The Relationship Between Planned Development and Green Space Sufficiency: The Case of Istanbul

Yıldız Aksoy *

Posted Date: 20 August 2025

doi: 10.20944/preprints202508.1523.v1

Keywords: planned development; green space sufficiency; spatial inequality; Istanbul

 doi:10.20944/preprints202508.1523.v1

Article

The Relationship Between Planned Development and Green Space Sufficiency: The Case of Istanbul

Yıldız Aksoy

Istanbul Medeniyet University, Faculty of Art, Design and Architecture, Urban and Regional Planning Department; yildiz.aksoy@medeniyet.edu.tr

Abstract

This study aims to evaluate the relationship between planned urban development and the sufficiency of active green spaces in Istanbul using 2024 data. The research analyzes the impact of planned development rates on the distribution of green spaces, in relation to socio-spatial variables such as population density, income level, and distance to the central business district. A spatial analysis was conducted using Geographic Information Systems (GIS) and regression analysis methods, based on up-to-date data covering Istanbul's 39 districts. The findings reveal that the average amount of active green space per capita in Istanbul is 5.2 m². This figure falls significantly below both the World Health Organization's recommended minimum of 9 m² and the 10 m² standard required within municipal and adjacent areas according to Turkey's Spatial Plans Construction Regulation (2014). In unplanned and densely populated districts (e.g., Esenyurt, Bağcılar), this figure drops below 1 m², whereas in well-planned and low-density districts (e.g., Sarıyer, Beykoz, Çatalca, Ataşehir, Başakşehir, Şile), it exceeds 10 m². The regression analysis identified a strong positive relationship between the proportion of planned development and the per capita amount of green space (R^2 = 0.61). Furthermore, it was found that access to green space decreases as the distance from the central business area increases. These findings highlight how unplanned growth deepens spatial inequalities and underscore the necessity of integrated planning strategies to ensure the equitable distribution of green spaces.

Keywords: planned development; green space sufficiency; spatial inequality; Istanbul

1. Introduction

1.1. Background

Urban spaces take shape as the spatial expression of people's needs to live together, produce, and socialize. The physical structure of these spaces is influenced not only by architectural elements but also by the socio-cultural and economic dynamics of the population that inhabits the city [1].

In terms of the holistic sustainability of urban ecosystems, green spaces function to maintain the balance between natural systems and human life. Green spaces play multidimensional roles such as regulating microclimates, acting as carbon sinks, supporting biodiversity, contributing to physical and mental health, and strengthening social cohesion [2, 3].

Therefore, the qualities and spatial distributions of green spaces are considered a significant indicator of urban quality of life. They must be addressed within the framework of the principle of spatial justice in planning. Especially in developed countries, urban planning processes are being reshaped in line with Nature-based Solutions, which aim to increase the accessibility of green infrastructure [4].

1.2. Literature Gap and Problem Statement

Rapid urbanization worldwide has led to a loss in the quantity and quality of green spaces, threatening both environmental sustainability and social equality in recent years [5]. This problem is even more pronounced; access to green spaces, particularly in large cities, shows inequality among

 doi:10.20944/preprints202508.1523.v1

social groups in Turkey. The example of Istanbul clearly demonstrates how this inequality is deepened by spatial patterns.

The World Health Organization [6] recommends at least 9 m² of green space per person, while in Turkey, this ratio is accepted as 10 m² according to the Regulation on the Preparation of Spatial Plans. However, in Istanbul, this value is significantly below these thresholds in many districts. Particularly in unplanned, high-density areas, this amount drops below 1 m², whereas in planned, low-density districts, it rises to 10 m² and above [7, 8]. This inequality leads to serious consequences, not only in terms of the imbalance of the physical environment but also concerning social welfare, health, and environmental justice. There's a need for studies that evaluate the relationship between spatial inequality and green space distribution using current data, especially in Turkey.

1.3. Research Aim and Contribution

This research aims to analyze the spatial distribution of active green spaces in Istanbul, based on 2024 population data. Specifically, the study evaluates the effects of variables such as planned urban development, population density, household income level, and distance to central business districts (CBDs) on the amount of active green space per person using a multiple regression model.

The research relies on current and reliable data sources, including the Istanbul Metropolitan Municipality's (2024) "Green Space Assets Inventory" and Urban Atlas (2024) map data. Spatial analyses were conducted using Geographic Information Systems (GIS), while statistical analyses were performed with SPSS 28.0 software. The statistical significance of the model was tested at a $p < 0.05$ level.

This research aims to reveal the existing spatial inequalities in access to active green spaces specifically in Istanbul, thereby offering a scientific basis for the development of sustainable and equitable urban planning policies. In this regard, it contributes to both theoretical knowledge production and has the potential to provide practical policy recommendations.

2. Methodology

This research adopts a mixed-methods approach to examine the relationship between planned urban development and the sufficiency of active green spaces in Istanbul. The study focuses on 2024 active green space data, covering all 39 districts of Istanbul.

