Location of urban green space using GIS and AHP method (study area: region 2 of Dezful city in Iran)

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Abstract

The study area in this research is region of 2 in Dezful city in Iran. This city has a population of 113100 people and also 11/03 square meters of green space per capita. The per capita green space is very different from the standard UN (20 to 25 square meters for each person). Given that this city is in a hot and dry region of country it is necessary to locate appropriate green space in order to mitigate climate and according to the needs of the population. The type of this research is descriptive-analytical and was done with an emphasis on the practical aspects. In this regard, based on location criteria, data layers were prepared: map of proximity to residential centers also, training, cultural, military, commercial, sanitary, religious centers and river. Finally in order to model each of the criteria based on their value and importance and the specified matrix, appropriate weight to each of the layers, is dedicated by "Expert Choice" software. Based on the results of the combined weighted layer, lands in the study area was prioritized to choose the right place to create green space and then the land was compared with the land use map. It was found that, the lands with good and very good degree are located in the vicinity of residential, cultural, educational centers and river margins, which were state-owned. Also poor and very poor grade lands that are located farther from compatible uses and more closely with industrial, office, healthcare, commercial centers which often have private ownership, not recommended for green space.

Key words: *Location, Urban Green Space, Analytical Hierarchy, GIS, Dezful City*

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1- Introduction

Currently, more than 50 percent of the world's population lives in urban areas. These cities are bigger every day and become large metropolises. Now this increase is 10 times since 1950 (United Nations, 2007). The rapid growth of cities caused many scientists and policy makers concerned about the actually impact this has on the quality of human life (Dye, 2008). Uncontrolled growth of cities in developing countries including Iran, has created many problems, one of these problems is indiscriminate construction, regardless of standards and environmental neglect of urban. This makes the amount of green space per capita in urban areas than in the space cities and areas considered highly reduced. In addition the lack of

detailed planning for developing cities is effective in reducing extreme urban green spaces, has led to inconsistency in distribution of this spaces.

Today the situation in the cities, not only order to creating green spaces in the extensive areas and careful planning but also more than any other time needs more green spaces in order to maintain ecological balance against the built environments **(Majnoonian, 2000).**

In line with population growth and expanding urbanization, humans have gradually away from nature. excessive density of population, interfere in the natural environment, and man-made environment, shown more various needs of environmental, physical and spiritual of human. To meet these needs, urban people has attempted to create gardens and artificial green spaces in urban areas **(Saeed nia, 2004).** Open spaces are considered not only for the recreational importance of them but also they are valuable because of their role in maintaining the balance of air pollution and nurture the soul and body of residents **(Denant:2002)**. So if green spaces especially as environmental attractiveness are well understood and interpreted can be considered as an incentive for people to do activities such as hiking, biking and other recreational activities**(Burton and Craik 1969).** Access to the urban services and urban justice requires that all people be able to equally take advantage of the green open spaces and urban parks and recreation areas not that upper classes and affluent people in society, be able to choose the most beautiful landscapes of cities to live and gradually all of these be reserved for upper classes of society (**Zangiabadi and Mokhtari, 2005**).

Nowadays one of the inevitable necessities that should be considered in planning and urban management is locate Urban Green Spaces as for the importance of ecological, social, economic and psychological aspects of these spaces in the urban environment. The study area has a population of 113,100 people in the city of Dezful and per capita green space is 11/03 that is far from the indicators set by the United Nations (20-25) square meters per person. This paper is based on the AHP model and GIS spatial analysis methods to locate the best places for parks in the study area. Then with using GIS and mentioned model, the most suitable land for the construction of a new green space in four specified areas with priority of so good, good, poor or very poor has been identified. The results indicate the importance and application of GIS and AHP model to identify the best locations for each user that is defined according to standard criteria.

1-1-   Materials and Method

The research method is descriptive – analytical, its theoretical principles is according to the documents, field visits and library research and refer to the relevant organizations. Criteria used to locate is selected based on the locate rules. This point should be considered in selecting software that with regard to the locating process has been a multi-trait decision-making and is performed using raster model, the software should support both vector and raster data models, moreover, be able to use decision rules for multiple trait. In this regard paired comparisons of criteria through "Expert Choice" software in order to preparing layers for spatial analysis in GIS and "Spatial Analyst" tools has been done. After analyzing the weighted layers obtained this way, priority areas for parks in the study area were identified.

