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Article

Environmental justice and urban parks. A case study applied to Tarragona (Spain)

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Abstract: There is consensus over the fact that urban green areas contribute to the quality of life of their inhabitants. So, efficient city management must assess whether the population has access to green areas and their quality in relation to vegetation, facilities or furnishings, for example. Therefore, the objective set is to establish the environmental justice of urban parks in Tarragona (Spain) by developing a Park Quality Index (PQI) and the sociodemographic characteristics (level of studies, Human Development Index [HDI], home sale and rental prices) of the population living within 300 metres of a park. To prepare this, a GIS-integrated Multi-Criteria Evaluation (MCE) has been produced. The results show that the green areas have low accessibility and availability and that most parks obtain an average-low PQI, with the best- valued aspect being the vegetation and the worst the facilities. As for the degree of environmental justice, a casual relationship emerges between the PQI and the indicators used. The average value of the home sale prices is the one that shows the greatest correlation. These results can be used together with participatory procedures as a basis for identifying places with greater inequality, and for selecting the more effective actions that enable increasing environmental justice with respect to green areas.

Keywords: Environmental justice, Urban parks, Tarragona

1. Introduction

The concept of environmental justice appeared in the last third of the 20th century, within the framework of «assessing the distribution of the benefits and damage caused by human agents between places and population groups, in order to determine whether or not serious discrimination exists» [1]. The general context was a growing awareness that the spatial distribution of some human activities was clearly discriminatory for one part of the population. For example, generating, handling and storing hazardous waste or the territorial distribution of certain pollutant industries tended to be located in areas occupied by the less favored part of the population. Environmental justice considers that «there is a universal right to nature» on all levels (individual, family, community...), with the environment being understood as a common good [2]. So, the basis of the concept is the non-discrimination of environmental benefits and damages and the need to establish participative decision mechanisms «that can distribute those benefits and damages equitably among a justice community made up of located entities (subjects and objects), both current and future, who may have unequal rights and obligations» [1].

From this point of view, environment justice or discrimination can be measured, in general terms, by calculating the overall computation (social, territorial and temporal) of the environment costs and benefits (which in economic terms are often called «externalities») generated by a certain activity or project, so as to later clarify whether or not the distribution of these elements is fair among the various groups that may be affected by said activity, one way or another. However, other authors uphold including other non-economic elements in the analysis, and choose to use indicators and variables of a different level of measurement, by applying multi-criteria analysis [3].

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Traditionally, the study of environmental justice has focused on analyzing the distribution of facilities with toxic emissions, waste dumps and other environment hazards that are disproportionately close to socially disadvantaged groups. However, recent works have extended the scope of this concept to include terms such as equitable access to green areas and other natural resources [4,5]. This new interest is related to the conviction that urban parks or urban green areas help to increase the quality of life of city inhabitants.

There is consensus over the fact that, broadly speaking, green areas imply benefits in six different areas [6]: 1) they help to fight pollution [7] and contribute to microclimate normalization [8,9]; 2) reduce noise [10]; 3) improve the population's emotional wellbeing and psychophysiological balance by increasing the feeling of security [11]; 4) they improve mental and physical health [12]; 5) promote outdoor life and social meetups [13] and 6) and they increase citizens' environmental awareness. So, urban green areas regulate the temperature and humidity, produce oxygen and filter radiation; also, they absorb pollutants and muffle noise; and, in addition, they are a place for going for a walk, an area for relaxing and for leisure. However, beyond their intrinsic value (their good organization, quality or degree of protection), often it is their symbolic dimension which makes them places citizens appreciate.

Therefore, the World Health Organization considers urban green areas to be essential due to their inherent benefits for physical and emotional wellbeing [14]. From this point of view, in order to focus efficient city management on community interests, we have to assess whether or not the population has access to green areas, and in addition, the quality of these areas in terms of, inter alia, the existence of vegetation, available or existing facilities or street furnishings. Therefore, the general objective of this work is to establish the degree of environmental justice in the urban parks in the city of Tarragona by establishing a PQI and learning about the population's socio-demographic characteristics. To do this (1) an MCE model has been constructed within a GIS, which allows us to establish the PQI, (2) indirect, standardized indicators have been determined for the socio-economic characteristics of the population living within 300 meters or less of the access to a park, such as the Synthetic Training Index (STI), the HDI or home sales prices in each sector and (3) the PQI has been correlated with the population's socio-economic characteristics to obtain the spatial justice results in terms of the availability and quality of the urban green areas. The work is organized into 7 sections, plus the bibliography. The introduction reflects on the concept of environmental justice; while the second section reflects on the rapport between the quality of life and urban green areas, as well as reviewing methodology and concept aspects; the third section introduces the area of study; the fourth details the methodology stages and the tools used, while the fifth reveals the results; the sixth contains the discussion and the last one contains the conclusions.

2. Environmental justice and urban parks through accessibility, quality and population characteristics. Approaches and methodologies for studying them

The accessibility and quality of urban parks are essential factors that are frequently used to establish whether or not environmental justice exists. In addition, other factors regarding population characteristics and socio-economic indicators are used. These components are related through different spatial analysis processing and methodologies.