Data was obtained from current and reliable sources. The Istanbul Metropolitan Municipality's 2024 "Green Space Assets Inventory" provides a comprehensive inventory of existing active green spaces. Urban Atlas (2024) data was utilized for spatial distribution and land use analyses. In this study, only active green spaces were evaluated; passive green spaces such as cemeteries, road medians, and afforestation areas were excluded. To analyze the factors influencing the distribution of active green spaces, dependent and independent variables were identified. The amount of active green space per person (m²/person) in each district was considered the primary dependent variable.

Independent variables include total district population, average household income, the proportion of planned developed areas, and distance to the central business district (CBD). Through these variables, the effects of population density, socioeconomic status, and planned/unplanned development on green space sufficiency were assessed. Additionally, the contribution of proximity to urban centers to green space access was examined.

Statistical analyses were performed using SPSS 28.0, while spatial analyses were conducted with ArcGIS Pro 3.1 software. The statistical validity of the model was tested based on a $p < 0.05$ significance level, thus reliably evaluating whether the effects of the independent variables were coincidental.

 doi:10.20944/preprints202508.1523.v1

3. Green Space Planning

3.1. Green Space Standards

Green space standards define the amount of green area per capita in a city, expressed in square meters. Determining these standards is a critical process for the sustainability and quality of life in urban areas. Key factors influencing the quantity and distribution of green spaces include needs (requirements), population, city size, geographical location, climate, and intensity of use [9].

The need for green spaces varies according to demographic and socioeconomic factors such as age, income, education, profession, and living environment. For example, population segments with different age groups or income levels may have different expectations from green spaces. The intensity of use of green areas also plays a significant role in setting standards; densities in areas designated for walking, relaxation, sports, and entertainment differ from one another. In large cities in particular, the insufficiency of green spaces emerges as a limiting factor for meeting these needs [10]. The size of the population and its distribution within the city are central to determining green space requirements, as the size and distribution of green areas are directly related to the population structure [11].

When developing green space standards, the question of whether to adopt a system of decreasing standards in response to increasing population is of critical importance. Existing green space standards should play a decisive role, particularly in guiding the environmental development of cities and their future expansion. In city centers and densely populated areas, achieving ideal standards through urban renewal projects is often not feasible. Therefore, it is essential to preserve the high standards established from the outset in newly planned settlements. In line with environmental planning objectives, lowering these standards should be avoided. At the international level, the determination of recreational space standards has become a mandatory component of urban and regional planning. Although similar approaches can be observed among countries, each nation has developed and implemented standards tailored to its own specific conditions.

The United States presents a globally recognized model in the field of urban green space standards, with these standards undergoing periodic revisions to adapt to evolving urban needs, environmental sensitivities, and scientific insights. At the core of the American green space standard system lies a variable approach based on population size. For instance, as in previous applications, cities with populations over 500,000 are recommended to provide 20 m² of green space per capita, while in cities with populations exceeding one million, this figure drops to 13 m² per capita [10] This reflects a trend in which per capita green space tends to decrease as population increases.

The American approach differs from the European model in terms of urban form and lifestyle culture. Historically, the establishment of large-scale public parks such as Central Park indicates an early awareness of the importance of urban green spaces in the U.S. Today, however, standards are addressed from a more comprehensive perspective that encompasses not only square meterage per person, but also the functionality, accessibility, quality, and contribution of green spaces to biodiversity.

In contemporary American urban planning, the principles of smart growth and green infrastructure play a central role in shaping green space standards. These approaches go beyond conventional parks to include green streets, green roofs for stormwater management, permeable surfaces, community gardens, and ecological corridors. In the context of enhancing urban resilience and mitigating the effects of climate change, green spaces are no longer seen solely as recreational zones but as essential infrastructure components that deliver urban ecosystem services—improving air and water quality, reducing the urban heat island effect, and supporting biodiversity (US EPA). Urban planning authorities are increasingly emphasizing the accessibility of green spaces for all residents and encouraging community participation in their planning and maintenance. This evolution is part of the broader transformation toward making American cities more sustainable, livable, and resilient.

European countries, by contrast, have adopted a more holistic and multi-layered approach when establishing urban green space standards. This approach encompasses not only directly usable green areas within the urban fabric—such as playgrounds, sports fields, and parks—but also larger-scale ecological zones located beyond the urban boundaries, such as green belts. These strategies reflect

 doi:10.20944/preprints202508.1523.v1

the understanding that green spaces are not only recreational amenities but also critical components that provide ecological and environmental benefits as integral parts of the city [12].

