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The Impact of Inefficient Urban Growth on Spatial Inequality of Urban Green Resources (Case Study: Urmia City)

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Abstract: Urban green spaces are essential for improving the livability of cities. Urban parks as green and public open spaces and signs of nature in cities have special economic and social value. The existence of neighborhood parks and their proper distribution is a key element for improving the quality of life in the cities. Spatial equity and accessibility to parks are factors influencing the performance of parks. This study was conducted to determine the current situation of Urmia city in this regard by using the travel cost approach and network analysis, and also examining the impact of rapid urban growth on spatial inequalities. According to the results, 18% of the residential land in Urmia city is located outside of the park service area, and 68% of residential lands outside the park's service area are areas that have developed as a result of urban growth in the last two decades. Based on the analysis, in 23 neighborhoods of Urmia city, the entire neighborhood is located in the service area of parks and has pedestrian access to this service. Other neighborhoods—to address the issue of spatial justice related to urban parks—fall into three categories: high, medium, and low priority.

Keywords: spatial equity; urban parks; Urmia city; network analysis

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1. Introduction

Urban green spaces are essential for improving the livability of cities [1,2]. The existence of such places in the urban environment, in addition to environmental functions such as air purification, reducing noise pollution, and improving microclimatic conditions improves the social and psychological conditions of urban residents [3–5]. Urban parks have special economic and social value as green and public open spaces and signs of nature in cities [6,7]. The existence of parks in the city is one of the most important factors in assessing sustainable urban development.

Accessibility to parks is a factor influencing the performance of parks [8]. Accordingly, the spatial distribution of parks should be considered for better management. An important norm proposed by Jane Jacob is the need to pay attention to the spatial distribution of parks, especially the relationship between diversity and the spatial location of parks [9]. The issue of spatial equality in urban areas' equipment and public services has received much attention during the last two decades [10–12]. Spatial equality includes the spatial access of residents to equal services [13]. In this regard, social justice in urban planning pays attention to how parks are distributed spatially [14].

The spatial distribution of parks in a city should be such that the service area of the parks covers the whole area of the city. Some studies have been conducted on the spatial distribution of parks [15]. In most of these studies, statistical indicators such as total park area, park area per capita, and the number of parks have been used to determine the service level of urban parks [16].

There are three main concepts in the field of spatial distribution of parks in urban planning: accessibility, diversity, and social needs. In social sciences, the study of both the physical and social dimensions of green space requires evaluating proximity or accessibility to the park. Most researchers believe that there is a direct relationship between accessibility to parks, walkability, quality of the neighborhood, and public health [4,15,17,18]. This is well illustrated in research conducted for assessing the effect of park proximity on physical activity and general health [19].

An increase in diseases caused by inactivity in human societies requires immediate attention to physical activity. Promoting physical mobility is one of the most important approaches to public health issues [20,21]. In this regard, the existence of neighborhood parks and their proper distribution is a key element. Neighborhood parks provide a desirable open space for relief and increase the per capita mobility of residents [22,23]. Providing adequate access to open spaces, especially parks in urban areas, is a good way to increase physical activity and improve public health [24]. Proponents of smart growth and advocates of sustainable development also believe that the distance between housing and services needs to be reduced to improve the quality of life in cities. Parks as open and public green spaces are one of the most important services that should be distributed throughout the city. Therefore, the proper distribution of parks is a step towards achieving sustainable development goals. The difference between a compact and a spiral city is in the accessibility to services such as parks. In a compact city, accessibility to services is reduced because the distance to services is increased [25].

Park accessibility is a function of several factors such as proximity, park size, and park safety [26]. Several influential factors have led to the complexity and variety of methods for measuring accessibility to parks. From a geographical point of view, the number and spatial distribution of parks in neighborhood units or at a local scale indicate park accessibility.

