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Using Fuzzy Logic Analysis in GIS and FAHP Method for Parks Site Selection in Urban Environment (Case study: Region 7, Tehran Municipality)

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ABSTRACT

The overall goal of this research is to determine the importance of affecting factors for site selection in parks and urban green spaces and also a suitable site selection for parks in the study area. Methodology of this research is an analytic descriptive research. At first by using library and literature review and Delphi approach effective parameters in site selection of parks were extracted and then, pair wise comparison performed in FAHP method with relevant experts to determine significance and weighted of criteria. Then, data layers standardized in IDRISI software and were prepared in the form of Fuzzy. And finally prepared Fuzzy maps overlaid in GIS software by considering their weights to identify suitable locations for the construction of parks in region 7 of Tehran municipality.

Key words: Site selection, Geographic information systems (GIS), FAHP, parks, urban environment, region 7 of Tehran municipality.

INTRODUCTION

Approximately half of people in the world live in urban areas. One important element for their well-being and quality of life is the availability of urban green space. There are different ways in which urban green space can positively influence well-being and health. However, in most urban areas, and particularly in inner-city areas, green spaces are in insufficient supply (Kabisch and Haase 2011). Individual countries and/or cities have begun to take an increasing responsibility in developing urban green space and improving the services provided by different forms of urban green spaces. Following the Convention on Biological Diversity ,these countries and cities have formulated national, regional, or local action plans to integrate urban biodiversity and ecosystem services (ES) provided by urban green space, among others, into management. (Bertram and Rehdanz 2014).

Urban green space is defined as any piece of land covered by vegetation and often referred to as parks, golf courses, sports field and other open spaces within urban built-up area whether publicly accessible or not (Rasidia, Jamirsahb, and Saidc 2012). Urban green spaces are essential component in new townships due to the opportunities they provide for people to come in contact with each other. In terms of social well-being, urban green space has the potential in reducing negative social behavior such as aggression and violence, thus contributing to a sense of place and harmony, and hence plays an important role in fostering social cohesion and social identity (Dempsey, Brown, and Bramley 2012).

Trees, parks, urban and per-urban woods (green spaces Categories included within Urban Forest) can mitigate temperature, decrease pollution, water run-off and soil erosion, increase aesthetics and quality of places, provide a place for recreation, education and learning. Trees can also contribute by direct and indirect ways to reduce CO2 in the atmosphere and contrast urban heat island (Paulelt and Duhme 2000). The development explosion of recent decades resulting in the loss of forest, farm, forest fringe, and other open space lands that somehow contributes to urban residents' quality of life. The growing scarcity of green space is at concern of local authorities nowadays since there are not much of quality green areas left. It is partly because the current condition of common urban green space was poorly design and eventually does not promote social interaction among urban residents (Rasidia et al. 2012).

In fact, considering locating and a suitable site selection for construction of urban green space is important and providing an initial suitable condition is almost an important issue. Accordingly, a site selection of green spaces in urban areas has always been a subject of interest to researchers, Policy makers and urban planners which Due to it, using geographical information system and multiple criteria decision systems has been considered for a suitable site selection of green spaces in recent years (Ziari et al. 2013; Aranf 1997). Geographic Information Systems (GIS) helps cities manage and site selection of green space projects efficiently and reduce management costs. GIS brings together different types of data for intelligent planning and also integrating different map layers into an urban green space site selection project improves insight for decision making (Tasoulasa et al. 2013).

Geographic information systems (GIS) is a powerful tool designed for spatial analysis which provides functionality to capture, store, query, analyze, display and output geographic information. As such they have big influence in spatial decision making process. Recent development in field of decision making leads to dramatic improvements in the capabilities of GIS in location analysis. These development are reviewed through analysis of attribute data especially procedures for Multi-Criteria and Multi-Objective location analysis in GIS. Special emphasis is given to the problems of incorporating subjective influence in the context of decision making; the expression of uncertainty in establishing the relationship between evidence and the decision to be made; procedures for the aggregation of evidence in the presence of varying degrees of trade-off between criteria; and procedures for conflict resolution and conflict avoidance in cases of multiple objective decision problems (Eastman, Jiang, and Toledano 1998). Geographic information systems are used in conjunction with other systems and methods such as systems for decision making (DSS) and the method for multi-criteria decision making (MCDM). Synergistic effect, generated by combining these tools contributes to the efficiency and quality of spatial analysis for industrial site selection (Eldrandaly 2013; Malczewski 2006).

