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ARTICLE / ARAŞTIRMA

Do Spatial Development Plans Provide Spatial Equity in Access to Public Parks: A Case with a Residential Area in Karabağlar and Buca (İzmir)

İmar Planlarında Park Erişiminin Mekânsal Hakçalığı: Karabağlar ve Buca'da bir konut alanı örneği (İzmir)

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ABSTRACT

Public parks' location is one of the major factors shaping their accessibility. Many natural and physical features (e.g., topography, stream ways, street network, traffic density, road junctions, and land uses) affect walking distances from dwellings to these locations. Also, the cost of access (measured in time and meter) to these locations vary among age groups with different walking capacities. Spatial plans in Turkey are the documents for determining and implementing the allocation of parks. However, plan-making practices have limitations in considering the park accessibility by walking among different groups of dwellers. This study considers the accessibility of public parks as an issue of spatial equity. It evaluates the park accessibility at a recent spatial plan about a residential area in Karabağlar and Buca Districts of İzmir. It aims to assess the allocations of planned parks and propose potential locations for new park areas. With a point-based approach to park accessibility, the study analysis performs the Location-Allocation (LA) Analysis with multiple criteria at Geographic Information Systems. The results show that at the plan, the specified residential area has spatial inequities with park accessibility. Among the other planned public service areas, some locations can be re-planned as new park areas, which partially improves spatial inequities at the plan. Also, the study is an example of how to prepare and run the data for the spatial analysis of allocations of public service areas with the help of GIS in Turkey.

Keywords: Accessibility; geographic information systems; spatial equity.

ÖZ

Kamusal parkların konumu, erişilebilirliklerini şekillendiren en önemli faktörlerden biridir. Birçok doğal ve fiziksel özellik (ör. Topografya, akarsu yolları, sokak ağı, trafik yoğunluğu, yol kavşakları ve arazi kullanımı) konutlardan bu konumlara yürüme mesafelerini etkiler. Ayrıca, bu konumlara erişim maliyeti (zaman ve metre cinsinden ölçülür), farklı yürüme kapasitesine sahip yaş grupları arasında farklılık gösterir. Türkiye'deki mekansal planlar, parkların tahsisinin belirlenmesi ve uygulanmasına yönelik belgelerdir. Bununla birlikte, plan yapma uygulamalarının, farklı mahalle sakini grupları için yürüyerek park erişilebilirliğini göz önünde bulundurmada sınırlı kalmaktadır. Bu çalışma, kamusal parkların erişilebilirliğini mekansal hakçalık sorunu olarak ele almaktadır. İzmir'in Karabağlar ve Buca ilçelerinde bir konut yerleşim alanı ile ilgili yakın tarihli bir mekansal planda park erişilebilirliğini değerlendirmektedir. Planlanan parkların tahsisini değerlendirmeyi ve yeni park alanları için potansiyel yerler önermeyi amaçlamaktadır. Çalışma, park erişilebilirliğine yönelik noktaya dayalı bir yaklaşımla, analizi Coğrafi Bilgi Sistemlerinde çok kriterle Konum Tahsisi (LA) Analizi ile gerçekleştirir. Sonuçlar, planda, belirtilen konut yerleşim alanının park erişilebilirliğinde mekansal hakkaniyetsizliğe sahip olduğunu göstermektedir. Planlanan diğer kamu hizmeti alanları arasında, bazı yerler yeni park alanları olarak yeniden planlanabilir ve bu da plandaki mekansal eşitsizlikleri kısmen iyileştirir. Ayrıca bu çalışma, Türkiye'de kamu hizmet alanlarının tahsisinin mekansal analizi için verilerin CBS yardımıyla nasıl hazırlanıp çalıştırılacağına bir örnek teşkil etmektedir.

Anahtar sözcükler: Erişilebilirlik; coğrafi bilgi sistemleri; mekansal hakçalık.

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TMMOB Şehir Plancıları Odası

1. Introduction

The plan-making procedures of urban development plans shape not only physical environment but also spatial justice in terms of public resource distribution (Marsh & Schilling, 1994; Rigolon, 2016; Talen, 1998b; Tan & Samsudin, 2017). Accessibility to public resources is an important issue of distributional justice concerning the public service areas (Beler, 1997). Urban planning discipline considers the public service areas as the areas developed with public resources. Ideally, urban plans are expected to provide individuals with the opportunities to benefit from these public areas affordably and effortlessly (Talen & Anselin, 1998). However, as in the case of Turkey, the zone-based distribution procedures for the allocation of public service areas do not put much effort to sustain accessibility of all local dwellers to public services (Kwan, 2010).

An important public service area is the public green areas, particularly, the neighbourhood parks. Urban green areas are important for the maintenance and improvement of the wellbeing of individuals, urban environmental quality, air quality, social integration and spatial equity (Ekkel & de Vries, 2017; Kara, Tuncay, & Deniz, 2011; Swyngedouw & Heynen, 2003; Williams, 2002). Meanwhile, neighbourhood parks are expected to be at the location within 5–10 minutes walking distance to residential buildings (Xia, Li, & Chen, 2018). In daily life, however, individuals' access to local parks varies in and among the neighbourhoods. The location of parks is a major factor shaping the park accessibility among the city dwellers. Due to the differences in walking capacities of individuals (Stafford & Baldwin, 2018), the locational choices for parks must consider many physical and geographical features (such as distance, slope, stream ways, street network, traffic density, and land use) that affect walkability.

