

Assessment of Environmental Benefits of Urban Parks: A Case Study from Nazilli, Turkey

Bariş Kara¹, Yasin Aşık²

¹Department of Landscape Architecture, Aydın Adnan Menderes University, 09970, Aydın, Turkey

²Department of Landscape Architecture, Burdur Mehmet Akif Ersoy University, 15030, Burdur, Turkey

Abstract

Urban parks, one of the most important components of cities, are taking on an increasing role in urban life. With these roles, urban parks offer social, economic and environmental benefits to the society. Urban parks offer a variety of environmental benefits that are important to the well-being of urban residents. Environmental benefits of urban parks include climatic amelioration, hydrological cycle, biodiversity, sustainability and noise screening. Parks increase the quality of life in urban areas with their environmental benefits. Evaluating the environmental benefits of urban parks can improve the understanding of urban green space protection and management. Among the parks of Nazilli district examined in this study, the park with the highest contribution to environmental benefits (Good level) is the Şehit Önder Ayıklar park with a score of 0.76, while those with the lowest contribution to environmental benefits (Poor level) are Adnan Menderes and Cumhuriyet park with a score of 0.35. While the contribution of the parks of Nazilli district to climatic amelioration is at the "Very Good" level with the highest score (0.87), their contribution to the hydrological cycle is at the "Poor level" with the lowest score (0.23). The contributions of the parks to noise screening (0.37) are "Poor", their contributions to biodiversity (0.55) and sustainability (0.56) are "Fair". The environmental benefits of Nazilli parks (0.52) are at "Fair" level. In order to increase the environmental benefits of Nazilli parks, their contributions to the hydrological cycle, noise screening, biodiversity and sustainability should be increased.

Keywords: Ecological function, landscape planning, urban ecosystems, sustainability

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I. Introduction

The largest and most visible parts of green spaces in cities are parks. Urban parks are essential for livable and sustainable cities (Konijnendijk, et al., 2013). Urban parks are an important part of the complex urban ecosystem network and have aesthetic, recreational, health, social, economic and environmental benefits for urban communities (Grahn, 1985; Burgess et al., 1988; Conway, 2000; Gehl and Gemzoe, 2001; Hussain et al., 2010; Asimgil, 2012). These benefits are important for improving the quality of life in urban areas (Sadeghian and Vardanyan, 2013). So, urban parks have a strategic importance for the quality of life of increasingly urbanized societies (Chiesura, 2004; Asimgil, 2012). Parks are important spaces for the quality of life, health and general well-being of the community with economic benefits (Shuib et al., 2015).

While people often draw attention to the aesthetic, social and recreational benefits of urban parks (Xie et al., 2019), they ignore the environmental benefits (Liu et al., 2017; Pietrzyk-Kas'nska et al., 2017). Environmental benefits, one of the various benefits that parks offer for communities, are for a better environment (Shukur et al., 2012). Parks fulfill many important ecological functions with their environmental benefits (Eagles, 1993). Environmental benefits of urban parks include climatic amelioration, hydrological cycle, biodiversity, sustainability and noise screening (Stiles, 2013).

The contribution of urban parks to climatic amelioration is that trees create shade and other vegetation helps to reduce temperature and cool urban areas by evapotranspiration (Nowak and Dwyer, 1996; Blum et al., 1998; Nowak et al., 1998; Cummins and Jackson, 2001; Sherer, 2006; Konijnendijk et al., 2013). The heat island effect is reduced, humidity levels are increased, and the microclimate of urban areas where the temperature is higher than the environment because of dense buildings is improved (Chiesura, 2004; Millennium Ecosystem Assessment, 2005; Sadeghian and Vardanyan, 2013). Permeable surfaces and vegetation of urban parks capture rainfall and give it to the atmosphere with evaporation and transpiration. Impermeable surfaces and water collection systems contribute to the hydrological cycle by encouraging the collection of rainfall. Thus, urban parks support water management (Konijnendijk et al., 2013) by providing stormwater/flow regulation (reducing the amount of stormwater flow), and help to prevent floods by absorbing excess water. (Sadeghian and Vardanyan, 2013).

