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Presenting an Optimal Model for Determining the Potential Areas of Industrial Development in Alborz Province

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Abstract
The expansion of urbanization has been accompanied by the development of industrial activities, which, despite the creation of employment and economic flourishing, have exposed citizens to various types of environmental pollution. In this study, three criteria and 10 sub-criteria and 18 indicators based on the ecological, economic and social characteristics of the Alborz province, while reviewing the internal and external resources, and using 30 expert opinions were sought in order to reach a collective consensus. Also, to measure their weight, the FAHP fuzzy hierarchy process was used. Then, using weighted linear combination and geographic information system, the fuzzy desirability map of desirable arenas and their area were determined for industrial development of the province. The results of this study shows that the integration of colonial competition and genetics meta-evolutionary algorithms for optimizing, due to the multiplicity of repetitions to achieve an optimal goal, while considering uncertainty, to provide an optimal model for locating potential and prone areas and prone to industrial development is very useful and it is possible to use it and taking into account the indigenous criteria of each province of the country, to prepare and use the optimal model of industrial development of each province of the country for decision making. The obtained results show that more than 66,000 hectares of research area has capability are based on the optimal compilation model presented for industrial development.
Keywords: optimal industrial locating, Fuzzy hierarchy analysis, Genetic Algorithm, Alborz Province

Introduction

Land use planning, one of the ecosystem-based applications for land use that can guide the environment, society and the economy to ensure the sustainability of resources as much as possible. With this pre-programmed science, the environmental, social and economic criteria are combined and reduce the degree of their opposition and meet the applied goals and resolve the inadequacies and promote priorities at all levels of the local, regional, national and global levels. The purpose and the ideals of this view, the proper distribution of population and construction activity in the

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area of the land, the implementation of well-being strategies for the individual and society, the desirable use of natural resources and human resources for the economic and social adequacy (Douvere, 2008).
Therefore, considering the status of the country's resources, it is necessary be done any planning for national and regional development with a view to the talents and capabilities of the land and within the framework of the assessment of the power and capacity of the environment and with the implementation of the vision and planning and sustainable development principles and the degree of tolerance and reconstruction capacity that their sum is balanced development (Natsios, 2005). In order to analyze the information and location of suitable areas for establishment of industrial settlement, AHP method and Fuzzy-GIS have been used. Finally, analysis of urban settlements in arak city showed that the current location of industries is not desirable; in fact there is a more suitable area in the north and north-east of the county. In a study entitled factors affecting the location of industrial settlements, considering the indicators of sustainable development and their prioritization, using triangular fuzzy numbers, social, economic, environmental, infrastructure and planning criteria are considered as effective measures in Locations on the development of industrial towns (Nasrollahi & Salehi, 2015). A study on ecological zoning in East Azarbaijan province was conducted to develop the industry by ranking method and tried to evaluate the results showed that the province has relative constraints for the development and development of the industry and industrial development talent has no power, what is emphasized in this assessment is that 21 percent of the province's talent for industrial development has the potential of two It is imperative that these limitations are considered by planners in the province. In a study entitled locate the specialized industrial town of Reili using fuzzy analytic hierarchical analysis method, they studied and identify potential fields for industrial development which was used in this study from a multi-criteria decision-making approach (Ahadi & Ghazanfari, 2012). Another study examined the positive and negative effects of Eshtehard industrial town on surrounding villages. The statistical population of this research is villagers living in villages or around the industrial city of Eshtehard and employers of industrial units based in industrial city. The results of the factor analysis of the positive effects of Eshtehard industrial town in the region showed that the social, economic, physical, agricultural and environmental impacts explain 65.98% of the total variance (Sarvar et al., 2010). In a paper titled Assessment of Environmental Capacity, Appropriate to the Nature Approach in Zagros forests, we evaluated the ecological capability of Saman Arfi Cham Haji Forest in Kakarzader of Lorestan province. As a result of this research, using ecological model of ecotourism of Iran and recognizing the characteristics of the region. In this study, a set of ecological and environmental criteria, economic and social criteria were used (Samari, 2012). In another study, the establishment of industries in the 50 km radius of Isfahan city was carried out. He evaluated the location of the establishment of industries within 50 km radius of Isfahan using the method of linear weighting and Boolean logic. later stages, weighing to the criteria was done using the AHP method and combined with weighted linear combination (WLC) method, thus, after removing areas with insufficient area for the establishment of industries, 4 suitable areas for the establishment of industries was determined (Esmaeili, 2014). In another study, an environmental model for the establishment of thermal power plants in the country was used. Effective characteristics in locating power plants were divided into three categories: environmental, technical and economic economics (Gu et al., 2014). In other study entitled Modeling of Environmental Impact Assessment Based on RIAM and TOPSIS for Desalination and Operating Units, the evaluation process, positive and negative environmental impacts of Masjid-I-Sulaiman desalination and operating units were assessed based on the results of multi-disciplinary team approach and the field survey data using RIAM method. In this regard, given that in today's world for a closer look at the environmental