In a site selection process, the analyst strives to determine the optimum location that would satisfy the selection criteria. The selection process attempts to optimize a number of objectives desired for a specific facility. Such optimization often involves numerous decision factors, which are frequently contradicting and the process often involves a number of possible sites each has advantages and limitations decision making is based on numerous data concerning the problem of selection appropriate site (Rikalovic,Cosic, and Lazarevic 2014; Eldin 2003; Jankowski 1995; Carver 1991). The ultimate goal of this research is to identify suitable locations for the construction of parks based on the FAHP model to help planners and decision-makers in the region 7 of Tehran municipality.

MATERIALS AND MRTHODS

The case study area

Region 7 is the central zone of Tehran which is located in an area of 1540 hectares and it is one of the narrow areas of Tehran Municipality. It is limited to region 3 and 4 of Tehran Municipality from the north and region 12 and 13 from the south and region 8 from the east and has a population of 329,920 thousand people. (Statistical Centre of Iran 2011).

MATERIALS

Fuzzy logic

Fuzzy logic has come of age. Its foundations have become firmer, its applications have grown in number and variety, and its influence within the basic sciences-especially in mathematical and physical sciences has become more visible and more substantive (Zadeh 1996).

Fuzzy set theory was designed to supplement the interpretation of linguistic or measured uncertainties for real-world uncertain phenomena. These uncertainties could originate with non-statistical characteristics in nature that refer to the absence of sharp boundaries in information. However, the main source of uncertainties involving in a large-scale complex decision making process may be properly described via fuzzy membership functions (Chang, Parvathinathan, and Breeden 2008).

The fuzzy logic analysis included both "fuzzy membership functions", which assigned ratings for attribute values in a given thematic layer between 0 and 1, and "fuzzy overlay tool," which merged multiple fuzzy membership results into the composite index map (Raines, Sawatzky, and Bonham-Carter 2010). Ratings of the thematic layer were represented as a likelihood (or possibility) of being a member of a fuzzy set, through the different types of fuzzy membership functions (i.e. fuzzification algorithms). Fuzzification refers to the procedure of transforming the attribute values of the thematic layer into the degree of membership (e.g.,

Table 1: Fuzzy range and the corresponding verbal expression

Verbal expression	Fuzzy numbers
Equal Preference	(1,1,1)
low to moderate Preference	(1,1.5,1.5)
moderate Preference	(1,2,2)
moderate to high preference	(3,3.5,4)
High perefrence	(3,4,4.5)
high to very high perefrence	(3,4.5,5)
very high perefrence	(5,5.5,6)
very high to quite high perefrence	(5,6,7)
Quite high perefrence	(5,7,9)

Table 2: Map standardization

criteria	Sub criteria	Fuzzy Function	Control points (m) d	c	b	a
Accessibility(Meter)	Main road	Decreasing Sigmoidal	500	100		
	Subsidiary road		300	0		
	metro		1000	100		
Density(one person in square meters)		Increasing linear			0.054518	0.002153
(proximity to the favorable centers(meter)	Cultural educational Therapeuticsecurity centers	Decreasing Sigmoidal	1000	100		
Distance from unfavorable centers(meter)	parkpetrol stations	Increasing Sigmoidal			1000	100

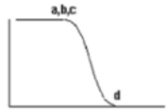
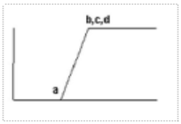
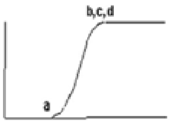
Source: (help software 17.0 IDRISI)

0 for the least suitable, and 1 for the most suitable) (Ki and Ray 2014).

Analytical hierarchy process (AHP)

The analytic hierarchy process (AHP), firstly proposed by Saaty (1980), is a popular method for solving multi-criteria analysis problems involving qualitative (Deng 1999). Actually it is a flexible, quantitative method for selecting among alternatives based on their relative performance with respect to one or more criteria of interest (Boroushaki and Malczewski 2008; Linkov et al. 2007). AHP resolves complex decisions by structuring the alternatives into a hierarchical framework. The hierarchy is constructed through pair wise comparisons of individual judgments, rather than attempting to prioritize the entire list of decisions and criteria simultaneously (Saaty 1980).

