🏆 *reviewed paper*

Evaluation of the Current Municipal Slaughterhouse of Babolsar and Locate an Appropriate Site via Fuzzy Logic in GIS for the Future One

Farhad Amiri Fard, Sadjad Mohammad Zahraei

(Farhad Amiri Fard, Islamic Azad University, Bandar Anzali Branch, Department of urban planning, Bandar Anzali, Iran. farhad_amirifard@yahoo.com)
(Sadjad Mohammad Zahraei, Islamic Azad University, Bandar Anzali Branch, Department of urban planning,, Bandar Anzali, Iran. parsshahrsepanta@gmail.com)

1 ABSTRACT

In 2010, Babolsar (a city in the northern Iran) with a population of about 47927 residence, consumes 14500 Kg meat per day approximately. The results of the current situation of slaughterhouse in Babolsar indicate that this location is inappropriate which in those required principals, standards and criteria for location selection were ignored and revelation of the adverse environmental effects would be predicted in the near future. In this study using a variety of data such as the distance from legal limits of the city, the distance of road communication, The potential for agricultural and construction, the distance of urban infrastructure, the distance of earthquake faults, the distance of surface water, wind aspects, pedology plan, hypsometric, vegetation ,geology and… .

These parameters in special models "fuzzy logic" are composed and selected the best location among different alternatives and different plans were sugested.

2 INTRODUCTION

Not only do Uncontrolled population growth, Urban development, The advent of new technology, The resulting changes in habits and consumption patterns and furthermore Restrictions on the use of natural resources cause a Variety of complex problems in our quality of life but they pose also social, economical and ultimately environmental issues. Growing urban population of Iran and also creating new population centers, policy and performance evaluation and many different urban operations based on Master plan and comprehensive national plans (land use planning) indicate the strongly requirements of planning for municipal slaughterhouse with the specialty of the scientific and correct locating. Continuing the traditional practice of slaughterhouses has posed a devastating effect on our environment, the quality of the public health and the residence in particular. It is widely admitted that the functional system of Iran's slaughterhouses acts based on traditional principles. This matter when would be harsh that its destructive effects on the other current urban systems, particularly ecological system are considered. One of the important research steps along with the planning for the slaughterhouses is locating factors and finding a suitable place of their settlement. Several criteria are involved in order to find the suitable location of slaughterhouse that they have their particular importance and make restriction on the choices either. Final goal of these criteria is to find a location that will pose minimal adverse environmental effects on the surrounding natural environment. Contamination of underground water resources and the soil pollution can be considered as an illustration. Researchers have been conduct that the population of Babolsar has been grown over the recent decades. For instance, in 1966 the average of the population was around 12016 which rose to 18810 in 1976 and 30200 in 1986. This city had 40630 residence approximately in 1996 (a village that is called Miandasht near to Babolsar has a population around 1986 which added to 38644 in terms of integration in this field). Growth rate for the period between1976-1986 was %4.8. Thus the population had a decrease around %3 between 1986-1996 and in 1999 was around 42738. It is also for Bbolsar in 2010, 47927 – growth rate: %2.15, in 2016, 66135n - growth rate: %2.5, in 2026, 84658 - growth rate: %2.5 would be predictable. With an assumed constant for meat consumption, Per capita consumption was 0.12 kilograms in 2010 per day, so that residence daily consumed 5500 kilograms of meat. In the other words based on the latest statistics, each person consumes 0.12 kilograms meat for their daily use that is equal with 43.8 kilograms annually.

According to the table1, Babolsar with a population around 47927 is considered in the category between 30001-50000 so the required area is 0.38 square meter per person or in another word this city needed a capacity around 18212 m² in 2010. But due to consideration of a Twenty-year planning horizon up to 2026 for this research thus, we should concentrate on the category between 50001-100000 that is 0.35 m² per person. As a result the required area for the infrastructure is 29630 m² (3 Hectare approximately). First

location of the Babolsar Slaughterhouse is located on the eastern part of the city. But it seems the current location neither has the standards for its space (7655 m²) based on the above table, nor has the qualified environmental status. Moreover, not only its destructive environmental effects appears now but also its negative impact will be seen in the near future and the sustainable development of the eastern part of this city is confronting a crisis. Locating the current situation of slaughterhouse in Proximity of the Shazdeh-rood river, putting in the city limits, being in the spatial and physical development of the city, local Prevailing winds that contain urbanscape pollution, uncontrolled population growth and the requirement of a wider space in order to prepare meat supply residents and the lack of responsiveness of the current landfill in the near future. The purpose of this study is selection an appropriate location or locations to optimize for Babolsar slaughterhouse which is based on natural and artificial information by the using of geographic information systems. During this study diffirent environmental variables by the using of fuzzy logic technique integrate and combine, then an appropriate location will be selected.