2- Discussion

Urban green spaces are part of physical range of the city with specific functions. Green spaces sometimes has decorative role (beautification of urban green space) and sometimes recreational role (resorts) but with the development of urban areas in recent decades, and surpassed urbanization on the urban that associated with numerous problems such as a rise in populations, non-targeted and physical development of cities and increased environmental pollution, it, has played an important role in maintaining balance in the environment and mitigate air pollution **(Mohammadi, 2001:15)**.The main function of urban green space is environmental function that makes environmental humane society significant and enhances environmental quality in cities **(Pour Ahmad, 2009)**.

 In this regard, green and open spaces are the best place to refresh people's physical and mental powers. In green spaces studies, in addition the amount of green space, access to these spaces is considered. Today, access to green space and recreation possibilities in these spaces is one of the main pillars of development. One of the main objectives is to create a balance in Urban Studies, this is most important for a city planner. If the placement and distribution utilities and land uses, including green space, has to be a balance, all segments of society will benefit as much as possible **(Dadashi, 2001).** so green space cannot separated from urban society, if be considered as part of the urban fabric and the civil service. Thus, in terms of quantity and quality of green space must be made in accordance with the physical volume, buildings, streets, roads and psychological needs of the community, leisure and health needs also according to ecological conditions and trends for future expansion of the city, to be active green space and efficiency environmental benefits **(Majnoonian, 1995)**.

3- Case Study

Zone 2 of Dezful municipality is the area under study. The region is between 32 degrees and zero minutes to 32 degrees and 58 minutes of north latitude and 48 degrees and 17 minutes to 49 degrees and 34 minutes of east longitude. The region has an area of 11,984,593.81square meters and its population is more than 113,100 people in 2010 **(Province Statistical Yearbook, 2006)**. Temperature of the city ranges from 3 degree centigrade in winter to 49 degree centigrade in summer. Regarding climatic conditions of this city and location in warm and dry region of Iran, doubles necessity of attention to optimal and proper localization of urban green spaces as recessional lungs of the city to modify climate (Statistical yearbook of Khuzestan province, 2006:28).
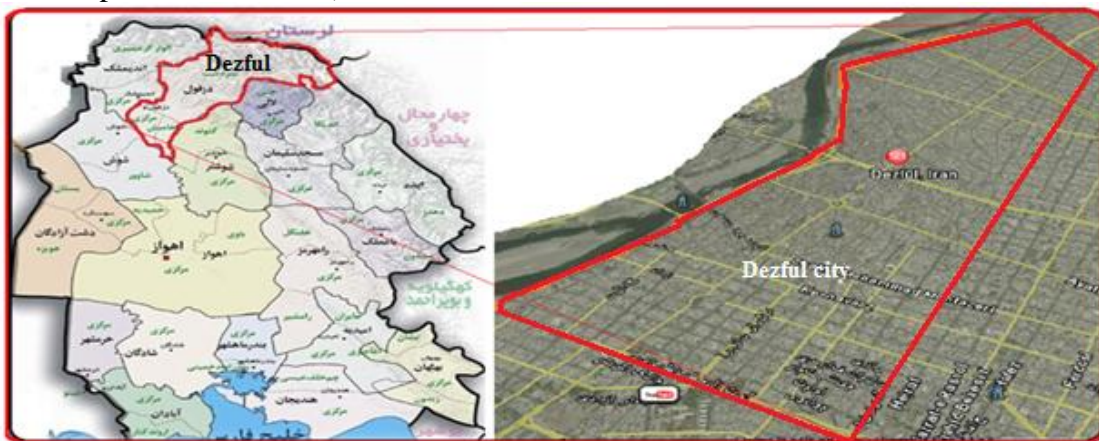

Figure1: Position studied region

4- Research findings

To locate in the geographical information system, should the factors, criteria and restrictions as map layers are produced and processed and analyzed. In this research, based on locating green spaces criteria in commensurate with the type of model used in this study (AHP), and knowledge of geography, socio - economic and physical conditions of area, factors affecting the location of green space (Table 1), to provide information layers in order to identify priority areas, were identified for locating urban parks.

