Green Areas and Environmental Justice: Toward the Urban Sustainability of León, Guanajuato

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Abstract Green areas help improve the living conditions for all inhabitants in cities. This study contributes to clarify the relationship between environmental justice and urban sustainability based on the analysis of the rate and distribution of urban green areas particularly in the case of the City of León, Guanajuato, Mexico. A systematic literature review related to the topic of study was conducted. In addition, spatial analysis of the rate and distribution patterns of urban green areas in the city was carried out and some of the basic principles that guide the planning of green areas in the city were discussed. The results showed that there is a rate of green areas in the City of León of 1.74 m^2, which follows a dispersed pattern of urban growth, characterized by a socio-spatial fragmentation of the city. The rate of green areas in the priority polygons is about 1.86 m^2, with unequal concentrations on each zone and an influence range that restricts an equitable access to the benefits of these areas. It has been identified that urban sustainability implies the habitability of the public space, which involves the guarantee of a more equitable, equal, and democratic use of the natural richness or of the one socially generated, where the

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green areas constitute a strategic element to reach the environmental, economic and social benefits of the sustainability.

Keywords Green areas · Environmental justice · Urban sustainability

1 Introduction

Cities certainly offer opportunities for employment, education and other basic services for human development; however, pollution, energy expenditure and consumption of natural resources, exclusion, as well as inequality and socio-spatial segregation that characterizes the cities, generate deficient living conditions and environmental, economic and social vulnerability, affecting large segments of the population.

The new approaches for sustainable development seek to understand and manage those factors that influence urban integration and well-being of the population. Strategies and policies are focused on the importance of meeting the needs of the inhabitants, their rights and aspirations, beyond the exclusive administration of the physical, anthropic or natural components of the city. Thus, the presence of sufficient and high quality green areas is one of the main variables that affect the well-being of urban dwellers, as well as their distribution and equitable access.

Different researches have documented the environmental, social and cultural benefits that green spaces provide for the improvement of the living conditions of the population, (Reyes and Figueroa 2010; Vélez 2009; García and Guerrero 2006; Chiesura 2004; Krishnamurthy and Rente 1997) particularly for sectors which are in poverty or social backwardness (Wolch et al. 2014).

Given the benefits provided by the green areas, these spaces gain a strategic relevance to generate sustainable urban environment, especially when considering that according to the United Nations (2016) in 2014, 54.0% of the world population lived in cities, and this number will continue to increase in the coming years. In Mexico, the percentage is even higher, 8 out of every 10 inhabitants were considered urban in 2010 (INEGI 2016).

In 2015 the General Assembly of the United Nations proposed 17 objectives to reach sustainable development, establishing the year 2030 as the deadline to achieve it. The eleventh objective in the Agenda, agrees that the cities and human settings should be inclusive, particularly for women, children, persons with disabilities and older persons (United Nations 2016).

The Quito Declaration (United Nations 2016) on the New Urban Agenda calls to promote the feeling of belonging to the cities, amongst other factors, through the well-connected and well-distributed public spaces within the city. These spaces need to be secure, inclusive, accessible, green and with high quality; contributing to the improvement of the social interaction and intergenerational coexistence, as well as to the free demonstration of the cultural expressions. The intention is to encourage the creation of inclusive, safe, peaceful and plural cities, where the specific needs of the

social vulnerable sectors are recognized. The equitable distribution and access to green areas is a matter of environmental justice and therefore important for achieving urban sustainability.

Given this panorama, the study makes a spatial analysis of the distribution of green areas in León, Guanajuato, aiming to clarify the relationship between environmental justice and urban sustainability. The research is based on the premise that sustainability seeks to make the city habitable by generating a suitable environment to fulfill the needs and aspirations of its inhabitants with the intention of improving their quality of life and that the presence of green areas is a decisive element of urban sustainability. For these reasons, this research also discusses some of the basic principles that guide the planning of green areas in the city of León.

