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GIS Application in Urban Green space Per Capita Evaluation (Case study: City of Tehran)

Hassan-Ali Laghai¹ and Hooman Bahmanpour²

¹Faculty of Urban Planning and Design, College of Fine Arts, University of Tehran, Tehran, Iran

²Department of Environmental Engineering, Shahrood Branch, Islamic Azad University, Shahrood, Iran

ABSTRACT

This study is an attempt to scrutinize the impacts of the urban expansion on the green space of Tehran. During the last two centuries, Tehran extent has increased from 5 kilometer square to 750 kilometer square, which is about 150 times greater than before. At the same time the population of Tehran has increased from 15 thousand people to more than 7 million people, amounting 400 percent growth. Current study is investigating on quantitative characteristics of Tehran green space by means of geographic information systems. In order to get to this object the information of Tehran population and its green space has been collected and by using GIS soft ware and map overlaying and also comparison of current situation with global standards final result has been reached. Green space development in Tehran has an increasing trend. The number of parks has been increased in Regional and local scale but the important point is the unsuitable distribution and dispersal of public green space in Tehran some Districts like (4,7,8,10,11,12,13,14,16,20,21) have the least green space per capita (less than 4 meter square). In addition to this, discussing spaces have been distributed improperly and they have low social and ecological efficiency. Finally, from comparison of four existing standards about ideal urban green space with Tehran green space in current situation (sum of green space consisting parks and afforestation is equal to 6.4 square meter) we came to this result that in order to get to green space equal to 12 square meter per capita according to the ministry of housing and urban development standards it's needed to develop Tehran green space about 44793002 square meters and in order to reach green space equal to 30 square meters per capita which is the standard of united nation it's needed to meet lack of urban green space about 169,943,706 square meters in Tehran city.

Key words: green space per capita, urban green space, ecological efficiency.

INTRODUCTION

Increasing expansion of cities in all countries of the world and exceptionally Iran is one of the unavoidable effects of technology and science age. Today expansion of cities exceptionally large cities in third world has resulted in negative effects of city development, which one of these negative effects is environmental pollution intensification. Increasing development and growth of urbanization has direct relation with skeletal expansion of cities. Physical development of cities has resulted in inaccessibility of nature and nature and human disturbance. Irregular and unsustainable extension of cities has caused living in suburban areas and also destruction of urban green areas and resulted in increasing demand for land. High demand for land will effect on green space destruction and land use change [1]. Green space is a part of city landscape and as one of real phenomenon which human being has contacted from very beginning. This subject has different aspects like environmental, social, cultural, economical and skeletal. Importance of green space is that much high that is known as one of the indices of sustainability [2]. The most important benefits of green space are as follow: A) Carbon dioxide attraction and attraction of other toxic gases and oxygen production [3]; B) Regulation and improvement of cities weather [4]; C) Noise pollution abatement and improvement of people spirits [1]; D) Prevention of water and wind erosion [5]; E) Hazard abatement of probable

floods [6]; F) Prevention of unsuitable urban development and creation of beautiful landscape. Suitable green space in cities is one of the effective factors in reduction of negative impacts of cities development [7].

Table 1, shows urban green space function and services.