At the core of green space policies in Europe lies the principle of accessibility. This approach aims to ensure that every urban resident has access to a high-quality green space within a reasonable walking or cycling distance from their home. In line with this principle, various types of green infrastructure are incorporated into city planning. For instance, in London, the goal is for every home to be located within 400 meters of a public green space, while in Berlin, the focus is on establishing extensive and interconnected green networks across the city. This integrative system adopted in Europe is based on the notion that as settlements grow and cities become increasingly detached from nature, the need for green spaces intensifies. The lifestyle changes brought about by urbanization, along with environmental challenges, have revealed that green spaces are not a luxury but a necessity for urban sustainability and public health. Recent research highlights numerous benefits of urban green spaces, such as promoting physical activity, improving mental health, enhancing social interaction, and mitigating the urban heat island effect [13].

Policies such as the European Commission's EU Biodiversity Strategy for 2030 have prioritized the expansion of green spaces in cities and the promotion of biodiversity. These strategies aim to make cities more resilient through nature-based solutions and to utilize green infrastructure in combating climate change [14]. In this context, European cities are developing policies that not only focus on quantitative standards but also emphasize the ecological quality, connectivity, and multifunctionality of green spaces.

In Turkey, urban green space standards have been defined primarily through the Regulation on the Principles of Making and Amending Zoning Plans, based on Zoning Law No. 3194. This regulation prescribes a minimum of 10 square meters (m^2) of active green space per capita. However, this uniform standard has long been criticized as a fundamental weakness in Turkey's green space planning system. The main issue lies in the lack of detailed criteria regarding the typology, content, functionality, and size of active green spaces within this standard.

As Aksoy noted in her research [12], this deficiency has led to an arbitrary approach in the planning and implementation of green spaces, ultimately hindering the development of healthy and high-quality public spaces in Turkish cities. Given Turkey's diverse geographical, climatic, and demographic characteristics, a single standard applied uniformly across all cities proves inadequate.

For example, the type and quantity of green space required in a metropolitan area differs significantly from those needed in a small Anatolian town.

Current planning approaches and international examples strongly emphasize the need for green space standards to be multidimensional, flexible, and context-sensitive. The literature points out that quantity-based approaches alone are insufficient and that standards should also incorporate the quality, accessibility, functional diversity, and ecosystem service capacity of green spaces [15].

In this regard, it is critically important to integrate the following aspects into green space standards for Turkey: Green spaces should not only serve as areas for rest but also include various functions such as active sports areas, children's playgrounds, community gardens, ecological corridors, and urban forests. Specific size and facility standards should be established for each functional type. The geographic distribution of green spaces within cities must ensure equal access for all neighborhoods and socio-economic groups. For instance, standardized access to specific types of green spaces within walking distance can be established. Green spaces should be designed not only for human use but also to support urban ecosystem health and biodiversity. This includes the use of native vegetation, water management features (such as rainwater harvesting), and wildlife-friendly design elements.

Green spaces must provide climate resilience benefits such as reducing the urban heat island effect, improving air quality, and offering natural solutions for stormwater management. The active participation of local communities and stakeholders in the planning of green spaces enables the creation of more suitable and widely embraced public environments. Revising and elaborating Turkey's current standards in line with these contemporary approaches is a crucial step toward

 doi:10.20944/preprints202508.1523.v1

ensuring urban sustainability, climate change adaptation, and the improvement of citizens' quality of life. Otherwise, uniform and inadequate standards will continue to give rise to "unhealthy spaces."

3.2. Factors Affecting the Spatial Distribution of Urban Green Spaces: A Sustainable Urban Planning Perspective

Urban green spaces are critical components that directly affect the sustainability, ecological balance, and socio-economic well-being of modern cities. The spatial distribution and effectiveness of these areas are shaped by the interaction of many complex factors. McBride [16] categorized the factors influencing land use in urban planning into four main groups: natural, socio-economic, historical-cultural, and urban factors. Green spaces fall under the urban factors category and stand out as one of the most important elements with the potential to sustainably mitigate the negative effects of urbanization. Accessible and high-quality green spaces contribute to social cohesion by providing recreational opportunities, thereby enhancing the quality and livability of settlements [17]. Unfortunately, dynamics such as rapid population growth and uncontrolled, irregular urbanization have led to the neglect of urban green spaces, underscoring once again the vital importance of green areas in urban planning today. During the formation of a city's green space system, detailed consideration should be given to the natural characteristics of settlements, the location (locational value) of the area, the attractiveness and facilities of green spaces, and users' leisure habits.

Natural factors affecting the spatial distribution of green spaces within the urban system are primarily related to the structural features of the landscape. These factors include relief (topographic structure), water bodies, streams, soil properties, vegetation (plant cover), and urban climate [12]. The general appearance and natural character of the city also influence the positioning and design of green spaces. For example, green corridors along a river or parks integrated into existing topography provide ecological benefits while enhancing the city's aesthetic value.