2.1. Environmental justice factors in urban parks. Accessibility, quality of the parks and socio-demographic characteristics of the population served

A significant part of the work on environmental justice and urban parks has focused on assessing the distribution of green areas in the city [15,16], by calculating the distance between the place of residence and the nearest green area, and using a geographic information system [17]. Although the unit often used is the distance in meters, some authors choose to measure accessibility using the travelling time according to the means of transport used (public transport, by foot, by bicycle and private car) [18]. Calculating these indicators using Euclidean and network distances shows a clear influence of the type of

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distance chosen (Euclidean versus the distance in the network). Therefore, we have to use these indicators carefully as planning support tools.

Analyzing accessibility, understood to be the physical or time separation between the actual location of the park and the users' place of residence, is complemented with architectural accessibility issues (for example, if it is a non-closed space); psychological accessibility (if it is attractive enough for the potential users to visit it) [19] or its «walkability», i.e. its transitability whereby the parks are accessible to people with limited mobility, such as children or the older population [20].

However, it is clear that the potential user public in each park (served population) is not made up of a uniform group of individuals with common demographic, economic and social characteristics. In fact, there is a consensus confirming that social injustice regarding urban green areas usually goes hand in hand with a certain social stratification and/or residential segregation [21], which can lead to what some authors call «green gentrification» [22]. In this respect, some contributions examine the relationship between the number, proximity and quality of green areas, the socio-economic characteristics of the inhabitants [23-26] and the composition of the dwellings [24]. In addition to these characteristics, consideration is often given to the ethical composition [27-29]. For example, De Sousa [22] in their comparative work between Faro (Portugal) and Tartu (Estonia), observed significant inequalities in the housing districts of the socialist stage in the first of the cities, where most of the Russian minorities live (with variable availability of public green spaces between 1.04 and 164.07 sqm. per inhabitant), whereas the Romanian communities in Faro were located in districts without access to public green spaces, although with smaller differences (from 1.22 to 31.44 sqm. per inhabitant). Other studies, on the other hand, focus on specific demographic groups like young people [6] or immigrants [30]. The availability of this information and its high degree of territorial disaggregation in sources like the Municipal Register of Inhabitants makes it easy to use since it can be georeferenced. The data on the population's income is a different case, because due to confidentiality issues, it is difficult to obtain. In this case, it is essential to use secondary sources to deduce the economic level of the population that a park serves.

2.2. Approaches and methodologies for the environmental justice study regarding urban parks

An important issue shared by the literature consulted is the actual definition of an urban park. Although there is no single definition, the one provided by Jennings *et al.* [31] is considered appropriate (as it is necessarily broad), and states that urban parks are «a kind of green area that is generally public property and, consequently, accessible to the general public; and can include children's parks, leisure facilities and other characteristics that promote open air recreation». In order to analyze these urban green areas, they have been divided into categories according to their surface area and function in the urban space, according to their contents, different services, uses and social values that they provide for different segments of the population [23, 32].

A large part of the works published on environmental justice regarding urban parks adopt a quantitative perspective. Qualitative approaches on this question are harder to find. In this respect, a notable exception is the work by Smiley *et al.* [33], who analyses the opinions and preferences of minority ethnic groups regarding the use of the urban parks in Houston (Texas) using the data obtained from two ad hoc surveys. From a quantitative orientation, GIS have been used to process the information. However, some authors have criticized the use of these tools, arguing that they specify the geographical units and threshold distances inappropriately and ignore the actual movement by people. Therefore, in some recent research, people have opted to use the georeferenced data produced by the mobile telephone to obtain behavior patterns within green areas. These emphasize the real activities by park users, in terms of both space and time [26]. Another option is applying a public participation GIS, which can be an alternative for obtaining multifaceted knowledge on accessibility patterns [34].

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In order to establish the relationship between the distribution and quality of the parks and the population's socio-demographic characteristics, the Pearson correlation coefficient [25], the index of dissimilarity or the analysis of conglomerates has been used [35]. Often, these parameters are accompanied by the use of statistical indicators to measure the significance of the differences observed, like the Gini coefficient or the analysis of variance (Anova) test [23,29]. Equally, in comparative works between two or more cities, logistic regression techniques have been used to control and neutralize the different characteristics of the urban fabric among the study cases [29]. Finally, another methodological aspect refers to the actual measurement of the social and environmental quality of the urban parks. In relation to this, some authors express the need to measure six parameters: access, services, security, social inclusion, visual and aesthetic quality, and, finally, the ecological function [36].

3. Area of study. The green areas and the urban parks in Tarragona

The city of Tarragona is part of an urban area with nearly 380,000 inhabitants, with 16 municipalities and a surface area of just over 350 square kilometers. In 2019, the municipality of Tarragona had a population of 142,859 inhabitants, who, when distributed over the 57.88 square kilometers of their municipal area, represent a density of 2.468 inhab./km^2. However, this average value does not reflect the internal inequalities, since the city has a clear «oil stain» layout, with a consolidated and densely populated urban center and a polarized periphery [37].

The Catalan Urban Planning Act (revised text of 2010) establishes that the urban structure of the municipalities is made up of general and local systems, the facilities and a system of free public places. The system of free spaces includes parks, gardens, green areas and spaces for amusement, leisure and sport. The urban green system is usually formed in the urban fabric in a series of isolated elements that can have an important ecological value with respect to the continuity of habits. So, the linear elements such as walks, park ways or linear parks, behave like connectors complemented by the tree-lined roads in the urban section. The interconnection between parks, gardens and interstitial spaces makes up a comprehensive green mosaic that increases biodiversity and implies an improvement in the quality of the public space.