impact of development projects and achieve a safer reply, using new implementation methods such as MCDM can be appropriate (Padash, 2017).
It is believed that by improving location studies and presenting optimal models such as the present study, it is possible to select the optimum and with more maneuver ability to locate industrial development. This feature is very important in the Alborz province, which is facing the proximity of the capital and land constraints due to the restrictions and inevitability of the influx of investors and the demand for the realization of industrial activities.

Material and Methods

Study area

Alborz province is located north of Mazandaran province, south of Markazi province, west of Qazvin province and east of Tehran with neighboring province (figure 1). The city of Karaj after the cities of Tehran, Mashhad, Isfahan and Tabriz is the fifth largest metropolis in the country and after Tehran is the largest migratory city in Iran. Alborz province has four cities: Karaj, Savojbolagh, Taleghan and Nazarabad. The city of Karaj with an area of 227326 hectares (44% of the province's total extent) includes 92% of the population of the province of Alborz.

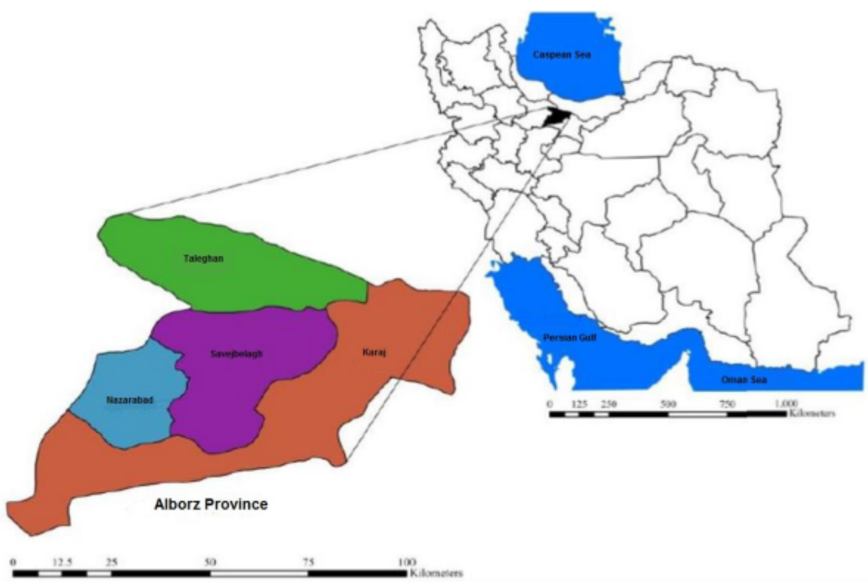

Figure 1. Geographic location of Alborz province

Morphologically, the province of Alborz, in a huge view of the province, represents the presence of high altitudes and the areas of the post and the area covering the province. High altitudes, some 4000 meters in some places, have often expanded to eastern-western parts of the northern part of the province. The postal and plain areas of the central provinces of the province are about 1,500 meters tall (Norozi et al., 2017; Keya et al., 2016). This general shape of the earthquake in the Alborz province has shaped a variety of different landforms in the province and also created the climatic diversity of the province. From the perspective of settlement, how villages are located, small villages are seen at high altitudes, but large settlements are located mainly in plains and valleys. So that small mountain villages in the city of Taleghan are located in the valleys and along the riverside sub-divisions. In other words, the settlements are formed in the direction of the streams in a linear fashion. Roads follow the same route from the waterways. The distribution of urban population of Alborz province at different altitude levels indicates that about 98% of urban population and consequently urban areas of Alborz province are located at an altitude of less than 1500 m, and only 0.2% of the urban population belonging to Taleghan and Asarah at altitude More than 1500 belong.