Urban parks play an important role in protecting and promoting biodiversity by providing various habitats for flora and fauna, especially common bird and animal species (Chiesura, 2004; Cornelis and Hermy, 2004; Millennium Ecosystem Assessment, 2005; Konijnendijk et al., 2013; Sadeghian and Vardanyan, 2013) contributes to biodiversity by acting as an ecological corridor between urban and rural areas (Sadeghian and Vardanyan, 2013). Urban parks contribute to sustainability by hosting native flora and fauna, helping to breathe better by acting as the lungs of the city, and making life enjoyable with common green spaces (The Office of the Victorian Government Architect, 2019). The contribution of urban parks to noise screening is especially because of the trees acting as noise barriers, reducing noise pollution and absorbing noise caused by human activities (Chiesura, 2004; Millennium Ecosystem Assessment, 2005; Sadeghian and Vardanyan, 2013).

Many studies have shown that urban parks have the potential to reduce the negative effects of urbanization, such as improving microclimate conditions, reducing noise levels, transforming cities into better quality environments (De Ridder et al., 2004; Lam et al., 2005; Feliciano et al., 2006; Schnell et al., 2012). Urban parks can offer a temperature drop of up to 4 °C with the cooling effect (Givoni, 1991; Avissar, 1996; Spronken-Smith and Oke, 1998; Shashua-Bar and Hoffman, 2000; Jonsson, 2004; Zoulia et al., 2009). Daytime temperatures in large parks are 2-3°C lower than in the surrounding streets (Sadeghian and Vardanyan, 2013). Assessment of the environmental benefits of urban parks can promote the conservation of urban green spaces and offer solid scientific evidence for urban park management (Xie et al., 2019). This study focused on the environmental benefits of urban parks, and in this context, a method was developed for the assessment of environmental benefits of urban parks in the city's example of Nazilli (Turkey).

II. Method

In order to investigate the environmental benefits of urban parks, 10 urban parks in Nazilli (Turkey) with various locations, sizes and land cover were examined (Fig. 1). Nazilli is the second most populated district of Aydın Province. The population of the district in 2020 is 160,877, and its surface area is 691.55 km². Nazilli is between latitudes 28°-29° and longitudes 37°-38°. Nazilli district center is 45 km east of Aydın and 160 km east of İzmir, Turkey's third largest city. Mediterranean climate prevails in Nazilli, which is in the Aegean region.

