Journal of Engineering and Applied Sciences 12 (Special Issue 8): 8426-8435, 2017
ISSN: 1816-949X

Selection of a Best Recreational Park Location in a City Using GIS Technique

[1]Alauldeen A. Rahman, [2]Jasim A.A. AL-Baghdadi, [2]Ala H. Elaiwi and [2]Falah Abed
[1]College of Applied Arts, [2]College of Technical Engineering,
Middle Technical University, Baghdad, Iraq

Abstract: Although, the recreational parks in a city are necessary for population entertaining, many people are still facing problems in accessing these leisure parks within the city. This is because that the parks locations are not favorable and not accessible for many citizens to reach from their places of residents. There are a number of planning standards (parameters) and designing specifications have to be followed to select the location of recreational parks. All of these planning standards are hard to be applied manually by urban planners. However, the procedure currently used to choose parks location is still inadequate and follows traditional style. The GIS technique can assist the specialists and planners to select the optimal location (e.g., recreational park location) according urban planning standards. Thus, this research proposed a new GIS procedure utilized to select the best recreational parks location in a medium size city (Shatrah) in the South of Iraq using GIS technique. ArcGIS Software was used to classify the spatial information of all elements including their influences on selection of the optimal park location. Six planning standards (parameters) are applied namely: open spaces, population density, park accessibility, the distances between the chosen park and the residential, rivers and swage pump stations. The methodology of this study was established to achieve simulations where the decision weights associated with all six parameters employed for modeling (choosing recreational parking site). The results reveal that the developed procedure can provide a best recreational parking location. Furthermore, the developed produce can reduce the cost and time spending on finding a proper park location compared with the traditional producer that currently used.

Key words: Best park location, spatial analysis using ArcGIS, expert choice, pairwise comparison, traditional, pump station

INTRODUCTION

Nowadays a rapidly growing in population and developing in cities cause a number of challenges representing in the lack of green space and recreational park. Making choices on where to locate the recreational spaces specified for entertaining purposes is a complicated process for urban designers and it bears high responsibility. Subsequently these processes (choosing the recreational spaces) may involve very long period of time. Moreover, they require substantial financial allocations. The second half of this century has witnessed remarkable development in a number of urban planning software such as Geographic Information System (GIS) to solve the problems of choice to facilitate the task of selecting the best location (e.g., best location for recreational spaces). GIS is a collection system designed to input, process, analysis, display all types of spatial or geographical data and descriptive information for specific goals (Ringo, 2009).

Many researchers employed various methods in GIS to select a potential land location suitable for, e.g., business investment, public car parks, lands availability or landfill areas. Ringo (2009) used GIS methods for selecting a profitable location that assists investors to find probable areas where one could build Dunn Bros Coffee House. The researcher claimed that GIS technology can provide spatial insight about appropriate business location. Kulinich and Lee (2015), Baseri *et al.* (2012) and Aydinoglu *et al.* (2015) also developed new GIS techniques for making decision about car park site selection. The developed procedures can solve traffic difficulty in the metropolises and the world large cities. In addition, the choice of the landfill site is an important step in the completion of the solid waste management program. It is hard to find a perfect location to process solid waste landfill in terms of geological features and water. Thus, Alanbari *et al.* (2014) introduced a GIS procedure and Multi Criteria Decision Analysis (MCDA) to determine optimal location for locating a

Corresponding Author: Alauldeen A. Rahman, College of Applied Arts, Middle Technical University, Baghdad, Iraq

suitable landfill area in Kerbala. The researchers identified and selected with assisting ArcGIS Software open areas about 63.179 and 138.1 km^2 that were appropriate for landfill.

However, the previous studies have not introduced a modern procedure for selecting the location of recreational infrastructure. In addition, the procedure currently used to choose the optimal locations recreational infrastructure (e.g., recreational parks) is still inadequate and follows traditional style. In fact, the GIS technique can assist the specialists and planners to select the optimal location (e.g., recreational park location) according urban planning standards. Thus, this research proposed a new GIS procedure utilized to select the best recreational parks location in a medium size city (Shatrah) in the South of Iraq using GIS technique.

In this study, the GIS was also employed to make decision about park site selection fast and easily by considering all of a number of effective planning standard parameters (Chandio *et al*., 2011; Nicholls, 2001; Lawal *et al*., 2011). In park site selection, the most significant parameters can be summarized by the size of open areas, population density, the distance between the site and the residential, accesses to the park, the distance away from rivers and water resources and the distance away from the present parks and green lands chosen to be planning standards (Chandio *et al*., 2011; Nicholls, 2001; Lawal *et al*., 2011). The weights of these parameters are systematically different over a range of interest. For example, some of these parameters such as near the park to a river and residential areas are more effective in park site selection than the other parameters. A pairwise comparison is a significant statistical analysis technique of paired comparisons utilized for parameters weight calculating and for assisting specialists to deal with complicated decisions. Pairwise comparisonnormally is used for process to compare entered parameters in pairs to judge which of each parameter isfavored (Chandio *et al*., 2011; Nicholls, 2001; Lawal *et al*., 2011). Therefore, in this study a pairwise comparison method are utilized to judge the selected six significant parameters (Fig. 1).