2 Equal Distribution of Green Areas: A Matter of Environmental Justice

In the urban field, sustainability is often reduced to the search for balance between the natural and built environments. If the city meets certain environmental criteria, such as water savings, energy savings, waste recycling and efficient transport, it is said to be sustainable. However, the concept goes beyond the conservation of nature and its availability to meet the current and future material needs of the population. Urban sustainability implies to make the city livable, regardless of its size (Lezama and Dominguez 2006), meaning the quality of a place to meet the people's needs and aspirations (Castro 1999 cited by Moreno 2008). Thus, the adaptation of the surrounding environment has a purpose: to improve the quality of life. Pérez Maldonado (1999 cited by Moreno 2008) argues that the quality of urban life involves the feeling of biological and psychosocial comfort of those who inhabit and live in the city, by determining the degree of satisfaction in the use of services and the perception of the urban space as healthy, safe and visually pleasing. The presence of green areas is therefore a conditioning factor of urban livability, resulting in the improvement of the inhabitants quality of life (Alcalá 2007).

An important principle of urban sustainability is undoubtedly social equity, which has its foundations in justice, regarding the distribution of resources and equal access to public services essential for development and enjoyment of life. In urban contexts, equity is related to inclusion in two dimensions: social and environmental. In a society, there will be social equity if there are no discriminatory or exclusionary practices that prevent inhabitants from participating as citizens in the economic, political and social spheres (Pierson 2000 quoted in Dempsey et al. 2011), and there is enjoyment of services and benefits of the ecosystem and a healthy urban environment, which also promotes social and environmental justice.

Urban areas in a poor living environment and with limited or unequal access to public services are areas of social and environmental exclusion and injustice. Key

public services to which all urban dwellers must have equitable access, include education, transportation, housing, infrastructure, spaces for culture, exercise and recreation, as well as green areas (Dempsey et al. 2011). However, it is clear that not all inhabitants have equitable access to these services, due to the social and structural conditions generated by the phenomenon of globalization and, on the other hand, to the accelerated process of urbanization that has taken place in many cities. Social and territorial fragmentation has resulted in poorly articulated urban systems, where a large part of the population lives in conditions of marginalization, social exclusion and with no environmental justice.

Environmental justice involves the recognition of the fundamental rights to a healthy environment, as well as the defense of human rights and prerogatives of a social, economic and human development nature, that ensure fair distribution and quality provision among all individuals and population groups to the environmental, social and cultural benefits that an ecosystem provides (Ramirez et al. 2015; Bonne and Fragkias 2013; Steward et al. 2013). A fair distribution means, that the most vulnerable population groups receive the greatest benefits, a goal that requires an equitable system in which public administration establishes compensatory, corrective and guaranteeing strategies and policies for access to environmental services, depending on the nature and context (Cancino 2014; Svara and Brunet 2005).

The provision of quality services, involves the ensuring of the long-term maintenance of ecosystem functions, as well as the transfer and acquisition in optimal conditions, under minimum standards, of the services and benefits for the whole population. In this sense, some sectors may have their own means of achieving a pleasant, dignified and valuable life, but others may not, unless the public administration guarantees it (Svara and Brunet 2005).

In relation to green areas, it has been established that environmental justice is given in the beginning, by the equal assignation of green area per inhabitant or by funds or sources of recreation per capita by neighborhood or socioeconomic status (Bonne et al. 2009). Other authors consider that, in addition, an equitable distribution in the number of green areas throughout the city is necessary to avoid socio-spatial segregation; however, proximity does not ensure itself equitable access or translate into positive effects if people cannot freely experience the place due to social factors in the environment such as crime or heavy vehicular traffic (Jennings et al. 2016). The sociodemographic characteristics of the population, as well as their needs, merits and choices, could also determine the opportunities for equitable access to these spaces (Hay 1995).

