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Investigation on the Current Status and the Potential of Urban Parks with GIS

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Abstract: The aim of this study performed in a part of Tehran city (capital of Iran) with 538 ha surface area, was locating the parks and determining the needs of the area to find suitable recreational spaces using GIS. The Ikonos imagery and 1:2000 topographic maps were applied to detect the parks in the regions. Classifying the parks in four categories of regional, zonal, local and neighboring levels, the influence rate of each park was determined using the standards and the areas without parks were identified in the region. Also the number of people using the parks was measured by overlaying the maps of park boundaries and people distribution. Then the map of gaps and their spatial pattern were prepared as the greatest potential of green space increase and they were ranked due to the necessity of park establishment and gap suitability. The gaps' surface area was 49.5 ha that have had no buildings. Regarding to the lack of parks in local and neighboring levels and overlaying the maps of gaps on park establishment necessities and needs, it was concluded that the area doesn't have the potential for park establishment at local level but about 1.8 ha of the gaps can be allocated to parks at neighboring level.

Key words: Gaps, green space, IKONOS imagery, influence rate, parks

INTRODUCTION

At present, about 3 billion people of the world settle in cities. Regarding to the rapid rate of population growth, more than 60% of the world's population may settle in cities till the end of 2030. The increase of population and city dwelling in recent years and the growth of world's city societies, specially in developing countries, cause different kinds of environmental pollutions in cities (ZangiAbadi and MalekAbadi, 2005; Andersson, 2006). Consequently, the increase of vegetation cover through urban forests establishment is necessary to improve climate conditions and respond to the recreational needs of the city dwellers (Pauleit and Duhme, 2000). Also green space plays an important role in enhancing the quality of urban life (Mathieu *et al*., 2007). It provides opportunities for citizens to relax, take exercises, meet friends and play sports (Su, 2003). Green space offers many significant environmental benefits in towns such as pollution control, water management and biodiversity. The 18th century influenced on urban forestry and parks as the starting point of creating the city green space and it becomes a necessity regarding to the environmental and recreational effects. So, the increase of vegetation cover through urban forests establishment is necessary to improve climate conditions and respond to the recreational needs of the citizens (Laing *et al*., 2006).

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The 18th century was the starting point of creating city green spaces such as parks and urban forests. Streets were planted by trees and regular geometrical spaces had natural appearance. Today it seems essential to develop this kind of appearance in cities.

In this direction, the application of technology with attention to quality standards and suitable distribution regarding to availability distance and proportion with population make a possibility to settle and plan city parks. Also one of the necessities to succeed in this matter is comprehensive management which has the power to collect up to date and available data. It is noticeable to use Geographic Information Systems (GIS) for the complicated management of modern cities (Freeman and Buck, 2003; Melesse *et al*., 2007).

Although there is no possibility to determine an acceptable standard for different countries and suggest the standard of green space for different cities even in one country, but it can be helpful to use some standards that have been presented by differed countries about green spaces, their classification and comparing them as a general guide in our country (Madjnoonian, 1993). The USA recreational office believes that 6072 and 2024 m^2 is suitable for 1000 people as local and regional parks. West Germany believes that 1 m^2 of green space is necessary for 1000 children who are less than 6 years old. In another classification of green space in USA, 2-8 ha is suitable for 2000 to 10000 people for local parks and 200-400 m^2 is suitable for 500-2500 people for neighboring park activities (Manlun, 2003).

In Iran, Noriyan and Naghdi (1999) calculated the influence rate of urban parks and declared that it is 800 m for local parks, 4800 m for regional parks and 16000 m for zonal parks. Sesar (2002) performed a project for urban parks in Kermanshah using factors such as park ranking, park surface area, population growth and current standards. He introduced GIS as a perfect tool in studying urban parks and their influence rates.

Akbary (2003) emphasized that 3 factors are needed to be considered to allocate an area to green space. These factors are:

- **Centralize:** Green space should be located in the center of city as far as possible that includes the center of localities, regions and city zones.
- **Hierarchy:** The structure of public green space functions should be adapted with the hierarchy of city green space structures. It means that public green space should be located appropriately to its functional situation and according to neighboring, local, regional and zonal unit.
- **Availability:** Each urban park should be in communication network according to their function.