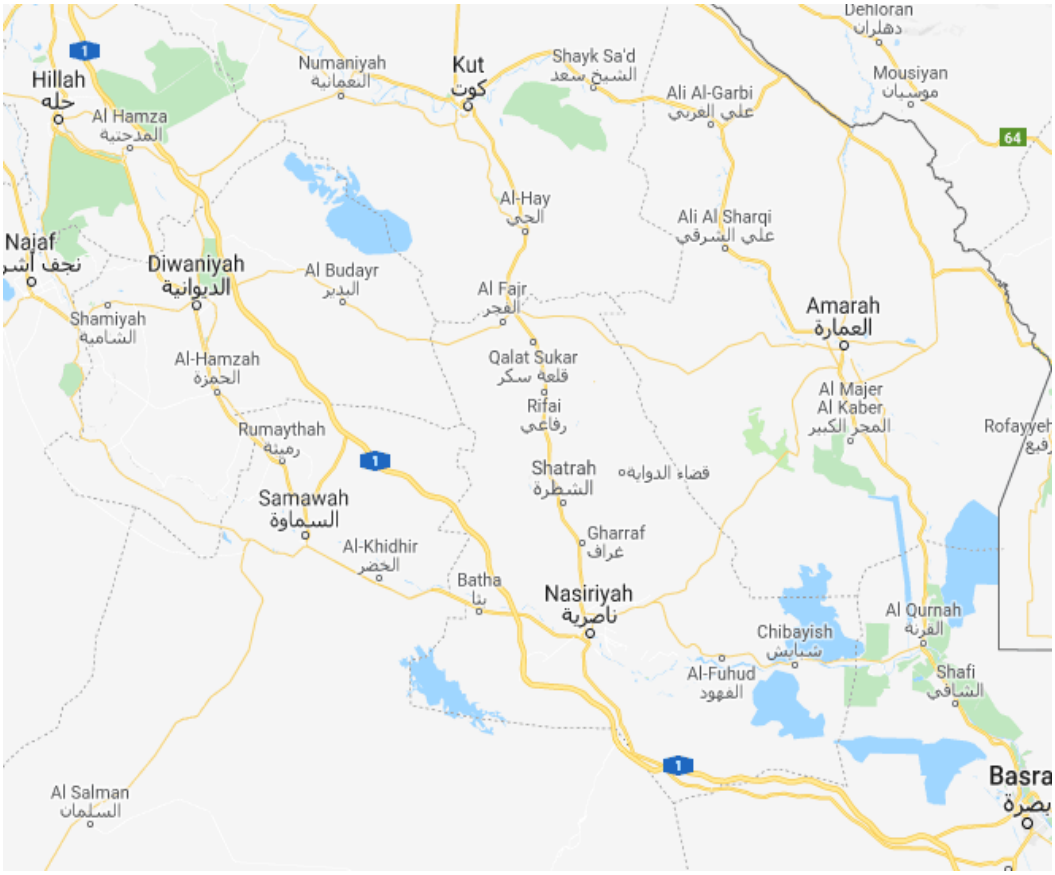

Fig. 1: The study area of Al-Shatrah City (Helaly, 2014)

Study area: The study covers the locations of AL-Shatrah City. The city is located on a river Garraf sub which is a branch of the Tigris River. It is in the mid-Euphrates Region South of Iraq. The city is away about 350 km^2 South of the capital Baghdad. It belongs administratively and geographically to the province of Thi-Qar. Al-Sahatrah is the most important settlement in Thi-Qar Province; located at 31°24'47.17" North latitudes and 46°10'4.52" East longitudes. Thus, it is almost the middle of the distance between Baghdad and the Southern provinces and the Arabian Gulf (Fig. 1). The city suffers from a lack of the recreational public parks. Most of the former residents of Shatrah intellectuals are the people the owners of the certificates and urban values and who are called locally as (the people of the state) but after the great migrations of the rural population and deserts (Bedouins) from the desert to the city of cities lost their original identity. For the population of the city, there are no accurate statistics of the total number but according to the census of the population of Iraq in 1997 the number reached roughly 147000 inhabitants (including the population of the city itself, villages and areas of her). Most of buildings are small houses, super markets or small government buildings. There are agricultural fields around the city, arid areas and gardens of palm and high trees. There are some irrigation projects around the city like Al-Badah gate way. The agricultural fields neighboring Ash-Shatrah well affect the atmosphere there.

MATERIALS AND METHODS

This research proposed a new GIS procedure utilized to select the best recreational parks location in a medium city (Shatrah) in the South of Iraq using GIS technique. The methodology of this study is achieved through several important stages including data collection, creation of classes, analysis and then determining the parameters weights to be the last stage.