Methods for assessing spatial accessibility to parks can be divided into three general categories: (i) the spatial proximity of the park, in which the cost of travel from the residential area to the park is considered; (ii) the content approach, in which the number and density of parks in a specific geographical area are measured; and (iii) the spatial interaction modeling approach, or gravity model approach, in which potential spatial access is measured using two components, park size and distance [26]. This study aims to determine the current situation of Urmia city in this regard by using the travel cost approach and network analysis, and also examining the impact of rapid urban growth on spatial inequalities. The city of Urmia is the tenth most populous city in Iran [27]. According to the national censuses of 2006 and 2016, the populations of the cities are 577,304 and 736,224, respectively [27]. As a result of rapid population growth, the area of this city has increased from 557,000 hectares to 768,000 hectares in a 15-year period (from 2005 to 2021). In addition to the high rate of population growth and city expansion, Urmia city is one of the most traffic-congested cities in Iran. Given the conditions mentioned for the city of Urmia, improving pedestrian access to urban services and also examining the effects of rapid urban expansion on spatial inequalities is of great importance.

2. Study Area

The city of Urmia, which covers an area of about 77 square kilometers, is the capital of the western Azerbaijan state of Iran (northwest of the country) and is located between longitude 44°58′ to 45°7′ and latitude 37°28′ to 37°35′ (Figures 1 and 2). Urmia city, with an average height of 1332 m above sea level, is mostly located on flat ground. In total, 71% of the city area is on a slope of less than 5%, 23% on a slope of 5 to 10%, and 6% on a slope of 10 to 23%. In the north and east, the city is bounded by plains; it is surrounded by mountains to the south and west.

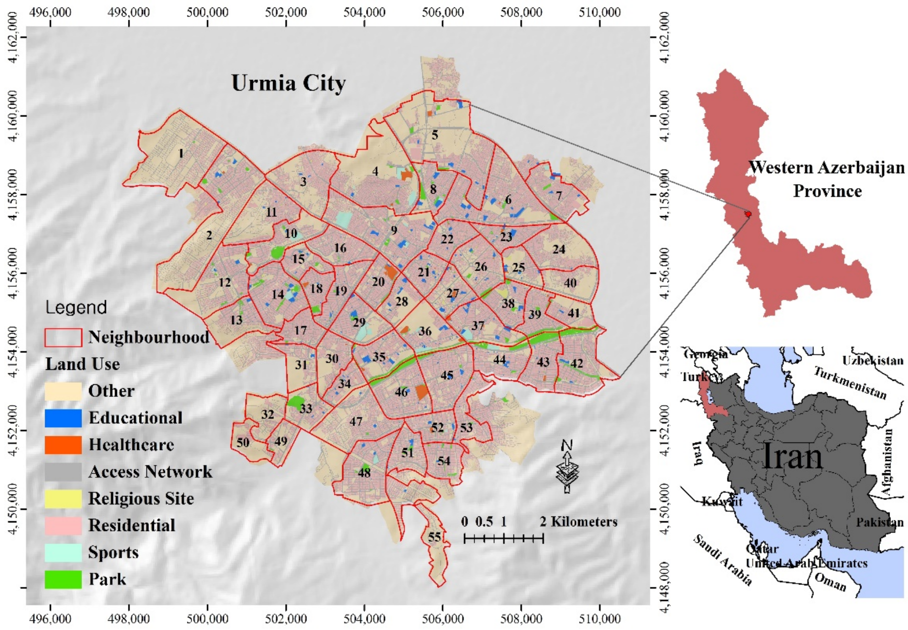

Figure 1. Location of the study area: Urmia city.

Figure 2. Photos of Urmia city; 1. Southeast view of Urmia (neighborhoods 38–43), 2. West view of Urmia (neighborhoods 14–19), 3. South view of Urmia (neighborhoods 45 and 46), 4. Northeast view of Urmia (neighborhoods 22–26).

3. Materials and Methods

Network analysis is a good tool for analyzing water distribution, material flow, and transportation networks. Node, link, the center of the facility, and network impedance are the key elements in this analysis. In this study, network impedance is determined based on the speed of the network user on the network. Since the average walking speed is between 0.75 and 1.2 m per second [16], in this study a walking speed of 1 m per second is considered. By creating the access network data set for a city (including all links usable to access the parks by walking) in the ArcGIS software environment and defining the location point of all parks on it as the centers of the facilities, the service area of each park can be determined by defining the maximum distance from parks on the network.