The aim of this study is to introduce GIS as a useful tool in urban studies and investigate the present situation and the potential of parks in the study area by studying the number and spatial pattern of them and comparison with standards.

MATERIALS AND METHODS

Study Area

The study area in this project is located in the North West of Tehran (Fig. 1) that is 538 ha. This region has 12 parks which can be classified in four categories: regional, zonal, local and neighboring levels. This region has a new structure in the north (Nasr St.) and an old structure in the south (ShahrAra St.).

Data

In this study, IKONOS imagery was used that was obtained by the fusion of 4 m MS and 1 m panchromatic IKONOS imagery. The acquisition date of this imagery was 2005. Also 1:2000 topographic maps were used to detect some data. The information related to parks and green spaces was obtained by Green Space and Park Organization and Tehran municipality. The population growth data was supplied by the Statistic Center of Iran.

Fig. 1: The location of Tehran Province in Iran

Parks Boundaries

At first, green spaces were detected by using 1:2000 topographic maps and field study. The boundary of each park was digited in Arcview3.2 applying satellite imagery, topographic maps and collected information.

Classification and Influence Rate Determination

Investigating the present situation of the parks, they were classified according to their surface area. In this method of classification, parks are allocated to neighboring, local, regional and zonal levels regarding to their surface area and function and the influence rate of them is determined. Following definitions introduce different kinds of parks and their influence rates:

Neighboring Parks

The parks that are established for neighboring units and their area is about 0.5 ha. The main applications of these parks are children's playing and adults' resting. According to the standards, a 9 year old child should be able to walk from the furthest point of the neighboring unit to the parks easily without passing main streets (Chaira and Kopplman, 1982).

Local Parks

The parks which are placed in a local unit and their surface area is about 1 ha and a 9 year old child should be able to walk from furthest point of the local unit to the parks easily with passing narrow streets (Manlun, 2003).

Zonal Parks

These parks are placed in a zone and their surface area is about 2-4 ha and the residents should be able to walk from the furthest point of the zonal unit to the parks easily on foot and they can pass different ways (Moughtin and Shirley, 2005).

Regional Park

It is applied to the parks placed in a region and their surface area is considered at least two times bigger than zonal parks and according to the standards, a visitor should be able to reach the parks by vehicle in a half an hour or more (Madjnoonian, 1993). Regarding to the standards, the results of similar studies, asking from park managers, experts and also field study; the influence rate of parks were determined (Table 1).

Table 1: The influence rate of different kinds of parks

The kind of park	Surface area (ha)	Influence rate (m)
Neighboring	<0.5	About 400
Local	About 1	About 800
Zonal	2-4	About 4000
Regional	>8	About 16000

The Influence Rate of the Parks

Considering the influence rate of each group of the parks and analyzing each group separately, the map of regions that are serviced by different parks was obtained. After setting the park boundaries, the regions which are serviced by the parks and the regions which need new parks were divided by polygons. Regarding to the standards, the neighboring parks influence rate continues till main streets. So the boundary was limited to main streets although it was not 400 m in all places (Table 1). Also the local parks influence rate continues till highways that limits access to local units. So new polygons were drown for boundaries due to the influence rate of different parks in the study area. After drawing polygons which showed the zones that were serviced by the parks, other zones that need new parks were specified with drawing separate polygons. Finally the results were two maps, one of them showed the necessity of new parks in neighboring level and the other one showed the necessity of new parks in local level. The maps were taken to Idrisi to determine land values and classification as following:

- Zones, which have access to all kinds of parks
- Zones, which have access to local parks
- Zones, which have access to neighboring parks
- Zone, which do not have access to any park

The Lands Evaluation

In this stage, different values were allocated to map polygons using classification methods. Then the final map that contained the polygons with different values was obtained by overlaying techniques. Each polygon showed one of the four levels which were explained in the previous part. The boundary of population groups, neighboring and local parks were overlaid to determine the population of the parks boundaries. Also the average of the population was calculated for neighboring parks because there were several neighboring parks in the study area.