Data collection: Is the first process in the analysis of the data collection area of the satellite imagery (spatial data) as shown in Fig. 2 and statistics of the piece (non-spatial data) through the state departments or by the survey and

Fig. 2: The used satellite imagery of Al- Shatrah

spatial data can be important to the process of spatial analysis in this study. Satellite image of the area taken in 2005, 0.6 m spatial resolution, GPS coordinates and an existing topographic map (scale 1/25000) of the city. Tents and patched and streams originating from the Department of Nasiriya Division of Geographic Information Systems. Non-spatial data and statistical table that contains the facilities, size and types of parking lots, pictures of the facilities, simple random sampling technique was adopted to determine. These data were obtained from the Department of the Municipality of Nasiriya Division GIS.

Data processing: The raw satellite imagery was corrected and geo-referenced toWGS84 spheroid (World Geodetic System 1984) Using Erdas Imagine 8.4. The rectified satellite imagery was imported to ArcGIS 10.0 to create a digital map that consists of different layers and shape files. Integration of both spatial and attribute data were achieved. GIS permits new processing methods to offer high-quality demonstration of processed data. GIS data was established via. criteria and sub-criteria. These criteria are considered decision-making tools in situations when data related to a choice that contains a spatial component. In fact, GIS is a system that offers a final solution to provide the likelihoods for an optimal and ideal analysis of information which requires for making quality decisions. In this study, the processes of finding the optimum recreational park location were accomplished using ArcGIS Software. These processes started with separating the study area into six classes before applying spatial and combining query and spatial data analysis procedures.

Choosing optimal recreational park location

Efficient criteria in choosing recreational parking site selection: There are a number of parameters to regulate location selection of recreational parking. Six main effective significant parameters (criteria) were taken into account during selection the optimal recreational park location in the study. Every parameter contains several sub-parameters as shown in Table 1. These parameters are: open areas (spaces), population density (people per km^2), the distance between the site and the residential, access to major thoroughfares and roads, the distance between the city river and a park and the distance between the park and water pump stations. These parameters are chosen to be planning standards.

Computation of six parameters weights based on the pairwise comparison matrix: A pairwise comparison is a significant statistical analysis technique of paired comparisons utilized for assisting specialists to deal with complicated decisions. Pairwise comparisonnormally is used for process to compare entered parameters in pairs to judge which of each parameter isfavored. In this study, six significant parameters were taken into account in ArcGIS Software to support the selection the optimal recreational park location. However, the weight of these parameters are systematically different over a range of interest. Thus, the methodology of this study was established to achieve simulations where the decision weights associated with all six parameters employed for modeling (choosing recreational parking site). Saaty (2007) developed Analytical Hierarchy Process (AHP) to calculate the weights of entered parameters. The AHP procedure requires pair-wise comparison of the decomposed parameters within a given level of hierarchal assembly with respect to the next advanced level. Based on Analytical Hierarchy Process (AHP), MATLAB Software (GIS_WEIGHTS.m) was designed in this study to calculate composite weights and weight linear combination after determining the pairwise comparison matrix a multi-objective decision. The formula that used to calculate the weighted linear combination (E) for the all six parameters is:

Table 1: The six parameters and sub-parameters have been applied in park site selection

Criteria	Sub-criteria
Open areas (spaces)	The park location should be chosen in an open area
Population	Population density (people per km^2)
Residential areas	The distance between the park and the residential areas
Access to major thoroughfares	Streets crossing, street width, pedestrian and roads
City rivers and water resources	The park location should be close to rivers and water resources
Water pump stations	The park location should be close to water pump stations

$$E = \sum_{i=1}^{n} w_i v_i \quad (1)$$

Where:

w_i = Relative importance or weight of factors/parameters i

v_i = Relative weight of parameters i

n = Total no. of parameters related to the study

Find an optimum recreational park location: The process of finding the optimum recreational park location started with separating the study area into six classes before applying spatial and combining query and spatial data analysis procedures. These classes were: the districts in

the city, city streets, open areas in the city, existing recreational parks, city river and water pump stations. ArcGIS 10.0 was used to plot each class into a separate layer. The description and the fine details of each layer were identified and connected with the available attribute tables. Before starting spatial and combining query and spatial data analysis processes, designed MATALAB Software (GIS_WEIGHTS.m) was used to determine the weighted linear combination (E) for the all six parameters of the six chosen parameters. The weights were given to each layers relying on the calculated linear combination (E) weights of the all six parameters. Spatial query process involved creating a buffers (or buffer) on all six layers with size similar to the distance identified around the source features. For example, buffering was done to the layers of building, streets, open area, existing recreational parks, city river and water pump stations. Based on the weight of the six selected parameters, the six layers of information were classified according the impact rate of these layers on selecting of the best recreational park. Finally, the best recreational park location was found after carrying out spatial data analysis processes using ArcGIS 10.0 Software.

RESULTS AND DISCUSSION

In this research, GIS technique was employed to select the best location for constructing a recreational park in AL-Shatrah City. The produced vector maps and location-allocation analysis were jointed and tested for the study area. Spatial analysis algorithm in ArcGIS Software was revised though taken into account the weights of the entered parameters. In this study, the results and the modeling processes were presented as several sequential steps. These steps were described as follows.