The operating radius of neighborhood parks is 600 to 1000 m. This distance is determined by assuming that access to neighborhood parks is via walking. Since the purpose of this study is to assess pedestrian access to the nearest park, all parks are considered as neighborhood parks. Therefore, the maximum travel time is 15 min; this means that any point with a maximum of 15 min from a park is considered inside the service area of that park. Assuming 1 m per second as the average speed of walking, this travel time on the access network equals 900 m.

Service areas are determined using network analysis in the GIS software environment. To perform this analysis, data related to the access network of Urmia city and the locations of the entrances to the parks in the city are needed. This data was obtained from Urmia Municipality.

To compare different neighborhoods of Urmia in terms of park accessibility, two indicators are used: the ratio of the park service area and the ratio of population covered by park services [16]. The ratio of the service area is a percentage of the residential area that is located in the service area of parks:

$$\text{Ratio of the Park Service Area (RPSA)} = \frac{\text{Residential area inside the Park service area}\left(\text{m}^2\right)}{\text{Total residential area}\left(\text{m}^2\right)} * 100$$

The ratio of the population covered by the park service represents the percentage of the population of the study area who live in the service area of the parks:

$$\text{Ratio of the Population Covered by Park Service(RPCPS)} = \frac{\text{Population living in the park service area}}{\text{Total population}} * 100$$

Using these indicators, the distribution of parks in neighborhoods of Urmia city was assessed. Since the area of parks is not considered in these two indicators, for a better comparison, we also calculate the ratio of park area per capita of neighborhoods.

4. Results

Figure 3 shows the service area map of parks in Urmia city. The green areas in this map show the service areas of all parks in the city, and the red color indicates areas where there is no park within a 15-min walk. According to this map, 73% of the area of Urmia city is located in the pedestrian service area of parks. Furthermore, it can be clearly seen that in some neighborhoods, spatial justice has not been well established in the field of the distribution of parks in the city. Using the park service area map (prepared using network analysis) and the building data layer, it is possible to identify residential areas that are located outside of the park service area. Figure 4 shows a map in which residential units inside and outside the park service area are distinguished. The red color in this map shows the residential buildings that are located outside the service area of the parks. According to this map, 18% of the residential space in the study area is located outside of the park service area—while, according to the service area map obtained from the Euclidian distance method, this is equivalent to 5%. Table 1 shows the indicators calculated to quantify the park distribution situation in the neighborhoods of Urmia city including the park area, park per capita, the percentage of residential area, the ratio of the park service area, and the ratio of the population covered by the park services.

Table 1. The general information of 55 neighborhoods of Urmia city.

Neighborhood	Area (m^2)	Population	Park Area (m^2)	Park Area per Capita (m^2)	Residential Area (%)	RPSA (%)	RPCPS (%)
1	3,162,514	6737	0	0.00	11	89	90
2	3,616,735	15,138	26,400	1.74	22	82	83
3	1,919,568	21,238	0	0.00	32	0	0
4	3,325,856	27,515	27,500	1.00	23	61	70
5	4,148,468	27,144	38,600	1.42	22	72	65