Table 1: Urban green space functions and services

Function / Service	Source
Increase physical activity prevalence	Van Sluijs <i>et al.</i> , 2007
Outdoor recreation	Grahn & Sorte, 1985; Busiey & Coles, 1995; Roovers <i>et al.</i> , 2002
Healthy	UN-World Health Organization, 1993
Social services	Escobedo <i>et al.</i> , 2008
Economic services	Conway & Urbani, 2007; Mcpherson <i>et al.</i> , 2005
Effective interceptors and reflectors of isolation (short wave solar radiation)	Chen & Jim, 2008
Improving thermal energy	Jeusen <i>et al.</i> , 2003; Mcpherson <i>et al.</i> , 1997
Lower indoor air temperature	Mcpherson <i>et al.</i> , 2006
Heating saving	Mcpherson <i>et al.</i> , 2006; Heisler, 1986
Reduce air pollution	Chen & Jim, 2008
Alleviate poor air quality by absorbing a gaseous pollutants (e.g., O ₃ , NO ₂), Intercepting particulate matter (e.g., PM ₁₀ such as dust, ash, pollen), Releasing oxygen, Moderating local air temperatures, Reducing the frequency of conditions leading	Mcpherson <i>et al.</i> , 2006; Nowak <i>et al.</i> , 2006
Reduce the risk of heat-related illnesses	Blum <i>et al.</i> , 1998
Reduce stress	Ulrich, 1981; Woo <i>et al.</i> , 2009
Reduce in the amount of storm water runoff	Xiao & Mcpherson, 2002
Heating & air conditioning	Mcpherson <i>et al.</i> , 2006
Intercept and store rainfall, reducing runoff volumes and delaying the onset of peak flows, Reduce flooding, hazards, surface pollutant wash out and pollutant loading of rivers and lakes	Mcpherson <i>et al.</i> , 2006
Increase the attractiveness of communities	Chen & Jim, 2008
Reduce noise	Mcpherson & Simpson, 2002
Improve wildlife habitat	Nowak & Dwyer, 2002
Provide recreational opportunities	
Increase neighborhood desirability	Pepper <i>et al.</i> , 2007
Air and water purification	Ulrich, 1981
Wind and noise filtering	
Micro climate stabilization	
Social and psychological services	
Providing recreational opportunities	Nowak & Mcpherson, 1993
Enhancing aesthetic values	
Support biodiversity	Gaston <i>et al.</i> , 2005; Smith <i>et al.</i> , 2005
Provide a sense of peace and tranquility	Keplan, 1985; Song <i>et al.</i> , 2007
Increase the sale price of nearby homes	Conway <i>et al.</i> , 2008; Chen & Jim, 2006

An important in site selection of green space is concerning social necessities. That's why urban designers and architects believe that "parks should be a place full of life and energy, a place which working and cultural, commercial and residential activities are under progress. Some urban parts have such valuable focal points. Such points look perfect for creating sectional parks and public spaces [7]. The meaning of urban green space is a kind of urban land use with man made green cover which has social and ecological efficiency (usage). Urban green space from city development point of view consists of different vegetative covers and as a living factor besides unloving frame work of city determines city morphology structure. Open urban spaces consists of existing green space and from the other hand this urban spaces known as potential spaces for urban green space development. Sustainable urban development is defined as "improving or enhancement of urban living quality like ecological, cultural, political, social, economic and facilities without making any problem for future generations which these problems could originate from reductions in natural reserves and local belongings. In another way sustainable urban development is focusing on management and development paths that are sustainable and in these paths some aspects of sustainable development like energy efficiency, green space and neighboring units are improved. One the shortest definition which is given about the ecologic city is "the ecologic city is a healthy city from ecological point of view" and it proceeds that such city doesn't exist [6]. There have been many studies and researches about Tehran green space .Different researchers like [3] and [4] have studied Tehran green space .some of these experts have focused on measuring Tehran green space per capita. One of these experts is Bahram soltani which conducted a research in the year 1995. But until now there haven't been comprehensive researches by means of geographic information systems about Tehran green space.

MATERIALS AND METHODS

At the first step the statistics of urban green space relating to the all twenty second Districts of Tehran and the data of population in these Districts have been gathered (all data which has been used in this paper are separated and including data of the year 2006). After gathering needed data by means of Excel software the discussing date is presented. After preparing the tables by means of Excel software in order to link these data to geographic information system software the ArcGIS software of 9.2 versions has been used. After entering and linking the data tables to each layer, the information was classified and presented in ideal form of map. In this study in order to show the best form of the maps cartographic abilities of software have been used. In the present research the urban green spaces of Tehran city have been known as parks and horticultures and based on the data of the year 2006 which is gathered from Tehran city parks and green space organization. Also the information of Tehran population (22 Districts) has been used based on prediction models of Iran statistics center. Steps in the Study process is illustrated in figure 1. Finally based on the gathered information from Tehran green space a comparison has been made with Iran existing standards and also international standards. Iran standards includes some suggested standards by ministry of Housing and Urban development and international standards includes suggested standards by United Nations , public health bureau and the ministry of housing of the united states of America and the institute of national recreation of the united states of America. The location of study area in the Iran is illustrated in figure 2.