Differential access of various groups with different socio-economic, gender or age characteristics to public service areas has been an important research area in urban studies (Cook & Hegtvedt, 1983; Fan, Xu, Yue, & Chen, 2017; Guzman, Oviedo, & Rivera, 2017). This study considers the achievement of accessibility to parks by local dwellers especially children, elderly and disabled (Macintyre, Macdonald, & Ellaway, 2008; Stafford & Baldwin, 2018) as an issue of "spatial equity" (Talen & Anselin, 1998). Meanwhile, in contrast to a large body of works at the city scale, a limited number of studies focus on smaller spatial scales (such as neighborhoods) at which spatial inequity is felt stronger on daily basis (Tan & Samsudin, 2017).

This study aims to contribute to spatial equity studies at smaller spatial scales. Particularly, it questions how to investigate, identify and sustain the park accessibility as proposed by the urban development plans at the neighbourhood level. For these purposes, it performs a multi-criteria decision analyses at Geographic Information System (GIS) using network based Location-Allocation Analysis. The analysis evolves at two stages: It assesses the accessibility of parks at the urban plan about a residential area in Karabağlar and Buca Districts of Izmir. Then to improve park accessibility for future dwellers, it proposes new park locations among the planned public areas. The accessibility measurements lays on a point-based approach in contrast to zone-based, that's the results are important for researchers and practioners in urban planning in Turkey. The main findings show that there is spatial inequity in access to parks in neighbourhoods with high population of children and elderly in İzmir. Furthermore, the study proposes an alternative park locations with higher accessibility by local dwellers. Apart from findings, the parts of discussion and conclusion reconsiders the main contributions of the study.

2. Allocation Mechanisms of and Accessibility to Public Service Areas

The distributive procedures of public services and facilities by urban planning have roots in the locational theories. The main objective of public service allocation has changed from sustaining maximum profit and utility (Pareto–optimal allocation) (Tiebout, 1956) to developing the social welfare (Harvey, 1975, 1996; Lineberry & Welch, 1989; Teitz, 1968). Lately, the increasing acceleration of inequalities in the resource distribution among society members has given a rise in environmental justice issues (Schlosberg, 2013; Sister, Wolch, & Wilson, 2010; Stafford & Volz, 2016). Recent approaches to public service allocation focus on both economic optimisation and spatial equity in allocation processes (Guzman et al., 2017; Omer, 2006; Talen, 1998a). Accordinly, a proper allocation model should consider both measurable criterion, such as proximity and capacity and also non-measurable criterion such as social needs of individuals (Rigolon, 2016; Talen & Anselin, 1998).

The operational meaning of spatial equity and economic efficiency is to sustain as much as high accessibility of different social groups (particularly the disadvantaged groups socio-economically and demographically) to public service areas within walking distances (Neutens, Schwanen, Witlox, & De Maeyer, 2010; Stafford & Baldwin, 2018; Stafford & Volz, 2016). To guide the operations of socio-spatial distribution of public services, "the equity" is considered to be achieved through the equality-, need-, demand- and market-based procedures. As the prevailing approach also in the urban planning practices, the equality-based equity considers an equal distribution of resources among individuals, regardless of their differences with socio-economic characteristics and status, ability to pay, and needs (Lucy 1981). Critics argue that this perspective has caused socio-spatial inequities among social groups in getting access to public resources (Frey 2017; Rigolon 2016).

Alternatively, the demand-based equity refers to people's demand for getting public services, based on their capacity for reaching to political power and mechanisms. Market-based equity considers public services' cost as the key factor in their socio-spatial distribution. It relates to the degrees about people's capacity and willingness to pay for a particular service (Lucy 1981). Whereas demand- and market-based equity favour the socio-economically advantaged groups over others, the need-based equity argues for prioritizing the needs of disadvantaged groups and for sustaining the distributive justice at the allocation of public services and facilities (Talen 1998; Frey 2017). It favours the distribution of public resources with a concern of social costs, spatial segregations and social justice among social groups (Byrne and Wolch 2009).

Along with the development of the Geographic Information Systems (GISs), the number of studies measuring and evaluating the spatial equity issues has increased. Similarly, for the assessment of the accessibility to public service areas, different operational bases have developed (Apparicio, Abdelmajid, Riva, & Shearmur, 2008; Talen & Anselin, 1998). These are in two main groups, namely, the place-based (zone-based) and point-based approaches (for details, see Kwan, 1999; Neutens, Schwanen, Witlox, & De Maeyer, 2010). Within the place-based approach, the studies assess the accessibility by considering the geographical distribution and the number of public service areas and the geographical distribution of related socio-demographic characteristics in a defined spatial unit (e.g., neighbourhood) (Rigolon, 2016; Talen & Anselin, 1998; Tan & Samsudin, 2017). In the case of green areas, this approach assumes that the dwellers of a neighbourhood with a sufficient size of green areas per person have access to and, thus, benefit from these local green areas. For its analysis of the accessibility, this approach performs various place-based measures, such as the travel distance to the nearest service location, the quantifiable size of services within either a spatial unit (e.g., neighbourhoods, districts) or a specified distance from the service point, and the attractiveness of services based on the gravity-based measurement (Kwan, 2010; Neutens et al., 2010; Tsou, Hung, & Chang, 2005).