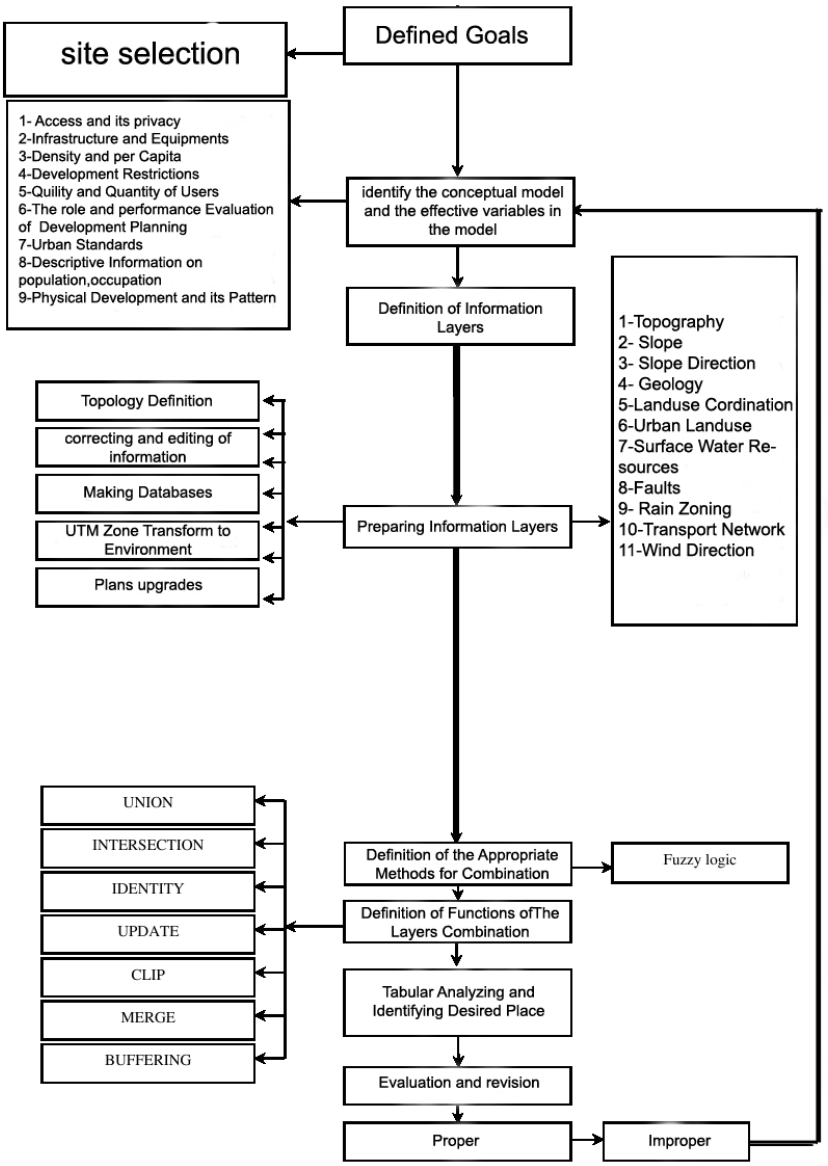
Population of city	Requierd area for each person (m²)
More than 10000 persons	0.86
From 10001 to 20000 persons	0.55
From 20001 to 30000 persons	0.48
From 30001 to 50000 persons	0.38
From 50001 to 100000 persons	0.35
More than 100000 persons	0.18

Table1: Required area for the infrastructure of Slaughterhouse based on population.

3 LITERATURE REVIEW

Finding an adequate location for urban infrastructure is one of the important subjects in Urban development planning. To express the importance of this subject for instance, management and finding a location for urban infrastructure accurately such as landfills, industrial slaughterhouses in some important provinces or states in Canada and The U.S like Quebec, Chattanooga, Washington, Massachusetts are considered as one of the main pillars of sustainable development and American planning association (APA) take it in to account as one of the significant goals for long-term and short-term plans of some states such as Chattanooga, Washington, Massachusetts, California, Seattle in order to reach to a stability in the 21st century.(Krizek et al,1996) Hendrix and Buckly in a study with the title of ‘’use of GIS for selection of sites for land application of sewage waste’’ in Vermont state in 1992, a 210-hectare area evaluated in the cases of physical and economical indicators such as appropriate soil, the depth of main rock, the land use, surface and underground water, zoning height…and they reconnoitered suitable places around an area which is called Mad.(Hendrix et al, 1992) the task of livestock slaughters and its pollution and dealing with this issue has a long experience. For instance, in an article with the title of “The use of water in its regulation in Medieval Siena” by Kucher, the waste water and the pollution from livestock slaughtered in Siena in the Medieval are discussed. He says contaminated water was caused a conflict between Butchers' guild and municipality, because the municipality claimed that the residual water from slaughter was caused the water pollution and as a result fountain contamination and it was believed the location of slaughterhouse must be transferred to somewhere outside of the city. He also mentioned to ancient water supply system of Yazd (a city in the middle part of Iran) that consumption and re-use of water could be considered as a symbol for developing and developed countries (Kucher, 2005). Shanmugan a scientist from Bangladesh has done a research based on the experience of ” GIS-MIS-GPS” for the realization of management of municipal facilities for the local environment and Bengal. In this research various aspects have been covered such as, requirements, methodology, development process for three systems “GIS-MIS-GPS”. The main part of this research is to deduce how the selected systems in each period of urban planning. In Iran finding the location for slaughterhouses has frequently done in the basis of urban master plan. But it is noticeable that the environmental points of view in this matter are not completely clear and it is specified just based on one or some limit indicators. In the seventh century AH, Ibne Okhveh is mentioned in the 16th article of municipal regulations about livestock slaughter that is incumbent upon the certain agent to prevent the butchers of slaughter in front of their shops due to side walk’s contamination which is absolutely forbidden and that