To ensure universal access to safe, inclusive and accessible green spaces it is necessary to have indicators that, through quantitative and qualitative variables, evaluate their nature, quality and functionality in the urban fabric (Keng et al. 2015; Haq 2011; Reyes and Figueroa 2010; Vélez 2009; Garcia and Guerrero 2006; Chiesura 2004). For example, for the green area per capita, the World Health Organization (WHO) established a minimum area of 9 m^2 per inhabitant (Saz and Rausell 2008).

The sources available agree that there is a deficit of green areas for the City of León. The ratio of green areas per capita is 1.7 m^2, according to the "Diagnóstico Ambiental de León (In English: "Environmental Diagnosis of León") (IMPLAN 2015). However, the use of this indicator, based on the total concentration of the surface in proportion to the population number, only covers one aspect of the phenomenon, whose reality could vary throughout the city, and, thus, determine the equal access different social groups have to the benefits provided by green areas.

3 Methodology

1. Study area and unit of analysis

The study area is located in León, one of the municipalities of the State of Guanajuato. It has a population of 1,578,626 inhabitants, equivalent to 26.0% of the state population (INEGI 2015); It is part of a metropolitan agglomeration of 1.7 million inhabitants, located to the northwest of the state, within the region known as the Bajío Mexicano, which is characterized by a growing economic dynamism in the automotive sector, which has favored the consolidation of an industrial belt that seems to develop with some autonomy.

Geographically speaking, the municipality is characterized by the presence of steep slopes and hills to the north, large expanses of plains and some hills towards the center, a portion that comprises the urban area and of greater growth of the city and by extensive plains towards the south, where different agricultural activities are performed. The center portion covers about 22 thousand hectares, that is, 17.0% of the total area of the municipality; it concentrates most of the population and presents average densities of over 50 inhabitants per square kilometer. Official data shows that there are 685 green areas located in the urban area of León, between parks and public gardens, covering an area of 228.98 ha. (IMPLAN 2015). In the study area, there are 559 green areas totaling an area of 215.98 ha.

The unit of analysis for this study is the Basic Geostatistics Area (AGEB), which gathers information on the characteristics of the population and housing according to the Census of Population and Housing survey conducted by the Instituto de National Institute of Statistics and Geography (INEGI) in 2010. In the study area, there are 398 analysis units, with a total population of 1,237,418 inhabitants.

2. Analysis of the distribution of urban green areas

The analysis of the distribution of urban green areas in the city of León was made from the classification of the study units into 9 classes, as shown in Fig. 1. The classification obeys three conditions: the presence of green areas, the coefficient of green areas and the degree of urban marginalization. The coefficient expresses the area (square meters) of green area per inhabitant, in two ranges: <9 square meters and ≥ 9 square meters. The computing of the coefficient was obtained from the population data of the Population and Housing Census 2010

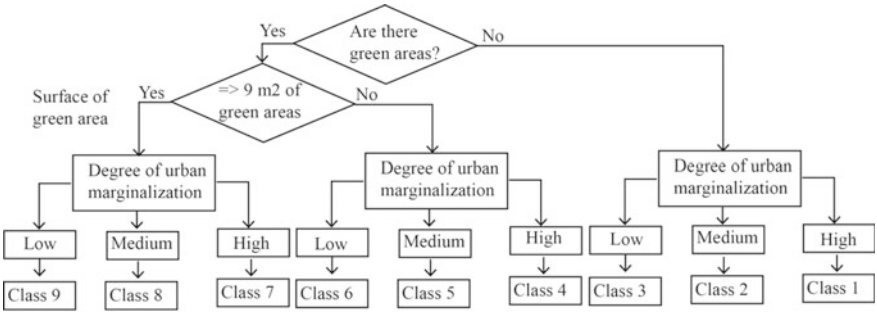

Fig. 1 Classification of the study units by classes

(INEGI 2010) and the total area of green area by AGEB, according to information from the Environmental Map of the Municipality of León (DGGA 2017). The degree of urban marginalization of the units of analysis was obtained from the classification made by the National Population Council (CONAPO 2010), which is a measure that expresses the shortcomings of the population in terms of income, health, education and housing. The degree of marginalization falls into three categories: high, medium and low. Finally, a non-parametric test of chi square was calculated at 95.0% confidence to evaluate the relationship between the degree of urban marginalization and the coefficient of green areas per inhabitant.