There is a direct relationship between the location of green spaces and the frequency with which users visit these areas. In green space planning, calculating the locational value of a green area is of great importance. According to widely accepted principles, accessibility to a green space within 5, 10, or 15 minutes walking distance increases the locational value and usage potential of that green space. The closer a green area is to a residential zone and the higher the population density of that zone, the greater the usage value of the green space. When organizing green areas, the population served and access distances play critical roles. As the scale shifts from the smallest settlement units toward the urban scale, instead of facilities reachable on foot, larger-scale recreation, entertainment, and sports areas accessible by public transport or private vehicles need to be planned [18]. Recent studies emphasize that access to parks and green spaces within a short walking distance positively influences physical activity levels and overall health in urban areas [19].

The attractiveness and amenities of green spaces are factors that directly influence their spatial distribution and frequency of use. The appeal of green areas can be enhanced through plant selection, artistic elements (such as sculptures), water features (ornamental pools, waterfalls), appropriate lighting systems, and various accessory components (benches, trash bins, playground equipment). High-quality design and maintenance enrich the user experience and increase the likelihood of green space preference. One of the most significant factors affecting the duration and frequency of public green space use is the leisure habits and preferences of users. These habits can vary according to demographic characteristics, cultural norms, and lifestyles. Therefore, collecting, analyzing, and evaluating such data for each settlement unit prior to green space planning is essential to enable more effective and needs-oriented planning decisions. Spatial analysis of the collected data provides a starting point for assessing the distribution of green spaces according to community needs. To understand disparities in green space distribution across different areas, it is critical to examine the relationship between socio-economic conditions and regional planning variations [20]. For example, lower-income neighborhoods are often observed to have lower green space quality and accessibility, which has been linked to health inequalities [21]. Consequently, green space planning is not only an environmental issue but also a matter of social justice and urban equity.

 doi:10.20944/preprints202508.1523.v1

4. Spatial Distribution of Active Green Spaces in Istanbul

Spatial analyses provide a fundamental starting point for assessing whether green spaces in cities are distributed in a manner that meets societal needs. Jim [22] notes that different land use types and urban development patterns create significant variations in the geometric forms, spatial distribution, and composition of green spaces. In this context, both the total amount and spatial pattern of green spaces are prerequisites for evaluating the current situation and monitoring changes over time.

In this study, focusing specifically on Istanbul Province, existing active green spaces were analyzed based on per capita square meter amounts, as well as total numerical and areal sizes, to conduct an adequacy assessment at the district level. This evaluation facilitates the consideration of access to green spaces throughout the city within the frameworks of spatial justice and sustainability principles.

Geographic Information Systems (GIS) serve as a vital tool for conducting such analyses, offering advantages such as speed in data generation, updatability, low archival space requirements, multi-scale map production, and centralized data management. Furthermore, by integrating the temporal dimension into analyses, GIS enables monitoring urban growth, assessing the adequacy of social and technical infrastructure, and conducting multi-criteria analyses to identify the most suitable sites [23].

Using GIS-based spatial analyses, this research evaluated the distribution of active green spaces in Istanbul and provided insights regarding the spatial cohesion of urban green infrastructure in line with sustainable urbanization goals. The findings aim to contribute to sustainable development objectives, such as resilient urban design and equitable access to nature.

4.1. Analysis of Active Green Space Adequacy Using a Regression Model

Regression analysis is an analytical method aimed at measuring and explaining the statistical relationship between a dependent variable and one or more independent variables. This model quantitatively expresses the relationship between variables through an equation developed based on existing data [24]. Multiple regression analysis was applied to analyze the determinants of the amount of active green space per capita in this study. Within this analysis, active green space per capita (m^2/person) was defined as the dependent variable; population size (x_1), average income level at the district level (x_2), proportion of planned development areas (x_3), and the distance of districts from the city's Central Business District (CBD) (x_4) were included as independent variables in the model. Accordingly, the study empirically tested the effects of the socio-demographic and physical characteristics of districts on access to active green spaces.

4.2. Regression Model

Regression analysis was conducted to determine the relationship between the amount of green space per capita and the demographic, socio-economic, and physical characteristics of the regions. The regression model used in this study, in its simplest form, expresses the relationship of one variable with one or more independent variables. It can also be represented by an equation created using existing data related to these variables [24].

4.3. Hypothesis and Definition of Variables

The main hypothesis of the study is that the spatial inequality of urban green spaces is significantly related to variables such as population density, socio-economic status, the level of urban planning, and distance to central areas. Within this framework, the variables used in the analysis are presented in Table 1. The amount of active green space per capita (m^2/person) was considered the dependent variable, while population size (x_1), per capita income (x_2), planned developed area (x_3), and the distance of districts to the city's Central Business District (CBD) (x_4) were evaluated as independent variables.

 doi:10.20944/preprints202508.1523.v1

Table 1. Regression Results (N = 39 districts, 2024).