The Tarragona Municipal Urban Planning Plan (2013) defines the municipality's system of free spaces in a broad sense. According to this document, this system includes the public parks and gardens, the ramblas (boulevards), squares and all the free, public green spaces located on urban, urbanisable or non-urbanisable land. For its part, Agenda 21 Local in Tarragona considers urban green to be the city spaces where natural elements penetrate in the form of parks or gardens, tree-lined, with water bodies or garden elements in the streets.

Between the years 2012 and 2017, the Environment Department of the Tarragona Town Hall quantified a total of 65 green areas intended for public spaces, totaling 371 Ha of urban green (3.71km^2). These areas include the green spaces that are part of the urban section [38]. Out of this group of green spaces in the city of Tarragona, 14 appeared defined as urban parks [39]. These are distributed throughout the municipal territory, except in the area of the residential estates in the east (Figure 1). These public facilities respond to very varied typologies, from landscaped urban squares, like the Sant Antoni park, just over 1200 m^2 or 0.12 hectares, to extensive areas of natural vegetation, like the fluvial part of the Francolí river, which reports 13.7 hectares.

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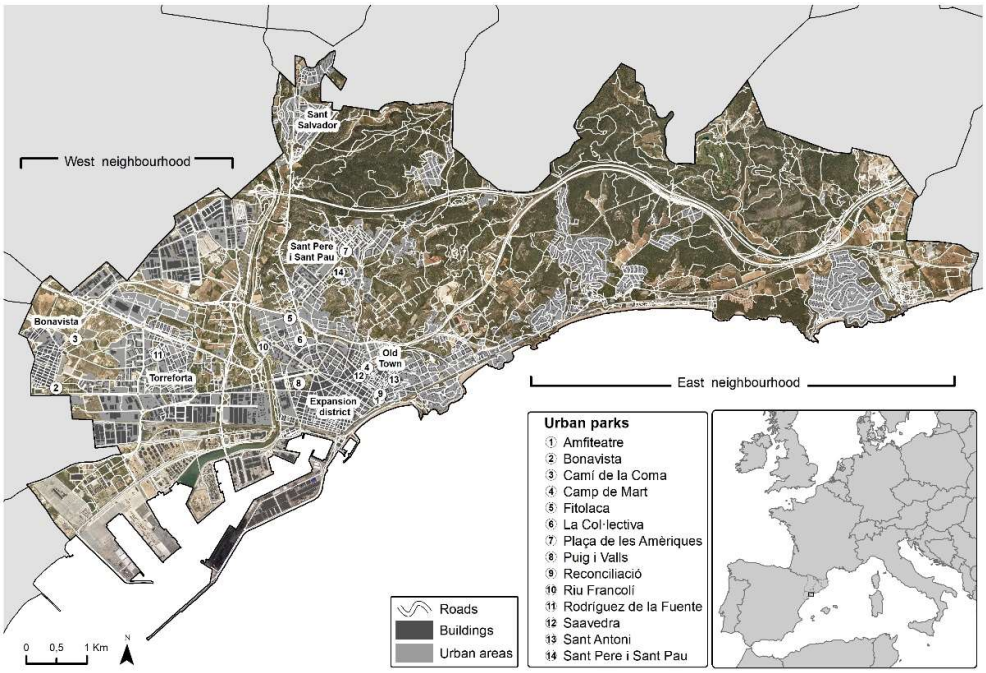

Figure 1. Location of the urban parks in Tarragona. Source: Own work. Orthophotomap base map 1:5.000 of Institut Cartogràfic i Geològic de Catalunya.

4. Data and methods

The analysis is divided into three well-defined stages grouping different tools and methodologies: (1) using a GIS and a MCE integrated into the former; (2) field work and (3) statistical analysis. Using a Geographical Information System (GIS) has made it possible to digitalize the elements existing in the parks and their limits, geolocate the data regarding the population registered in the Municipal Register of Inhabitants, and select the target population; in other words, that lives within 300 meters or less of an access point of any of the parks and, finally, obtain part of the information needed to develop the factors of the MCE model using spatial analysis operations and implementing them.

Field work has also been carried out, through visits to the parks included in the study, between the spring and summer of 2018. The purpose of these visits was to obtain direct information to establish the PQI, check the digitalized mapping and take photographs to characterize these spaces.

Finally, a statistical analysis was carried out on the sample taken from the selection of inhabitants register at a distance equivalent to or within 300 meters from a park access point to try and characterize the socio-demographic viewpoint of the potential user population of the said space.

With the set of indicators, both direct and indirect, that characterize the quality of the urban parks, a hierarchical and weighted Multi-criterial Assessment Model has been designed which has allowed us to obtain the PQI. This index has been correlated with the demographic and socio-economic characteristics of the target population.

4.1. Assessing the quality of the parks

The quality of urban parks is very important with respect to spatial and environmental justice [40]. The quality-of-life community indicators for parks used in this work have been selected from the Madrid case (Spain) [41] and Bucaramanga (Colombia) [42]. In each urban park in Tarragona, we have generated a spatial and theme-based database with information on the urban location, the surface area covered by vegetation, the covered green shadow and the various facilities (Figure 2). This information has been digitalized

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based on the Topographic Map 1:5.000 and orthophotography on the same scale; both documents provided by the Institut Cartogràfic i Geològic de Catalunya.