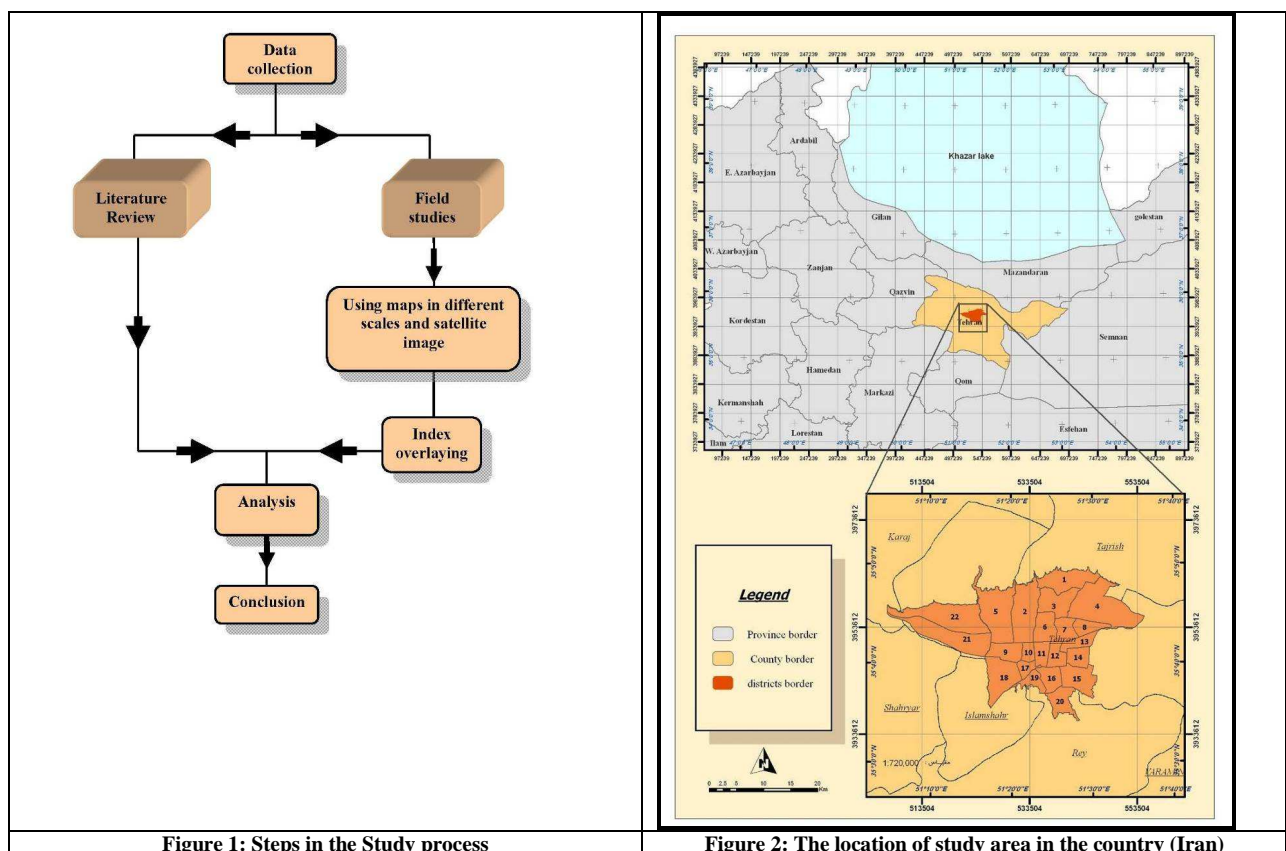


Figure 1: Steps in the Study process

Figure 2: The location of study area in the country (Iran)