Similar to many countries, Turkey deploys the legislative regulations within the place- or zone-based approach in order to develop urban plans to allocate public services and facilities (Aksoy, 2001). The practices of and the education about urban plan-makings in Turkey rely on this approach for the distribution of public resource.

On the other hand, the point-based approach develops with more complex spatial models that include a higher number of variables for the measurement of accessibility of public areas (Apparicio et al., 2008; Kwan, 2010; Neutens et al., 2010; Tsou et al., 2005). As part of this approach, the walkability distance and the kernel density measurements and related methods take the accessibility by calculating the network distance between the destination points (e.g., service areas) and origin points (e.g., dwelling units) (Fan et al., 2017). Besides reflecting the geographical distance with the street network, the models with this approach recognise the quantity and the scale of service areas, the number of people to serve, and physical and natural thresholds or barriers to the walkability by different groups (Barton, Hugh; Grant, 2010).

This study deploys the point-based approach to assess and evaluate park accessibility as proposed by an urban plan of a residential area in Turkey. It argues that the alternative deployment of this approach will highlight new perspectives in Turkey. Moreover, the analysis with the network distance at small spatial scales (here, the neighbourhood level) is able to detect the daily characteristics of the spatial inequity resulted by different access opportunities for the dwellers in the same neighbourhoods (Tan & Samsudin, 2017; Tsou et al., 2005). With the help of GISs, meanwhile, many scholarly studies especially in the western countries assess the accessibility to public services at the neighbourhood level and evaluate the results for the spatial equity (Boone, Buckley, Grove, & Sister, 2009; Fan et al., 2017; Moise, Kalipeni, & Zulu, 2011; Sister et al., 2010). However, in contrast to these real life case, this study in Turkey assesses and evaluates the park accessibility at an urban development plan and, thus, before the realization of related allocation decisions in urban space.

3. Study Site and Methodology

3. 1. Study Site

The selected urban plan, or the study site, is about a residential area in Izmir. With around 4.5 million people in 2020, İzmir is one of the most populous city in Turkey. Among total 30 districts, the central districts (total 9) have higher population density (Turkish Statistical Institute, 2020). However, some districts have lower sizes of green areas (including, park areas) per person than city averages, according to a research project about Izmir we conducted (see footnote 1).

The residential area subjected to this study is composed of parts of multiple adjacent neighbourhoods in Karabağlar and Buca, two central districts with lower amount of green areas. These neighbourhoods are Aydın, Aşık Veysel and Yunus Emre (Karabağlar District) and Seyhan (Buca District) and have 0.7 m^2 park size per dweller. At these neighbourhoods, the percentages of children (or, 0–13 age group) and elderly (the age group with 65 and above) are respectively 19% and 11%, and higher than the İzmir's averages (in nine central district) with 14% and 10%.