Table 3: Fuzzy function Formula & figure.

fuzzy function Formula	Fuzzy function figure	Fuzzy Function
$\mu=\cos^2$ α=(x-point c)/(point d-pointc)*pi/2 When x<point c ,μ=1		Decreasing Sigmoidal
$\mu=\cos^2$ α=(1-(x-point a)/(point b-point a))*pi/2 When x>point b ,μ=1		Increasing linear
$\mu=\cos^2$< α=(1-(x-point a)/(point b-point a))*pi/2 Ω η ε ν x>point b ,μ=1		Increasing Sigmoidal

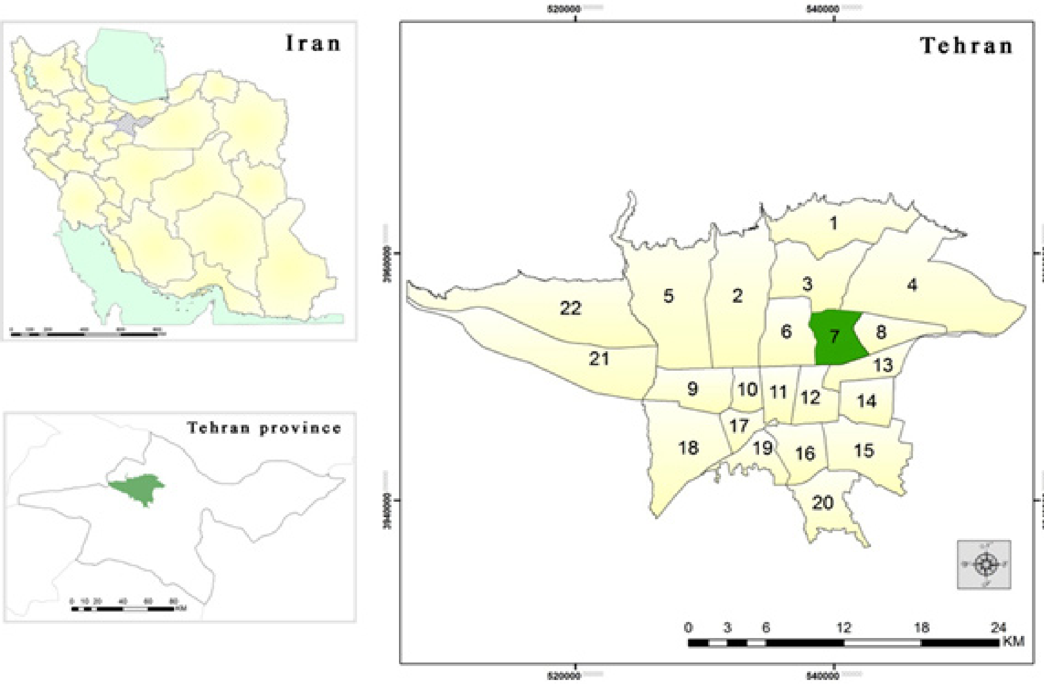


Fig. 1: Study area (region 7 of Tehran municipality) Reference: Statistical Centre of Iran, 2011

Therefore, AHP is a systematized and hierarchical analysis method which is qualitative and quantificational. That is, we can get rid of deviation caused by subjective qualitative evaluation before, and incorporate objective into reality (Lai et al. 2011; Vafai ,Hadipour, and Hadipour 2013).

Table 4: Fuzzy membership functions and relations

Relation	function
AND	$\mu_{combination}$ =MIN (μ_A, ìB,...)
OR	$\mu_{combination}$ =MAX ($ì_A$, ìB,...)
PRODUCT	$\mu_{combination} = - \Pi_{(i=1)}^{n} \mu_i$
SUM	$\mu_{combination} = 1 - (\Pi_{(i=1)}^{n} (1 - \mu_i))$
GUMMA	$\mu_{combination}$ =(Fuzzy Sum) ^{ã} × (Fuzzy Product) $^{1-ã}$γÎ[0,1]

Source: (Malczewski 1999)

The AHP procedure generally involves six steps (Lee, Chen, and Chang, 2008; Hosseinali and Alesheikh 2008):

(1) Define the unstructured problem, stating clearly its objectives and outcomes.

(2) Decompose the complex problem into decision elements (detailed criteria and alternatives).

(3) Employ pair wise comparisons among decision elements to form comparison matrices.

(4) Use the eigenvalue method (or some other method) to estimate the relative weights of the decision elements.

(5) Calculate the consistency properties of the matrices to ensure that the judgments of decision-makers are consistent.

(6) Aggregate the weighted decision elements to obtain an overall rating for the alternatives.