causes outbreaks. Thus, they must slaughter inside the slaughterhouse and moreover butchers are not be able to hang the slices of meat outside of their shops, because they can collision with people and making a mess. In the other part of this article he says, all the butchers are obliged by the agent to salt their work tables in order to prevent infections by the parasites due to high temperature, furthermore, they should cover them by a straw and some heavy dishes in terms of prevention of dogs licking and also protect of insects' entrance. In a research with title of criteria and standards of industries settlement the environment organization classifies the slaughterhouses as highly polluting industries and assigns criteria for finding the appropriate location but just concentrate on dos and don'ts in particular(Habibi, 2005).. In volume 9th of mayor Green series by Saeeid nia, the slaughterhouse discussion is proposed as a section of urban facilities and is mentioned some criteria for finding their location (saeeid nia, 1999). In 1995, in a research with title of placement mathematical model for poultry slaughterhouses in Shahed investment Company by Nouri is explained about select the optimal location, preparation and capacity estimation. He used the transportation model in this research and to maximize profits by the consideration of checking the cost and revenue (Nouri, 1995).



4 METHODS, MODELLING AND RESEARCH DATA

In the process of positioning the appropriate lands, conceptual model and effective variables in model such as access and its privacy, infrastructure and equipment, production, consumption, recycling... identifying and after the definition of the levels of information such as topography, geological slop, geology, barriers to the development, fault, rural communication network, surface water…, preparing these Layers in terms of topology definition, correcting and editing, upgrade…have done and after definition, the appropriate methods of Identify the composition and functions of layer composition in terms of union, intersection,

clipping, buffering, merge, update…in order to combining layers have been performed and after an analyze the database Table is merged, appropriate location has been identified and evaluated. The algorithm of the below indicates the method.

5 VARIOUS MODELS OF INFORMATION INTEGRATION IN ORDER TO SITE SELECTION

One of the most significant capability of GIS which introduces it as a special and exclusive system is site selection, data integration capability in terms of modeling and determination of land suitability by valuation of the land area. Due to the integration and combination of norms, the best place to establish the optimal centers and places would be chosen. There are several ways in order to combination the criterias. The most important are:

(1) Boolean Logic

(2) Index Overlay

(3) Probability Logic

(4) Coefficient of Correlation

(5) Artificial Neural Networks

(6) Fuzzy Logic

Fuzzy was first introduced by Iranian professor Asgar Lotfi Zadeh, professor of Brekly University – USA to implement in uncertainty condition. This theory is able to provide several of phenomena, variables and the ground to deduction, control and decision making in uncertainty condition.

One of critical levels in tradition Site Selection analysis which it's hypothesizes, assured accuracy of fully unreal incoming data. In a comprehensive analysis, is too hard and sometimes impossible to provide accurate numeric data required by traditional methods base on Boolean algebra. For an example, for a particular activity it's possible to have a natural partitioning border between proper and non-proper regions, but in many cases of description cases about location conditions, they do not have natural cut offs determined threshold limit. In the common approach to a threshold limit, for example in a manner which defined that an acceptable site should be located in 1 KM from the river. But such a threshold limit is not natural. Why a site in 0.99km from the river will be acceptable, and a site located at 1.01km from the river will be placed in an acceptable class? Usually there a kind of ambiguity and lace of explicitly in such conditions. In addition usual methods always assume that criteria weights are given in a numeric form, which provide a preference from the most important to most unimportant of Site Selection standards. So, related discussion to ambiguity, doubt and inaccuracy should find a solution in Site Selection problems, which this may work well with Fuzzy set theories and Fuzzy logic (Rajabi et al. ,2009).