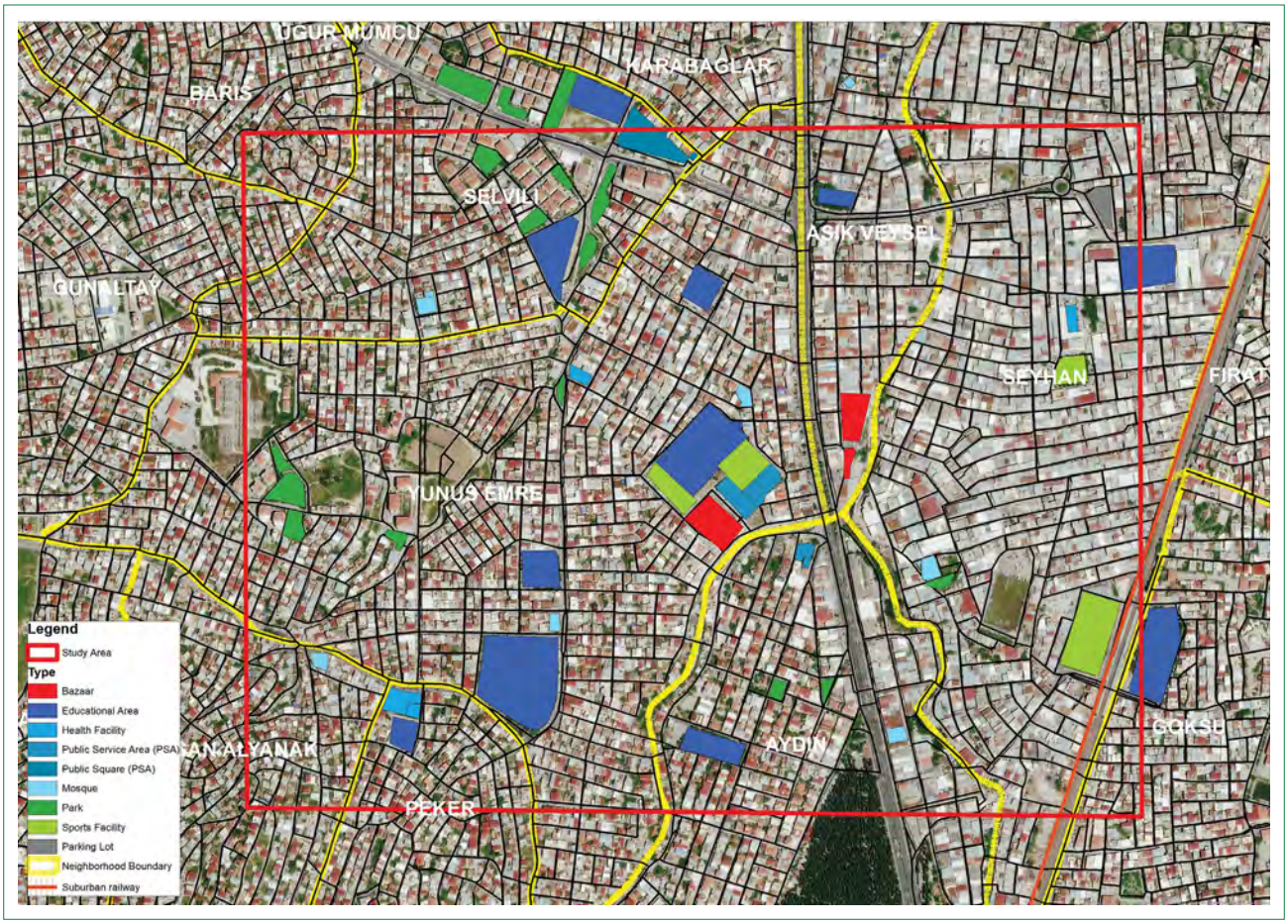

Figure 1. Near here boundaries of the study area (red square) and top view of the contemporary site.

The study area's boundaries are determined with various spatial barriers, such as water streams, railway, major roads, and slope levels. The railway to the east, the hilly area to the south, and the 50 m wide road to the north are part of these boundaries. At the west, the boundary corresponds to the plan diagram hiding data about local spatial features (Fig. 1).

Currently in 2019, the study area has 28177 m^2 park area with 16 parks (Fig. 1) and 40600 dwellers, according to an approximate calculation of number of residential buildings (Fig. 2). At its large portion, it has attached housing and high population density (185 p/h). At its large portion, this area has attached housing with four stories at average and up to nine stories. There are two stream ways along which many residential buildings stand at a distance (lower than 50 m) to stream bed.

The spatial development plan at this study is a 1/1000 scaled implementation plan developed in 2019. It proposes attached and block housing with approximately 2–3 stories. The proposed population is nearly 65000 at 7500 residential and mixed-use buildings. Thus, the local population will increase by 50%. The plan has 86 public service areas, including 11 educational service areas, four health facilities, six mosques, nine administrative facilities, 20 parks, 29 green areas, four sports facilities, and one playground.

Some of the parks are proposed alongside the stream ways in the leftover spaces created by the removal of some buildings. The part between the two streams has almost no parks compared to the rest of the plan. At the eastern part, parks have relatively an even spatial distribution, while those to the west are at two clusters (Fig. 3).

An examination of the recent land prices at the study area shows that the local land prices are the highest alongside the main traffic road (50 m). They decrease at the locations distant from this road, particularly to the east of the area. At the plan, most of the parks are away from the main traffic roads. Except for a few, parks are at locations with relatively low land prices (Fig. 4).

The planned street network follows the existing pattern of today. There are varied physical and natural features that can affect walkability to local service areas, particularly for those