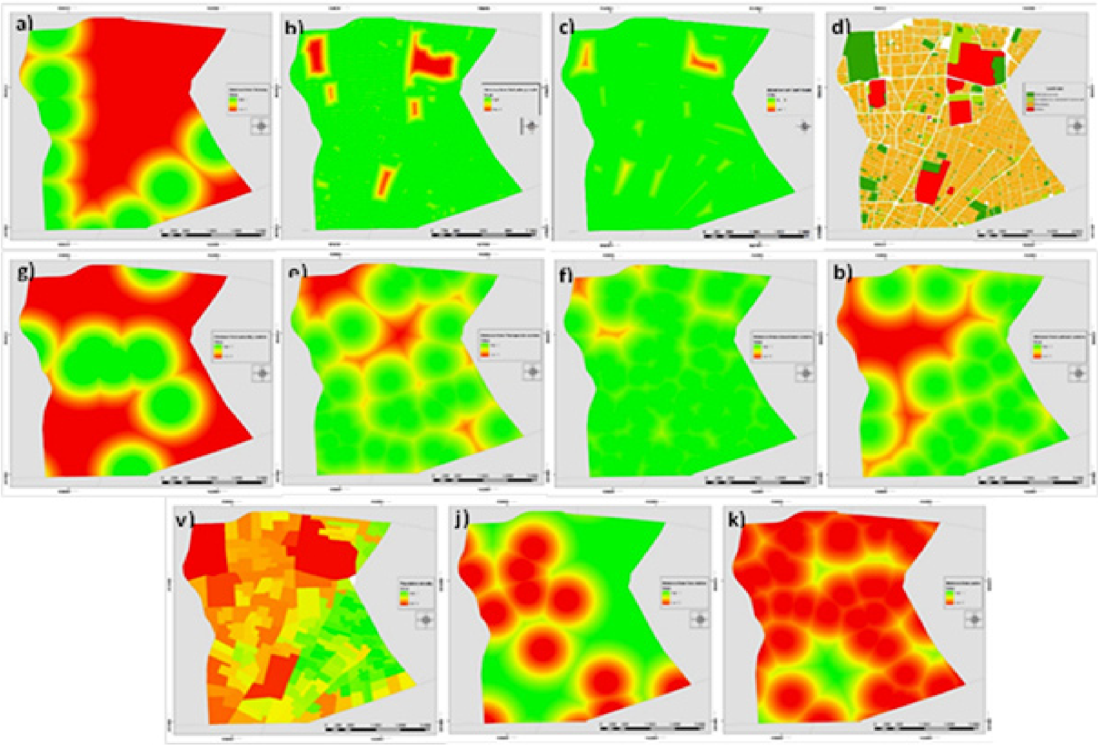


Fig. 2: d) land use, c) main roads, h) subsidiary roads, a) subway network, b) distance from cultural centers, f) distance from educational centers, e) Distance from Therapeutic centers ,g) Distance from security centers ,k) Distance from park , j) distance from petrol station, v) population density map .

Table 5: Criteria pairwise comparisons by Fuzzy combination in hierarchical analysis model

Criteria	Land use	Accessibility	population	Favorable centers	Unfavorable centers	Geometrical average
Land use	(1,1,1)	(1,2,2)	(3, 4, 4.5)	(5,6,7)	(0.5,0.5,1)	(1.496,1.888,2.29)
Accessibility	(0.5,0.5,1)	(1,1,1)	(1,2,2)	(3,3.5,4)	(0.222,0.25,0.333)	(0.803,0.974,1.217)
population	(0.222,0.25,0.333)	(0.5,0.5,1)	(1,1,1)	(1,2,2)	(0.143,0.167,0.2)	(0.437,0.53,0.668)
Favorable centers	(0.143,0.167,0.2)	(0.25,0.286,0.333)	(0.5,0.5,1)	(1,1,1)	(0.111,0.143,0.2)	(0.288,0.321,0.422)
Unfavorable centers	(1,2,2)	(3,4,4.5)	(5,6,7)	(5,7,9)	(1,1,1)	(2.371,3.201,3.554)