Step 1; Spatial and attribute data collection: Is the first process in the analysis of the data collection area of the satellite imagery (spatial data) and statistics of the piece (non-spatial data) through the state departments or by the survey and spatial data can be important to the process of spatial analysis in this study. The raw satellite image of the area was taken in 2005 with 0.6 m spatial resolution, GPS coordinates and an existing topographic map (scale 1/50000) of the city. ArcGIS Software was used for geo-referencing the raw satellite image of the study area (Fig. 2). In addition, a statistical data of the study area was gathered to build a geo-database. These data include the number of population in each district of the city (Table 2) and the ground coordinates (GPS coordinates) of the water pump stations.

Step 2; Producing layers of vector maps: Vector maps were produced based on corrected satellite imagery of Al-Shatrah City and field surveying data using ArcGIS 10 Software. These layers were employed to create a geo-database of the city. The produced maps involve, data from the above mentioned databases are represented on a map in the form of a number of layers. These layers were:

- Layer exhibited the all districts of the city. It showed positions of residential objects-on selecting any building (Fig. 3)
- Layer demonstrated city street network-on selecting a street on a map, information on street name and rank is displayed (Fig. 4)

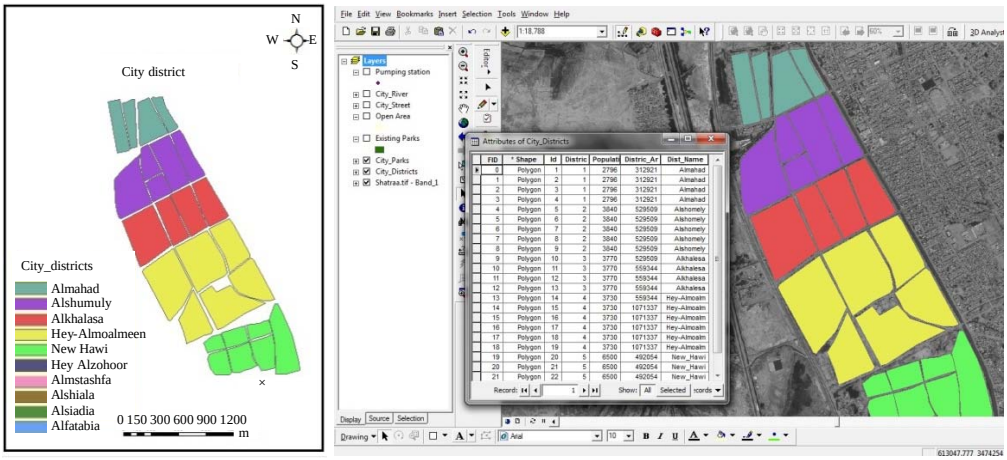

Fig. 3: Layer exhibits the all districts of the city and shows number of residential objects of selecting buildings

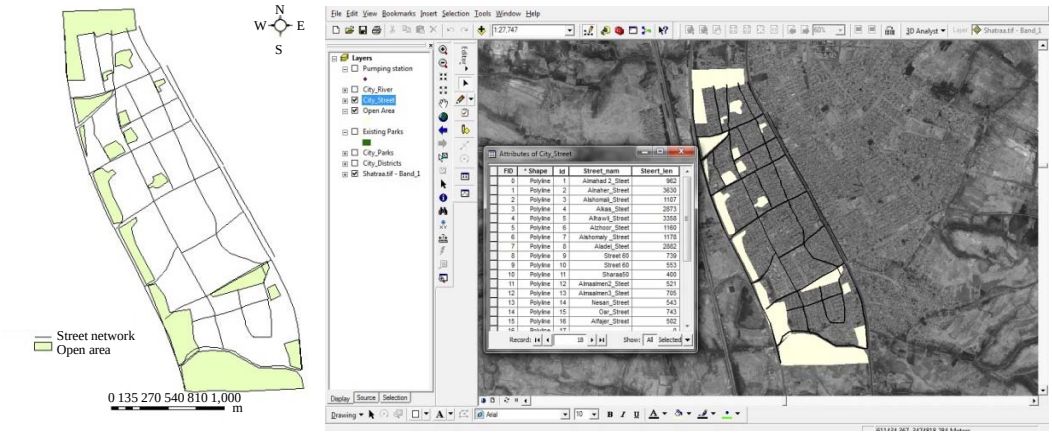

Fig. 4: Layer demonstrates city street network and information of street name and length

