lack of resources. In this regard, Salas-Esparza and Herrera-Sosa (2017) find that only 32.1% of UGS are attended to by municipal authorities, with the rest suffering from maintenance, irrigation, pruning, and infrastructure deficiencies. The participation of various actors responsible for maintaining nearly one-third of UGS, as indicated in this study, is particularly notable. For Ciudad Juárez, the lack of shade, drinking fountains, and vegetation is a major concern, given its desert climate with extreme temperatures. In fact, Salas-Esparza and Herrera-Sosa (2017) report a temperature difference of up to 3.82°C between tree-covered UGS and those without trees in the city.

CONCLUSIONS

Regarding UGS, there is a significant gap between theoretical and conceptual discussions, as well as between the regulatory framework and the development of planning instruments. While the importance of these spaces and their benefits is well-established and globally recognized, ensure the equitable distribution of high-quality UGS mere statistics. When evaluating accessibility, their quality is often overlooked; they are not planned in an integrated or long-term manner with urban green corridors or green infrastructure; their design is not inclusive, lacking citizen participation that could foster cross-institutional management and collaboration among various actors. UGS continue to be a secondary concern in planning instruments, regulations, and public policies, to the extent that their implementation in UDP is still not assessed.

Despite the well-documented benefits of the multifunctional nature of UGS and their contribution to urban well-being and quality of life from social, economic, environmental, and health perspectives (Meza & Moncada, 2010), UGS has not been fully integrated into planning policies, as evidenced in this study. In Ciudad Juárez, decades of urban planning have not resulted

in homogeneous access to quality UGS, making it a priority for planning authorities to systematically and consistently ensure the equitable distribution of high-quality UGS. The findings contribute to key issues regarding not only the quantity, area, and distribution of UGS in planning but also their quality. This enables more informed decision-making and the prioritization of objectives and resources (Haaland & Van den Bosch, 2015). The analysis of UGS planning in Ciudad Juárez revealed that urban development plans have not effectively incorporated the equitable distribution of UGS, leaving certain population sectors underserved, despite some progress in the latest UDP regarding the recognition of these spaces' importance.

The reviewed UDPs indicate that the quality of UGS is not considered a significant issue. For instance, in the 2003 UDP, only two UGS were highlighted as important due to their size, but no proposals were made regarding their quality or multifunctionality. These UDP show fluctuations in the total area of UGS over recent years, primarily due to inconsistent counting methods. Initially, private-access parks were included, but later excluded, while recreational and leisure spaces such as public squares, municipal gyms, and sports units were counted, even if they only featured small areas with vegetation. Regardless, all results point to a backlog of UGS in the city, without addressing quality issues, even though many are in deficient condition, as this study demonstrates.

The IERAF exposed the deficiencies in most UGS and offered valuable insights for planning new spaces and managing existing ones. The results emphasize the lack of tree cover and the prevalence of incivilities such as dog excrement, graffiti, litter, and alcohol use in many spaces. Additionally, numerous UGS lack essential amenities such as water fountains, shade shelters (despite the city being in a desert region), picnic tables, restrooms, trash bins, lighting, and irrigation systems. They also lack facilities for physical activities (sports courts or exercise stations), first aid equipment, and emergency devices, among others.

In conclusion, UGS lack genuine planning and continue to be treated as a minor or secondary concern in planning instruments, regulations, and public policy. Embracing integrated, systemic, and long-term planning approaches could unlock opportunities to fully leverage the ecosystem services that UGS provide.

Translation: Erika Morales.

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