Table 1. *Cont.*

Neighborhood	Area (m^2)	Population	Park Area (m^2)	Park Area per Capita (m^2)	Residential Area (%)	RPSA (%)	RPCPS (%)
6	3,026,083	43,976	40,500	0.92	45	90	87
7	1,259,427	21,184	17,600	0.83	47	87	77
8	1,000,088	9600	66,000	6.88	34	100	100
9	2,907,144	29,738	15,900	0.53	40	81	71
10	1,377,102	10,083	92,100	9.13	30	76	70
11	1,748,743	13,733	0	0.00	30	25	20
12	2,153,324	15,245	17,300	1.13	32	93	81
13	1,227,788	9745	19,200	1.97	32	97	87
14	1,704,285	15,789	68,100	4.31	54	100	100
15	721,778	7771	14,500	1.87	46	100	100
16	1,126,645	14,520	3000	0.21	51	100	100
17	784,756	14,612	3600	0.25	58	100	100
18	638,251	7747	33,200	4.29	57	100	100
19	1,041,133	10,540	4600	0.44	52	100	100
20	904,928	9296	16,800	1.81	43	100	100
21	810,410	10,195	3500	0.34	50	100	100
22	833,751	11,863	2100	0.18	58	100	100
23	766,593	10,650	6900	0.65	52	100	100
24	1,587,144	20,387	100	0.00	34	51	44
25	776,116	5831	5300	0.91	23	100	100
26	1,385,654	11,397	35,500	3.11	42	100	100
27	947,356	6890	1200	0.17	35	76	75
28	836,125	5191	3300	0.64	33	100	100
29	1,208,524	8068	13,900	1.72	37	100	100
30	1,002,774	9244	1200	0.13	40	88	78
31	914,256	5488	0	0.00	25	70	65
32	907,708	2386	3000	1.26	14	16	15
33	947,168	4108	102,500	24.95	26	48	47
34	635,720	4241	4200	0.99	48	85	80
35	1,242,521	3914	86,000	21.97	36	100	100
36	1,414,247	4228	60,300	14.26	25	48	40
37	1,369,114	12,171	39,400	3.24	39	57	54
38	964,577	8728	42,300	4.85	45	100	100
39	890,071	11,269	71,000	6.30	52	100	100
40	1,023,233	6797	0	0.00	21	8	5
41	767,259	8517	30,300	3.56	35	100	100
42	1,856,088	16,264	155,200	9.54	40	100	100
43	1,172,445	11,225	140,700	12.53	47	100	100
44	1,178,649	7185	84,700	11.79	37	100	100
45	1,679,834	15,580	43,100	2.77	49	81	78
46	1,627,543	12,822	127,600	9.95	39	84	80
47	2,079,953	20,196	3000	0.15	33	56	46
48	1,861,769	18,646	38,000	2.04	44	95	90
49	590,138	2386	3000	1.26	25	54	50
50	666,679	2401	0	0.00	19	22	30
51	882,211	11,948	16,500	1.38	45	100	100
52	818,399	9775	2600	0.27	47	93	83
53	959,196	11,482	7900	0.69	55	97	90
54	860,509	10,572	23,700	2.24	54	98	97
55	1,568,718	5658	0	0.00	14	0	0

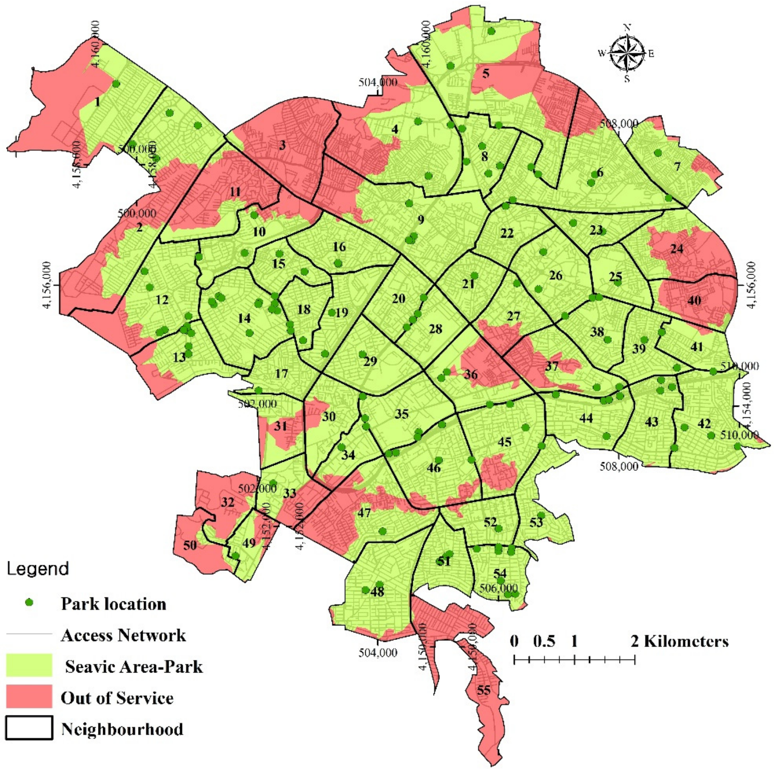

Figure 3. Park service area in Urmia city.