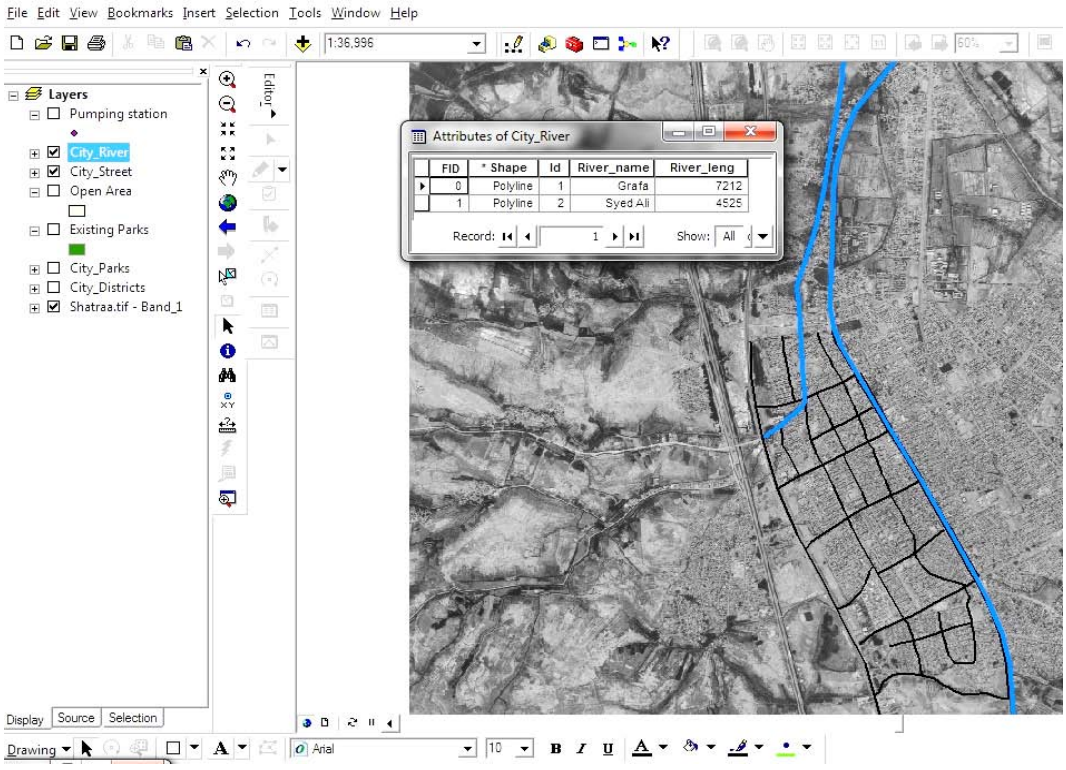

Fig. 5: Layer revealed the river of the city (Gharaf River) and the branch of this river (Syed Ali Branch)

Table 2: Statistical data of the study area

City parts	Construction (%)	No. of population
Hey-Almoalmeen	88	8730
Hey-Alzohoor	75	2600
Alhawi	82	6500
Alfatahia	69	5430
Alkhalesa	90	7770
Alshomely	90	3840
Almstashfa	92	4672
Alshiala	93	3987
Almahad	76	2796
Alsiadia	70	6120

- Layer showed the empty areas in the study area (Fig. 4)
- Layer revealed the river of the city (Gharaf River) and the branch of this river (Syed Ali Branch) (Fig. 5)
- The Locations of existing leisure parking on the city were represented in the separate layer (Fig. 6)
- Layer devoted to display the water pump stations (Fig. 7)