6 ANALYZING AND ASSESMENT OF THE BABOLSAR SLAUGHTERHOUSE LOCATION

The Babolsar slaughterhouse was created around 30 years ago and is situated in near the Shazdeh Roud Bridge, Beheshti Street. Municipality of Babolsar has run it during these years. Waste, or possibly sick livestock which produce daily, are burnt by a particular machine and the wastes are carried by waste transporting car. The slaughterhouse is divided in to 2rooms for cattle and sheep slaughter, bath, guard room, veterinary chamber, rest room for slaughterers. The compound is 9980 m^2 and the infrastructure is 695 m^2.

Current location of the Babolsar slaughterhouse is situated in the western legal limits of the city. The different environmental plans of this area express that the current location cannot satisfy scientific criteria for site selecting and it does not consider some problems such as pollution of surface water and groundwater, aesthetic tasks conflict, community(utilization conflict), economy(property and land prices) and neglect of tourist attractions due to its proximity with Shazde Roud river.

The coordinate of Babolsar slaughterhouse's current location in the UTM system is X=649471.09 and Y=4063138.20 which is quite unfavorable environmentally. The most significant reasons are:

(1) Wind diagram based on climate data indicates that the wins blow to the city from the north-west direction mainly and obviously the site selection of the slaughterhouse should not be on the way of prevailing winds, while the current situation is situated on this way.

(2) This current location is located in the legal limits of the city while based on master plan of Babolsar the legal distance form a large slaughterhouse to a town border is around 6 Km, for a middle size one is 3 Km and for small ones is considered 2 Km.

(3) Air pollution and the odor of it especially in the warm seasons pose an unpleasant effect on the tourism and public health and safety of surrounding places are under threat.

Fig. 1: Current location of the Babolsar slaughterhouse.

7 SITE SELECTION CRITERIA FOR THE BABOLSAR SLAUGHTERHOUSE

For site selecting of a slaughterhouse there are not any fixed and defined standards but for the most of variables used in this study, reliable reasons can be find that due to environmental constraints and potential of each area checking back of that criteria is a top priority. In order to find an appropriate landfill as a preliminary and initial instruction, following articles could be followed:

7.1 Location relative to the city

The site location should be place out of the city limits. Moreover site selecting must not be on the way of the city development.

7.2 Distance to the city

The legal distance form a large slaughterhouse to a town border is around 6 Km, for a middle size one is 3 Km and for small ones is considered 2 Km.

7.3 The position in relation to communication roads

The site should be located near to one of the arterial roads or a byroad link to the arterial road. In cities that are located on the railway track, it is more accurate to choose a place for slaughterhouse near the railway and if it possible create a branch line to be observed.

7.4 Slope

It should be constructed in an area lower than the city level in order to prevent the spread of contamination.

7.5 Prevailing wind

It must not situate on the way of prevailing wind.

7.6 Required water

It should be constructed in an area which in the required water can be accessible. Due to high consumption of water, tap water is not recommended. In this task drilling deep or semi-deep wells are favorable

7.7 Geometric shape of the area

It should be selected as rectangular shape because the infrastructure of slaughterhouse is situated longitudinally.

ISBN: 978-3-9503110-2-0 (CD-ROM); ISBN: 978-3-9503110-3-7 (Print)
Editors: Manfred SCHRENK, Vasily V. POPOVICH, Peter ZEILE, Pietro ELISEI

7.8 Wastewater treatment

The site should be positioned in order to prepared wastewater treatment and outgo as well. Thus, the following points are recommended in order to achieve this purpose: For a city with sewage system, the site should be selected on a place that the slaughterhouse wastewater does not flow in to sewer. When a city does not have sewage system and the slaughterhouse is situated somewhere near a river, after treatment of the slaughterhouse's wastewater, the harmless excess water could be directed in to the river. If there is no a river, the slaughterhouse's wastewater should refined after ensuring that the remaining water to be disposed in to adjacent lands in terms of agricultural use

7.9 Location of polluting industries

Slaughterhouse should not be exposed to pollution from industrial operations, dust, smoke, ash…

7.10 Watercourse

The land of a slaughterhouse should be away from the watercourse and it has an ability to have a durable foundation and columniation.

7.11 Farmers and nomads

Site selection should be in a place which is on the way of nomads but this criterion is important in areas where livestock passes specifically.

7.12 Access to electricity network

In the terms of the requirement of a slaughterhouse to electricity, site selection must be located in a place that the power grid is legally permissible. In large slaughterhouses the required electricity could be prepared by the use of a generator instead of power network but it is not recommended except in emergencies.

It should be noted that some measures such as slope, aspect, rainfall, distance from the historical and cultural monuments due to being non-functional do not consider in this study. For instance, the slop is rarely bigger than 0.5%, so it is not different for the slope direction and the rainfall is almost equal for this area.