CR^m =0.013 CR^g =0.046Compatible

Table 6: Land use sub criteria pairwise comparisons by Fuzzy combination in hierarchical analysis model

land use	barren and arable	Military	official, industrial, commercial	Municipal services	residential	Geometric average
barren and arable	(1,1,1)	(5,7,9)	(5,5.5,6)	(3,3.5,4)	(3,3.5,4)	(3.272,3.815,4.324)
Military	(0.111,0.143,0.2)	(1,1,1)	(0.5,0.5,1)	(0.25,0.286,0.333)	(0.5,0.5,1)	(0.37,0.4,0.582)
, official, industrial, commercial	(0.167,0.182,0.2)	(1,2,2)	(1,1,1)	(0.5,0.5,1)	(1,2,2)	(0.608,0.817,0.956)
Municipal services	(0.25,0.286,0.333)	(3,3.5,4)	(1,2,2)	(1,1,1)	(3,3.5,4)	(1.176,1.476,1.605)
residential	(0.143,0.167,0.2)	(1,2,2)	(0.5,0.5,1)	(0.25,0.286,0.333)	(1,1,1)	(0.447,0.544,0.668)

CR^m =0.026 CR^g =0.052Compatible

Since its introduction, The AHP has become one of the most widely used multiple criteria decision making (MCDM) methods (Lee et al. 2008). The pair wise comparison is the basic measurement procedure employed in the AHP method. This comparison is used in the decision making process to form a reciprocal decision matrix, thus transforming qualitative data to crisp ratios and making the process simple and easy to handle. By making pair wise comparisons at each level of the hierarchy, participants can also develop relative weights to differentiate the importance of the criteria (Boroushaki and Malczewski 2008). Saaty (1980) recommended a suitable measurement scale ranging from 1 to 9 for pair wise comparisons in which 1 means no difference in the importance of one criterion in relation to another, and 9 means one criterion is much more important than another. Reciprocals of these numbers are used to express the inverse relationship (Vahidnia, Alesheikh, and Alimohammadi 2009).

Finally we can say that AHP is widely used for tackling multi-criteria decision making problems in real situations. In spite of its popularity, the AHP is often criticized due to its inability to adequately handle the inherent uncertainty and imprecision in the pair wise comparison process (Deng 1999). To overcome this shortcoming, the fuzzy analytical hierarchical process (FAHP) method was developed (Bellman and Zadeh 1970). FAHP uses a range of values to express the decision maker's uncertainty (Lee et al. 2008). The decision maker is free to select a range of values that reflects his confidence. Alternatively, he can specify his attitude as optimistic, pessimistic or moderate, representing high, low, and

Table 7: Accessibility sub criteria pairwise comparisons by Fuzzy combination in hierarchical analysis model

Accessibility	Main road	Subsidiary road	metro	Geometric average
Main road	(1,1,1)	(3,3.5,4)	(0.5,0.5,1)	(1.145,1.205,1.587)
Subsidiary road	(0.25,0.286,0.333)	(1,1,1)	(0.143,0.167,0.2)	(0.329,0.362,0.405)
metro	(1,2,2)	(5,6,7)	(1,1,1)	(1.71,2.289,2.41)

CR^m =0.003 CR^g =0.011Compatible

Table 8: Favorable centers sub criteria pairwise comparisons by Fuzzy combination in hierarchical analysis model

Favorable centers	cultural	educational	Therapeutic	security	Geometric average
cultural	(1,1,1)	(0.5,0.5,1)	(1,2,2)	(0.222,0.25,0.333)	(0.577,0.707,0.904)
educational	(1,2,2)	(1,1,1)	(3,3.5,4)	(0.5,0.5,1)	(1.107,1.368,1.682)
Therapeutic	(0.5,0.5,1)	(0.25,0.286,0.333)	(1,1,1)	(0.167,0.182,0.2)	(0.38,0.401,0.508)
security	(3,4,4.5)	(1,2,2)	(5,5.5,6)	(1,1,1)	(1.968,2.576,2.711)

CR^m =0.006 CR^g =0.055Compatible

Table 9: Unfavorable centers sub criteria pairwise comparisons by Fuzzy combination in hierarchical analysis model

Unfavorable centers	park	Petrol station	Geometric average
park	(1,1,1)	(3,4.5,5)	(1.732,2.121,2.236)
Petrol station	(0.02, 0.222, 0.333)	(1,1,1)	(0.447,0.471,0.577)

middle ranges of values respectively (Jeganathan 2003).

Effective parameters in site selection

Some parameters are considered Based on available information, for selecting a proper location of parks and urban green spaces, as are follows:

(1) Land use: Arable and Barren lands, military, official, industrial, commercial, servicing and residential lands are considered. After these considerations it should be said; region 7 doesn't have any arable and barren lands.

(2) Accessibility: Include Main and Subsidiary roads and metro.

(3) Density: population density considered with zone partition.