Research materials: topographic map (1/25000), mapping organization, land use map and land cover (25000/1), country mapping organization, climate data of Alborz Meteorological stations - Tehran - Qazvin, geological map (100000 / 1) Geological Survey of Iran, statistics of the Center for Statistics of Iran, available water (Ministry of Energy) and computer software used as: IDRISI Andes, ARC GIS, MATLAB (Yang et al., 2014; Shahabi et al., 2015; Padash, 2014; Park et al., 2011; Soto, 2012).

The research framework: The stages of implementation of the research are summarized as follows:

- Determining criteria, sub-criteria and indicators
- Mapping indicators
- Standardization of indicators
- Mapping based on standards
- Weighing criteria and sub-criteria with
- Integration of criteria and indicators
- Modeling of Industrial Development Capacity in Alborz Province
- Comparison of areas of allocable areas
- Combining different models to overlap errors (Figure 2).

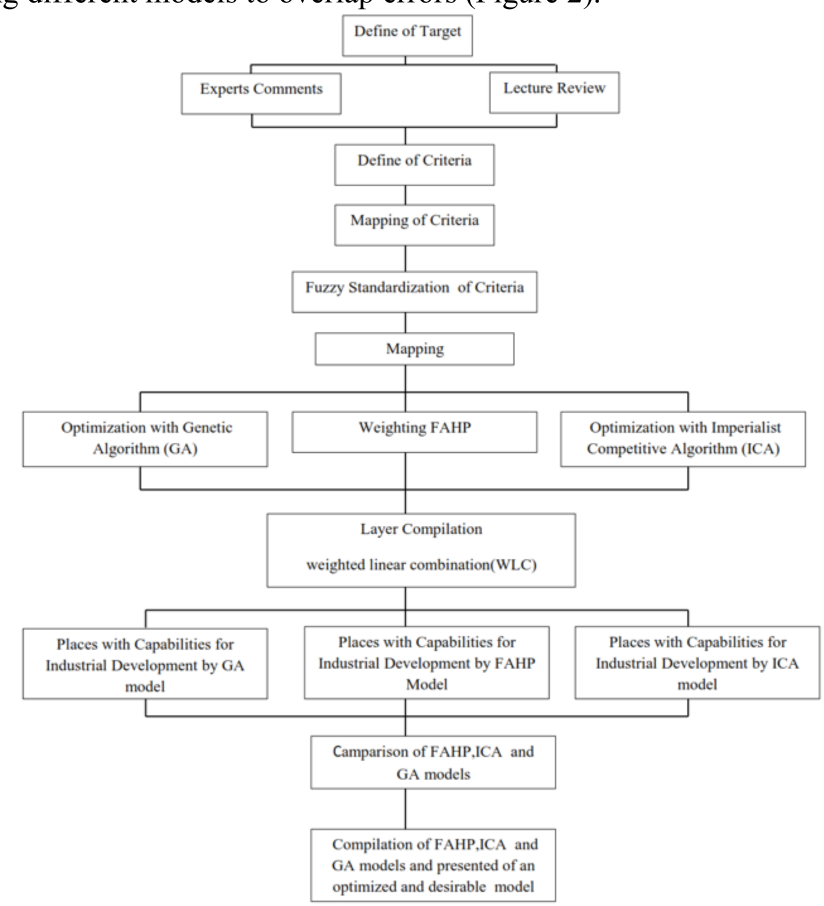

Figure 2. Process diagram of the study method

Result and Discussion

The results of the following steps were obtained in the method of methodology as follows:

1- *Identification of criteria and sub-criteria related to industrial development*

The criteria and criteria and local indices of the province for industrial development were conducted on the basis of reviewing the resources and expert opinion experts. Then, the criteria and criteria were ranked using the Delphi preference method. The criteria identified in this study include 3 criteria, 10 sub - criteria and 18 indices as described in table 1. In the following, each of the subs - criteria and criteria are elaborated.

Table 1. Criteria, sub-criteria and indicators identified from the review of internal and external resources