According to the given the parameters, Site selection in the eastern Babolsar does not seem appropriate. Thus, reselecting for the slaughterhouse is a priority. On the other hand, physical planning for the urban development in terms of urban, regional and national levels must seek new geographic area that qualify for the creation of new cities, towns, infrastructure locating… or define urban development.

In this research a range of 20 km radius around the legal limits of the city is considered which includes 15 natural and artificial layers. By the use of different methods such as fuzzy logic these layers were combined and by the terms and conditions, prioritizing or in another words weighting the desired location for municipal solid waste landfill for at least 20yeras in the future in three prioritizations will prepare.

As mentioned that for the first time the fuzzy logic theory was expressed by Dr. Asgar Lotfizadeh UC Berkeley professor for the conditions of uncertainty. For reasoning, control and decision making under uncertainty this theory is able to define the mathematical formulation for a host of inaccurate and vague data, variables and systems. Accordingly, for the fifteen-fold layers of this study, membership degree of variables can be defined:

The distance of artificial objects (urban infrastructure, slaughterhouse, gas station, aviculture…) =

$$\int_0^{600} 1/x + \int_{600}^{2700} 2700 - \left(\frac{x}{2400}\right) + \int_{2700}^{\infty} 0/x$$

The minimum distance: 600m

The maximum distance: 2700m

Class number: 7

Data Domain: 300m

First class: 2700-300/2400=1

Second class: 2700-600/2400=0.87

Third class: 2700-900/2400=0.75

For all the layers this operation has done and it's weighting results with its plans present. Then, by the use of overlapping functions, these layers with their membership degrees are combined together and after the calculation of the total weight belong to the final map and classified them in to different classes, 3 sites are selected and defined. It should be noted that the proposed area consists of 32000 Polygon integrating layers is selected and presented. The most important characteristics these three sites are:

- The vegetation cover is low.
- Average distance from water sources is 570m
- Average distance of artificial objects (urban infrastructure, slaughterhouse, gas station, aviculture,…) is 1100m
- Average altitude is -21m
- Windward is low-intensity
- Appropriate for construction
- inappropriate for cultivation
- The lands have the potential for construction
- The lands do not have the potential for cultivation
- The soil type is coastal, gravel, sand and shelly geologically
- In terms of urban development compare with the other areas, construction will not be found
- The field has a saline soil and drainage problems are recognizable
- Average distance to Babolsar is 6000m
- Average distance for all 3 sites to communication roads is 550m
- Average distance to the legal limits of Babolsar is 8100m
- Average distance to the major faults around the city is 1200m

8 CONCLUSION

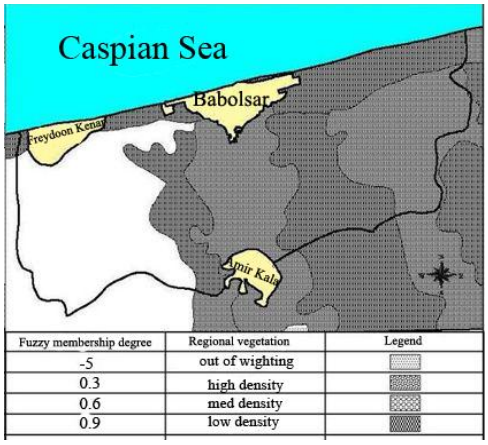
Babolsars urban development has been consequence from two main phenomenon, rural-urban continuum and natural growth of urban population. As an illustration, the growth from 18810 in 1976 to 47921 in 2010 it is clear to everyone that the urban management system in a critical condition and is far from ideal situation. This task is more tangible when the slaughterhouse site selecting was done based on criteria and standards. It means that the current location of slaughterhouse has not constructed based on scientific, technical criteria and appropriate planning. Assuming continuation of current urban meat consumption, 14.5Ton daily and 5296Ton annually, the requirement of accurate and efficient site locating should be a top priority.

The initial location of Babolsar slaughterhouse is situated in the south part of the city. But based on the mentioned criteria, this location is not required the sufficient standards in case of its area in particular (7655m²). Furthermore, it has an inappropriate environmental situation and not only its environmental pollution has emerged now, but also it will pose a devastating effect on the environment in the near future and sustainable development of the eastern city is facing a crisis. The proximity of the location to the Shazdeh Roud, being in the legal limited area of the city, locating in the urban physical development, being on the way of prevailing winds that cause landscape pollution, sharp increase in urban population, the requirement for a larger area in order to produce more meat for the residence and end of useful life of the current landfill in the near future, all the requirements for finding a new location have made it an absolute necessity.