Table 10: Final criteria weights matrix

Criteria	Final fuzzy weight	Final definite criteria Weight
Land use	(0.184,0.273,0.424)	0.289
Accessibility	(0.098,0.141,0.226)	0.151
population	(0.054,0.077,0.124)	0.083
Favorable centers	(0.035,0.046,0.078)	0.052
Unfavorable centers	(0.291,0.463,0.659)	0.469

Table 11: Final sub criteria weights matrix

Criteria sub	Final fuzzy weight	Final definite criteria Weight
barren and arable	(0.074,0.148,0.313)	0.17
Military	(0.008,0.015,0.042)	0.02
official, industrial, commercial	(0.014,0.032,0.069)	0.037
Municipal services	(0.027,0.057,0.116)	0.067
residential	(0.01,0.021,0.048)	0.025
Main road	(0.026,0.044,0.112)	0.057
Subsidiary road	(0.007,0.013,0.029)	0.016
metro	(0.038,0.084,0.171)	0.094
cultural	(0.004,0.006,0.018)	0.009
educational	(0.007,0.013,0.033)	0.016
Therapeutic	(0.002,0.004,0.01)	0.005
security	(0.012,0.024,0.053)	0.028
park	(0.179,0.379,0.676)	0.403
Petrol station	(0.046,0.084,0.175)	0.097

Table 12: Classification of maps data

	Fuzzy Sum		Fuzzy Or	
Values classification	**Area (Square meters)**	**Percentage**	**Area (Square meters)**	**Percentage**
0-0.2	1237182.333599	10.619816	10172809.152	87.320692
0.2-0.4	9133851.210584	78.403818	411847.911766	3.535193
0.4-0.6	1278719.552995	10.976366	1025866.40727	8.805765
0.6-0.8	——-	——-	39417.606248	0.33835
0.8-1	——-	——-	——-	——-

(4) Distance from favorable centers: Cultural centers, mosques and sport centers and educational centers; schools and universities, Therapeutic centers; health center and hospitals, security centers; police stations and traffic police and fire stations have been considered.

(5) Distance from unfavorable centers: Parks and petrol stations are considered.

METHODS

In terms of performance this is an analytic descriptive research. Theoretical background of this research was performed by using library and literature review methods about effective parameters in site selection of parks and urban green spaces, and for these purpose, relevant parameters determined. Then spatial data were collected. In this regard, with using FAHP technique the significance and weighted criteria and sub-criteria obtained.

The process of weighting criteria with using Fuzzy AHP approach is As follows:

First stage

According to Fuzzy approach method in this research, the verbal expressions and Fuzzy numbers which listed in (table 1) were used for pair wise comparison. After that, in order to consensus of expert's opinion, geometric average of respondent's pair wise comparison obtained.

Second stage; the calculation of rows geometric average

In this stage, geometric average of each table's pair wise comparison rows is obtained according to the following equation.

$$\tilde{z}_i = [\prod_{j=1}^{n} \tilde{t}_{ij}]^{\frac{1}{n}} \qquad \forall i \qquad ...(1)$$

Third stage; geometric average normalization

In this stage, values of second stage are normalized. For each matrix values are normalized with a total as equation (2):

$$\tilde{z}_i = [\prod_{j=1}^{n} \tilde{t}_{ij}]^{\frac{1}{n}} \qquad \forall i \qquad ...(2)$$

Fourth stage; weights combination

Final weights are calculated by the combination of alternative weights (toward Criteria) with criteria weights, according to equation (3):

$$\tilde{U}_i = \sum_{j=1}^{n} \tilde{w}_i \tilde{r}_{ij} \qquad \forall i \qquad ...(3)$$