Green Space Potential

Green space potential was applied to the gaps that have not specific applications or had specific applications but have not been performed. The gaps were identified by bare soil reflection which was different from impervious surfaces on the satellite imagery. These zones were distinguished by satellite imagery and airborne photographs on the monitor and they were confirmed by field studies.

Ranking of the Gaps

Overlaying the map of gaps and park establishment necessity, the zones which were suitable for establishing parks in neighboring and local levels were determined. These areas consisted of zones that have had suitable conditions both in surface area and access network and were located in the necessity area.

RESULTS

Regarding to the standards, a zonal park can be divided into two regional parks, a local park and seven neighboring parks (Fig. 2). Figure 3-6 show park boundaries in local and neighboring levels before and after corrections and Fig. 7 and 8 show park boundaries in zonal and regional levels. As it

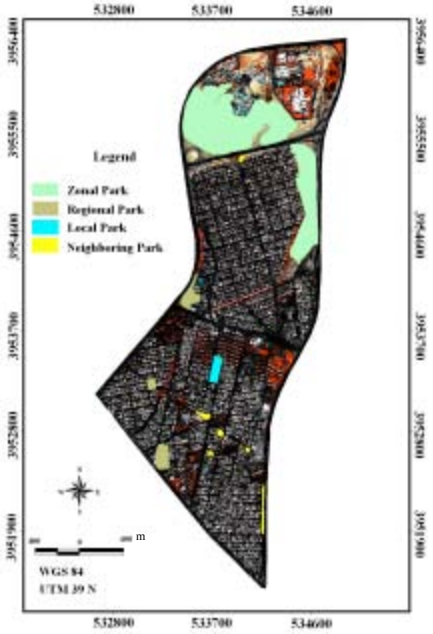

Fig. 2: The parks in the study area

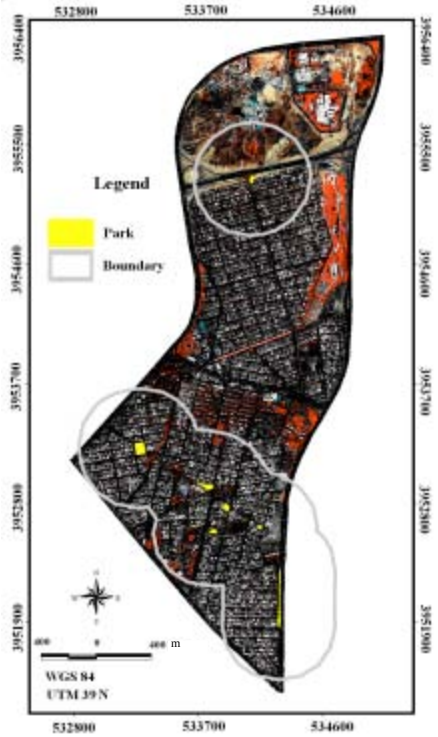

Fig. 3: The neighboring parks boundaries

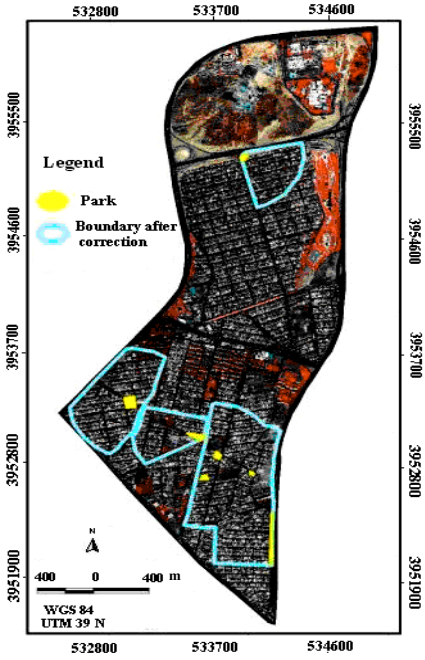

Fig. 4: The neighboring parks boundaries after correction

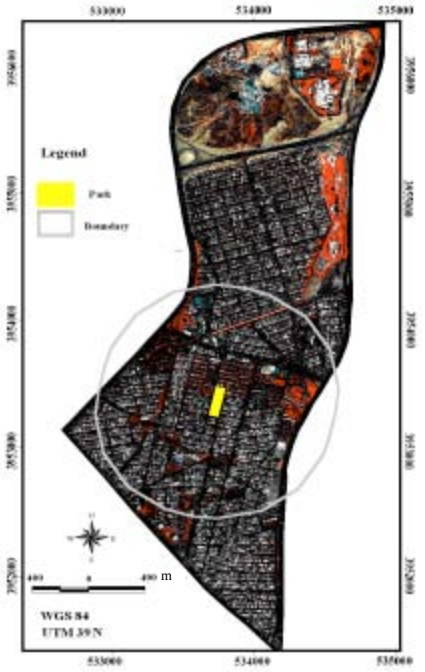

Fig. 5: The local parks boundaries

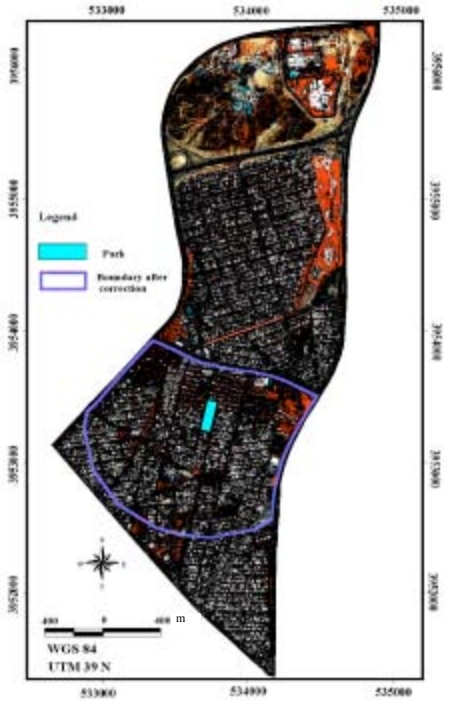

Fig. 6: The local parks boundaries after correction

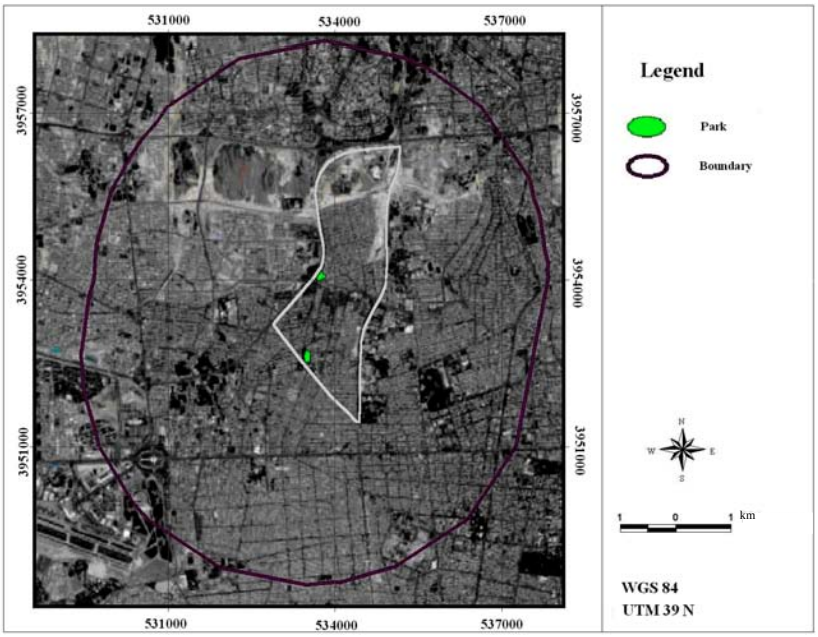

Fig. 7: The zonal park boundary

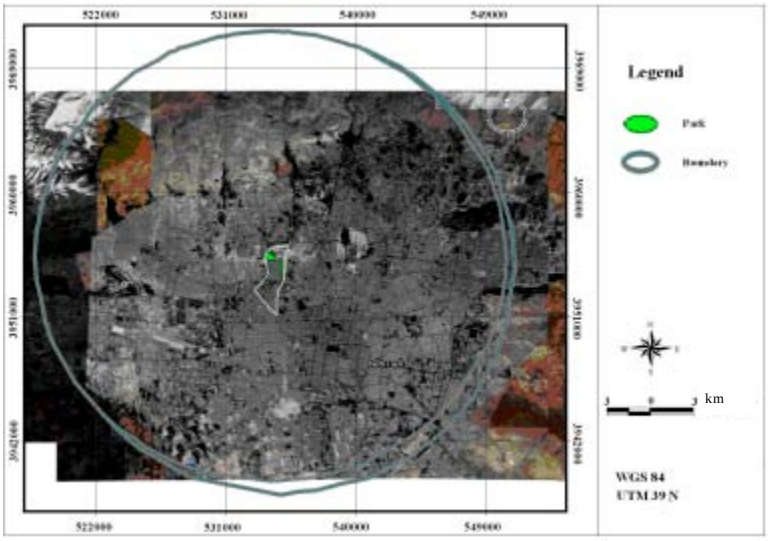

Fig. 8: The regional park boundary

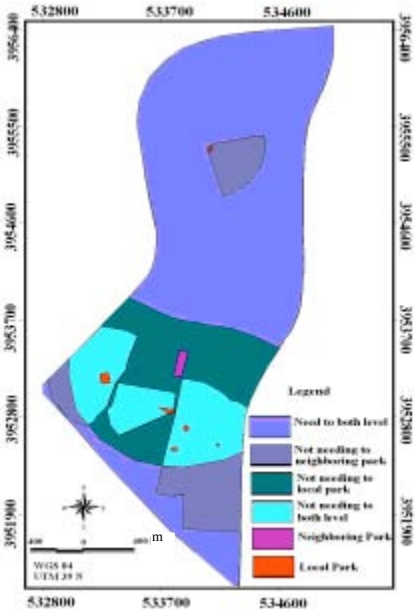

Fig. 9: The necessity of local and neighboring parks establishment