Variable	B Coefficient (β)	Standard Error	t-value	p-Value	Significance
Constant (β_0)	3.142	0.685	4.59	0	***
Population (x_1)	–0.012	0.005	–2.40	0.021	**
Income per capita (x_2)	0.008	0.003	2.67	0.011	**
Planned developed area (x_3)	0.024	0.007	3.43	0.002	***
Distance to CBD (x_4)	–0.015	0.006	–2.50	0.017	**

During the data analysis process, a multiple linear regression model was established using SPSS 28.0 statistical software; through this model, the effects of the independent variables on green space adequacy were tested. The analysis was structured to determine the linear relationships between variables and to reveal the structural factors underlying spatial inequalities.

5. Findings and Interpretation

In this study, using data from 39 districts of Istanbul, a multiple linear regression analysis was conducted to identify the key socio-spatial variables affecting the amount of active green space per capita. The four independent variables analyzed within the model are: population, income per capita, the proportion of planned developed areas, and distance to the Central Business District (CBD). The findings related to the regression model are presented in Table 1.

When examining Table 1, it is observed that *** $p < 0.01$ and ** $p < 0.05$ indicate significance levels.

Negative coefficients show an inverse effect of the variable on green space, while positive coefficients indicate a direct effect. The regression model was found to be significant overall ($F(4,34) = 13.28$; $p < 0.001$), and the explained variance with an R^2 value of 0.61 was evaluated as moderate to high. The overall performance and statistical validity of the model are detailed in Table 2.

Table 2. Regression Model Performance Metrics.

Model Metrics	Value
R^2 (Explained Variance)	0,61
Adjusted R^2	0,57
F (4,34)	13,28
p (overall model)	0,000
Variance Explanation Power	Moderate-High

These findings indicate that the independent variables included in the model have strong explanatory power in accounting for the amount of active green space per capita at the district level in Istanbul.

5.1. Proportion of Planned Developed Area

According to the results presented in Table 1, the variable with the strongest and most significant effect on per capita green space is the proportion of planned developed area ($\beta = 0.024$; $p = 0.002$). This finding reveals a strong positive relationship between regulated zoning practices, urban planning, and green spaces. In districts such as Ataşehir, Başakşehir, and Beylikdüzü—which have undergone planned development particularly since the 2000s and have been supported by investments in public green spaces—the amount of active green space per capita ranges between 8 and 12 m^2.

 doi:10.20944/preprints202508.1523.v1

5.2. The Effect of Population

In Table 1, the population variable is shown to have a negative and significant effect (β = –0.012; p = 0.021). This indicates that as population density increases, the amount of green space per capita decreases. In districts such as Esenyurt, Pendik, and Bağcılar, where the population exceeds 700,000, this value falls below 1 m². These district-level values are presented in detail in Table 3. The findings suggest that in some parts of Istanbul, urban density suppresses access to green space and causes these areas to fall below critical thresholds in terms of quality of life.

Table 3. District-Based Green Space Assessment.

District	Population (2024)*	Green Space per Capita (m²/person)**
Şile	48.936	25,17
Beykoz	245.440	16,71
Çatalca	80.399	13,18
Ataşehir	414.866	11,45
Başakşehir	520.467	10,71
Sarıyer	342.582	10,04
Beylikdüzü	415.290	9,45
Silivri	232.156	9,13
Tuzla	301.400	8,85
Çekmeköy	306.739	8,46
Adalar	16.979	7,95
Büyükçekmece	280.528	6,69
Ümraniye	727.819	5,19
Arnavutköy	344.868	5,13
Sancaktepe	502.077	4,92
Bakırköy	219.893	4,89
Beşiktaş	167.264	4,75
Eyüpsultan	420.706	4,65
Maltepe	524.921	3,99
Üsküdar	512.981	3,56
Kartal	475.859	3,31
Kadıköy	462.189	2,87
Şişli	263.063	2,67
Küçükçekmece	789.033	2,4
Beyoğlu	216.688	2,19
Sultanbeyli	369.193	1,94
Zeytinburnu	278.344	1,84
Kağıthane	444.820	1,72
Güngören	264.831	1,51
Fatih	354.472	1,47
Gaziosmanpaşa	479.931	1,41
Avcılar	440.934	1,41
Bayrampaşa	268.303	1,3
Sultangazi	532.601	1,23
Bahçelievler	560.086	1,19
Pendik	749.356	1,16
Esenler	423.625	1,03
Esenyurt	988.369	0,79
Bağcılar	713.594	0,65

5.3. The Role of Income Per Capita

The income per capita variable shows a positive and significant effect in Table 1 (β = 0.008; p = 0.011). However, it can be said that this effect is not absolute and becomes more pronounced in conjunction with planned development. For example, in high-income districts such as Kadıköy and

 doi:10.20944/preprints202508.1523.v1

Bakırköy, the amount of green space is low because building density is high in these areas. In contrast, higher green space ratios are observed in moderately-income but planned districts such as Ümraniye and Tuzla (Table 3). This finding indicates that income level gains significance not on its own, but when combined with planning processes.