3. Analysis of the regulatory framework related to green areas.

The analysis of municipal plans, programs and legislation included the revision of the normative instruments in urban and environmental matters, in force in December 2016, in order to know the conceptual and operational bases that assist the planning of the green areas of León dealing with the endowment, maintenance or conservation of the green spaces located within the urban area of the city.

4 Results

1. Planning and regulation of green areas

Planning and administration of green areas involve the departments of urban, environmental and planning administration in the City of León. It is related to problems in matter of environmental, territorial, landscape and institutional management. Public administration possesses four policy instruments to regulate the management of green areas: "Programa Municipal de Desarrollo Urbano y de Ordenamiento Ecológico y Territorial" (H. Ayuntamiento de León 2015), "Reglamento para la Gestión Ambiental" (H. Ayuntamiento de León 2014), "Programa Municipal de Espacios Verdes Urbanos" (H. Ayuntamiento de León

2016) and "Código Reglamentario de Desarrollo Urbano" (H. Ayuntamiento de León 2010).

The "Programa Municipal de Espacios Verdes Urbanos" (In English: "Municipal Program of Urban Green Spaces) states that green areas are components of the public space, which contains living elements that constitute the physical basis of their environmental value and of the relationship that the community maintains with the natural environment in the urban context. Operationally, the municipal green areas are spaces with plenty of plants in stratification, with layers that go from trees to low vegetation and with urban illumination equipment. Green areas are located within urban land and possess the status of common property in behalf of all citizens because of the environmental, recreational, cultural and educational services they provide and the improvement of the urban image. Its typology includes: urban park (when the surface is equal or greater to ten thousand square meters), public garden (if its surface is less than ten thousand square meters) and landscaped areas.

Strategies of urban policy are based on an environmental approach which addresses two aspects: the increase of green areas surface and the maintenance of the existing ones. Regarding the first aspect, the definition of the term "green area" contains a key concept: "donation area", which reveals the mechanism that is used to promote the global increase of the surface of municipal green areas. According to the "Código Reglamentario de Desarrollo Urbano" (In English: "Regulatory Code on Urban Development"), a "donation area" is defined as: "*the area of land that the developer transmits to the Municipality, destined to the provision of urban equipment and green areas of the subdivisions and condominium developments, in the proportion established in the Territorial Code, with respect to the total area of the authorized project*;" (H. Ayuntamiento de León 2010, p. 8). In this context, the creation of new municipal green areas, urban parks or public gardens, is subject to a process of transmission of goods, from a private to a public one, linking the increase of the green area of common use and public utility with the dynamics of Housing Development market, which is marked by the times and practices between the public administration and the real estate sector. For that situation, there is an unequal access and distribution of the benefits that green areas provide throughout the city and for different population groups.

2. Distribution of green areas along city

A crossing data analysis on the degree of urban marginalization and the coefficient of green areas for each unit of study was held and the results of the spatial analysis show an unequal, inequitable and deficit distribution of the green areas in the study area.

The average coefficient of green areas per inhabitant in the study area was calculated in 1.74 m^2 (215.98 hectares of green area/ 1,237,418 inhabitants). However, for 45.94% of the population there is an absence of green areas in their living surroundings and for only 3.26% of the population, the surface of green areas is higher than 9 m^2 per inhabitant, which is the recommendation issued by World

Health Organization (Saz and Rausell 2008). There is a significant association between the degree of marginalization and the coefficient of green areas ($X2 = 95.27$ $p < 0.001$).