The current site selecting has not considered the environmental parameters such as being away from earthquake faults, agricultural land, human settlements, suitable soil, urban physical development, wind direction, surface water, geology…and it indicates tangible kind of poor urban and regional management which threatens the future sustainability of the area. On the other hand, the future of the city is creating based on growing urbanization, the urban area formation, settlement of refugees….Defining plans and project in terms of guiding and controlling development for urban area which leads to compromise damages to biological resources and improving the tourism around the Shazdeh Roud. So, protection of valuable

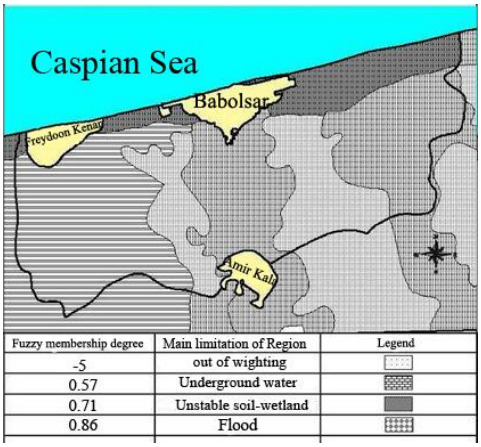
environmental zones around the city, including the current place of slaughterhouse and sufficient site selecting with a less harm effects on environment and sustainable development are of significant requirements.

Combining artificial and natural data by the use of fuzzy logic and implement it in GIS can be practical not only for Babolsar, but also for the other regions of this country. Three areas which have been positioned in this research will satisfy all the requirements in this case for 20 years. The city requirements will satisfy due to its placement in an average radius around 6Km even up to 100 years in the future. The coordination is: the first priority, X=645019.31, Y=4058183.39 the second priority, X=654592.23, Y=4059100.06 the third priority, X=642790.14, Y=4056579.22.



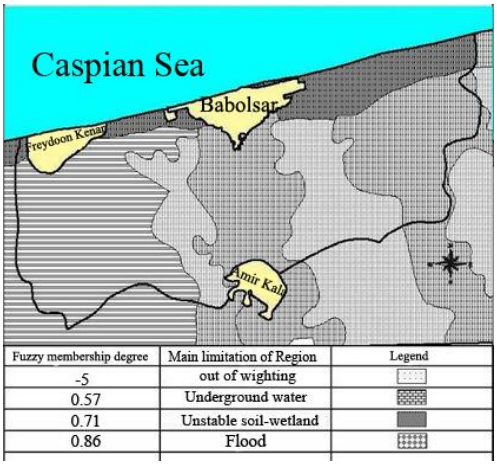
Fuzzy membership degree	Regional vegetation	Legend
-5	out of wighting	
0.3	high density	
0.6	med density	
0.9	low density	

Fig. 1: Vegetation zone and determination of the fuzzy membership degree



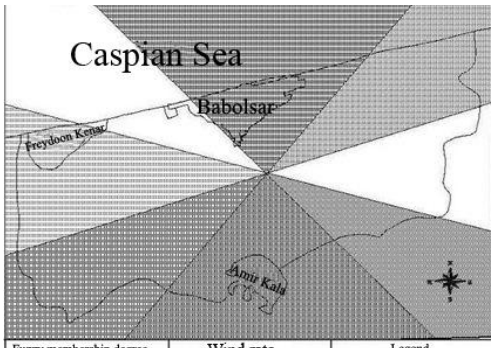
Fuzzy membership degree	Main limitation of Region	Legend
-5	out of wighting	
0.57	Underground water	
0.71	Unstable soil-wetland	
0.86	Flood	

Fig. 2: The main limitations of the area and determination of the fuzzy membership degree



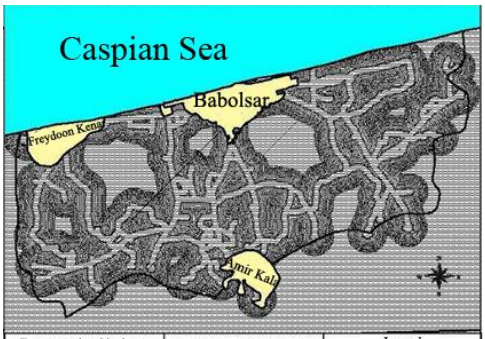
Fuzzy membership degree	Main limitation of Region	Legend
-5	out of wighting	
0.57	Underground water	
0.71	Unstable soil-wetland	
0.86	Flood	

Fig. 3: The Regional Geology in terms of Cultivation and determination of the fuzzy membership degree



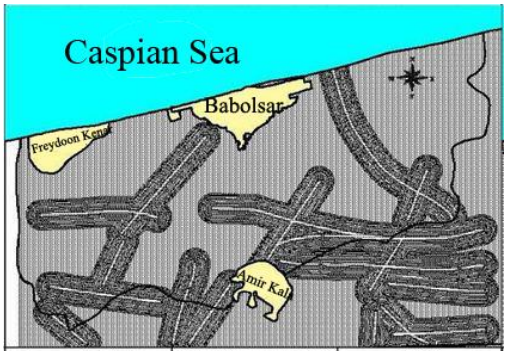
Fuzzy membership degree	Wind rate	Legend
0.745	11.375	
0.830	5.875	
0.833	7.063	
0.878	5.438	
0.905	4.25	
0.910	4	
0.930	3.125	
0.950	2.25	