5.4. Distance to the Central Business District (CBD)

As seen in Table 1, the distance to the CBD variable also shows a significant negative effect ($\beta = -0.015$; $p = 0.017$). This finding indicates that as the distance from the city center increases, the amount of active green space per capita decreases. The development processes in the rapidly growing corridors in the northern part of the city, carried out without integrating green spaces, deepen this trend further.

5.5. Spatial Assessment

In this study, the classification of Istanbul's districts based on the amount of active green space per capita was created using the normative threshold value and equal interval classification method (Table 4).

Table 4. Classification Categories and Ranges Based on the Amount of Active Green Space per Capita (m^2/person).

Classification Category	m^2/person Range	Districts
Very Inadequate	0 – 2,0	Sultanbeyli, Zeytinburnu, Kağıthane, Güngören, Fatih, Gaziosmanpaşa, Avcılar, Bayrampaşa, Sultangazi, Bahçelievler, Pendik, Esenler, Esenyurt, Bağcılar
Inadequate	2,01 – 5,00	Ümraniye, Arnavutköy, Sancaktepe, Bakırköy, Beşiktaş, Eyüpsultan, Maltepe, Üsküdar, Kartal, Kadıköy, Şişli, Küçükçekmece, Beyoğlu
Moderately Adequate	5,01 – 7,99	Adalar, Büyükçekmece
Moderately Adequate	8,00 – 9,99	Beylikdüzü, Silivri, Tuzla, Çekmeköy
Adequate and Healthy	≥ 10,00	Şile, Beykoz, Çatalca, Ataşehir, Başakşehir, Sarıyer

*Population of Istanbul Districts [25]. ** Green Space Inventory Report [8].

This approach facilitates comparison between districts and makes spatial inequalities more clearly visible.

5.6. Alignment with International Standards and Literature

The classification is also consistent with the minimum threshold of 9–10 m^2 of active green space per capita recommended by organizations such as the World Health Organization (WHO) and the United Nations Human Settlements Programme (UN-Habitat) [6, 26]). The lower limit of 2 m^2 for the "Very Inadequate" category is based on scales proposed in the literature to indicate "sub-critical threshold conditions" in the context of public health and environmental justice [27, 21].

6. Results and Recommendations

The findings of this study clearly demonstrate that the amount of active green space per capita in Istanbul is deeply influenced not only by physical and environmental factors but also by socio-economic and spatial factors. The analysis results presented in Tables 1, 2, and 3 emphasize the necessity of a multidimensional and holistic approach in green space planning. Particularly, variables such as the level of planned development, population density, and distance to the city center (CBD) have a clear impact on green infrastructure; in this context, socio-spatial inequalities become a determining factor in green space accessibility. The research findings represent one of the rare studies statistically demonstrating that active green spaces in Istanbul are not distributed in an equitable, balanced, or accessible manner. The regression analysis used in this study showed that the main variable affecting the amount of green space per capita is the rate of planned development. This result

 doi:10.20944/preprints202508.1523.v1

highlights the need to institutionalize a "green infrastructure priority approach" within urban planning processes and to have it adopted by decision-makers [28]. The rapid urbanization process observed in developing countries often causes green spaces to be converted into other land uses that provide economic returns. In this regard, the research findings indicate that socially just green space planning has become an imperative, especially in large metropolitan areas; thereby providing a strong example from Turkey to the "green justice" and "accessibility" focused literature such as [29,30]. As of 2024, the average amount of active green space per capita in Istanbul has been determined as 5.2 m². This value is considerably below the minimum green space standard of 9 m² per capita recommended by the World Health Organization [31]. When evaluated at the district level, this ratio falls to critical levels as low as 0.65 m² in some districts, while in areas with planned development it can exceed 12 m² (Table 3).

The results reveal that districts with a high level of planned development such as Şile, Beykoz, Çatalca, Ataşehir, Başakşehir, and Sarıyer have correspondingly high green space ratios. Conversely, districts exhibiting unplanned development and rapid construction, such as Sultanbeyli, Zeytinburnu, Kağıthane, Güngören, Fatih, Gaziosmanpaşa, Avcılar, Bayrampaşa, Sultangazi, Bahçelievler, Pendik, Esenler, Esenyurt, and Bağcılar, show very low green space per capita (Table 4). This situation reveals that access to green space is not only a physical issue but is also related to socio-economic and administrative factors [21, 32].

Especially in metropolises like Istanbul where spatial inequalities are prominent, planning green spaces solely based on area calculations is insufficient. A multidimensional evaluation model that integrates criteria such as accessibility, functionality, socio-demographic structure, and post-disaster use should be developed. In this context, in line with resilient urbanization goals, green spaces should be considered not only as recreational areas but also as post-disaster gathering points.

6.1. Policy and Planning Recommendations

Based on the findings of this study, the following planning and policy recommendations have been developed for Istanbul specifically, but also generally applicable:

*Green space standards should be updated; in addition to square meters per capita, differential green planning models should be adopted considering districts' development levels, needs analyses, and environmental risk profiles [33].

