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Araştırma Makalesi Research Article

Evaluating The Sufficiency, Accessibility and Integrity of Green Spaces in Urban Environments

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Keywords
Urban Green Spaces, Urban Planning, Geographical Information System (GIS)

Abstract

Availability of urban green space is acknowledged as one of the most important elements of well-being and quality of life in cities. Green space provides physical activity, psychological well-being, and the general public health for urban residents. Forming up green spaces in a city is an effort to embrace ecological environment and taking it into cities that have been isolated from surrounding flora and fauna due to excess urbanization, therefore, supports the ecological functioning and integrity of cities. Further benefits are the moderation of adverse environmental conditions such as air pollution, urban heat island effect, noise, and water run-off. Urban green space is diverse and multifunctional such that it varies in size, proximity, vegetation cover, species richness, environmental quality, facilities, and offered services. However, in most urban areas, and particularly in inner-city and areas that lack a former plan, green spaces are in insufficient supply.

In this study, we explore the urban green spaces of İzmit city that has been subject to excess urbanization for decades. Urban green spaces in this study are analyzed for their distribution pattern and by their properties namely; size, functionality, and accessibility using Geographic Information Systems (GIS). Our research reveals that distribution of urban green spaces is scarce and disproportionate which is also recognized as an environmental justice issue. Outcomes revealing regions of the city that are in insufficient supply of green space are portrayed as map layouts. Outcomes of the study can communicate status of urban green spaces to the decision makers for the moderation of the green space in the city, at the urban, district and neighborhood scales.

Kentlerde Yeşil Alanların Yeterlilik, Erişebilirlik ve Bütünsellik Açısından Değerlendirilmesi

Anahtar Kelimeler
Kentsel Yeşil Alanlar, Şehir Planlama, Coğrafi Bilgi Sistemleri (CBS)

Öz

Kentsel Yeşil Alanların varlığı, kentlerde refah ve yaşam kalitesinin en önemli unsurlarından biri olarak kabul edilir. Kentsel Yeşil Alanlar, kent sakinleri için fiziksel aktivite, psikolojik rahatlama sağlar ve genel halk sağlığına katkıda bulunur. Kentsel Yeşil Alanlar oluşturmak, yoğun kentleşmeden dolayı etrafındaki flora ve faunadan izole olmuş kentlerin ekolojik çevreyi tekrar içine dahil etmesi çabasını da içerir, bu şekilde, kentlerin ekolojik işleyişi ve bütünlüğü desteklenmektedir. Kentsel Yeşil Alanların diğer yararları ise, hava kirliliği, kentsel ısı adası etkisi, gürültü ve su drenajı gibi olumsuz çevresel koşulların hafifletmesidir. Kentsel Yeşil Alanlar, boyutları, hangi mesafede oldukları, bitki örtüsü, tür zenginliği, çevre kalitesi, içerdikleri tesisler ve sunulan hizmetler bakımından çeşitlilik gösterir ve çok işlevlidir. Bununla birlikte, çoğu kentsel alanda, özellikle şehir içi ve plansız gelişen bölgelerde yeşil alanlar yetersizdir.

Bu çalışmada, İzmit kentinin uzun yıllardır yoğun biçimde kentleşmeye maruz

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kalmış kent yeşil alanları incelenmektedir. Kentsel Yeşil Alanlar, mekansal dağılım desenleri, boyutları, işlevsellik ve erişilebilirlik özelliklerine göre Coğrafi Bilgi Sistemleri (CBS) kullanarak analiz edilmiştir. Elde edilen bulgular, İzmit kentinde yeşil alanların dağılımının yetersiz olduğu ve dengesiz bir dağılım gösterdiğini ortaya koymakta ki bu da aynı zamanda bir çevresel adalet konusu olarak da görülmektedir. Çalışmanın sonucu olarak kentteki yeşil alan açısından yetersiz bölgeler ve erişebilirlik açısından zayıf bölgeler haritalanmıştır. Bu sonuçlar, kentsel yeşil alan deseninin özelliklerini kentteki karar vericilere sunarak, şehirde kent, mahalle ve komşuluk ölçeklerindeki kentsel yeşil alanların düzenlenmesi için yön göstermektedir.