Class 1 and class 9 represent the extremes in terms of the best and worst conditions in the distribution of green areas along the city. 12.52% of the population belongs to class 1, characterized by a high degree of urban marginalization and absence of green areas. It is located in the periphery of the city, in areas of recent urban expansion, as shown in Fig. 2. By contrast, only 2.55% of the population is within class 9, showing a low degree of marginalization and a provision of green areas higher than 9 m^2. This population is grouped in three blocks to the northwest, northeast and south of the city.

The majority of the population (46.3%) belongs to classes 2 and 5; showing medium levels of marginalization and a low or even an absent coefficient of green areas. These classes are located at the center and western parts of the city. Population with high levels of marginalization, classes 1, 4 and 7, constitute 17.41% of the total population. They are characterized by the lowest rates in the provision of green areas, which denote inequity in the distribution of green areas for the population that most need them. However, the absence of green areas affects all population groups as shown in Table 1. 45–94% of the population does not have

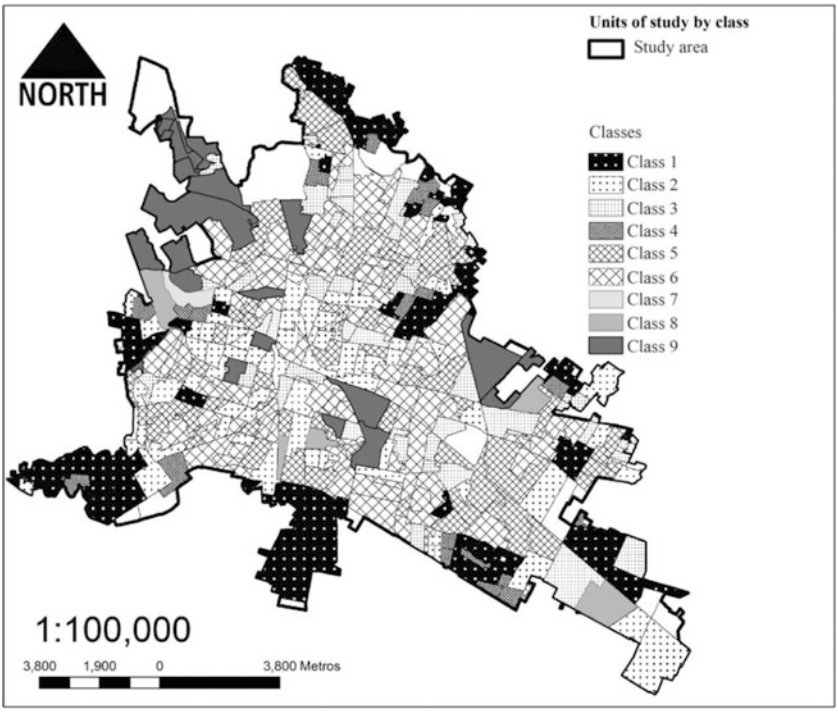

Fig. 2 Distribution of units of study by classes

Table 1 Population classes by the degree of urban marginalization and coefficient of green areas

		Degree of urban marginalization % of population			Total of green areas surface (%)
		High	Medium	Low	
Coefficient of green areas by inhabitant (square meters)	0.00	Class 1 = 12.52 (154,972 inhabitants)	Class 2 = 24.93 (308,546 inhabitants)	Class 3 = 8.48 (104,920 inhabitants)	45.94 (568,438 inhabitants)
	0.01 a < 9.00	Class 4 = 4.75 (58,764 inhabitants)	Class 5 = 21.44 (265,244 inhabitants)	Class 6 = 24.62 (304,665 inhabitants)	50.81 (628,673 inhabitants)
	≥ 9.00	Class 7 = 0.04 (437 inhabitants)	Class 8 = 0.67 (8,349 inhabitants)	Class 9 = 2.55 (31,521 inhabitants)	3.26 (40,307 inhabitants)
Total of population in urban marginalization		17.31 (214,173 inhabitants)	47.04 (582,139 inhabitants)	35.65 (441,106 inhabitants)	100.00 (1,237,418 inhabitants)