Figure 2. Example of the mapping database of the Fitolaca park (Tarragona). Source: own work.

For assessment purposes, the model has included a total of 20 factors associated with the quality of the parks. Each of these factors has been assessed on a scale of 0 to 3, where in a standardized way, the value of 0 corresponds to the situation of the lowest quality of the park, and the value of 3 refers to the highest quality of the park.

4.2. Demographic and socio-economic population indicators

Data from the Municipal Register of Inhabitants was used to characterize the population in the city of Tarragona on 31 December 2019. This database stores the residents' postal address, and therefore it was possible to geolocate the registers based on this address and build up a mapping layer. Subsequently, those inhabitants living within 300 meters of the nearest park access point were selected, considering the mode of transport to be walking because it is healthy and not affected by economic conditioning [43].

Some authors [44] use two factors to characterize the population demographics: the level of studies and nationality. The level of studies collected in the register of inhabitants in Tarragona refers only to the population aged 16 years old and over, and it has been grouped into five categories. To compare the different territorial units analyzed, a Synthetic Training Index (STI) was created based on introducing a weight weighting for the population at each training level. This way, an index is obtained with values between 0 and 1, where 0 would be equivalent to the whole of the illiterate population and 1 would represent the opposite extreme, with all the population having university education. In order to neutralize the influence of the population's aged-based structure in terms of education (an older population tends to have lower education levels than a young population), a direct standardization was carried out, based on applying a typical population structure (the whole of the population of the city of Tarragona) to the fourteen neighborhoods of the parks under analysis.

The second variable chosen is that regarding the origin of the population. In this case, we have opted to use the population's place of birth, as opposed to the nationality because it addresses the idea of those people from immigrant families who have been born in Spain. In order to compare the different territorial units, the population born abroad has been characterized using the average value of the HDI published by the United Nations Population Division in 2020. In addition, in order to reflect better the diversity of the

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population born in Spain, the HDI of the autonomous community of birth was taken into consideration from the Instituto Valenciano de Investigaciones Económicas (year 2019).

In third place, and due to the lack of disaggregated data on the income level, the population's economic characterization has been analyzed indirectly based on housing prices. This information has been taken from the property portal, Idealista.com, which allows you to consult the average renting and purchasing prices per square meter for apartments in a specific area. Thanks to this option, it was possible to define the 300 meters area of influence around each park. The information obtained this way is comparable with that from the Register of Inhabitants.

4.3. The Multi-criterial Evaluation (MCE) and the Park Quality Index (PQI)

This work adopts the multi-criterial assessment model in order to discover the degree of quality or suitability of urban parks, based on selecting a series of indicators, subindicators and factors (Figure 3). To do this, the initial 20 factors (first hierarchical level) have been grouped into 7 subindicators (second hierarchical level) and, in turn, these have been joined together in three indicators that correspond to (1) the quality of the vegetation, (2) the quality of the facilities and (3) the quality of the street furnishings (level 3). Finally, the combination of the three indicators leads to the Quality-of-Life Community indicator for parks - PQI (level 4).

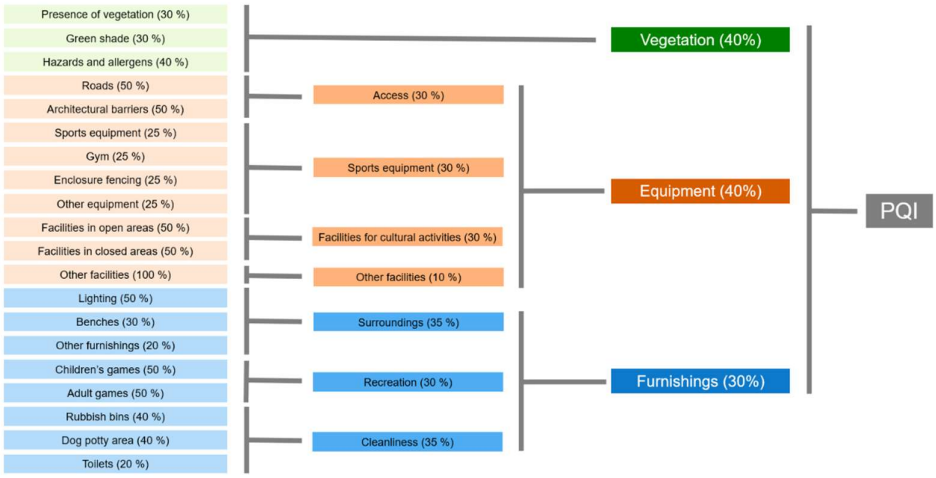

Figure 3. MCE of the quality of the urban parks. Source: own work.

One of the essential characteristics of an MCE is the importance or weights by percentage of each factor, subindicator and indicator used in the model. The final result obtained will depend very much on the weight assigned to each part of the model. In this case, the weight assignment is related to the established hierarchies and groups so that they each add up to 100%. If we take the third hierarchical level as an example, and apply the decision formula or rule, vegetation is combined with a 40% weighting and facilities with a 30% weighting, while the weighting for property is 30%.