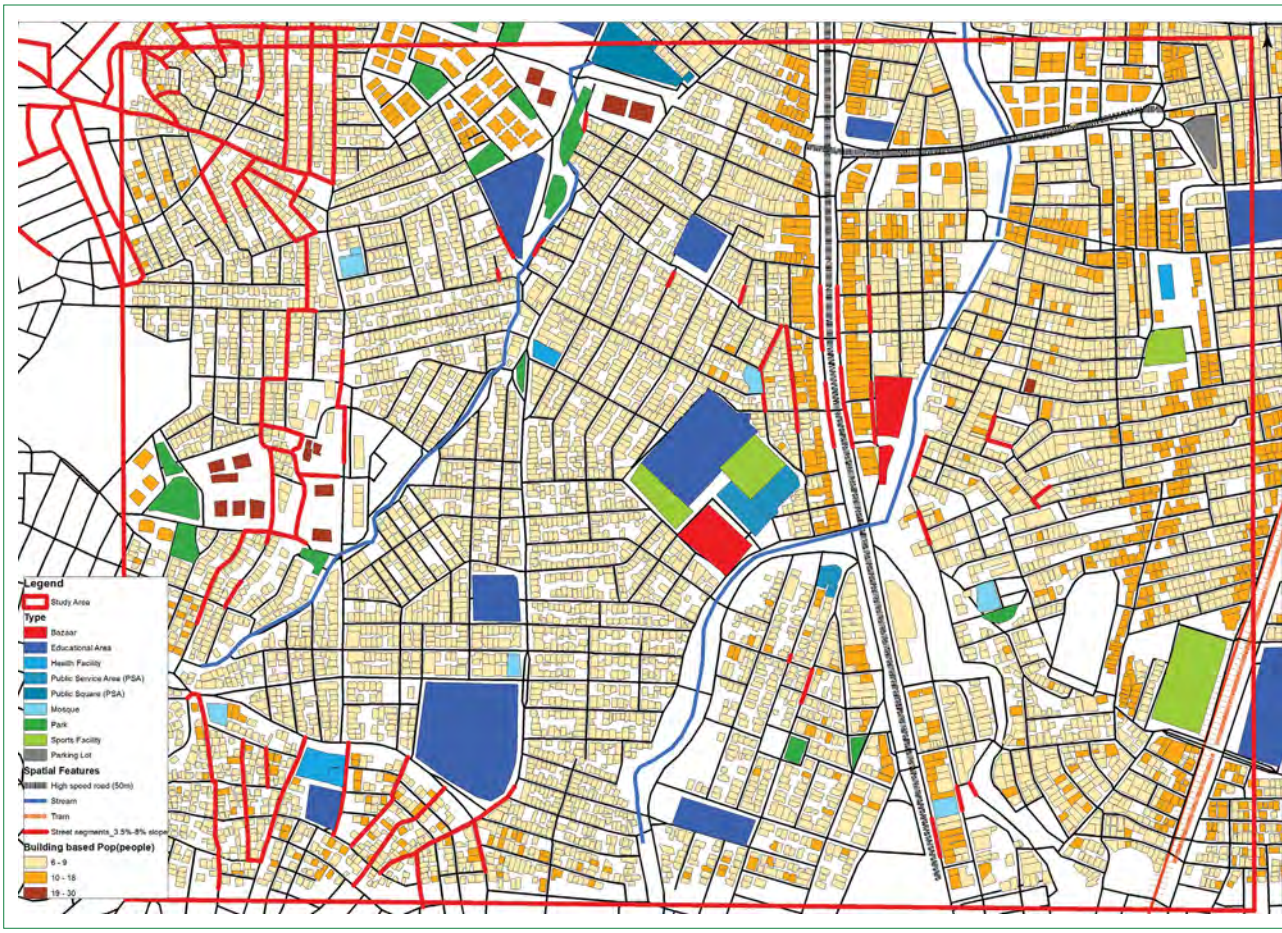

Figure 2. Near here current spatial distribution of number of building floors.

with limited walk capacities. These spatial hindrances are two stream ways, one suburban tram line, one major road (with 50 m wide) and a slope level more than 3.5% up to 8%.

3. 2. Study Methodology

With a case study design, this study develops at the neighbourhood scale with a point-based measurement to accessibility (Ekkel & de Vries, 2017; Kwan, 1999; Yeh & Chow, 1996). It is designed as a GIS-based multi-criteria decision analysis (MCDA) using ArcMap 10.5.. The MCDA provides a framework that facilitates the resolution of complex locational decision problems regarding the sets of decision criteria. With its ability to manage multi-criteria, multi-objective, and multi-actor, GIS-based spatial decision models (Gold, 2006) can both assess spatial clustering of locations and further detects the most appropriate location considering measurable factors (such as distance, slope, and time) (Malczewski, 2006). Within the context of MCDA, this study uses network based Location-Allocation (LA) Analysis (Cooper, 2005; El Karim & Awawdeh, 2020) to measure the park accessibility at a spatial development plan (dated 2019) and then to propose "better" locations for new parks among the other planned public areas.

The location allocation of parks as a problem of spatial equity requires to take into consideration various features the built-environment. With a set of locational solutions, the probabilistic algorithms appear as the efficient tools to assess alternative solutions for these allocation problems (Cooper, 2005). At the LA analysis, the algorithm works by allocating each demand point (i) to its closest supply centre (j). Also, it calculates new locations (z) for new supply centres for each demand points (Rushton, 1979; Yeh & Chow, 1996).

$$z = \sum_{i=1}^{n} \sum_{j=1}^{m} a_{ij} w_i d_{ij}$$

where, according to Yeh & Chow (1996):

a_{ij}="*(1 if demand point i is closest to supply centre j, 0 otherwise)*"

w_i= "*weight associated with each demand point*"

d_{ij}="*distance between demand point i and supply centre j*"

The procedure of location-allocation models take the locations of public facilities in order to assess their accessibility by optimising the settled spatial criteria. This study determines the context-based spatial criteria according to the following steps:

Figure 3. Near here proposed parks at the plan.

(i) It takes the georeferenced and population weighted residential buildings as the demand points and park service areas as the supply points. Population of residential buildings are measured by multiplying storey number and average household population of İzmir. Here it was assumed that at each building floor, there will be one residential unit.

(ii) 300 m is taken as the maximum walking distance via georeferenced street network.