RESULTS AND DISCUSSION

3.1. The procedure of green space development:

The procedure of green space development in Tehran city since the year 1990 has shown a new and different face. The procedure of parks development during last decade (1991-2001) has been showed in the Table 2 during this totally period, 302 parks have been created. The whole area of these parks is about 636.1 hectares. The total area of all horticultures of Tehran parks and green space organization since the year 1991 until the year 2001 has been about 14400 hectares and the area of Districts development since the year 1990 until the year 2001 has been about 114400 hectares.

Table 2: The procedure of parks development by Districts and parks and green space

Year	Number of constructed parks	Area (m ²)
1991	99	931576
1992	70	436227
1993	103	629889
1994	37	229428
1995	54	298753
1996	64	620656
1997	33	1236753
1998	14	95943
1999	21	123571
2000	51	1196995
2001	65	561332
Total	302	6361143

Source: Authors

The total area of Tehran parks is 1298.6 hectares. Among Tehran Districts the maximum area of green space is consisted to the Districts number 22. In these Districts 77.45 percent of the area is consisted to the green space. The Districts number one has the least area of green space which is about 4.12 percent.

3.2. Transmittance and distribution of green space

The table 3 shows the population size, the amount of green space and the green space per capita in all twenty second Districts of Tehran. The figure 3 shows the transmittance and distribution of population in all twenty seconds Districts of Tehran. Also the figure 4 shows the transmittance and distribution of green space in twenty seconds Districts of Tehran. In order to get the information of green space per capita in Tehran city the discussed layers including population size and amount of green space have been overlaid (Fig 5).

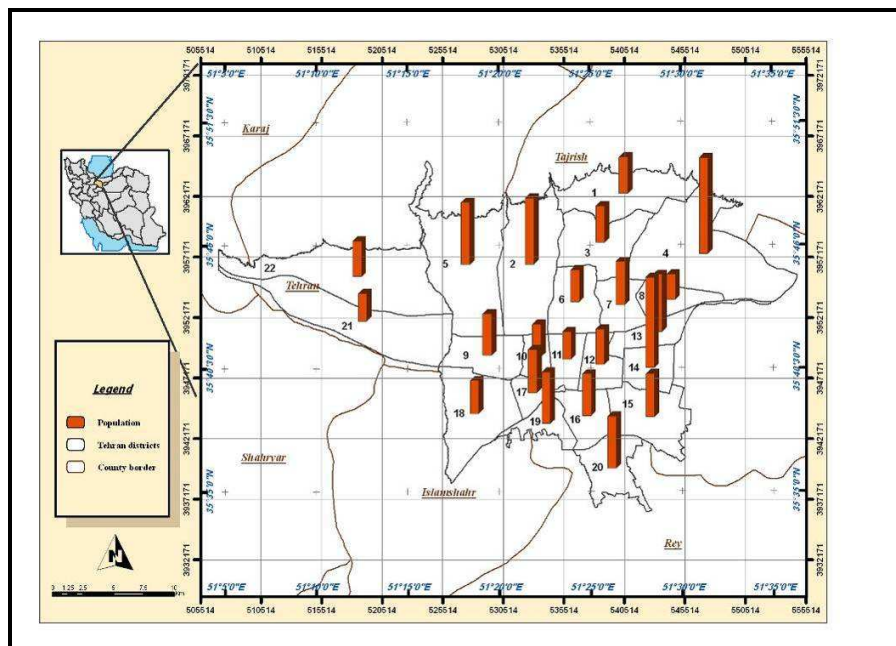


Figure 3: Transmittance and Distribution of population in all Districts of Tehran