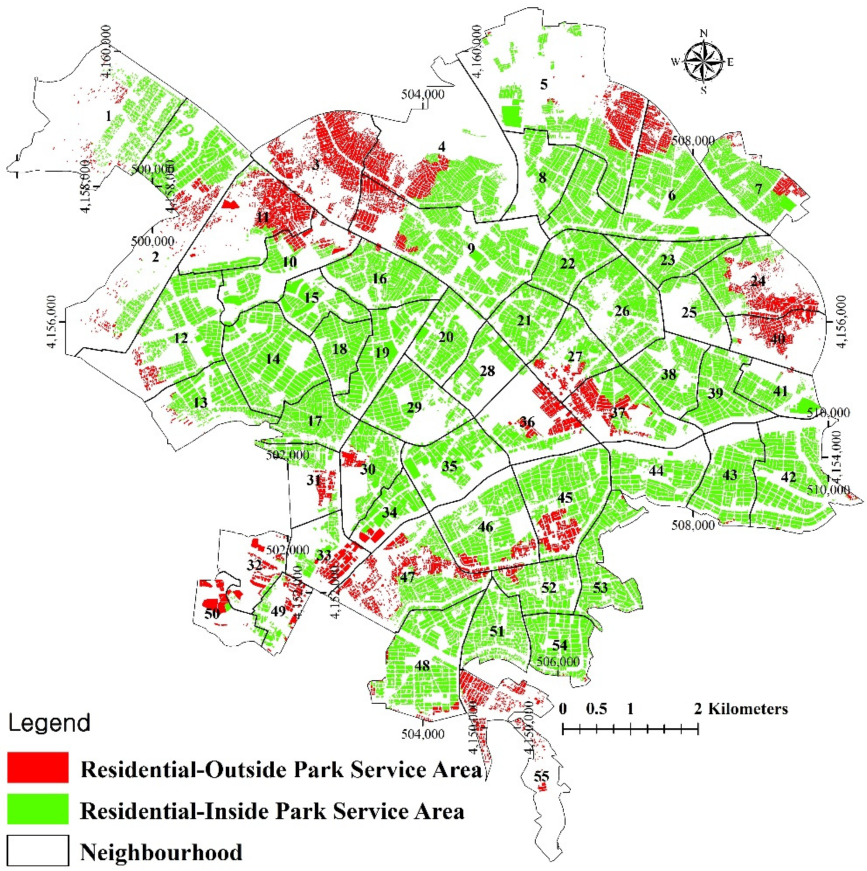

Figure 4. Residential area inside and outside of park service area in Urmia city.

There are no parks in neighborhoods 1, 3, 11, 31, 40, 50, and 55. Neighborhoods 33, 35, 36, 43, and 44 with 24.95, 21.97, 14.26, 12.53, and 11.79 square meters, respectively, have the highest park area per capita. Based on the results obtained from the calculation of indicators presented in Table 1, in 23 neighborhoods of Urmia city, the entire neighborhood is located in the service area of parks and has pedestrian access to this service (Table 1). To address the issue of spatial justice related to urban parks in other neighborhoods, prioritization was conducted based on the percentage of the residential area and population covered by park services in each neighborhood. In this regard, neighborhoods with an RPSA or RPCPS of less than 25 were placed in the high-priority category (neighborhoods 3, 55, 40, 32, 50, and 11), medium priority was assigned to neighborhoods with an RPSA or RPCPS of more than 25 and less than 70 (33, 36, 24, 49, 47, 37, 4, 31, and 5), and low priority was given to neighborhoods with an RPSA or RPCPS of more than 70 and less than 100 (10, 27, 9, 45, 2, 46, 34, 7, 30, 1, 6, 12, 52, 48, 13, 53, and 54).

In order to examine the impact of rapid urban expansion on the spatial inequalities of parks, residential areas outside the parks' service area were plotted on the Urmia city expansion map (Figure 5). Accordingly, 68% of residential lands outside the parks' service area are located in early-developed urban areas (1995–2021).