Table (1): Specified standard criteria for locating urban green space

Standard distance to every land use	Sort compatibility	criterion	Row
150 m ≤	Compatible	Near to residential centers (m)	1
150 m ≤	Compatible	Near to cultural centers (m)	2
150 m ≤	Compatible	Near to didactic centers (m)	3
150 m ≤	Incompatible	Near to commercial centers (m)	4
500 – 1000 m	Incompatible	Near to industrial centers (m)	5
150 – 500 m	Incompatible	Near to urban installation centers (m)	6
150 m ≤	Incompatible	Near to arid land (m)	7
150 m ≤	Incompatible	Near to ministerial centers (m)	8
150 m ≤	Incompatible	Near to sanitary centers (m)	9
150 m ≤	Compatible	Near to river (m)	10

Reference: (Hosseini, 2002) & (Varesi and colleagues, 2008)

5- Standardized criterion maps using AHP Model

Effective layers in locating (criteria) should be standardized to locate and integrate the plans. It means, the layers, using decision rules are converted to a scale that they can be merged **(Shahabi, 2009)**. Hierarchical analysis is used for this purpose. Analytical Hierarchy Process Method (AHP) which was presented in 1980 by Satty is based on three principles: decomposition, comparative judgment and synthesis of priorities **(satty,1980).** In decomposition principle, it is necessary that decision-making problem is decomposed into a hierarchical that have elements define of the hierarchical structure with regard to the origin of the higher levels. Synthesis principle in each of the spatial priorities with a scale gives a proportion in the various levels of the hierarchy and creates complex set of priorities for the lowest level of the hierarchy (options). It is the principle of hierarchical analysis involves the following main steps: (Qodsipoor, 2003)

a)   Comparison binary matrix production: a major scale with values from 1 to 9 is used to determine the relative priorities of two criteria (Table: 2).

b)   Calculate weights of criterion: this step includes: 1. Sum of the values in each column comparison binary matrix. 2. Each matrix component divided into the sum of matrix column (new matrix, is called the comparison binary matrix of normalized). 3. Average estimated components of each row of the normalized matrix.

Table (2):Comparison binary Scale

Importance rate	Definition
1	Equalimportance
2	Equal to moderate importance
3	Moderate importance
4	Moderate tostrong importance
5	Strong importance
6	Strongto verystrong importance
7	Verystrong importance
8	Very strongtoextremelystrong importance
9	Extremelystrong importance

Source: (Qodsi pour, 1384)

c)   Estimates the consensus proportion: this step involves the following operations: 1. Determine the vector sum of the weighted by multiplying the weight of the first criterion in the first column of the original comparison binary matrix then multiply the second criterion in the second column, the third criterion in the third column of the original matrix, Finally, sum up the values in rows. 2. Determinates the consensus vector by dividing the weight vector into criteria weights which has already been determined (Malczewski, 1999).

Simple additive weighting model is most common techniques in spatial multi-criterion decision making. This technique is also known as the weighted linear combination or Scoring Method. This method is based on the concept of weighted average. The decision maker or analyst gives weights to the criteria, directly based on the relative importance of each criterion then by multiplying the relative weight of attribute value, a final value for each option (for example, in the analysis of the spatial picture element) is obtained. After that the final value