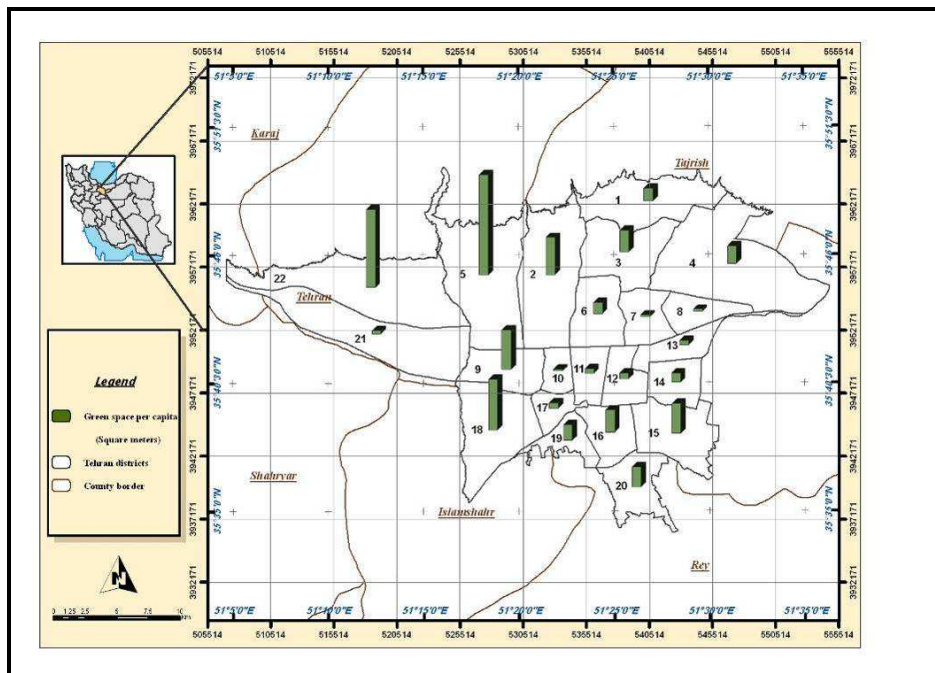


Figure 4: Transmittance and Distribution of Green space in Districts of Tehran

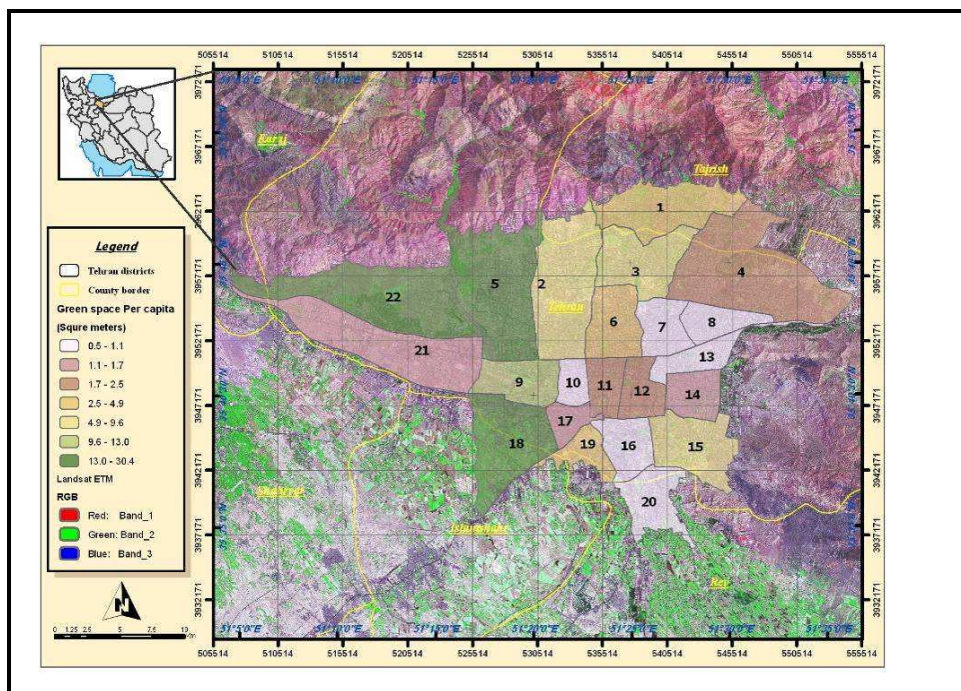


Figure 5: Map of the Tehran City Green space per capita

Table 3: The area of green space, population and per capita in Tehran city (2004)