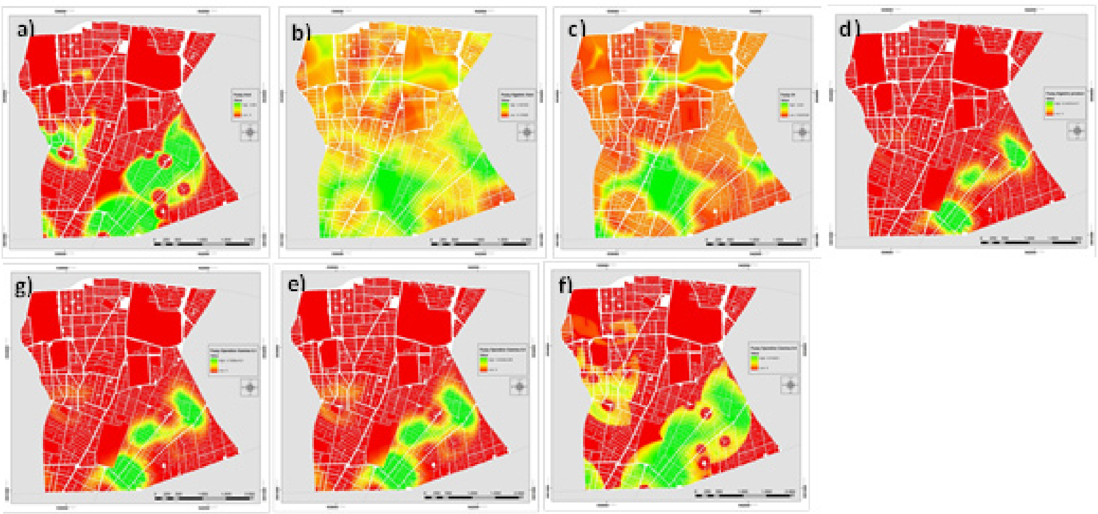


Fig. 3: a)areas site selection map by using and method , b) areas site selection map by using sum method, c) areas site selection map by using or method, d,g,e) : areas site selection map by using gamma 0.9.0.5.0.3 method, f) areas site selection map using product method.

Fifth stage; DE fuzzy

In this stage, fuzzy weight being de fuzzy according to equation (4):

$$Crisp(\widetilde{U}) = \frac{(u_l + 2 \times u_m + u_r)}{4} \qquad ...(4)$$

Then, with the help of IDRISI software, some layers in (table 2 and 3) standardized and in GIS software, layers overlaid and priority areas presented for development of parks by subtracting these layer parks as constraint layer. In this research for finding suitable locations for construction of parks and green spaces, map production have been performed by applying 5 operators of fuzzy Gamma¡ Fuzzy Product¡ Fuzzy AND ¡ Fuzzy OR and Fuzzy SUM, that each one has its own characteristics.

In (table 4), function and relation of these Fuzzy membership operators are presented. At the end, maps which provided by these operators are discussed and compared.

Findings

In this research, due to the Fuzzy approach, verbal expressions and fuzzy numbers which listed in (table 1) where used for pair wise comparisons in order to obtain criteria and sub criteria weights.

Criteria and Sub criteria pair wise comparisons by using FAHP

In order to achieve the object, pair wise comparison questionnaires designed and pair wise comparisons which are shown in (table 5 to 9) conducted with the help of experts.

FAHP model weights

Based on various sources and expert opinions and FAHP techniques, Weights of each criteria and sub criteria obtained, which are shown in (table 10 and 11).

RESULTS

Affecting parameters analysis in the site selection of study area

Weights listed in (table 10 and 11) are Actually FAHP model out puts which were used as data layer weights. Also it should be mentioned that, region 7 has not been considered as a closed region and a 1000 meter buffer has been connected for more ensure and to obtain more detailed maps. At the end, map of each effective parameter in park and green space site selection of region 7 of Tehran municipality was prepared by using GIS and layer standardization in IDRISI software (Figure 2).

It should be noted that each data layer map from affecting parameters in green space site selection of region 7 of Tehran Municipality were combined together in GIS. Result of this combining and the final model output will be observed as a final optimal urban green space map.