of each option was determined, options, that have the maximum amount, would be the most appropriate option for the target (Shahabi, 1387). Target can be determine the suitability of earth for a particular application or evaluate the potential for a special event. In this way the decision rule, the value of each alternative Ai is calculated by the following equation.
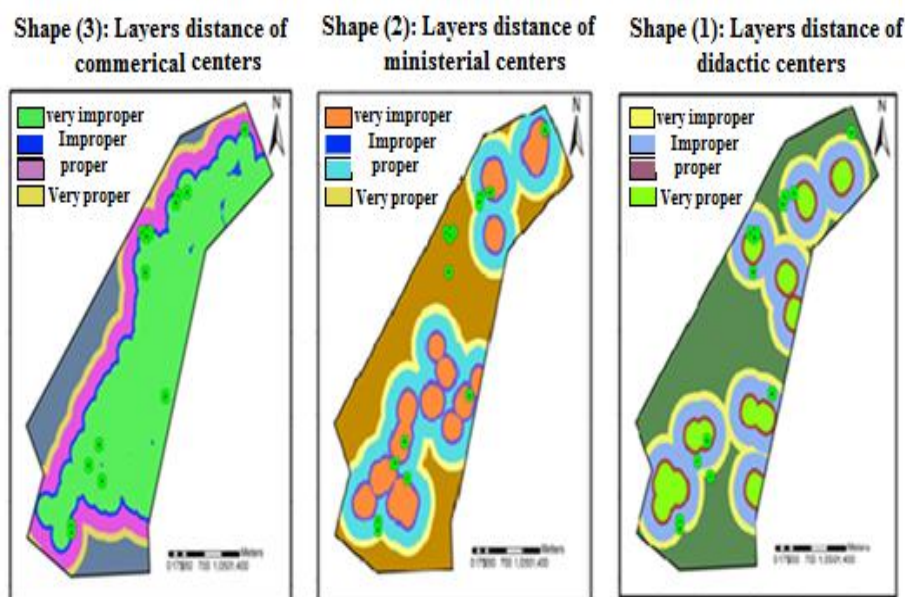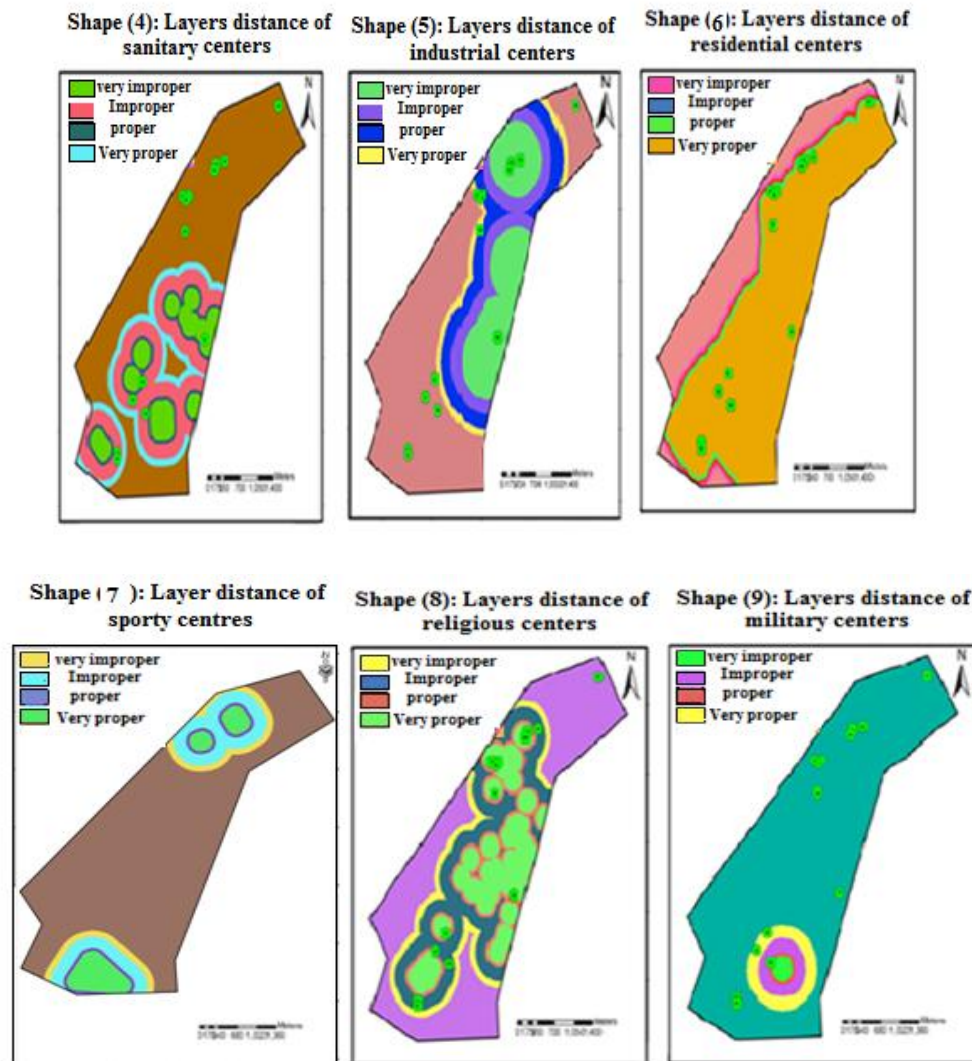
Equation 1:

$$\sum w_j = 1$$

$$Ai = \sum wj \times xij$$

In this formula Wj is index weight of j'th, Xij is the value that i'th position has accepted, in other words, this value can indicates the appropriate level of i'th position in associated with the j'th index. n is the total number of indicators and the value of Ai belongs to the i'th position finally.