5. Results

The results of the research are structured in three areas. First of all, those related to the distribution and provision of the urban parks in the city; secondly, reference is made to their quality based on calculating the PQI; and finally, thirdly, an attempt is made to determine whether environmental justice exists by relating, on the one hand, the quality of the parks and, on the other hand, the population's socio-demographic characteristics.

5.1. The distribution and provision of urban parks in the city

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The distribution of parks in Tarragona reveals a concentration in the central part of the city. This corresponds to the area with the greatest density populations: out of the fourteen parks in existence, five are located in the Ensanche area (Saavedra, Camp de Mart, La Col·lectiva, Riu Francolí and Puig i Valls parks). Equally, this highlights the number of parks in the eastern area, with the Amfiteatre park, in Sant Antoni and Reconciliació park. However, three aspects need to be specified: a) it is the urban area with the largest surface area in the whole city; b) the total surface area of the existing parks is not very big, and most of them cover an average or small surface area; and c) most are in the area nearest the city center, neighboring on the historic center, where there is no urban park because of the morphological characteristics. The northern area has low-density residential estates and does not have this kind of facilities (Figure 4). No doubt, the existence of a high number of private urban green areas means there are no public urban spaces. The districts to the west of the city have a high population and proportionally few urban parks.

According to the data taken from the land registry plots in each of the fourteen urban parks listed by the town hall in the city of Tarragona, their total surface area is 374,606 sqm. However, this overall figure hides various case studies: the surface area differs considerably between the parks, with two of them, the Riu Francolí park (with 130,684 sqm.) and Sant Pere i Sant Pau park (with 122,130 sqm.) representing two thirds of the total surface area of urban parks (Figure 4). At the other extreme, we find parks corresponding more to the concept of landscaped square, such as the Sant Antoni square (1,294 sqm.) and Fitolaca square (1,558 sqm.).

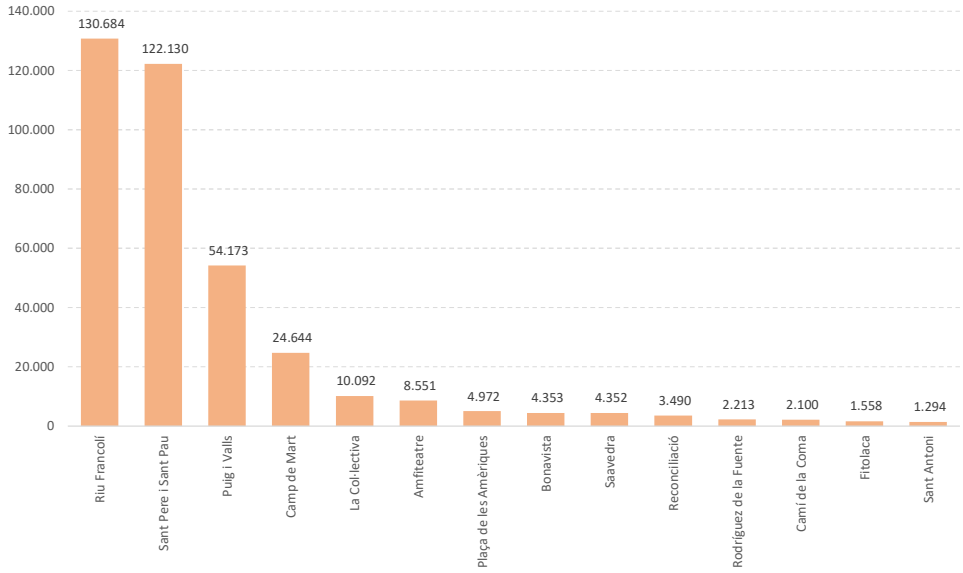

Figure 4. Surface area of the urban parks in Tarragona, in sqm. Source: own work.

There is also a difference between the occupancy percentages of each surface area type in the parks (green areas, bare soil, roads and facilities). Generally speaking, vegetation is the predominant type, as it covers a little more than half the area (55.1%), with much higher values in the cases of the Bonavista (81,5%) and particularly, the Sant Pere i Sant Pau (88.2%) parks. In the case of the latter, its large surface area makes it the city's big «green lung». On the other extreme, we have the «landscaped squares» in Sant Antoni and Rodríguez de la Fuente, which have extremely low vegetation values (14.5% and 17.0%, respectively).

Finally, it is worth highlighting the disparity between the surface area occupied by the various facilities (sport, culture, etc.) in each park. In some parks, these elements are completely non-existent (La Col·lectiva and Rodríguez de la Fuente parks), while in others (Camp de Mart and Camí de la Coma park), at least one third of the surface area is covered by facilities.

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5.2 The provision and distribution of urban parks with respect to the population

The surface area of the urban parks in relation to the inhabitants shows an average available surface area of 2.62 sqm. per inhabitant. This figure rises to 15.09 m^2/inhab. with all the green spaces (periurban) in the municipality. The value achieves the thresholds recommended by the World Health Organisation, which establishes a figure around 10-15 sqm./inhabitant. As for their accessibility, 39% of the population in the Tarragona capital live within 300 metres of an urban park and the average distance in a straight line is 710 metres, which is much higher than would be recommended (Table 1).