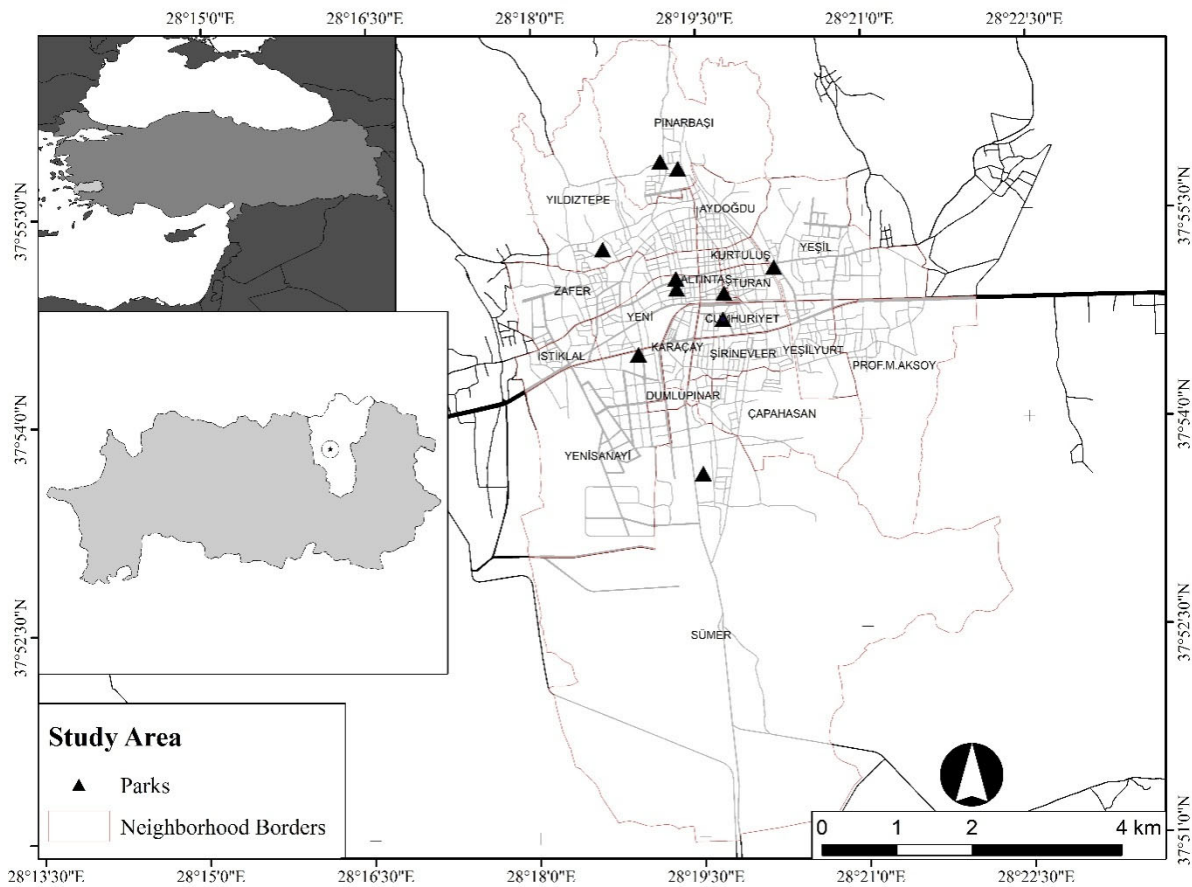


Fig. 1. Study area

The environmental benefits of 10 parks determined in Nazilli district were examined according to 5 main criteria and 18 sub-criteria belonging to the main criteria (Table 1). Observation results were written on the observation form and then scored as 0 and 1 and entered the SPSS software. The scores of the main criteria of the parks were determined by taking the average of the scores of the sub-criteria. The environmental benefits scores of the parks were determined by taking the average of the scores of the main criteria. By taking the average of each main criteria and environmental benefits scores of ten parks among themselves, the scores of the relevant criteria and environmental benefits of the parks of Nazilli district were found. Parks were classified on a 5-point Likert scale according to their scores (Very poor: 0-0.19; Poor: 0.20-0.39; Fair: 0.40-0.59; Good: 0.60-0.79; Very good: 0.80-1). Then, the data were interpreted by creating tables, correlation and regression analyzes were performed to find the relationship between the data. SPSS (Statistical package for social sciences) software was used for data analysis.