Criteria	Sub criteria	Index	Zarabadi and Khaliji,2014	Nasrollahi and Salehi, 2015	Monavari et al, 2012	Soltani et al.,2002	Jafari et al, 2004	Jahangiri et al., 2016	Provotorov et al.,2016	Escavy and Herrero,2013	Fernández ,Ruiz, 2009	Puente et al,2014	Queiruga et al, 2010	Gupta and Goldar, 2005	Dudukovic, 2009
Ecological	Climate	Temperature	■		■	■		■		■	■			■	
		Climate Classification		■			■			■		■		■	
	Topography	Slope	■		■	■		■		■	■	■		■	
		Height						■						■	■
	Geology	Land use Capability		■	■		■	■		■	■				■
		Formation Type	■		■							■		■	
	Land use & Land cover	Vegetation Cover Density													■
		Land use Type		■				■		■		■		■	■
	Environmental Hazards	Seismicity			■										
		Distance from Faults			■										
Economical	Water	Available Water	■		■	■	■	■	■		■	■		■	■
	Infrastructure	Distance from Roads	■				■		■	■	■		■		■
		Distance from Installation				■	■		■	■		■	■		■
		Distance from Settlements		■					■	■	■		■		■
	Ownership	Private or Governmental					■		■				■		■
Social	Demography	Population Density	■		■	■	■		■		■	■	■		■
		Unemployment Rate		■					■		■	■	■		■
	Type of Activity	Employment Prevails							■						

According to the purpose of the study, three main criteria consist of ecological criteria, economic and social criteria and the hierarchy is designed in these criteria.

Ecological and environmental criteria: environmental, climatic, geological, and land cover characteristics that are of great importance in land planning (Makhdoom, 2005). Six sub-criteria were identified that include climatic characteristics, topography, geology, utilization and coverage and environments.

Economic benchmark group: Many studies show the importance of economic criteria for land allocation for industrial development. In this study, 2 subscales and 4 indicators were identified in the economic criterion group.

The Social Dimension and Local Communities Group: It is the inalienable principle of sustainable development and the integration of the land of the community and local communities, so that many researchers point to social issues beyond ecological and economic issues. In this study, social criteria were presented in terms of demographic characteristics and type of activity.

2- Prioritization of criteria, sub-criteria and indicators

In this study, 30 experts expressed their views. In order to select criteria, sub-criteria and indicators to identify the areas susceptible to industrial development, the charts of the significance of the criteria were designed and adjusted. In this graph, the percent importance of each criterion in the horizontal axis and the degree of importance of each criterion in the vertical axis are displayed. Each of the criteria, sub-criteria and indicators were displayed on the graph on the basis of these two components, and to determine their priority, the highest percentage and significance of the criteria were used. In this way, the chart was taken on the basis of half the maximum importance grade, the four sections were divided and criteria, sub-criteria and indicators that had at least half the numerical value of each axis were used for zoning (Stanney, 2003).
Percent and degree of importance of criteria, indicators and sub-indicators were obtained according to the following calculations. In the following, prioritizing the effective factors in identifying the areas prone to industrial development was determined from the normalization of the product of the degree of importance and the importance (weight coefficient) (Cardona, 2006).
Mathematical relations calculate the percentage and importance of the criterion as follows (Ghodsypour et al., 1998).
The number of people who voted in any grade (point):n and Number of queries: N

Adjusted weight $(y_i) = \frac{x_i}{\sum x_i}$ (1)

Weighted Score (z_i)=$y_i \times n$ (2)

Percentage importance of the criterion $= \frac{\sum z_i}{N} \times 100$ (3)

Percentage importance of the criterion $\frac{\sum (x_i \times n)}{N}$ (4)

In this regard, xi is the initial weight, n the number of people who have voted for each degree of importance (rating), N is the number of respondents. After calculating the product of normalized multiplication, the degree and percentage significance, a linear mathematical relation was obtained for the integration of maps for application in the GIS (Ercanoglu and Temiz, 2011)

3- Mapping of criteria and sub-criteria:

In order to map the indicators identified for this study, the indices of each sub-criterion in the subcategory of the criteria using the base maps and data collected from related devices and land surveys and land surveys were prepared for each of the index maps for the standard groups using the Arc GIS software (Rahman et al., 2012). For this purpose, the temperature and climatic indices of climate and climatic data, slope indexes, geographic and altitude from the sea level, using topographic maps; types of formations and land suitability indices from geological map; density Vegetation coverage and land use type using land use map; seismicity and distance from faults and slipping areas using geological map and hazards; available water for industrial development using Water map available to the country's areas; Distance from communication networks, distance from facilities and population centers using a map and coverage. Mathematical, type of land use master plan Alborz data, population density, unemployment rate and employment data using the most population and housing census were prepared. Figures 3 to 20 show status maps of different zones.