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1. Introduction

Urban green space include parks, gardens, playgrounds, sporting fields, forests, reserves, riparian areas and other green spaces like conservation areas, cemeteries, and refugees (transportation). Urban green space also has a major role on quality of life of residents of the city as well as city's functional, ecological, environmental sustainability. Size, function, and accessibility can be regarded as the most prominent properties of green spaces to inhabitants in urban environments. Hence, spatial organization, accessibility and efficiency of urban green are very essential to urban planning.

Green space filter air, help reduce air pollution, reduce noise pollution, help diminishing urban heat island (UHI) effect, infiltrate storm water, and refill groundwater (Nowak et al., 2006; Escobedo et al., 2011). Most obvious effects of urban green land however are experienced by the inhabitants. Urban green land serve as places for physical activity, which is associated with enhanced health and reduced risk for all-cause mortality, obesity, and many chronic diseases (Barton and Pretty, 2010; Wolch et al., 2011). Urban green land also has positive psychological impacts on people through recreation. People can experience peace, tranquility and solitude, reconnect to nature while encountering plants and animals, which help reducing stress (Ernstson, 2012). Green and open spaces also provide occasions for gathering of which enable social interaction of people from various cultures.

Study area, İzmit is recognized as a city that is in insufficient supply of urban green spaces. This is mainly attributed to city's rapid urbanization that lacks an adequate urban plan to accommodate excess immigration of workers in the industry.

Size and spatial distribution of the green spaces are the main factors that determine the sufficiency and accessibility of green spaces in urban environments. Besides, within cities number, size and location of green spaces are not always equally distributed which is recognized as an environmental justice issue (Gaither and Gragg, 2012). Injustice in urban environments causes urban inequities and spatial segregation (Brambilla et al., 2013). In this study with essential demographic data at district level, we adopted districts as basis to our study to investigate green spaces sufficiency at local level to understand the inequalities.

City of İzmit is divided into 51 residential administrative districts/wards (mahalle) where we take 29 of the central districts of commercial utilities and settlement that exclude industrial regions, environs and suburbs. In this study 'parks' and 'playgrounds' were explored.

This study investigates the sufficiency and accessibility of the urban green spaces including parks and playgrounds in İzmit and addresses two questions,

- Are the green spaces sufficient in size?
  Ratio of green space: m2 of green space per resident for each district is calculated.
- Are the green spaces in sufficient accessibility?
  Ratio of service area (walking distance) of green spaces to total space for each district is calculated.

The World Health Organization (WHO) has suggested that every city should have a minimum of 9 m2 of green space per person. An optimal amount should be seated between 10 and 15 m2 per person. Development law with the code 3194 (imar kanunu) enforces that a city should have a minimum of 10m2 urban green space that comprise parks, playgrounds and sporting areas. Nevertheless, many cities of various countries may have urban green space rates at above 20 m2 per person.

Accessibility on the other hand is defined as "the

extent to which land use and transport systems enable individuals to comfortably reach activities or destinations in a reasonable time by means of transport models (Geurs and Van Wee, 2004, PTALs, 2010). An accessibility analysis is well suited for a Geographic Information System (GIS). GIS provides an environment by which geographically dependent data can be stored, analyzed and displayed in an easily understandable visual format to simplify the process s of decision-making. A service area calculation is a procedure that is accomplished with network analysis. Service area can be defined as a geographical zone characterized around an entity or institution that distinguishes the population which utilizes its services (Clarke and Clarke, 2005). Service area circles based on walking distances or walking durations depict the grades of accessibility of the urban environments to green spaces. Areas that have low accessibility are assumed as lacking satisfactory accessibility to urban green spaces.

2. Study Area

İzmit city is located at the İzmit Bay of the Marmara Sea, in the Northwest of Turkey. The city has experienced an excess urbanization initiated by gross industrial activities in 1960's. At the period, city lacked an adequate planning, which then lead to insufficient urban green and open spaces of today, likewise other spaces for social facilities. The topography is another factor that limits the settlement activities and leads to densification in the city center. City sprawls mainly on east-west direction. Road network is not well-organized due to barriers such as; sea, topography and major transportation corridors (O4, D100, and railway). Urban green spaces in the city are recognized as insufficient to serve to inhabitants especially at neighborhood level.