Fig. 4: Regional Winds affecting on construction



Fuzzy membership degree	Distance from comunication network	Legend
0	more than 1100 m	
1	100-200 m	
0.9	200-300 m	
0.8	300-400 m	
0.7	400-500 m	
0.6	500-600 m	
0.5	600-700 m	
0.4	700-800 m	
0.3	800-900 m	
0.2	900-1000 m	
0.1	1000-1100 m	

Fig. 5: Distance from communication networks and determination of the fuzzy membership degree



Fuzzy membership degree	Distance from current faults	Legend
-5	Out of weighting	
0.1	100-200 m	
0.2	200-300 m	
0.3	300-400 m	
0.4	400-500 m	
0.5	500-600 m	
0.6	600-700 m	
0.7	700-800 m	
0.8	800-900 m	
0.9	900-1000m	
1	more than 1000 m	

ISBN: 978-3-9503110-2-0 (CD-ROM); ISBN: 978-3-9503110-3-7 (Print)
Editors: Manfred SCHRENK, Vasily V. POPOVICH, Peter ZEILE, Pietro ELISEI

Fig. 6: Distance from faults and determination of the fuzzy membership degree

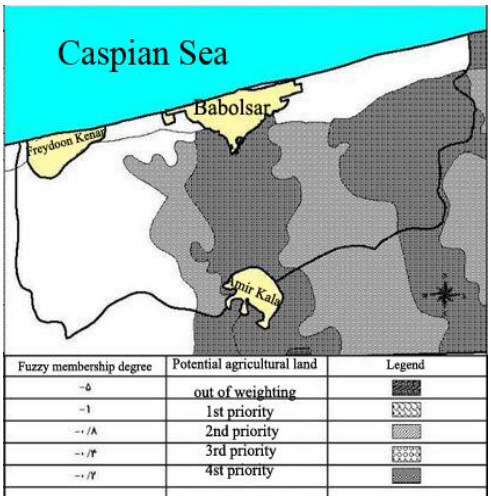


Fig. 7: Regional agriculture capability and determination of the fuzzy membership degree

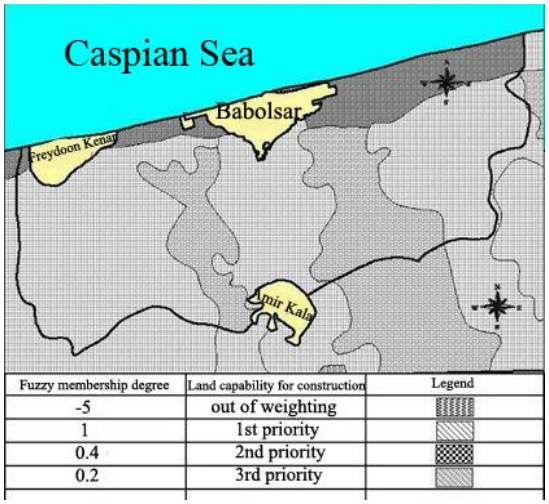


Fig. 8: Land capability for construction and determination of the fuzzy membership degree