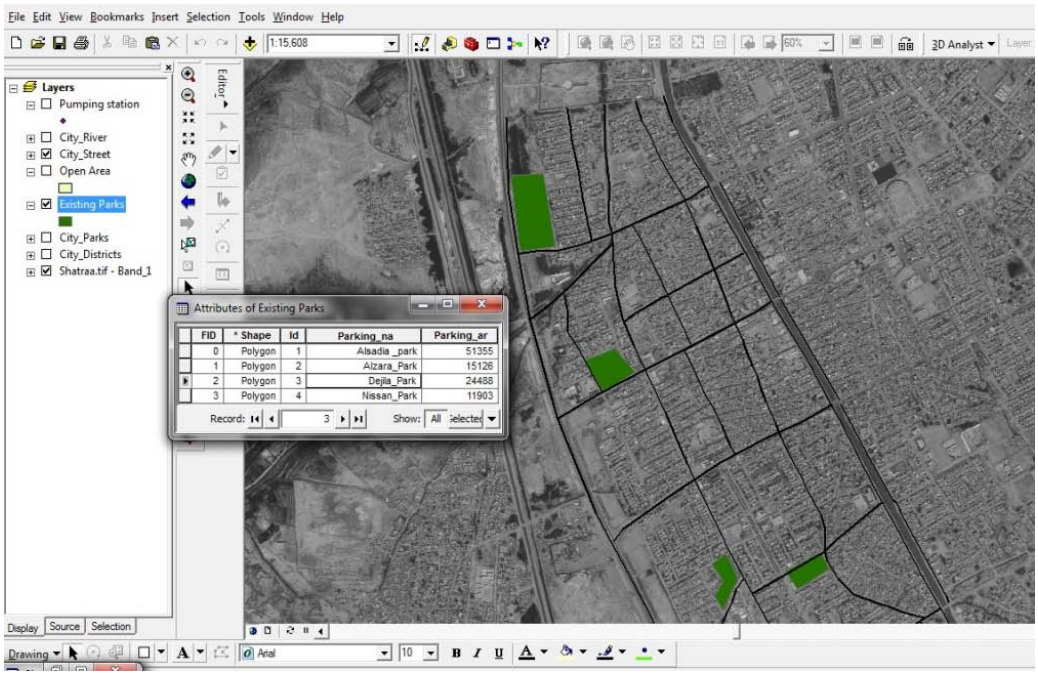

Fig. 6: The locations of existing leisure parking

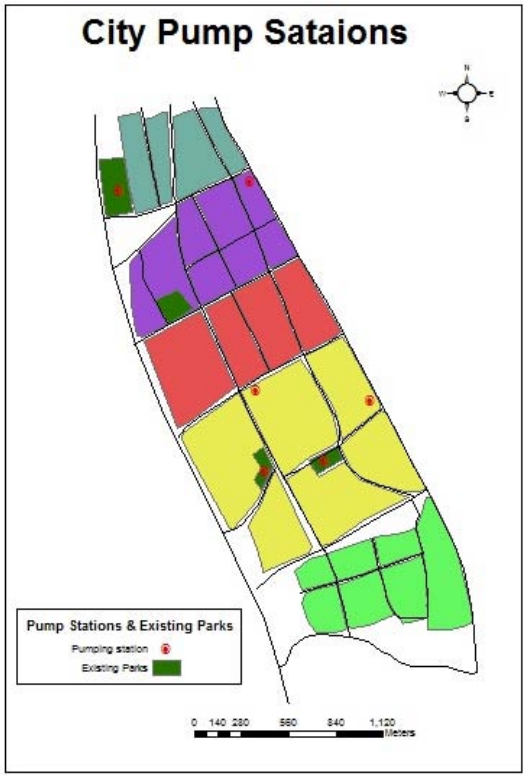

Fig. 7: The locations of existing leisure parking on the city map

The stated layers represent a basis for forming additional layers that were used in the spatial analysis.

Step 3; Calculating the weight matrix to the parameters: The Analytical Hierarchy Process (AHP) was utilized to estimate the priority weight of each parameter from the six selected parameters (open spaces, population density, the distance between the chosen park and the residential, access to chosen park, the distance away from rivers and water resources and the distance away from the present parks and green lands) chosen to be planning standards and sub-criteria (parameters). MATLAB Software (GIS_WEIGHTS.m) was designed in this study to calculate composite weights and weight linear combination after determining the pairwise comparison matrix a multi-objective decision. The parameter's weights were illustrated in Table 3. According to Table 3, the layers of the river and the open area had the high impact 27 and 28%, respectively on park selection. Whereas, the water pump station had the minimum 7% and negative influence on park selection.

Step 4; Find an optimum recreational park location: Spatial query process involved creating a buffers (or buffer) on all six layers with size similar to the distance identified around the source features. Buffering was done to the layers of building, streets, open area, existing recreational parks, city rivers and water pump station.

Table 3: The weight matrix to the parameters and sub-parameters

Criteria	Sub-criteria	Composite weight	Weight (%)
Open areas (spaces)	**The park location should be chosen in an open area**		
	Big area	0.13	28
	Medium area	0.09	
	Small area	0.06	
Population	**Population density (people per km^2)**		
	High density	0.07	13
	Medium density	0.04	
	Small density	0.02	
Residential areas	**The distance between the park and the residential areas**		
	Close distance	0.06	14
	Medium distance	0.05	
	Far away distance	0.03	
Access to major	**Streets crossing, street width, pedestrian**		
thoroughfares and roads	Major road	0.07	11
	Local road	0.04	
City rivers and water resources	**The park location should be close to rivers and water resources**		
	Close distance	0.12	27
	Medium distance	0.09	
	Far away distance	0.06	
Sewage pump stations	**The park location should be close to water pump stations**		
	Close distance	0.04	7
	Medium distance	0.02	
	Far away distance	0.01	
Total weight (Σw_i)		1.00	100