(iii) Various spatial impedances are identified as the barriers to walkability. At the analysis, these include the slope levels above 3.5%, the railway, local stream ways and the roads with 25 m and 50 m width.

3. 2. 1. Preparation of Data

Data preparation process constitutes an important step of this research. The process has two stages. The first one is the data formatting. Data formatting includes geo-referencing of the blueprints of 1/1000 scaled plans in raster format and digitisation of each spatial data in vector format. The second stage recognizes the spatial barriers and weighting the spatial vector data by related attributes.

The raster data of spatial development plans constitutes a base for study area and the study area consists of six 1/1000 plans. Each plan is aligned with 5 control points to use polynomial transformation method of the Geo-referencing tool in ArcMap. By updating control points, each raster data are coordinated in accurate location with accurate dimension. Apart from raster data, the spatial data is digitized in vector format including polygons of residential buildings, parks and other service areas and polylines of water streams, railway and streets. These are digitised as distinct layers upon the raster data in ArcMap.

Furthermore, spatial barriers are prepared by weighting vector data based on an attribute. These attributes are slope level and road width for street data and further population number for residential buildings. Firstly, the attribute of slope level is sustained from DEM (digital elevation model). The DEM data is downloaded from an open-sourced online aerial photo database of Earth Explorer (https://earthexplorer.usgs.gov/). Slope data is produced using slope tool of ArcMap upon DEM data. The street segments that correspond to slope higher than 3.5% are weighted by their slope value. Secondly,

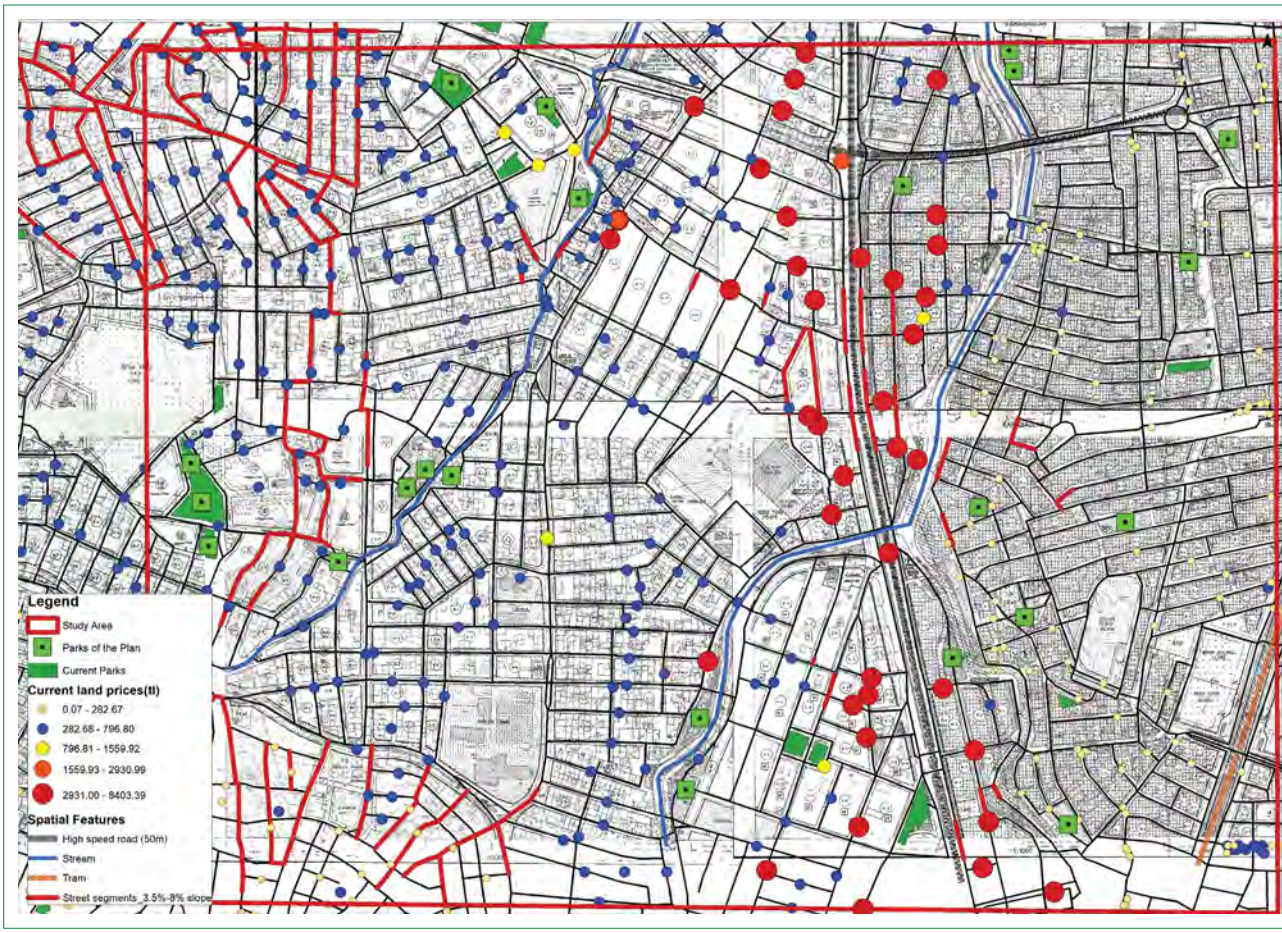

Figure 4. Near here the distribution of current land prices and the proposed parks and other open green areas.

the proposed road widths of the plan is used and the streets with wider than 25 m (25 m and 50 m roads) are weighted by their width. Lastly, residential buildings are weighted by population number that is computed multiplying the number of storeys at that building by the average household size of İzmir. Eventually, street segments with slope level higher than 3.5%, major traffic roads wider than 25 m, stream ways and the railway are prepared to use as spatial barriers in the analysis.