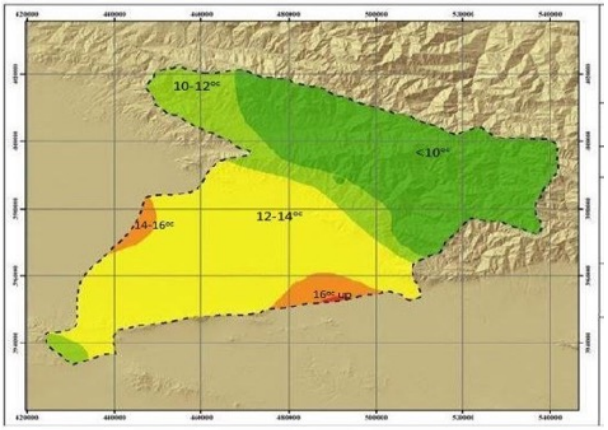

Figure 3. Mapping of temperature in zone of study

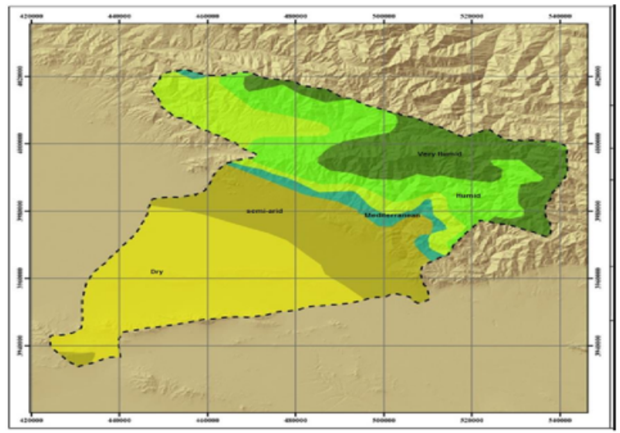

Figure 4. Mapping of climate classification in zone of study

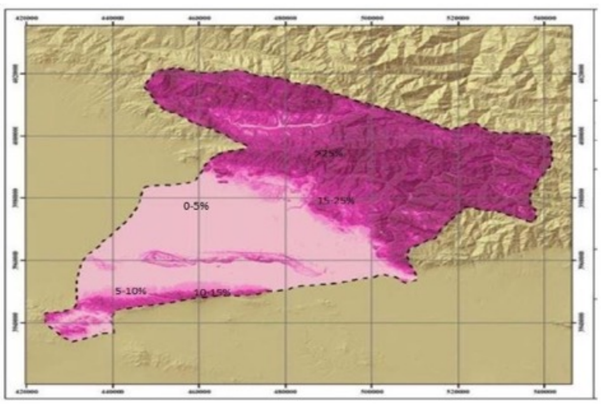

Figure 5. Mapping of slope in zone of study

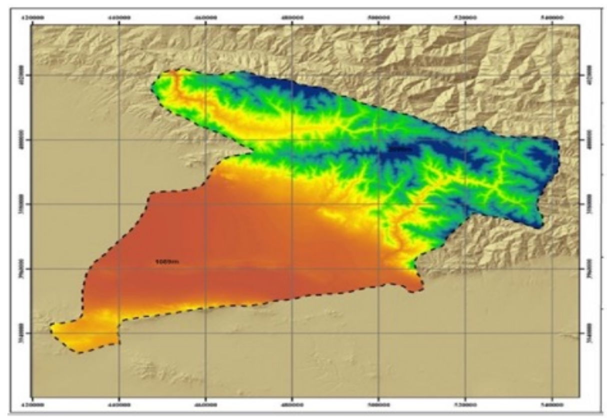

Figure 6. Mapping of Height classification in zone of study

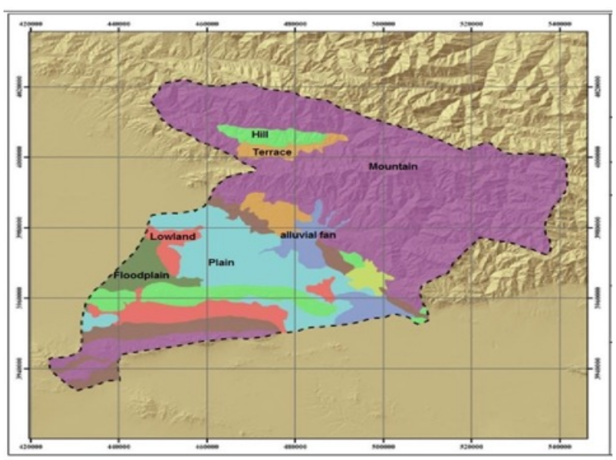