is obvious the study area did not need zonal and regional parks so the study was focused on neighboring and local levels. For lands evaluation, as explained before, a final map with four categories which showed the necessity of establishing local and neighboring parks, was produced (Fig. 9).

After drawing polygons and separating the gaps from impervious surface areas, the map of green space increasing potential was obtained. This map showed that 49.5 ha of surfaces have had no buildings (Fig. 10). Overlaying the map of the gaps and the map of park establishment necessity, the

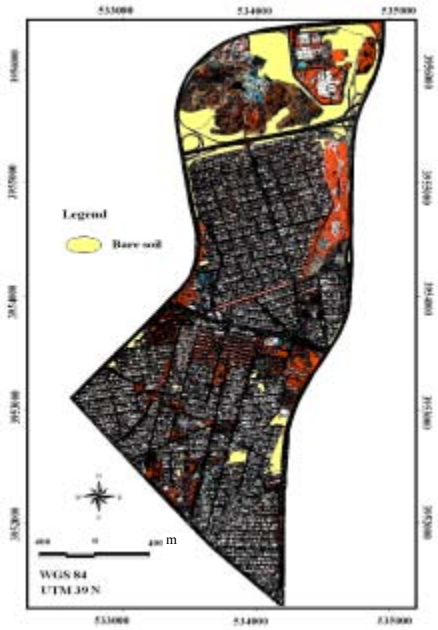

Fig. 10: The map of green space increasing potential

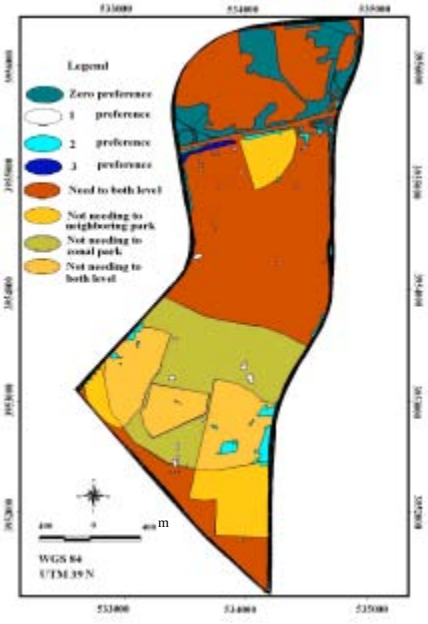

Fig. 11: The maps of the gaps and park establishment necessity

gaps that were suitable for park establishment were determined (Fig. 11). In the zones that needed local park establishment, there were no gaps with suitable surface areas. In spite of acceptable surface area, the zones located beside Hakim highway (close to the Nasr Park) were not suitable