III. Results

When the parks are examined in terms of sub-criteria, only 23 Nisan park and Cumhuriyet park are "inadequate" among 10 parks according to the "percentage of vegetation", which is one of the sub-criteria of "climatic amelioration". In terms of "canopy ratio" and "woody plant coverage", only Adnan Menderes park is "inadequate". While Cumhuriyet, Şehitler and Turunç parks are "inadequate" in terms of "amount of permeable surface", which is one of the sub-criteria of "Hydrological cycle", all parks show density in terms of "amount of impervious surface". There are no "water collection systems" in any of the parks. When the parks were evaluated in terms of "presence of plants", which is one of the sub-criteria of "Biodiversity", it was seen that all the parks had plant existence. Only Şehit Önder Ayıklar and Sümer parks have "presence of animals". Again, only Şehit Önder Ayıklar park has "networks" between green belts and "invasive woody plants" only in Hüsnü Kutsal Park. All parks are at "adequate" level in terms of "amount of open space per person", which is included in the sub-criteria of "Sustainability". While all parks support "native flora", only Şehit Önder Ayıklar park supports "native fauna". While "regionally produced compost" is not used in any park, "recycled / renewable materials" are not used in Atatürk, Turunç and Uğur Mumcu parks. Atatürk, Hüsnü Kutsal, Şehit Önder Ayıklar, Sümer and Uğur Mumcu parks are "adequate" in terms of "height and density of wood and bushes", one of the sub-criteria of "Noise screening". There is "protection against winds" in 23 April, Atatürk, Hüsnü Kutsal, Şehit Önder Ayıklar, Sümer and Uğur Mumcu parks. No noise screening was constructed with "construction materials" in any park (Table 1).

Table 1. The state of having the main criteria and sub-criteria that make up the environmental benefits of the parks.

		Sub-Criteria	Parks									
			23 Nisan	Adnan Menderes	Atatürk	Cumhuriyet	Hüsnü Kutsal	Şehit Önder Ayıklar	Şehitler	Sümer	Turunç	Uğur Mumcu
Main Criteria	Climatic amelioration	Percentage of vegetation*	○	●	●	○	●	●	●	●	●	●
		Canopy ratio	●	○	●	●	●	●	●	●	●	●
		Woody plant coverage**	●	○	●	●	●	●	●	●	●	●
	Hydrological cycle	Amount of permeable surface	●	●	●	○	●	●	○	●	○	●
		Amount of impervious surface	●	●	●	●	●	●	●	●	●	●
		Presence of water collection systems	○	○	○	○	○	○	○	○	○	○
	Biodiversity	Presence of plants	●	●	●	●	●	●	●	●	●	●
		Presence of animals	○	○	○	○	○	●	○	●	○	○
		Networks between green belts	○	○	○	○	○	●	○	○	○	○
		Presence of invasive woody plants	○	○	○	○	●	○	○	○	○	○
	Sustainability	Amount of open space per person	●	●	●	●	●	●	●	●	●	●
		Support of native flora	●	●	●	●	●	●	●	●	●	●
		Support of native fauna	○	○	○	○	○	●	○	○	○	○
		Use of regionally produced compost	○	○	○	○	○	○	○	○	○	○
	Noise screening	Use of recycled /renewable materials	●	●	○	●	●	●	●	●	○	○
		Height and density of wood and bushes	○	○	●	○	●	●	○	●	○	●
		Protection against winds***	●	○	●	○	●	●	○	●	○	●
		Construction materials	○	○	○	○	○	○	○	○	○	○

*: Including lawns; **: 60% in relation to lawns; ***: Especially evergreen trees; ○: None/Inadequate; ●: Available/Adequate

When the parks are examined in terms of main criteria, 7 of the 10 parks observed are "Very good" in terms of "climatic amelioration" (Atatürk, Hüsnü Kutsal, Şehit Önder Ayıklar, Şehitler, Sümer, Turunç, Uğur Mumcu park), 2 of them are "Good" (23 April, Cumhuriyet park), 1 of them was "Poor" (Adnan Menderes). In