Table 1. Average surface area available per inhabitant and average distance to the nearest urban park

Urban parks	Total population			Population living < 300 meters		
	Inhabitants	Average distance (m.)	sqm./ inhabitant	Inhabitants	Average distance (m.)	sqm./ inhabitant
Amfiteatre	4053	518.1	2.11	918	205.2	9.31
Bonavista	9945	337.1	0.44	4440	181.7	0.98
Camí de la Coma	2931	436.7	0.72	308	270.3	6.82
Camp de Mart	5618	294.3	4.39	2841	202.3	8.67
Fitolaca	1089	334.9	1.43	314	235.4	4.96
Riu Francolí	6799	207.3	1.48	6131	123.2	1.65
La Col·lectiva	6190	257.9	0.80	4374	189.4	1.14
Pl. de les Amèriques	20,867	1285.5	2.60	6296	170.6	8.60
Puig i Valls	32,105	369.3	0.11	13,046	154.1	0.27
La Reconciliació	2015	155.6	64.86	2015	155.6	64.86
Rodríguez de la Fuente	23,728	435.6	0.09	5331	172.7	0.42
Saavedra	9565	324.9	0.45	4245	196.0	1.03
Sant Antoni	15,168	2424.4	0.09	3004	157.2	0.43
Sant Pere i Sant Pau	2786	179.8	43.84	2395	137.2	50.99
Total	**142,859**	**710.3**	**2.62**	**55,658**	**166.4**	**6.73**

Source: own work.

If the urban areas are taken as the analysis unit, we can observe that the provision of urban park surface area per inhabitant is unequal according to the area of residence. This geographic distribution shows an important degree of environmental injustice. So, some areas appear without any urban parks inside them (the historical centre and Sant Salvador), whereby the rate is 0 sqm./inhabitat. In some areas, like the case of Bonavista, the parks lie in the periphery of the urban area. In others, such as Torreforta and Ensanche, there is a minimum provision per inhabitant, resulting from the combination of its relatively high population and the low surface area of the existing parks. The area with the residential estates in the eastern area (Levante) has below-average values, but due to its urban characteristics, it is marked by low density, the presence of private green areas and its disconnection from the city.

5.3 The quality of urban parks

The average PQI in Tarragona is 53.39 points, with the highest assessment in vegetation (67.86), followed by street furnishings (45.50) and facilities (32.32) (Table 3 and Figure 5). Out of the fourteen urban parks analysed, none of them has a «good» quality (PQI equal to or higher than 70 points), and only four have a «medium-high» rating (60-69 points). Specifically, these are the Puig i Valls park (62.81), the Riu Francolí park (62.22), the Amfiteatre park (61.42) and the Fitolaca park (60.29). Their overall score (total

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assessment of vegetation, facilities and furnishings) is due to different factors. So, the Puig i Valls and Amfiteatre parks owe their high assessment to the vegetation (number of examples, green shadow and absence of allergenic species, 80.00 and 83.33 respectively), although with the other two indicators they have fairly discrete scores (facilities 39.00 and 32.08; furnishings 40.02 and 59.15, in the same previous order). On the contrary, the good score obtained by the Riu Francolí park is not due to the assessment of its vegetation (with 53.33 points, it is only just the third lowest urban green area in the city). Instead, it is due to the good quality of both its facilities (74.78) and its furnishings (67.43), in which it leads the city ranking as a whole.

Table 2. PQI values for each park and each indicator

Urban parks	Vegetation (40%)	Facilities (30%)	Furnishings (30%)	PQI (100%)
Amfiteatre	83.33	39.00	40.02	61.42
Bonavista	86.67	31.60	33.67	59.65
Camí de la Coma	36.67	54.28	52.00	44.90
Camp de Mart	63.33	35.48	41.34	50.87
Fitolaca	80.00	30.00	51.17	60.29
Riu Francolí	53.33	74.78	67.43	62.22
La Col·lectiva	80.00	15.65	47.00	55.66
Pl. de les Amèriques	46.67	26.00	62.83	45.54
Puig i Valls	80.00	32.08	59.15	62.81
La Reconciliació	63.33	14.40	45.58	46.66
Rodríguez de la Fuente	63.33	33.15	16.33	44.04
Saavedra	63.33	34.63	36.60	49.47
Sant Antoni	66.67	1.25	56.60	47.80
Sant Pere i Sant Pau	83.33	3.20	27.35	56.05
Total	**67.86**	**32.32**	**45.50**	**53.39**

Source: own work.

With a «medium-low» score (between the values 50 and 59 in the PQI) we find four parks: Bonavista, Sant Pere i Sant Pau, la Col·lectiva and el Camp de Mart. The good quality of their vegetation, which helps to offset fairly mediocre scores in the other two PQI components, gives them an intermediary score. The most representative case in this respect is the Col·lectiva park, where the quality of the vegetation (80 points, the sixth highest) offsets the discrete score for its facilities (15.65).

Finally, we find six parks with a «low» assessment for their quality (PQI under 50 points): Saavedra, Sant Antoni, La Reconciliació, plaça de les Amèriques, Camí de la Coma and Rodríguez de la Fuente. In all of them, with the exception of the Camí de la Coma park, the best scoring indicator is the vegetation, while in the other two indicators (facilities and furnishings), the values obtained are low (Table 2). The extreme cases are the furnishings score in the Rodríguez de la Fuente park (16.55) and, particularly, the score for the virtually non-existent facilities in the Sant Antoni park (1.25).

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Figure 5. Location and quality level of the urban parks in Tarragona. Source: own work.