Table 2: The rankings and their characteristics

Ranking	Surface area (ha)	No. of polygon
0	37.2	16
1	1.8	28
2	9.0	42
3	1.4	1

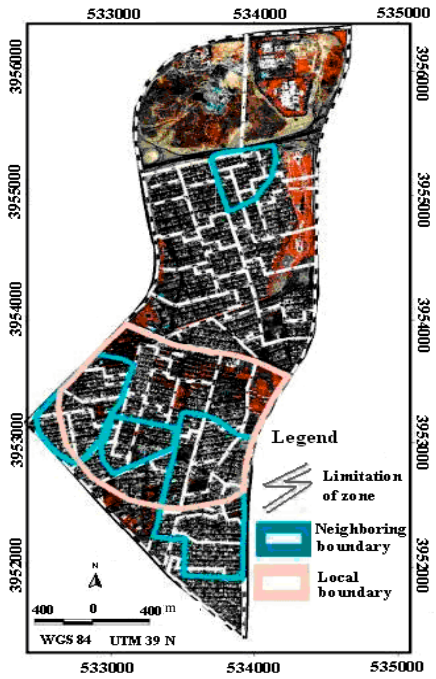

Fig. 12: The maps of population and park boundaries

because of no access network. In the north of Nasr alley, there was a one ha gap but its access network was suitable just from one side.

Different rankings, their surface area and the number of polygons are presented in Table 2.

The zero ranking included the gaps that could not be changed to parks such as the zones without plant that were in the triangular of highways and could be allocated to green space to increase the average of green areas. The second one included the zones which neighboring parks could be established in them and were located in the places that needed park establishment in this level. The third one included the lands which did not need park establishment but they could be changed into parks according to their situation. The last one included the zones that could be changed into local parks because of their suitable surface area and the necessity of park establishment but their accessibility was not suitable. Also after overlaying the maps of population and park boundaries (Fig. 12), it was concluded that the neighboring parks with less than 500 m^2 area covered 3350 to 3840 people in their boundaries and the local parks with one ha area covered 29049 people in their boundaries.

DISCUSSION

This research was performed to determine the necessity of park establishment in the study area using GIS. It was concluded that the study area does not need new parks with more than 8 ha surface

area but some small areas can be allocated to parks in order to increase green space, improve the relationship between people and nature and answer their recreational needs.

According to the results of this research, 399 ha of the study area did not have small parks (at neighboring level) according to the determined classification (Akbary, 2003). A part of this area which included residential areas could be used for park establishment to increase the average of green space and remove needing to this level of parks according to the standards. Also the results indicated that 367.7 ha of the study area was not covered by local parks but unfortunately, there is not enough space to establish such parks or it is not possible to create an effective boundary around it if any. The results of another study in a part of Tehran (Noriyan and Naghdi, 1999) indicated that there was no necessity for zonal and regional parks establishment. Although the classification did not include neighboring level and there was no conclusion about this level, but it was mentioned that the region only needed park establishment in local level. Also the results of this study proved the capability of GIS in studying urban parks and their influence rates (Sesar, 2002).

CONCLUSION

Due to the population which local and neighboring parks cover and in comparison with mentioned standards, it was concluded that the parks supported a population more than the standards and it was clear in local parks. Considering the results of studies about the parks carrying capacity and the number of real visitors, it is possible to prove the mentioned point. In addition to show the present status of the study area, this research showed the ability of new tools for monitoring complex and changeable conditions of cities and revealed the necessity of traditional method's replacement with new management equipments.

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