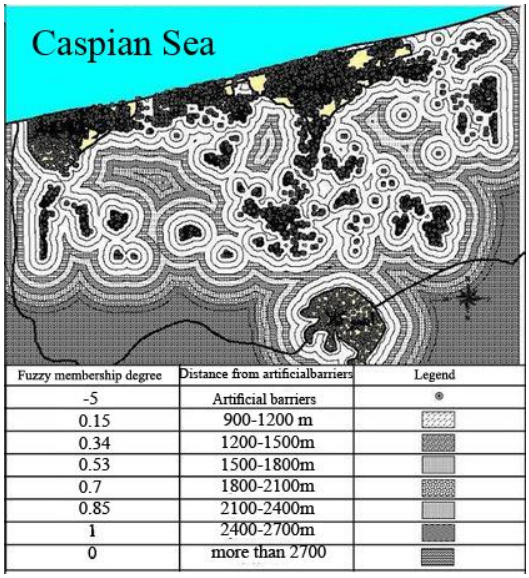
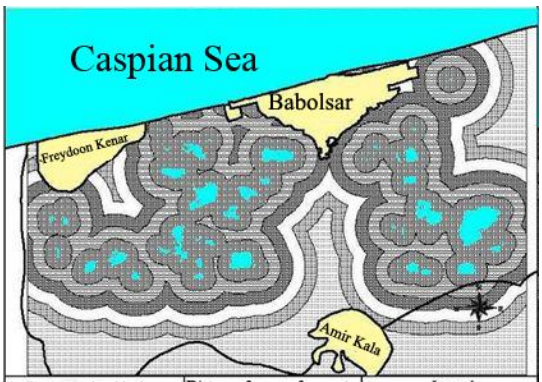
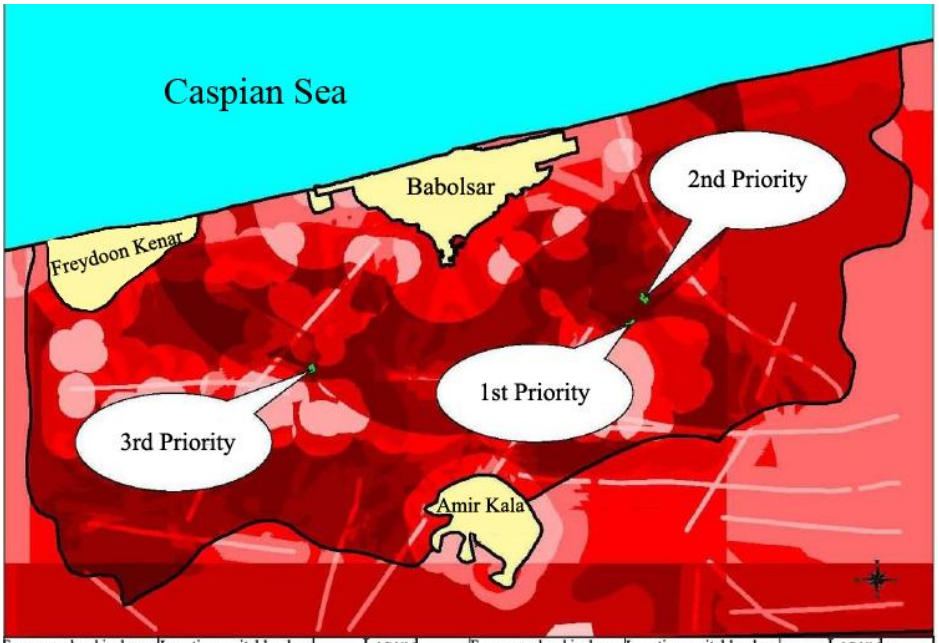


Fig. 9: Distance from artificial objects and determination of the fuzzy membership degree



Fuzzy membership degree	Distance from surface water	Legend
-5	surface water	
-5	out of weighting	
0.2	600-1200 m	
0.4	1200-1800 m	
0.6	1800-2400 m	
0.8	2400-3000 m	
1	more than 3000m	

Fig. 10: Distance from surface water and determination of the fuzzy membership degree



Fuzzy membership degree	Locatimg suitable place	Legend	Fuzzy membership degree	Locatimg suitable place	Legend
	اولویت ششم			Located points	
	اولویت هفتم			1st Priority	
	اولویت هشتم			2nd Priority	
	اولویت نهم			3rd Priority	
	اولویت دهم			4st Priority	
				5st Priority	

Fig. 11: Distance from artifical barriers in the case study and fuzzy membership degree

9 REFERENCES

Krizek, K., Power, J.: A planners Guide to sustainable development, American planning Association (APA) Chicago, 1996.

Hendrix, W., Buckly, D.: Use of GIS for selection of sites for land application of sewage waste, journal of soil and water conservation, Vol. 47, Issue 3, pp. 271-275. 1992.

Kucher, M.: The use of water and its regulation in medieval Siena, Journal of urban history, Vol. 31 No. 4, pp. 504-536, 2005.

Gimblett R.H. , Ball G.L. and Guise A.W.: Autonomous rule generation and assessment for complex spatial modeling ,Landscapeand Urban Planning, Vol. 30, pp. 13–26, 1994.

Wang, F., Hall, G.B., and Subaryono: Fuzzy information representation and processing in conventional GIS software: database design and applications. International Journal of Geographical Information Systems, Vol. 4, Issue 3, pp. 261-283, 1990.

Habib, K., Pour Ahmad, A.: Spatial –Physical Planning for Sanandaj city with use of GIS, Sanandaj, 2005 In Persian.

Saeeid nia, A.: Infrastructure and urban services, Mayor Green series, Vol.9, Tehran, 2010 In Persian.

Nouri, A.: Placement mathematical model for poultry slaughterhouses, Shahed Investment Company, Tehran, 1995 In Persian.

Rajabi,M., Mansourian, A., Borna, k.: A Comparison Between Intelligent Aalgorithms for Solving Site-selection Problems in GIS, Spatial Data Serving People: Land Governance and the Environment - Building the Capacity,7th Conference,Hanoi, 2009.

ISBN: 978-3-9503110-2-0 (CD-ROM); ISBN: 978-3-9503110-3-7 (Print)
Editors: Manfred SCHRENK, Vasily V. POPOVICH, Peter ZEILE, Pietro ELISEI