3. Materials and Methods

This study investigates the sufficiency and accessibility of urban green spaces in İzmit city. Both parks that serve all inhabitants of the neighborhoods and districts, and children playgrounds that are for the use of children at the age between 0 – 6 years. Sufficiency is explored through calculating area of green spaces per capita at district level. Accessibility is analyzed through mapping service area of green spaces based on walking distances with network analysis. Parks and playground areas were digitized using up-to-date maps and satellite images and transferred into GIS environment. Size and type of these green spaces were stored as attributes. Demographic information including population of each district to calculate green space area per capita is obtained from census data. Road data that is necessary to calculate service areas using network analysis were obtained from the Metropolitan Municipality.

3.1. Sufficiency of Urban green spaces

The most convenient way to understand whether the amount of green spaces is sufficient or not is calculating the area of green space that falls for per person that is described as m2/person. In this study, we explored green space per person by dividing the total area of green spaces in each district to population of the same district. If this rate is not under 10 m2 / person it is assumed as sufficient. Figure 1 is a thematic map that depicts the rate of green for each district. It can be seen that most of the districts are below the expected standard 10 m2/person.

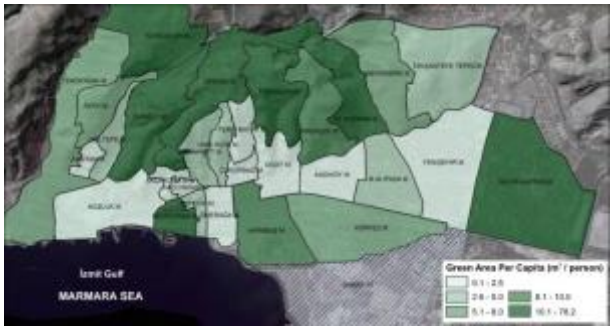


Figure 1: Urban green space rate, area per capita for each district

3.2 Accessibility of Urban green spaces

In order to analyze the accessibility of urban green spaces in the city, a geodatabase was created with a polygon feature datasets that represent the urban green spaces of the study data. This dataset is assigned as source and service areas from the source locations were mapped with network analysis. To conduct network analysis, road data including all streets and pedestrian paths was processed to build up a network. Regular road vector data was converted in to a set of segments and intersecting nodes. Network analysis utilizes road network data characterized as a sequence of segments which are connected by nodes (intersections), where each segment is accredited a travel cost. Urban green space polygons were assigned a point representation and the nearest segment or node is assigned as the centroid of the service area. In order to calculate service area intervals based on time or distance should be pre-defined to determine the grades of accessibility across the urban environment. In this study we adopted time constraint as basis. Accordingly, regular walking speed of an individual is 1.33 m/sec, and walks approximately 400 m in 5 minutes and 800 m in 10 minutes (PTALs, 2010) and a child is presumed to walk 1.1 m/sec according to a research on child walking (de David et al., 2006). 5 minutes and 10 munities were taken as boundaries of high and medium accessibility. Another issue is the slope of the terrain that is especially prevalent at the northern districts. Slope is a factor that makes moving across the space tougher and slower. As the slope increases, calories burned increase and walking gets harder and slower (URL-1). A graph that shows the relationship between slope and the

rate of decrease of speed of walking is calculated taking information given in URL-1 into account.

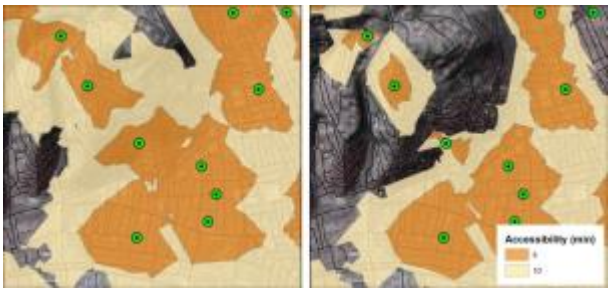
Slope of the terrain has been included as a cost factor into service area analysis with the following equations.

Dec. rate speed = 0.0213*Slope + 0,0054

Walking Speed (With Slope) = Walking Speed – Walking Speed * Dec. rate speed

Walking speed: 1.33 m/sec for adults and 1,11 for children.