Districts number	The area of green space (m ²)	Population (person)	Green space per capita (m ²)
1	1248649	261455	4.7
2	3709916	479310	7.7
3	2132511	261454	8.1
4	1761594	693677	2.5
5	9988124	447811	22.3
6	1141222	230780	4.9
7	203189	314280	0.6
8	211041	182008	1.1
9	3895343	299165	13
10	188935	236539	0.7
11	492202	198683	2.4
12	598586	256715	2.3
13	422186	412956	1
14	915731	651187	1.4
15	3010495	312397	9.6
16	2205098	300854	0.7
17	557014	310131	1.7
18	5076485	238126	21.3
19	1588330	372878	4.2
20	1964276	372678	0.5
21	333860	200142	1.6
22	7818541	256473	30.4
Total	49463328	9997399	Mean per capita=6.4

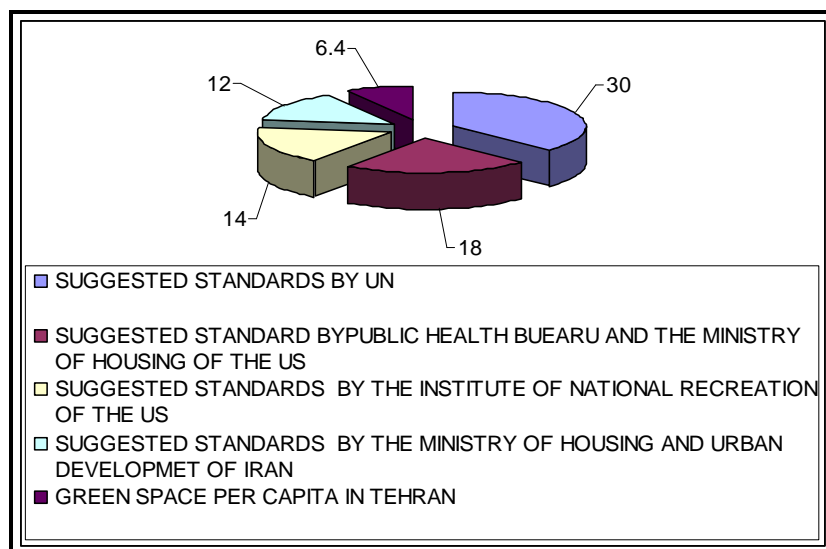
Source: Authors**Figure 6: The comparison of Tehran green space per capita with existing standards**

Table 5: Comparison of Tehran existing green space with available standards and assessing shortage and surplus