Simple additive weighting method can be implemented by GIS overlay capabilities. By the overlay techniques in GIS we can product a composite map layer (Map output) via combined and integrated of input layers (Map input). Using this method in both raster and vector formats of GIS is practical(**Valizadeh & Shahabi:2009).**

6- Preparation of required layers (criteria) to location

This is a process that includes obtaining data format changes, the reference pitch, setting up, and documentation of data **(Farajzadeh, 2005).** Geographic Information System data that is entered, including: existing land use digital map and digital map layers residential centers, educational, cultural, rivers, office, industrial, educational, cultural and military centers. Using existing data, a new layer is obtained such as maps numbers (1 -9) away from the residential center, the cultural center, away from military facilities, distance from commercial centers, industrial space, distance from treatment centers distance from administrative centers, Health centers , away from the river.

Shape (3): Layers distance of commerical centers

Shape (2): Layers distance of ministerial centers

Shape (1): Layers distance of didactic centers

Shape (4): Layers distance of sanitary centers

Shape (5): Layers distance of industrial centers

Shape (6): Layers distance of residential centers

Shape (7): Layer distance of sporty centres

Shape (8): Layers distance of religious centers

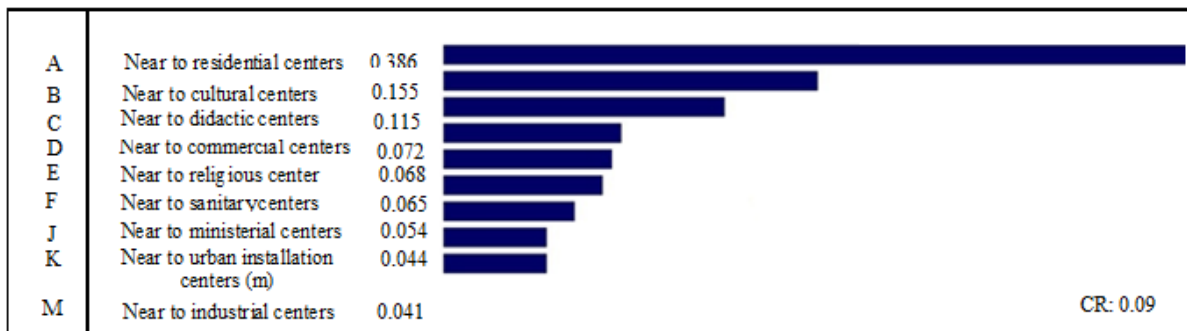Shape (9): Layers distance of military centers

7- Standardization layers for analysis and identification of optimal locations for Green spaces

To do this, we first compared the individual values and are dedicated the relative importance of each pair, according to the scoring table (3) and it will arrive in a matrix. After the weights and proportions of consensus (CR), was calculated (Figure 1), if this ratio is less than 0.1, the comparison is acceptable and the calculated weights are derived. If the consensus proportion is more than 0.1 then, set it to an acceptable level by applying changes in the comparison binary matrix. Given the weakness in the ArcGIS, Calculate the weights and consensus proportion is done by the Expert Choice. If done comparisons be acceptable, the result will be announced, but if the ratio (CR) is less than 0.1 **(Shahabi, 2009)**. The ratio (CR) for our data was less than 0.1 which indicate an acceptable result. Finally, priority areas were identified for landscaping by multiplying the weights obtained in effective layers for locating in Weighted Overlay and integration weighted layers in Raster Calculator (Figure (10)).
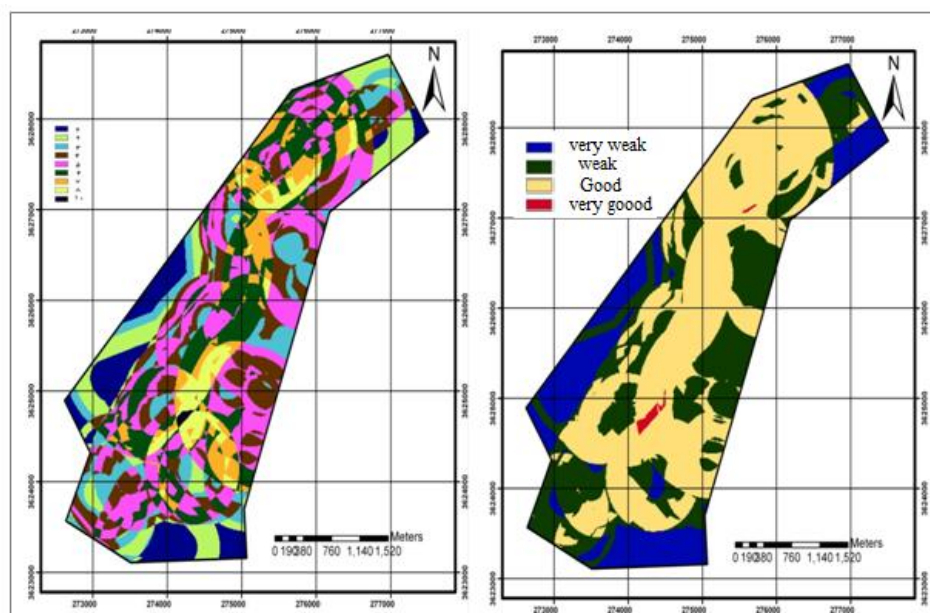
Table(3):Comparisonpaired Layer inexpert choice