Figure 2 illustrates 5 minute walk service area of parks in a sloping terrain without slope effect and with slope effect in Figure 2 a and b respectively.



(a) (b)

Figure 2: Service area of high accessibility (5 minute walk) (a) without slope effect and (b) with slope effect

Service areas of 5 min and 10 min walking with slope effect that represent high and low accessibility respectively was mapped for districts of İzmit. Pie charts representing the proportions of high accessibility areas were also illustrated for parks (Figure 3) and for playgrounds (Figure 4).

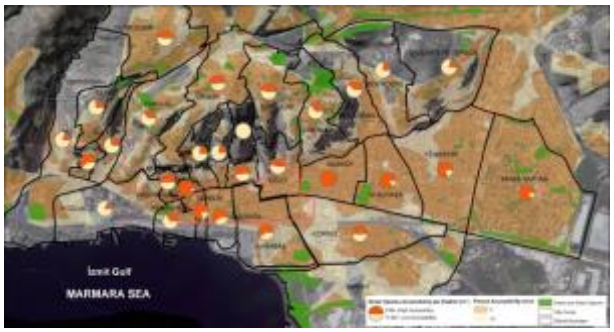


Figure 3. Service areas for parks showing high and low accessibility and the pie charts for high accessibility rates for each district

Figure 4. Service areas for playgrounds showing high and low accessibility and the pie charts for high accessibility rates for each district

4. Results and Conclusions

Results for the analysis of rate of urban green space that describe the sufficiency of urban green spaces were mapped. Rates were listed in descending order for all of the 29 districts. First four of the districts have urban green space per capita of equal or higher than 10 m2 which is accepted as sufficient. Accordingly, districts that are in eastern part of the city center are in sufficient supply of green space. However, districts that are at the close vicinity of the city center at the sloping terrain have very low rates of green space (Table 1). These areas are the oldest residential parts of the city that developed without an adequate plan.

Table 1. Green spaces per capita for each district in İzmit city

District	Area (m^2)	Urban green space per capita (m^2)
28 HAZİRAN	174050.00	27.14
ERENLER	110216.40	16.25
TOPÇULAR	86290.17	11.71
YAHYA KAPTAN	225087.80	11.25
TURGUT	88507.66	9.94
KEMALPAŞA	18748.52	8.94
ORHAN	88563.76	8.60
BEKİRDERE	72492.41	8.51
KARABAŞ	58870.05	7.44
M.ALİPAŞA	42197.21	6.89
HACI HIZIR	14354.57	6.33
FATİH	22205.06	5.73
TÜYSÜZLER	53782.06	4.82
GÜLTEPE	11845.29	4.77
TEPECİK	5484.00	4.76
VELİAHMET	13362.00	4.53
KADIKÖY	19393.23	4.39
HACI HASAN	2885.06	4.02
TAVŞANTEPE	40011.79	3.45
KÖRFEZ	37673.05	3.36
YENİŞEHİR	39725.56	3.15
YENİDOĞAN	45051.15	3.09
ZABITAN	3181.39	2.79
CEDİT	11299.76	2.63
AKÇAKOCA	2300.35	2.19
ÇUKURBAĞ	1424.26	1.13
ÖMERAĞA	3058.78	1.13
TERZİ BAYIRI	1624.34	0.73
KOZLUK	519.99	0.06

Besides the outcomes that highlight the inefficiency of the green spaces and their low accessibility, green spaces are also observed to be dispersed across the city. Green spaces scattered as parks mostly consistent with availability of land doesn't support the ecological integrity in the city. In order to improve the green land for the districts that are in insufficient supply, new green spaces should be built up. However, these spaces should be organized so as to be in close vicinity in the neighborhood scale, hence provide high accessibility. In order to enhance accessibility of the green spaces, number of parks should be increased and distributed homogeneously across space, even though they can be small in area, especially on the areas with sloping terrains. In order to support ecological integrity, green spaces should be organized in a connective manner where larger parks connected with smaller ones in a mesh structure and/or green corridors should be built.

Conflict of Interest

No conflict of interest was declared by the authors

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