The results of the analysis reveal a meagre relationship between the location of the parks in the urban area and their quality. In terms of environmental justice, it could be expected that the parks located in the more peripheral areas were a lower quality, while those in the center of the urban hub were a better quality. However, in all the urban areas, there are parks with different assessments according to their PQI. Just one example in this case: two urban parks very close together, the Amfiteatre park and Reconciliació park, separated by just one street, have very different PQI values: while the first one has «medium-high» quality (61.42 points), the second one has «low» quality (46.66).

5.4 Environmental justice regarding socio-economic characteristics: the level of studies, the place of birth and housing prices

As we can see from Figure 6A, the relationship between the PQI value and the standardized STI of the population living within 300 meters reveals a degree of environmental inequity. On the one hand, with the positive value of the R^2 coefficient, and, on the other hand, the actual positive slope of the trend line, it can be concluded that there is a casual relationship between the parks with a lower level of quality and the lower level of studies among the population living within 300 meters. In spite of this, this relationship is not particularly robust, with an R^2 coefficient value = 0.1159. One factor that influences this behavior lies in the lower values of some urban parks, much lower than the rest of the cases analyzed. In the urban parks with better values, the relationship of their coefficient is not so clear, or in other words, the higher values in a variable correspond to the highest scores in the other one.

The results of the correlation between the HDI of the place of birth and the PQI reveal a clear correlation: the PQI value for each park and the average value of the HDI correlate with a R2 of 0.1667 (Figure 6B).

The correlations between the PQI and the average price per square meter purchased or rented (Figures 6C and 6D, respectively) show fairly similar situations: both if the dwelling is purchased or rented, its price is higher among those located near the greater quality parks. There is also a clearer relationship (R2 = 0.2123) in the case of purchased dwellings, as the result of a direct linear correlation, whereby the lowest values of one variable are related to the also lowest indicators of the other variable, and vice versa. It could be thought that this direct relationship has something to do with the more or less

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central location of each park with respect to the city as a whole, understanding that the housing prices follow a more or less concentric logic, whereby the more central apartments have higher prices than those located in peripheral areas.

At any event, although this idea in the case of the dwellings is certain, it has already been mentioned that the quality of the parks does not follow this same pattern, and so the robustness of the relationship is not due to this trend. A weaker, but equally positive (Figures 6C and 6D) relationship is the one between the price of home rentals and each park's PQI (R^2=0.1530).

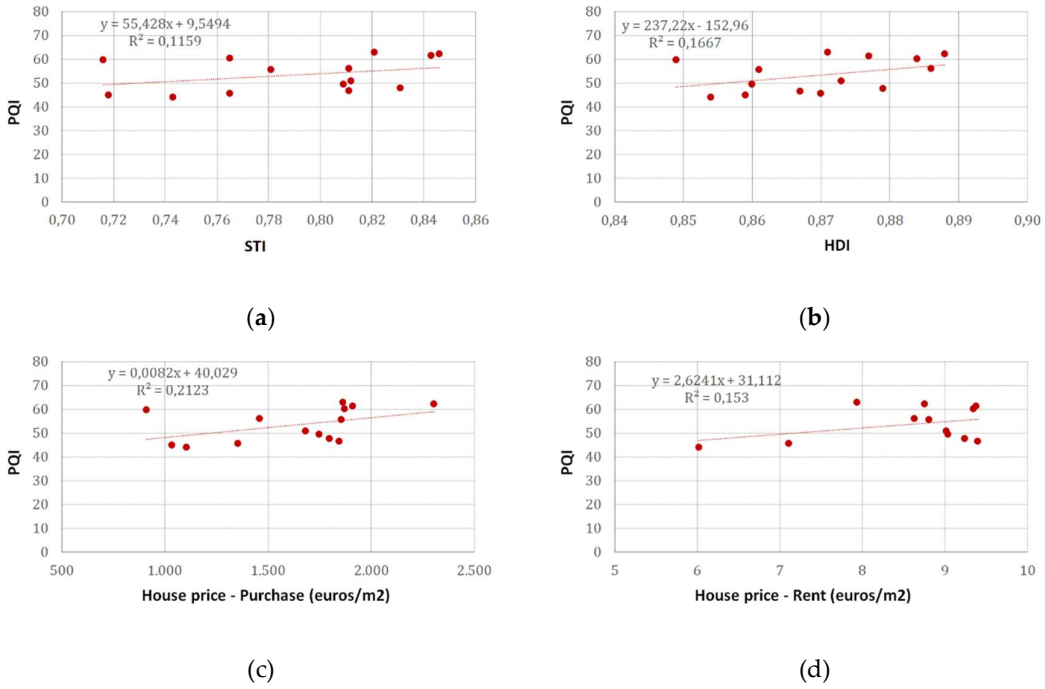

Figure 6. Correlation between the quality of the parks (PQI) and the socio-demographic variables of the population living within 300 meters of the nearest park: (a) study level index for the population; (b) average value of HDI; (c) Average value of the purchasing price (euros/m^2) and (d) average value of the rental price (euros/m^2). Source: own work.