M	K	J	F	E	D	C	B	A	Criteria
4	4	4	5	6	4	6	7	1	A
3	2	3	4	3	3	3	1		B
3	3	3	3	3	3	1			C
2	2	3	3	2	1				D
2	3	2	3	1					E
1	2	2	1						F
1	2	1							J
2	1								K
1									M

Chart (1) : Weightscalculationchart inExpert choice

A	Near to residential centers	0.386
B	Near to cultural centers	0.155
C	Near to didactic centers	0.115
D	Near to commercial centers	0.072
E	Near to religious center	0.068
F	Near to sanitary centers	0.065
J	Near to ministerial centers	0.054
K	Near to urban installation centers (m)	0.044
M	Near to industrial centers	0.041

CR: 0.09

Figure (2): Identified priorities places for creating green space

8- Results

With the environmental crisis and reduce the level of people living in cities, healthy urban environment and preserve the environment for future generations, has significant importance. In the spatial development plans, attention to green space to achieve balanced and sustainable development is so important. Currently, the environmental pollution is increasing in most cities a harmonious and equitable development of urban parks and green spaces is effective in creating sustainable urban living. In this research, locating urban green spaces were analyzed using GIS and AHP model in order to provide efficient and effective distribution model of the park in region 2 of Dezful city. Analysis of the results of the output of the final layer obtained from the AHP model in GIS environment and compliance with the land use map of Dezful city, shows that the areas with very good degree are close to residential centers, educational, cultural and river margins and are away from incompatible uses and function radius of existing parks. Considering that this area is considered as high density part of Dezful city also many state agencies are in this region such as training centers, military, administrative…, so by changing land use and transforming them into green space in terms of ownership of the land, there would be fewer problems. Lands with a good degree within the study area are near the training centers, residential, cultural also are away from function radius of existing parks and are also state-owned land so there will be minor problems of the land use changes. The Switch will be difficult for lands with poor level, due to the proximity to incompatible land uses such as industrial, medical, office, commercial, and also because private owners so these lands are not proposed for green space. Lands with very weak degree are another type of preferred lands for green space, this lands due to distance from function radius of existing parks also distance from the residential, educational and cultural centers and located within the functional range of incompatible installations, are not proposed for green space as well.

Today, expansion green space in cities is the basis and foundation for urban sustainable development. In addition to the psychological impact factor, expansion of the town parks and resorts is effective in creating a healthy city and can lead to a healthy environment and pleasant city space for citizens. Urban planners and administrators should take appropriate measures to increase green space and expanding spatial justice through access to these spaces for all areas of the city. In this regard, by using GIS we can save an enormous amount of spatial data and non-spatial in a room in form of integrated and with required processing, do analysis problems locating green spaces and provides needed information in form of graphical and non-graphical outputs for decision-making. By the analysis of Data Layers can be obtained proposed and optimized locations based on the criteria and standards for the distribution and dispersion of urban green spaces. By analyzing the mentioned parameters in the study area, and the use of GIS and AHP method we have been able to select suitable places for green space.

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