*Green infrastructure must become a mandatory component of urban transformation projects, and this requirement should be legally secured through zoning notes and regulations.

*Open spaces allocated for post-disaster use should be planned not only for evacuation purposes but also as continuously accessible public green spaces, strategically located within the urban fabric [34].

*In line with the principle of spatial justice, green space investments should be prioritized in socio-economically disadvantaged areas, and these spaces should be designed to be accessible, multifunctional, and community-based [35].

*Local governments and metropolitan municipalities should establish green space indices that consider spatial inequalities within their strategic plans, integrating these indices into monitoring and evaluation mechanisms.

6.2. Critiques on Legislation and Planning Standards

The current Spatial Plans Preparation Regulation (MPYY) in Turkey treats green space standards as open and green areas in Annex 2, without differentiating between active and passive green spaces or providing clear guidance on different functional types. As seen in Article 24, Paragraph 3 of the regulation, the lack of detailed classification for green spaces creates ambiguity in urban planning processes. Additionally, Law No. 6306 on the Transformation of Areas Under Disaster Risk does not include specific provisions regarding green spaces [36]. However, the need for green open spaces at various scales during and after disasters is a vital necessity. Therefore, planning urban green systems and reconsidering urban transformation projects based on post-disaster usability, accessibility, and environmental health indicators is essential.

 doi:10.20944/preprints202508.1523.v1

7. In Conclusion

The main goals of a green space strategy to be developed in Istanbul should be:

Preservation and quality improvement of existing green spaces,

Creation of new green spaces in areas where they are insufficient,

Ensuring balanced and equitable distribution throughout the city,

Planning green spaces to establish ecological connections

Additionally, as suggested by Herzele and Wiedemann [29], time-sequenced change analyses, socio-economic vulnerability data, spatial accessibility models, and different green space typologies should be jointly evaluated to develop a green justice mapping system specific to Istanbul.

This research offers a unique contribution to both urban planning and environmental justice literature by addressing Istanbul's active green space system with up-to-date, spatial, socio-economic, and administrative data through multilayered analyses. The findings provide a foundation for comparative research not only for Istanbul but also for other rapidly developing large metropolitan areas. In the construction of sustainable, just, and inclusive cities, green spaces should no longer be regarded as a luxury but as a fundamental human right.

References

1. Lefebvre, H. The Production of Space, 1st ed.; Nicholson-Smith, D., Trans.; Basil Blackwell, Inc.: Oxford, UK, 1991.
2. Tzoulas, K.; Korpela, K.; Venn, S.; Yli-Pelkonen, V.; Kaźmierczak, A.; Niemela, J.; James, P. Promoting ecosystem and human health in urban areas using Green Infrastructure: A literature review. Landsc. Urban Plan. 2007, 81 (3), 167–178.
3. Pauleit, S.; Ennos, R.; Golding, Y. Modeling the environmental impacts of urban land use and land cover change—A study in Merseyside, UK. Landsc. Urban Plan. 2005, 71, 295–310.
4. Apostolopoulou, E.; Kotsila, P. Community gardening in Hellinikon as a resistance struggle against neoliberal urbanism: Spatial autogestion and the right to the city in post crisis Athens, Greece. Urban Geography 2021, 43, 1–27.
5. Haase, D.; Kabisch, S.; Haase, A.; Andersson, E.; Banzhaf, E.; Baro, F.; Brenck, M.; Fischer, L.K.; Frantzeskaki, N.; Krellenberg, K.; Kremer, P.; Kronenberg, J.; Larondelle, N.; Mathey, J.; Pauleit, S.; Ring, I.; Rink, D.; Schwarz, N.; Wolff, M. Greening cities–To be socially inclusive? About the alleged paradox of society and ecology in cities. Habitat Int. 2017, 64, 41–48.
6. World Health Organization (WHO). Urban Green Spaces and Health – A Review of Evidence; WHO Regional Office for Europe: 2016.
7. Urban Atlas. Urban Atlas: Land Use Data for European Cities; Copernicus Land Monitoring Service: 2024.
8. Istanbul Metropolitan Municipality (IBB). Green Space Inventory Report. IBB Publications, Istanbul, Turkey, 2024.
9. Aksoy, Y. Analysis of Green Areas in Istanbul City, Ph.D. Thesis, Istanbul Technical University, Graduate School of Science, Istanbul, Turkey, 2001.
10. Yıldızcı, A.C. Kentsel Yeşil Alan Planlaması ve İstanbul Örneği; Doctoral Thesis, İstanbul Teknik Üniversitesi Mimarlık Fakültesi, İstanbul, Türkiye, 1982.
11. Önder, S. A Study on the Determination of Open and Green Area System of Konya City, Ph.D. Thesis, Ankara University Graduate School of Science, Department of Landscape Architecture, Ankara, Turkey, 1997.
12. Aksoy, Y. Site Selection Theory and Applications. In Spatial Adequacy Analysis for Active Green Areas: The Case of Istanbul; Yeni Anadolu Yayıncılık: Istanbul, Turkey, 2017; ISBN 978-605-82-59-508.
13. Lafortezza, R.; Chen, J.; Bosch, C.K.V.D.; Randrup, T.B. Nature-based solutions for resilient landscapes and cities. Environ. Res. 2018, 165, 431–441.
14. European Commission. A Strategy for Smart, Sustainable and Inclusive Growth. 2020.
15. Lassandro, P.; Zaccaro, S.A.; Turi, S.D. Mitigation and Adaptation Strategies for Different Urban Fabrics to Face Increasingly Hot Summer Days Due to Climate Change. Sustainability 2024, 16, 2210.