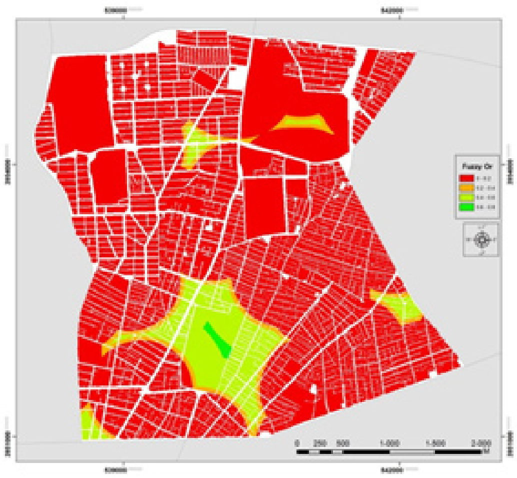


Fig. 4: Classification of or operator

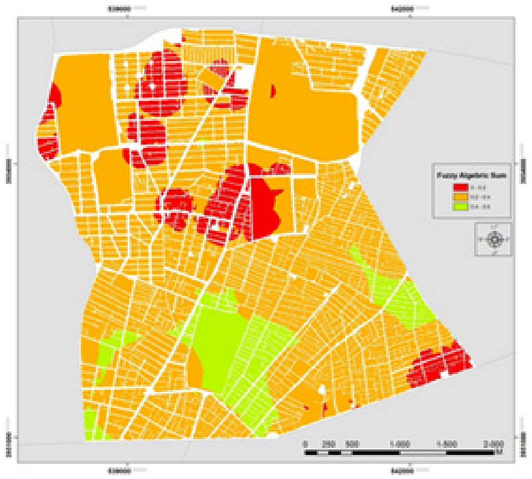


Fig. 5: Classification of sum operator

In this research different operator compared with each other and their final map is obtained. We should say about operators that, fuzzy subscription operator (FUZZY AND) is similar to the subscription in classic sets. Effect of this operator is an output map handled with the smallest amount of fuzzy membership which occurs in any situation (Karimi 2014).

Also, fuzzy gamma operator (FUZZY GAMMA) that combines the methodology of Fuzzy Algebraic product and Fuzzy Algebraic Sum applied when increasing and decreasing effects exist in the interaction of parameters (Salari, Moazed, and Radmanesh 2012).

Fuzzy sum operator (FUZZY OR) is similar to the sum in the classic sets. Effect of this operator is an output map handled with the largest amount of fuzzy membership which occurs in any situation (Karimi 2014) and it applies when criterion maps have an increasing effect on each other (Atkinson et al. 2005). (FUZZY SUM) is the supplement of the fuzzy algebraic product .unlike fuzzy algebraic, fuzzy algebraic sum is always greater than or equal to the biggest fuzzy membership. (Atkinson et al. 2005). Finally in the fuzzy product operator (FUZZY PRODUCT), all input membership maps affect output map unlike AND, OR. This operator applies when criterion maps have a decreasing effect on each other (Salari et al. 2012).

Finally, these operators output is shown in (figure 3) as a final optimal location map for the construction of park and urban green spaces in region 7of Tehran municipality.

Finally, tow operator of fuzzy sum operator and Fuzzy or operator identified as proper operators in park and green space site selection of region 7 of Tehran municipality.5 classes were considered for these maps that these classifications are shown in (figure 4 and 5). It should be noted that none of these maps have 5th or ideal class. These maps data summary is shown in (table 12).

CONCLUSION

Real world is full of uncertainties and constraints and we cannot talk about facts accurately. Due to these, range of values should be used to express uncertainty and constraints. Therefore, in this research authors tried to explain uncertainties with using Fuzzy methods. In this research, with the combination of Fuzzy methods, multiple criteria decision making (MCDM), geographic information systems and IDRISI software and considering constrains, suitable locations for construction of parks and green spaces determined with range of values expression. So 5 operators applied in overlaying layers in region 7 of Tehran municipality site selection. It should be said that in Fuzzy product operator (FUZZY PRODUCT) all input membership maps affecting output map and all of the criteria considering at the same time. Thus, this operator just determines the best locations without considering any unfavorable conditions in construction of park and green spaces. Next operator is Fuzzy gamma operator (FUZZY GAMMA) that combines the methodology of Fuzzy Algebraic product and Fuzzy Algebraic Sum. If gamma number be closer to 1 it will shows FUZZY GAMMA importance but if it became closer to 0 it will shows FUZZY PRODUCT importance. In Fuzzy gamma maps which have been produced by 0.3,0.5,0.9 numbers, if the number oriented to 1 it will be considered more suitable area for construction of parks and green spaces. We should say that fuzzy subscription operator (FUZZY AND) is considering unfavorable factors and Because of this, it determines less extent area than (OR FUZZY) and in comparison with (FUZZY PRODUCT) and (FUZZY GAMMA) operators with the expectation of 0.9 gamma number, it determines more extent areas. In general, this operator considerate more caution than OR FUZZY operator in the comparison with Fuzzy product and Fuzzy gamma operators consider less caution. Fuzzy or operator (OR FUZZY) is controlled with suitable factors and Because of this it determines more extent area with varying desirability levels for site selection and considers less caution.

Finally, in Fuzzy sum operator because of the mutual increasing criteria effects, maximum area is considered for the construction of parks and green spaces and also less caution is considering and it has the most abnegation from unfavorable factors. We should say about operators that fuzzy product operator, fuzzy gamma operator, fuzzy subscription operator are considered the most suitable areas for site selection but they are unacceptable because of many restrictions in urban area. And we should say that or and especially sum operators had the most logical method for parks site selection in urban environments.

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