district	Green space area (existing situation) square meters	Needed green space per capita based on 12 square meter per capita standard	Shortage and surplus	Needed green space per capita based on 14 square meter per capita standard	Shortage and surplus	Needed green space per capita based on 18 square meter per capita standard	Shortage and surplus	Needed green space per capita based on 30 square meter per capita standard	Shortage and surplus
1	1248649	3137460	-1888811	3660370	-2411721	4706190	-3457541	7843650	-6595001
2	3709916	5751720	-2041804	6710340	-3000424	8627580	-4917664	14379300	-10669384
3	2132511	3137448	-1004937	3660356	-1527845	4706127	-2573616	7843620	-5711109
4	1761594	8324124	-6562530	9711474	-7949880	12486186	-10724592	20810310	-19048716
5	9988124	5373732	+4614392	6269354	+3718770	8060598	+1927526	13434330	-3446206
6	1141222	2769360	-1628138	3230920	-2089698	4154040	-3012818	6923400	-5782178
7	203189	3771360	-3568171	4399920	-4196731	5657040	-5453851	9428400	-725211
8	211041	2184096	-1973055	2548112	-2337071	3276144	-3065103	5460240	-5249199
9	3895343	3589980	+305363	4188310	-292967	5384970	-1489627	8974950	-5079607
10	188935	2838468	-2649533	3311546	-3122611	4257702	-4068767	7096170	-6907235
11	492202	2384196	-1891994	2781562	-2289360	3576294	-3084092	5960490	-5468288
12	598586	3080580	-2481994	3594010	-2995424	4620870	-4022284	7701450	-7102864
13	422186	4955472	-4533286	5781384	-5359198	7433208	-7011022	12388680	-11966494
14	915731	7814244	-6898513	9116618	-8200887	11721366	-10805635	19535610	-18619879
15	3010495	3748764	-738269	4373558	-1363063	5623146	-2612651	9371910	-6361415
16	2205098	3610248	-1405150	4211956	-2006858	5415372	-3210274	9025620	-6820522
17	557014	3721572	-3164558	4341834	-3784820	5582358	-5025344	9303930	-8746916
18	5076485	2857512	+2218973	3333764	+1742721	4286268	+790217	7143780	-2067295
19	1588330	4474536	-2886206	5220292	-3631962	6711804	-5123474	11186340	-9598010
20	1964276	4472136	-2507860	5217072	-3252796	6708204	-4743928	11180340	-9216064
21	333860	2401704	-2067844	2801988	-2468128	3602556	-3268696	6004260	-5670400
22	7818541	2401704	+5416837	3590622	+4227919	4616514	+3202027	7694190	+124351
Total	49,463,328	86,800,416	-44,793,002	105,802,916	-46,896,336	124,506,333	-84,651,209	218,690,970	-169,943,706

CONCLUSION

As you can see in table 2 and in figures 3 to 5 transmittance and distribution of green space in Tehran is not in good status. The Districts (4,7,8,10,11,12,13,14,16,20,21) have shortage in green space per capita. The amount of green space in these Districts is less than 4 square meters. The spatial distribution of green space should be in a form that is accessible for people. In some resources the estimated time for reaching the park is equal to 10 minutes, which this time is equal to 400 to 500 meters from residential areas.

The important point is that there is shortage of green space in most Districts of Tehran, and the amount of green space in Tehran dose not matches with any standards even internal standards. As it's said before the green space per capita in Tehran is equal to 6.4 square meters. According to Tehran reposing plan the suggested value for green space per capita must be equal to 12 square meters per capita. On the other hand there is tremendous difference between Tehran green space and suggested standards from international societies and institutes. Fig 6 illustrates the great difference between Tehran green space and other standards.

Based on existing data from public census and calculations about Tehran population in the year 2004 and also the statistics of green space area in all Districts of Tehran city in the same year, the green space per capita has been calculated and the out come was compared with the international and national standards (Table 4 & 5).

Table 4: The comparison of Tehran green space with existing standards

Existing standards	Description
Suggested standards by the ministry of housing and urban development of Iran: 12 square meters	In this situation only the Districts (18,9,5 and 22) have exceeding urban green space and rest of the Districts have shortage and according to above standard it's needed to establish green space with the area of 44793002 square meters in total area of Tehran
Suggested standards by the national institute of the US:14 square meters	In this situation only the Districts (18, 5 and 22) have exceeding urban green space and rest of the Districts have shortage and according to above standard it's needed to establish green space with the area of 46896336 square meters in total area of Tehran.
Suggested standards by the public health bureau and the ministry of housing of the US:18 square meters	In this situation only the Districts (18, 5 and 22) have exceeding urban green space and rest of the Districts have shortage and according to above standard it's needed to establish green space with the area of 84651209 square meters in total area of Tehran.
Suggested standards by the United nations:30 square meters	In this situation only the Districts 22 has exceeding urban green space and rest of the Districts have shortage and according to above standard it's needed to establish green space with the area of 169943706 square meters in total area of Tehran.

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