4. Findings

About the accessibility of the proposed parks within the specified walking distance, the first group of findings shows some parks with "weak" or "no" access and others with relatively "better access" (Fig. 5). The second group is about the potential locations for new parks among planned non-park public areas (Fig. 6).

Detailed in Figure 3, the parks at the eastern part of the area have relatively an even spatial distribution and, at the western part, clustered at two points. The sub-area between two streams has almost no parks.

According to the first group of results (Fig. 5), on the plan, 3370 residential buildings or 28800 dwellers have access to any park area within 300 m walkable distance. In other words, 44% of the future local population has park accessibility. Most buildings with weak or no access to parks are between two stream ways, on the hilly areas to the northwest section, and alongside the major road. The buildings with better access are scattered at some parts near the stream ways and more at the eastern part (Fig. 5). Ultimately, this planned residential area has a spatial inequity in access to parks. The proximity between residences and parks, and the presence of railway and wide (25 m and 50 m wide) traffic road affect the inequity in park accessibility. The slope level and stream ways have limited roles as barriers to walkability in this area.

The "most accessible" park (that is, with higher service lines to residential buildings at LA Analysis) serves nearly all 400 residential buildings (with 3600 dwellers) at its surrounding. On a flat topography to the east, this park is 600 m far from the railway and the major road. At the upper east side, the "least accessible" park has service only for 11 residential buildings with 69 dwellers. This park is near the stream way and without any crosswalk leading there.

Figure 5. Near here results of LA analysis about the accessibility of the parks in the plan.

The second group of findings is about proposing alternative locations for new park areas among the other public areas in the plan. Out of the total of 86 public service areas, 20 include existing and planned park areas. Others include open spaces (such as 'green areas') and public areas with buildings, including the mosques, administration, schools, and health facilities.

For proposing additional locations for park areas, the study considers multiple preconditions. Firstly, based on Figure 5, the public areas in the sections of the plan with low park accessibility are prioritized. The results in Figure 6 show that 14 public areas (the orange and ticked boxes) have relatively high accessibility to residential buildings and are to the west and north of the area.

Secondly, the potential areas should be among the newly planned non-park areas. Out of the specified 14 public areas, nine serve as the schools, mosques, open sports areas, and green areas (Fig. 1, Table 1). Five green areas are newly proposed by the plan. Four of these green areas are between two streams. One of them is at the hilly part to the north (Fig. 6). Based on the local authorities' other criteria, all or only some of these green areas can be re-planned and implemented as new park areas to increase local park accessibility. For the latter case, thirdly, the demand capacity of each public area is the criterion (Table 1).

The green area with ID number 5 has the highest demand capacity, thus, accessibility among all five green areas. This is the only planned green area between two streams with almost no parks and few other public areas. In any case, this section of the plan will lack park accessibility unless other solutions are checked. Developing new public land or re-utilizing open spaces of existing or planned public facilities (for instance, gardens of schools) for park purposes can be among these solutions.

5. Discussion and Conclusion

This study aims to assess and increase spatial equity in access to public parks at the neighbourhood scale. It considered "spatial equity" as the achievement of park accessibility by a high number of people with limited walking capacities.