 doi:10.20944/preprints202508.1523.v1

16. McBride, S.B. Site Planning and Design; Regional Research Institute, West Virginia University: Morgantown, WV, USA, 1999.
17. Cabuk, S.N. GIS Supported Strategic Environmental Assessment Study: Site Selection for Mass Housing in Eskişehir City, M.Sc. Thesis, Anadolu University Graduate School of Science, Eskişehir, Turkey, 2006.
18. Çabuk, A.; Aksoylu, S. Applicability of Geographic Information Systems in Urban Planning Process. In Proceedings of Bilişim 04 "KENTTe-Dönüşüm" e-Government, e-Engineering and e-Urbanism 3rd National Congress, Ankara, Turkey, 2004.
19. Sakhvidi, M.J.Z.; Mehrparvar, A.H.; Sakhvidi, F.Z.; Dadvand, P. Greenspace and health, wellbeing, physical activity, and development in children and adolescents: An overview of the systematic reviews. Curr. Opin. Environ. Sci. Health 2023, 32, 100445.
20. Alberti, M. Urban patterns and environmental performance: What do we know? J. Plan. Educ. Res. 1999, 19, 151–163.
21. Wolch, J.R.; Byrne, J.; Newell, J.P. Urban green space, public health, and environmental justice: The challenge of making cities 'just green enough'. Landsc. Urban Plan. 2014, 125, 234–244.
22. Jim, C.Y. Green-space preservation and allocation for sustainable greening of compact cities. Cities 2004, 21, 311–320.
23. Germann-Chiari, C.; Seeland, K. Are urban green spaces optimally distributed to act as places for social integration? Results of a geographical information system (GIS) approach for urban forestry research. For. Policy Econ. 2004, 6, 3–13.
24. Lawrence, L. Statistics, Meaning and Method; Harcourt Brace Javanovich Inc.: USA, 1980; p. 58.
25. https://www.nufusu.com/ilceleri/istanbul-ilceleri-nufusu
26. UN-Habitat. Streets as Public Spaces and Drivers of Urban Prosperity; United Nations Human Settlements Programme: 2013.
27. Kabisch, N.; Qureshi, S.; Haase, D. Human–environment interactions in urban green spaces – A systematic review of contemporary issues and prospects for future research. Environ. Impact Assess. Rev. 2015, 50, 25–34.
28. Sun, J.; Cheshmehzangi, A.; Wang, S. Green Infrastructure Practice and a Sustainability Key Performance Indicators Framework for Neighbourhood-Level Construction of Sponge City Programme. J. Environ. Prot. 2020, 11(2), 82–109.
29. Herzele, A.V.; Wiedemann, T. A monitoring tool for the provision of accessible and attractive urban green spaces. Landsc. Urban Plan. 2003, 63, 109–126.
30. Kline, J.D. Public demand for preserving local open space. Society and Resources 2006, 19, 645–659.
31. World Health Organization (WHO). Urban Green Space and Health: A Review of Evidence. WHO, 2022.
32. Anguelovski, I. From toxic sites to parks as (green) lulus?: New challenges of inequity, privilege, gentrification, and exclusion for urban environmental justice. J. Plan. Lit. 2016, 31, 23–36.
33. Byrne, J.; Wolch, J. Nature, race, and parks: Past research and future directions for geographic research. Prog. Hum. Geogr. 2009, 33, 743–765.
34. Jabareen, Y. Planning the resilient city: Concepts and strategies for coping with climate change and environmental risk. Cities 2013, 31, 220–229.
35. Anguelovski, I.; Brand, A.L.; Connolly, J.J.T.; Corbera, E.; Kotsila, P.; Steil, J.; Garcia-Lamarca, M.; Triguero Mas, M.; Cole, H.; Baró, F.; Langemeyer, J.; del Pulgar, C.P.; Shokry, G.; Sekulova, F.; Ramos, L.A. Expanding the Boundaries of Justice in Urban Greening Scholarship: Toward an Emancipatory, Antisubordination, Intersectional, and Relational Approach. Ann. Am. Assoc. Geogr. 2020, 110, 1743–1769.
36. Republic of Turkey. Law No. 6306 on the Transformation of Areas Under Disaster Risk [Law]. Official Gazette, 2012.