6. Discussion

This article assesses the environmental justice in the city of Tarragona (Spain) with respect to the accessibility, availability and quality of the urban parks and the socio-demographic characteristics of its population. According to the Regional Office for Europe of the World Health Organization [14], the minimum surface area of urban green areas must be between 10 and 15 square meters per inhabitant, and within a distance of 300 metros or 5 minutes walking of the dwelling. However, some authors [19] maintain that this strictly quantitative measurement of the provision of green spaces is not enough, and that the parks must fulfil three basic conditions: availability (they are within a maximum distance that allows its potential users to enjoy it), accessibility (when the user feels welcome, can access it freely and use it for recreational purposes at any time) and, finally, a certain degree of attractiveness (when the space responds to individual needs, expectations and preferences).

The relationship between the disaggregated and precise socio-economic data has made it possible to obtain positive correlations between these characteristics, park accessibility and quality, providing evidence of the deficits in some areas in the city of Tarragona. Certain urban areas are under-endowed with urban parks vis-à-vis the land occupancy system, and are mostly under dispersed forms and without general system reservations, beyond the needs arising from mobility. Despite this, they require greater research attention. By comparing the different green areas with the neighborhood's social

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characteristics, it is possible to identify the priority areas so as to improve their condition, accessibility, quality and distribution [45]. This research has not segmented the socio-economic information on specific groups (according to age, origin), although it has standardized the values used for analyzing them. In future research, it would be relevant to consider the different user groups, the feeling of safety and security and social interaction.

This work has not considered the quality of the parks as a factor of environmental justice because urban green areas are relevant for the urban quality of life and for promoting environmental equity [46]. For their part, some authors [47] believe that in order to determine environmental justice, the accessibility and availability of green areas, you have to also consider their quality. The results from their analysis, combined with the socio-economic characteristics, broaden the understanding of environmental justice with respect to the parks. The literature on this issue has found numerous proofs of this. Corley et al. [36] established relationships between the various aspects involved in the quality of urban green areas, and Brown et al. [48] found significant associations between the types of urban parks and their benefits for the population. Another important conclusion from these approximations, is that improving and designing urban parks should consider resident preferences so as to keep them in mind [49, 50]. These actions would allow them to become community assets [51].

In response to this need, this work has built the PQI; synthetic index that can be used to assess environmental justice, with greater precision than the availability of green surface areas or their distance. Another significant contribution from this work is that the lack of information on the population's income level has been substituted by alternative sources. So, to establish the correlations with the PQI, the work instead used the level of studies, the resident population's HDI and home sale and rental prices within a distance of 300 meters of a park. Out of these variables, the one that has shown a greater correlation is home sale prices.

Some of the limitations found in this study are related to urban mobility. By selecting a population within a distance threshold with respect to a park, you start with the premise that the population only uses the urban parks in their own urban residency area, in other words, as if these urban divisions led to «islands» or self-contained compartments, without people moving from one to the other. Obviously, this is not entirely true, since mobility is a fundamental component of cities, conditioned by the place of residence and the locations people visit regularly (work, leisure areas, daily shopping, children's study area). Therefore, beyond the analysis of the provision of urban parks based strictly on the place of residence, it would be important to bear in mind the population's daily mobility. The type of mobility used here is by foot, following the recommendations of the World Health Organization. However, due to the promotion of public transport as part of countries' commitment to reduce the consumption of hydrocarbon fuels, and the proliferation of Personal Mobility Vehicles (PMV), this segmented conception of the city has to change or, at least, reconsider the cut-off thresholds and take into account other types of mobility. It is also necessary to mention that when selecting the population served by a park, it was decided to apply the Euclidean distance, i. e. the distance in a straight line from the access of the nearest park to the place of residence, instead of the real distance using the city road section. With this latter consideration, accuracy could be increased. On the other hand, the central location of the urban parks with respect to the city as a whole, can influence the value of the homes located in more central areas, as opposed to others further away. In the case of the quality of the Tarragona parks, we have not found this association, and so the statistical correlation does not follow this trend.

Using the MCE techniques to build the PQI is an attempt to reduce subjectivism, but this always remains because just choosing the factors and their weights is a subjective action. Differentiating the selection of weights (vegetation 40%, facilities 30% and furnishings 30%) can provide a positive reading due to the possible actions aimed at increasing the quality of the parks: the improvements to vegetation may require a greater economic effort which in some cases has a temporary repercussion (e.g. annual vegetation) or in others long-term results are obtained (e.g. time it takes for the tree vegetation to reach

adult age). Intervention and maintenance both regarding facilities and, particularly, furnishings, can lead to gains in the quality of the parks in a relatively economic way, in a short-term and with significant durability.

7. Conclusions

There is great disparity among the parks in the city of Tarragona: peripheral parks and central parks; large parks and landscaped squares. In terms of quality, vegetation is the parameter with the best score, while facilities and furnishings have deficiencies. The value obtained in accessibility is lower than that recommended by the EU, and the same occurs with the availability of green spaces, although this reduces if we consider green spaces on the whole. Based on the correlations between the PQI and the population's socio-economic characteristics, it can be stated that there is a casual relationship between these variables. However, the levels of environmental injustice are reduced.

This work has shown that the relationship between access to green areas and environmental justice is complex. The deficits in accessibility and quality can be overcome with strategies and actions that increase the number of green areas available in places where there are inequalities. The new urban agendas include analyzing urban habitability, reducing social inequalities and improving healthy conditions so that the planning, design and management of urban green areas should take socio-spatial attributes into account.

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