terms of "Hydrological cycle", 7 parks were evaluated as "Poor" (23 April, Adnan Menderes, Atatürk, Hüsnü Kutsal, Şehit Önder Ayıklar, Sümer, Uğur Mumcu park), and 3 parks were evaluated as "Very poor" (Cumhuriyet, Şehitler, Turunç park). When the parks are evaluated in terms of "biodiversity", 7 parks are "Fair" (23 April, Adnan Menderes, Atatürk, Cumhuriyet, Şehitler, Turunç, Uğur Mumcu park), 1 park is "Poor" (Hüsnü Sacred Park), 1 park is "Good" (Sumer park), 1 park is at the "Very Good" level (Şehit Önder Ayıklar Park). In terms of "sustainability", 6 parks are "Good" (23 April, Adnan Menderes, Cumhuriyet, Hüsnü Kutsal, Şehitler, Sümer park), 3 parks are "Fair" (Atatürk, Turunç, Uğur Mumcu park), 1 park is "Very good" (Şehit Önder Ayıklar Park). Looking at the "Noise screening" scores, 5 parks are "Good" (Atatürk, Hüsnü Holly, Şehit Önder Ayıklar, Sümer, Uğur Mumcu park), 4 parks are "Very poor" (Adnan Menderes, Cumhuriyet, Şehitler, Turunc park), 1 park "Poor" (23 April park). According to the "environmental benefits" scores got by averaging the scores of 5 main criteria, It has been determined that 5 parks are "Fair" (23 April, Atatürk, Hüsnü Kutsal, Şehitler, Uğur Mumcu park), 3 parks are "Poor" (Adnan Menderes, Cumhuriyet, Turunç park), 2 parks are at "Good" level (Şehit Önder Ayıklar, Sümer Park). No parks at a very good level have been identified. Among the Nazilli parks, the park with the highest environmental benefits score is Şehit Önder Ayıklar (0.76), while the parks with the lowest environmental benefits score are Adnan Menderes (0.35) and Cumhuriyet (0.35) parks (Table 2, Fig. 2).

Table 2. Main criteria scores according to the parks.

Parks	Main Criteria					Environmental benefits
	Climatic amelioration	Hydrological cycle	Biodiversity	Sustainability	Noise screening	
23 Nisan	0.67	0.33	0.50	0.60	0.33	0.49
Adnan Menderes	0.33	0.33	0.50	0.60	0.00	0.35
Atatürk	1.00	0.33	0.50	0.40	0.67	0.58
Cumhuriyet	0.67	0.00	0.50	0.60	0.00	0.35
Hüsnü Kutsal	1.00	0.33	0.25	0.60	0.67	0.57
Şehit Önder Ayıklar	1.00	0.33	1.00	0.80	0.67	0.76
Şehitler	1.00	0.00	0.50	0.60	0.00	0.42
Sümer	1.00	0.33	0.75	0.60	0.67	0.67
Turunç	1.00	0.00	0.50	0.40	0.00	0.38
Uğur Mumcu	1.00	0.33	0.50	0.40	0.67	0.58



Fig. 2. Parks in Nazilli with the highest environmental benefits (a/Şehit Önder Ayıklar/0.76) and the lowest (b/Adnan Menderes/0.35 and c/Cumhuriyet/0.35).

Nazilli district parks have the lowest score (0.23 ± 0.16) in terms of "hydrological cycle" as "Poor", with the highest score (0.87 ± 0.23) at the "Very good" level in terms of "climatic amelioration". Nazilli's parks are at the "Fair" level in terms of "biodiversity" (0.55 ± 0.20) and "sustainability" (0.56 ± 0.13), and "Poor" in terms of "noise screening" (0.37 ± 0.33). Nazilli has "Fair" parks in terms of "environmental benefits" with a score of 0.52 ± 0.14 . There was a significant correlation between environmental benefits and hydrological cycle and noise screening. Among the Main Criteria, only hydrological cycle and noise screening had a significant relationship ($p < 0.05$).

Table 3. The scores and correlation results of the examined parks in Nazilli district in terms of main criteria and environmental benefits.