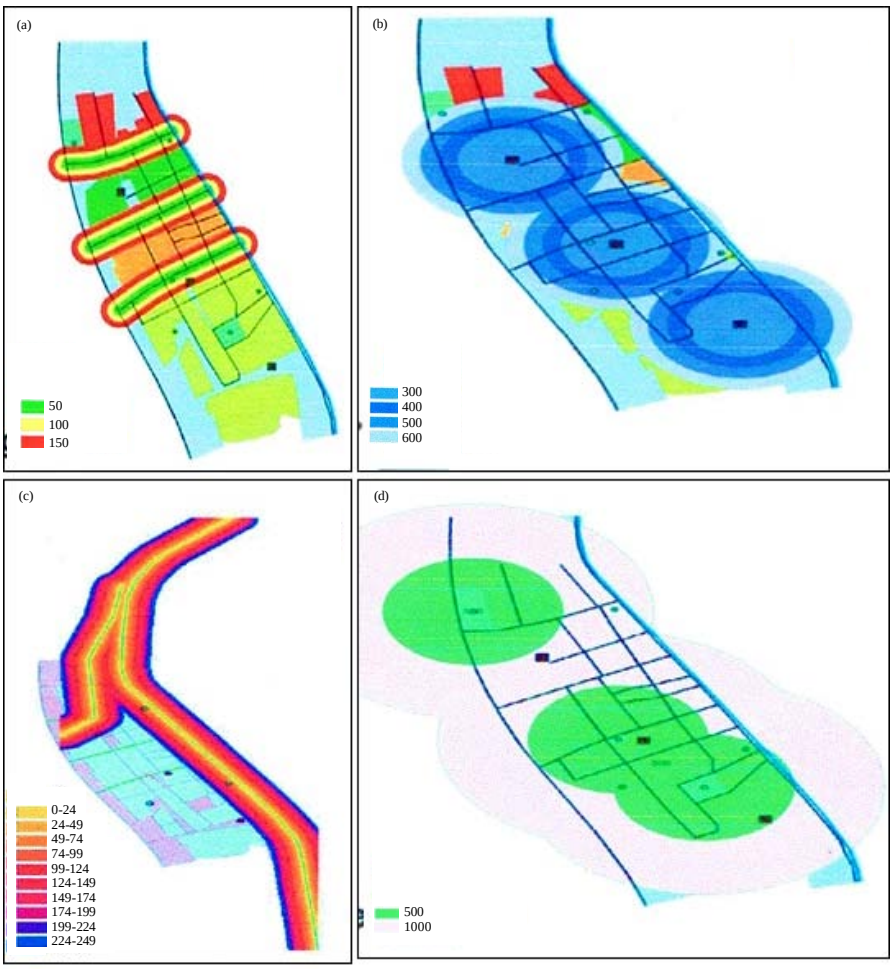

Fig. 8: Creating buffer area around: a) Main streets; b) Water pump stations; c) City river and d) Existing parks

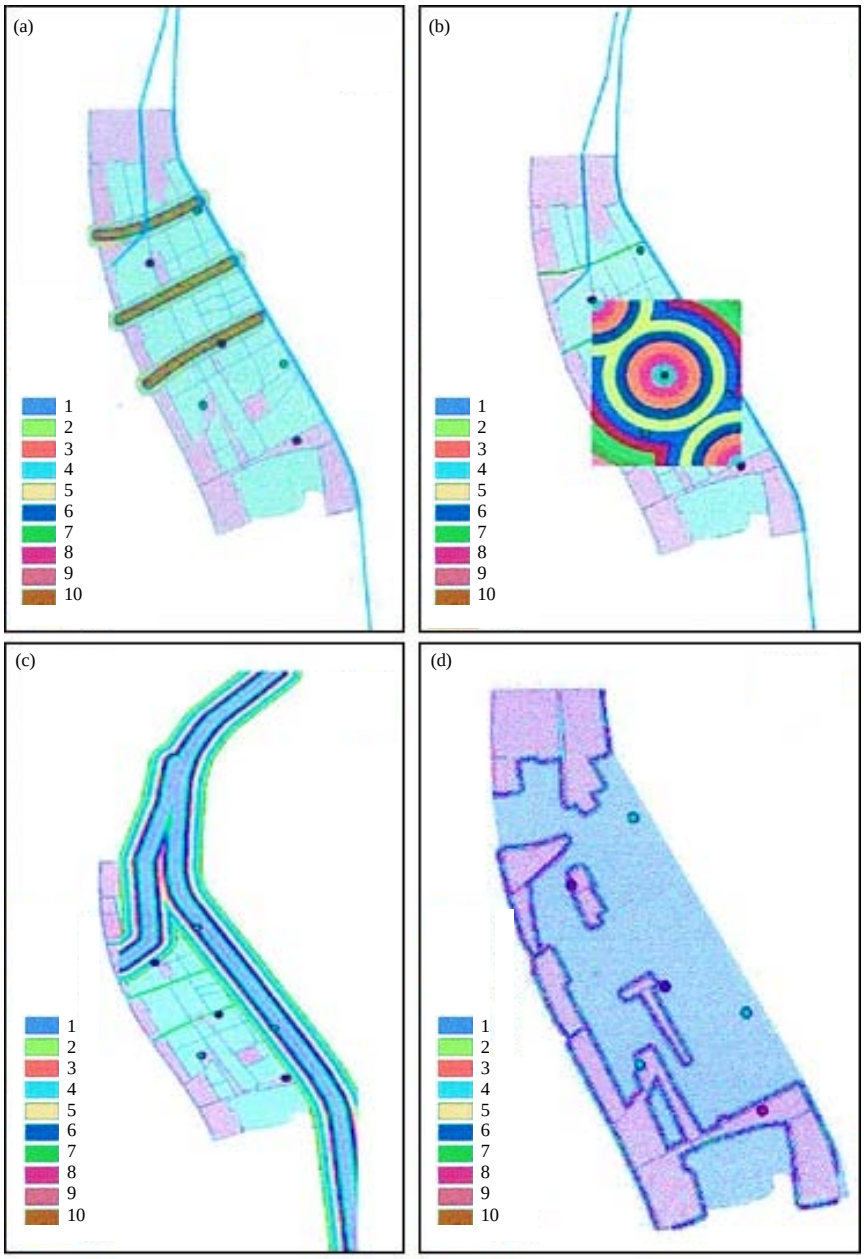

Fig. 9: Spatial data analysis and classification using ArcGIS: a) Main streets; b) Water pump stations; c) City river and d) Existing parks

Figure 8 shows an example of buffering process and exhibits the creating buffer area around main streets, water pump stations, city river and existing parks. Based on the weight of the six selected parameters, the six layers of information were classified according the impact rate of these layers on selecting of the best recreational park. Finally, the best recreational park location was found after carrying out spatial data analysis processes using ArcGIS 10.0 Software.