Information sources Elaborated with data from the Census of Population and Housing (INEGI 2010), the Environmental Map of the city of León (DGGA 2017), and the classification on degrees of urban marginalization by the National Population Council (CONAPO 2010)

immediate access to green areas. 24.93% and 8.48% in that condition show degrees of marginalization classified in medium and high, respectively. It denotes an uneven distribution in the green areas of the city for all population groups.

Regarding the urban zones with the highest poverty conditions or so-called "priority polygons for human development", the coefficient of green areas per inhabitant was estimated in 1.86 m^2. It is comparatively higher than the city average rate, but still negative. As seen at Table 2, the distribution of green areas among the polygons is unequal. For instance, five zones show low rates below the municipal average and two of them rate at half of the municipal average.

Regarding the maintenance condition of existing green areas, the "Programa Municipal de Espacios Verdes Urbanos (In English: "Municipal Program of Urban Green Spaces") points out that projects, measures and actions need to be developed to ensure maintenance, conservation and improvement of green areas. That requirement is evident, because of that 43.37 ha of green areas shown at Table 3 (20% of the total area of urban green spaces) are neglected, especially in poverty zones as is the case in priority polygons for human development in León, which contrasts with the good maintenance condition of green areas located in the middle and high socioeconomic strata (IMPLAN 2012), reflecting inequalities and exclusion in access to quality public services for the whole population and the need for environmental justice.

Table 2 Green areas within the "priority polygons for human development"

Name of the priority polygons for human development	Population (Inhabitants)	Green areas surface (Hectares)	Quantity of green areas	Surface of green areas per capita. (m^2/ inhabitant)	Negative balance of green areas (Hectares)
Diez de mayo	127,952	23.62	45	1.8	91.53
Jacinto López	47,644	39.77	15	8.3	31
Las Joyas	70,400	8.27	35	1.1	55.08
Los Castillos	73,850	4.21	18	0.5	62.24
Medina	158,113	24.46	38	1.5	117.84
Piletas	43,357	4.85	9	1.1	34.16
San Francisco	74,275	5.88	61	0.8	60.95
	595,591	111.08	183	1.8	42.49

Information source Elaborated with data from Diagnóstico del Municipio de León (IMPLAN 2015)

Table 3 Condition of urban green areas by class

Category	Number of Green urban spaces	Surface (Hectare)	Number of Green urban abandoned spaces	Surface (Hectare)
Urban parks				
Metropolitan parks	6	45.22	0	0
Urban parks	41	67.46	16	26.20
Public gardens				
Neighborhood parks	53	35.48	7	5.13
Neighborhood parks	545	73.48	79	12.04
	645	221.63	102	43.37

Information source "Programa Municipal de Espacios Verdes Urbanos" (In English: "Municipal Program of Urban Green Spaces") (2016)

Planning regulations assess the distribution of green areas along the city through four indicators: surface for the use of green areas, improving surface of green areas, number of linear parks and percentage of urban green spaces in use per year.

Indicators are intended to describe a specific process, condensing information of several attributes, characteristics or important properties of a system, unlike the strictly numerical information (Masera et al. 2000). The changes that occur can be measured by means of qualitative and quantitative variables, which allow the full evaluation of the achievement of an objective, a product or a project. In the case of León, the indicators measure mainly quantitative aspects: the concentration of green area surface in relation to the total urbanized area. This approach leaves aside other variables both quantitative and qualitative that would serve to evaluate quality and

functionality of green areas at multiple scales of the territory. Consequently, the instruments that have assisted the urban planning in the city of León have provoked an unequal distribution and access to the green areas, in terms of surface and quality, which is a matter of environmental justice, and also limits the aspiration for achieving urban sustainability in the city.