Main Criteria		1	2	3	4	5	Mean±SD
1	Climatic amelioration	-					0.87±0.23
2	Hydrological cycle	-0.066	-				0.23±0.16
3	Biodiversity	0.161	0.175	-			0.55±0.20
4	Sustainability	-0.201	0.145	0.535	-		0.56±0.13
5	Noise screening	0.543	0.763*	0.255	0.035	-	0.37±0.33
Environmental benefits		0.585	0.646*	0.594	0.315	0.910**	0.52±0.14
Correlation is significant at the * $p < 0.05$; ** $p < 0.01$							

IV. Conclusion and Recommendations

In order to increase the environmental benefits of parks in Nazilli district, sub-criteria of "climatic amelioration", "hydrological cycle", "biodiversity", "sustainability" and "noise screening" main criteria should be improved. It is stated that urban parks can clean the air, improve the microclimate within their boundaries, and reduce noise (Cohen et al., 2014). In order to increase the contribution of the parks to the "climatic amelioration", the "percentage of vegetation" should be increased in the 23 Nisan and Cumhuriyet parks, and the "canopy ratio" and "woody plant coverage" should be increased in the Adnan Menderes park. For this, native plant species compatible with the Mediterranean climate such as *Nerium oleander* L., *Pinus pinea* L., *Pinus brutia* Ten. should be planted.

In order to improve their contribution to the "hydrological cycle", the "amount of permeable surface" should be increased in Cumhuriyet, Şehitler and Turunç parks, and "water collection systems" should be established in all parks. For this, impermeable surfaces that allow rainwater harvesting should be protected, and permeable hard floors should be created.

In order to improve their contribution to "Biodiversity", "presence of animals" should be increased in other parks except Şehit Önder Ayıklar and Sümer Parks, and "networks" among all parks except Şehit Önder Ayıklar Park should be increased. In the Hüsnü Kutsal park, the "presence of invasive woody plants" should be reduced. Using invasive woody plants should be prevented in all parks and natural plant species that can attract different animal species should be given priority instead of these species. Parks fulfill maintaining, restoring and enriching the native flora and fauna, as well as protecting and improving the natural environment (Rakhshandehroo et al., 2017).

In order to increase their contribution to "Sustainability", "support of native fauna" in all parks except Şehit Önder Ayıklar park, "regionally produced compost use" in all parks, and "recycled/renewable materials use" in Atatürk, Turunç and Uğur Mumcu parks should be increased. Natural tree and shrub species that offer shelter and feeding opportunities for the native fauna should be used. Areas should enable the waste materials to be got because of grass cutting and pruning activities in the parks to be used as compost. Using urban equipment made of environmentally friendly "recycled/renewable materials" should be encouraged.

In order to improve their contribution to "noise screening", the use of "height and density of wood and bushes" in 23 Nisan, Adnan Menderes, Cumhuriyet, Şehitler and Turunç parks, "protection against winds" in Adnan Menderes, Cumhuriyet, Şehitler and Turunç parks should be increased. Also, "construction materials" should be used for "noise screening". High and densely textured native trees and shrubs should be used in "noise screening". "Wind screening" should be created, comprising species with deep roots and strong stems in the prevailing wind direction. In narrow areas where plant materials such as trees and shrubs can not be used for noise screening, "construction materials" should be used for this purpose.

In order to increase the contribution of Nazilli parks to environmental benefits, the contribution levels to the hydrological cycle (0.23) and noise screening (0.37) with the lowest score at the "Poor" level should be increased. For this, the contribution of parks to the hydrological cycle can be increased by increasing the amount of permeable surface and amount of impermeable surfaces and by creating water collection systems. Contributions of parks to noise screening can be increased by increasing the height and density of wood and bushes, creating protection against winds, and using construction materials alongside plant material in noise screening. In addition, the contribution levels of the parks of Nazilli district, whose contributions to biodiversity (0.55) and sustainability (0.56) are at "Fair" level, to these main criteria can be increased, and their contribution to environmental benefits (0.52) at "Fair" level can be increased. Parks in urban areas are natural buffers for stabilization of the urban ecosystem. So, careful planning is required to get maximum benefit from urban green spaces and parks (Hussain et al., 2010).

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