The steps of spatial data analysis processes and parameters classification using ArcGIS are summarized (Fig. 9). Based on the weight of the six selected parameters, the six layers of information were classified according the impact rate of these layers on selecting of the best recreational park. Finally, the best recreational park location was found after carrying out spatial data analysis processes using ArcGIS 10.0 Software (Fig. 10).

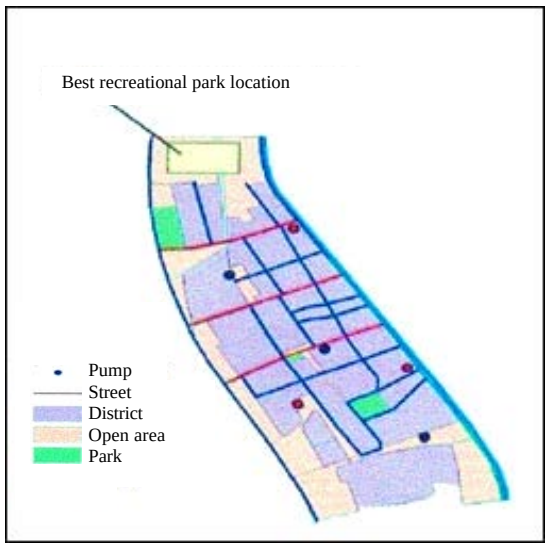

Fig. 10: The optimum recreational park location

All these scenarios were combined to determine potential land for establishing a recreational park in Al-Shatrah City.

CONCLUSION

This research involves developing a new GIS technique to select the best location of recreational park in Al-Shatrah City. The six sustainable planning standards (parameters) have been considered in this study. These parameters are: open areas (spaces), population density (people per km^2), the distance between the site and the residential, access to major thoroughfares and roads, the distance between the city river and a park and the distance between the park and water pump stations. These parameters are essentially for park site selection. Planning standards of park site selection are vital in the planning process and sustainable distances from recreational park location to city residents should be taken into account. Therefore, these planning standards (parameters) do not have same weight. Pairwise comparison matrix has utilized for computation of six parameters weights. The process of finding the optimum recreational park location started with separating the study area into six classes before applying spatial and combining query and spatial data analysis procedures.

The results show the layers of the river and the open area had the high impact (27 and 28%, respectively) on park selection. Whereas, the sewage pump station had the minimum (7%) and negative influence on park selection.

RECOMMENDATIONS

In addition, the best recreational park location was found after carrying out spatial data analysis processes using ArcGIS 10.0 Software. GIS can be a valuable tool to determine appropriate land in urban development and it can and provide a proper solution for complicated decisions that involve land location selection.

REFERENCES

Alanbari, M.A., A.N. Ansari and H.K. Jasim, 2014. GIS and multicriteria decision analysis for landfill site selection in Al-Hashimyah Qadaa. Nat. Sci., 6: 1-23.

Aydinoglu, A.C., M. Senbil, D. Saglam and S. Demir, 2015. Planning of parking places on transportation infrastructure by geographic information techniques. Proceedings of the 2015 3rd International Conference on Istanbul Smart Grid Congress and Fair (ICSG), April 29-30, 2015, IEEE, Istanbul, Turkey, ISBN:978-1-4673-6624-3, pp: 1-5.

Baseri, M.A., R.M. Malekabadi and A. Gandomkar, 2012. Site selection of public parking in Isfahan City, using AHP Model. Sustainable Dev., 8: 1-4.

Chandio, I.A., A.N. Matori, D.U. Lawal and S. Sabri, 2011. GIS-based land suitability analysis using AHP for public parks planning in Larkana City. Mod. Appl. Sci., Vol. 5,

Helaly, A.I.A., 2014. Land cover mapping using supervised classification of a satellite imagery of Ash-Shatra City. Kufa J. Eng., 3: 38-48.

Kulinich, I. and H. Lee, 2015. Conceptual GIS application for decision making of parking site in Khabarovsk. Adv. Sci. Technol. Lett., 120: 145-148.

Lawal, D.U., A.N. Matori, I.A. Chandio and A.L. Balogun, 2011. Framework for recreational park suitability sites. Intl. J. Civil Environ. Eng., 11: 82-93.

Nicholls, S., 2001. Measuring the accessibility and equity of public parks: A case study using GIS. Managing Leisure, 6: 201-219.

Ringo, L.G., 2009. Utilizing GIS-Based site selection analysis for potential customer segmentation and location suitability modeling to determine a suitable location to establish a dunn bros coffee Franchise in the Twin Cities Metro. University of Minnesota, Minneapolis, Minnesota. http://www2.smumn.edu/gis/GradProjects/RingoL.pdf.

Saaty, T.L., 2007. Time dependent decision-making; dynamic priorities in the AHP/ANP: Generalizing from points to functions and from real to complex variables. Math. Comput. Modell., 46: 860-891.