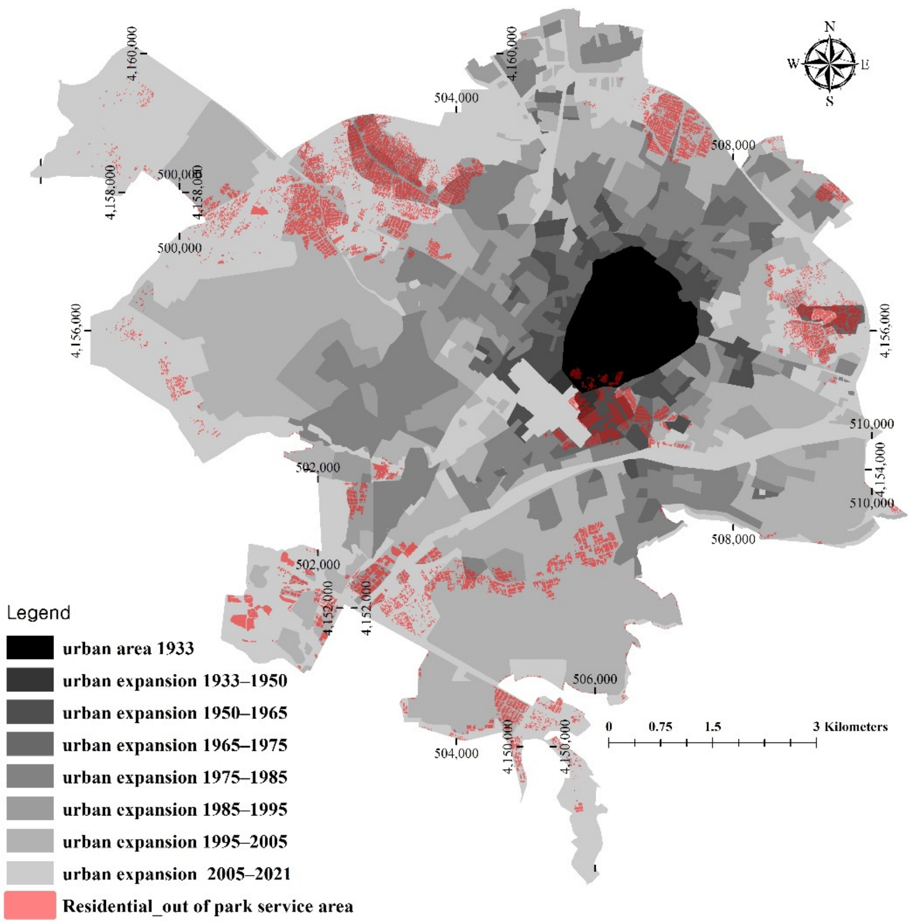

Figure 5. Urmia city expansion map and residential lands out of parks' service area.

5. Discussion and Conclusions

In recent years, urban planners have paid more attention to accessibility rather than mobility [28]. Increasing the transportation services in the city is an approach that should be considered and revised. The alternative approach is to improve the availability of urban services in cities and efforts to create walkable cities [29].

Key solutions include preventing urban spatial expansion, decentralizing services, and increasing alternatives to automobile transportation [29]. Decentralization of services in the city is useful in order to increase access to services as well as increase walking as a substitute for car transportation in cities. Improving the accessibility to urban services requires a greater focus on the spatial distribution of services over the entire city.

In most studies, the Euclidean distance is used to determine the service area of parks. In this way, for example, the service area of each park up to a direct radius of 900 m is determined. This is a direct distance from the park to residents, while citizens have access to services through the access network. Therefore, determining the service area should be defined based on the distance to the services on the access network. In the Euclidean distance method, the access network is not considered and as a result, the scope of the service area is increased incorrectly. In this paper, network analysis was used to determine the service area of parks in Urmia city, and the assessment results were presented using the relevant indexes. The results of the analysis were presented by table and maps. This information can be used to evaluate the spatial distribution of parks, judge the spatial equity, and also locate new parks in a better way.

Simultaneous study of the spatial distribution of parks and the history of the development of Urmia city shows that in this city, rapid urban development has led to an increase in spatial inequalities in access to urban services. Considering the increasing trend of the urban population in Iran over the last three decades, it seems that the results of this study can be generalized to other cities of Iran. However, proving this claim requires further consideration of case studies. In recent decades, Iran has faced two phenomena of rapid population growth and explosive urbanization. An examination of the urbanization situation in Iran over the past six decades shows that Iran, as a developing country, has been strongly influenced by the urbanization trend over the past decades. The trend of urbanization based on national censuses shows the rapid growth of urbanization in this country. The share of Iran's urban population has increased from 31.4% in 1959 to 74% of the total population in 2016 [27].

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