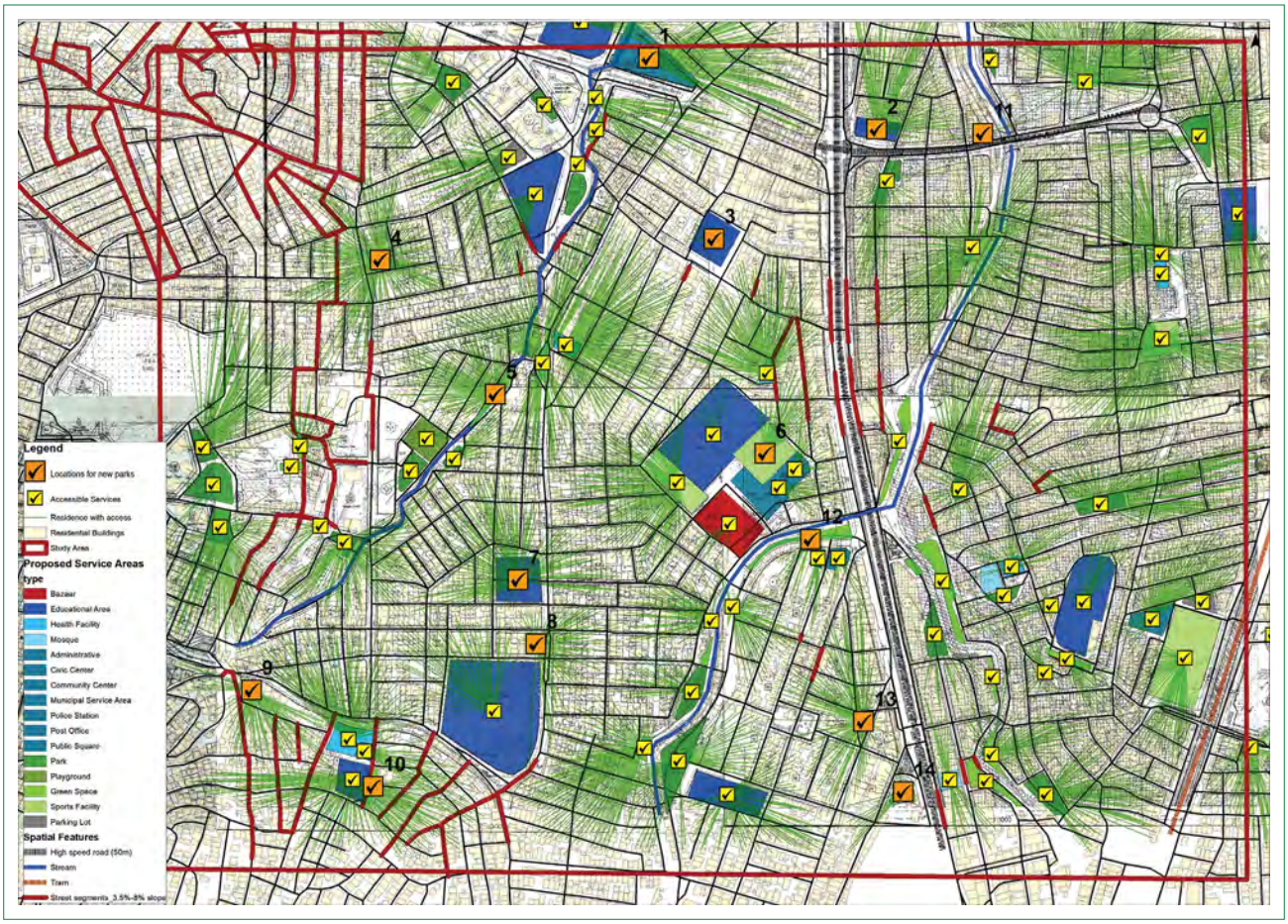

Figure 6. Near here results of the LA analysis about potential locations for new parks among non-park public areas.

Rather than a zone-based approach (e.g., park area per person living in a neighbourhood), the park accessibility is sustained by a set of spatial criteria by a point-based approach at the neighbourhood scale.

This study performs a network-based Location-Allocation Analysis of the accessibility of parks proposed at 1/1000 scaled urban plans. The study is among a few works about spatial equity issues at the neighbourhood scale in Turkey. It shows the ways to produce spatial data units from open-sourced databases in GIS, which is significant for the data-poor context of Turkey. Finally, it develops as a case bridging between the locational theories and the planning practices with allocation procedures for public service areas.

The study findings underline the need for paying attention to the allocation decisions about park areas at the spatial plans. Although the plans provide park accessibility in terms of planned green area per person, they do not consider the location of parks to sustain park accessibility for all dwellers. To have maximum benefit from public spending and detect optimum location, multi-criteria decision models can

Table 1. Near here characteristics of potential locations for new parks

ID	Demand count	Demand weight	Landuse type
1	143	1332	Public service area in current
2	127	1074	Educational area in current
3	6	54	Educational area in current
4	249	1863	Mosque in current
5	131	1179	Grren area in plan
6	44	393	Sports area in current
7	207	1863	Educational area in current
8	95	855	Mosque in current
9	89	759	Mosque in current
10	29	240	Green area in plan
11	6	60	Green area in plan
12	15	126	Green area in plan
13	132	1164	Green area in current
14	19	171	Green area in plan

assist to simulate park accessibility. As in this study, these simulations can consider multiple spatial features, including slope levels, network connectivity, crosswalks, stream ways, major roads, the distance between buildings and service areas, and more, if needed. According to the study findings, although each park is accessible, they have different service capacities for those with 300 m. as their maximum walking capacities (e.g., children, elderly and disabled people). LA Analysis shows that 44% of planned population have park access considering the distance, slope, and network connectivity. The public facilities in hilly areas are not accessible for those with limited walking capacities. With the clusters of public facilities in particular sub-areas, this residential area lacks access to parks and other public facilities in other parts. In other words, this residential area faces spatial inequities if the plan is implemented in this version.

Consequently, this study proposed an alternative process to the zone (standard) based approach practiced at urban plans in Turkey. Against the limitations of the current planning system, a point-based and multi-criteria model is suggested to achieve maximum accessibility and, thus, spatial equity in the allocation of public service areas by local authorities. Also, the process of spatial analysis is important to enhance the use of GIS in the allocation of public areas and the public service distributions.

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