In recent years, new patterns of urbanization in León have been characterized by the construction of different models of housing development. Some of them, under a design pattern in controlled access clusters and the presence of private green areas, where groups with a medium and high-income level reside. Other housing complexes have a popular character with null or low provision of green areas and are characterized by a population of low income level. In addition, irregular settlements inhabited by a marginalized population have emerged, with less access to essential public services for a better quality of life and better social well-being (Suárez et al. 2015). Thus, the green areas have not been evenly distributed along the city, so that the inhabitants do not have the same possibilities of accessing them and therefore the benefits they offer.

The importance of green areas as a strategic element for achieving urban sustainability is justified if we assume that they fulfill environmental, social and cultural functions that improve the quality of life and social well-being, as illustrated in Fig. 3. Green areas are therefore a strategic element to be considered within planning or urban development programs, contributing to the achievement of the goals set by the United Nations General Assembly and the New Urban Agenda, which, however, until now have been rarely contemplated, as it is the case of the City of León, Guanajuato.

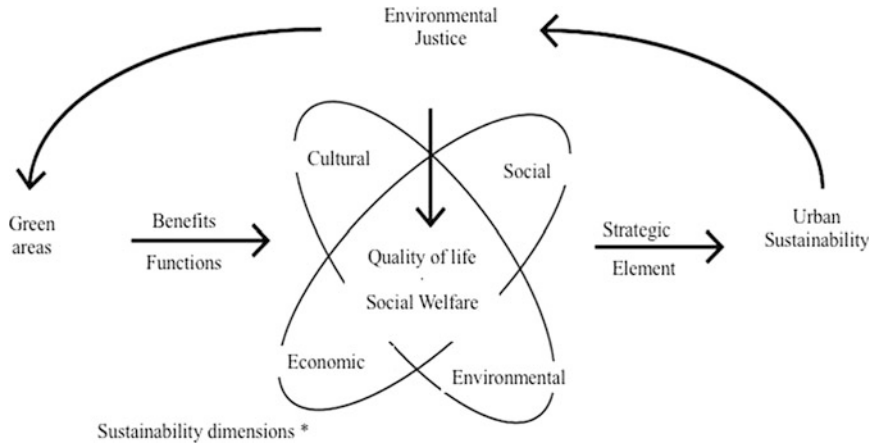

Fig. 3 Importance of green areas for urban sustainability

5 Conclusions

The recent incorporation of the concept of sustainability into the scientific field requires clarifying of its theoretical and methodological implications. This article aims to offer an insight that sustainability involves a multidisciplinary approach, which holistically addresses problems of a complex nature. The reflection on the concept of urban sustainability has led to the conclusion that it is necessary to provide elements for a more equitable, egalitarian and democratic access to a natural or socially generated wealth. This implies ensuring habitability, providing environmental justice, equity and social inclusion. As it has been discussed, green areas are a strategic element for the achievement of these objectives because of their environmental, economic and social benefits that encompass all dimensions of sustainability. Green areas have qualities that lead to improved living conditions, as they contribute to the construction of inclusive urban environments with a healthy environment conducive to coexistence, quality of life and social well-being. The results of the study on spatial analysis based on variables related to the coefficient of green areas per capita and the degree of urban marginalization showed an unequal, inequitable and deficit distribution of the green areas in León. The challenge that lies in this city, which is subject to processes of rapid and dispersed urbanization is to achieve a fair and equitable distribution of green areas, as well as guarantee the accessibility and enjoyment of the benefits they provide, particularly for socially vulnerable groups. Future studies are needed to analyze the accessibility of these groups to green areas and its contributions to the improvement of quality of life and social well-being. The latter would help generate effective strategies and instruments to achieve urban sustainability, with environmental justice.

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