Figure 7. Mapping of Land capability in zone of study

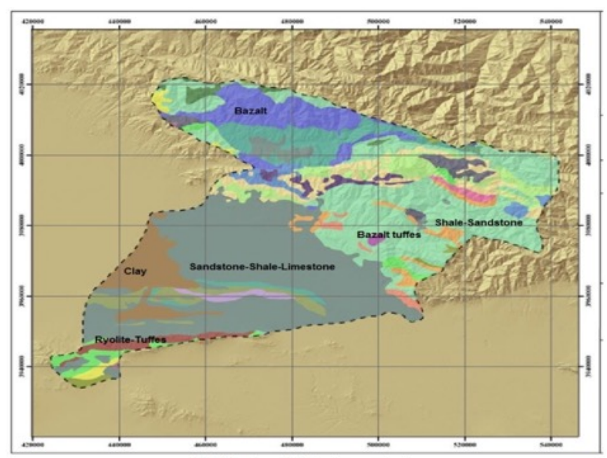

Figure 8. Mapping of Geology in zone of study

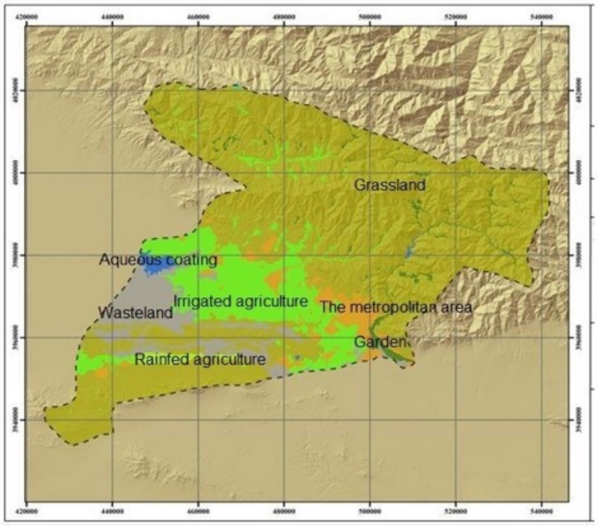

Figure 9. Mapping of Land use in zone of study

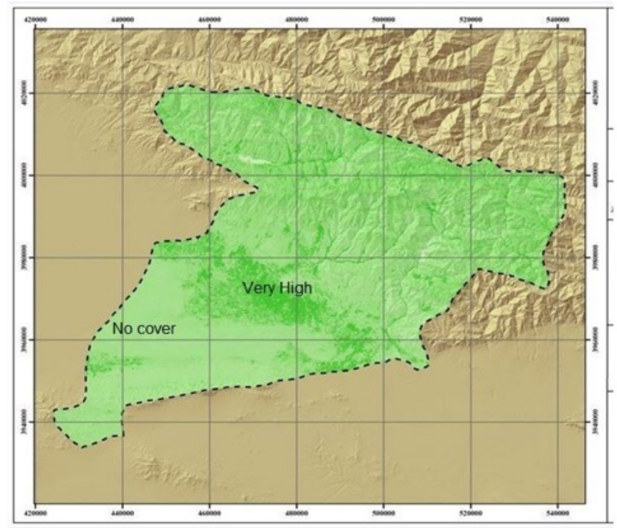

Figure 10. Mapping of Vegetation cover density in zone of study

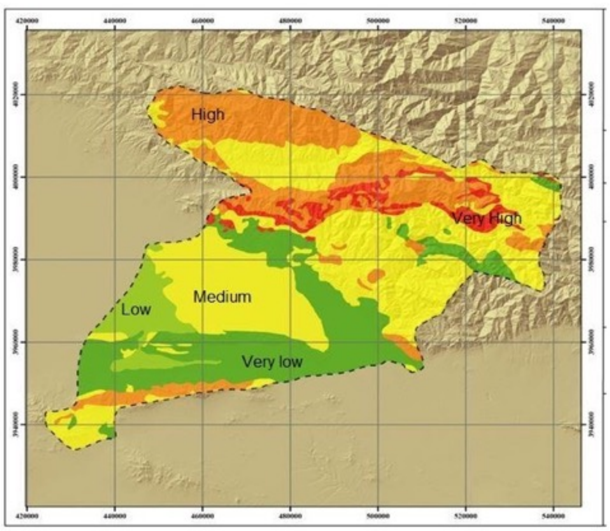

Figure 11. Mapping of Seismic risk in zone of study

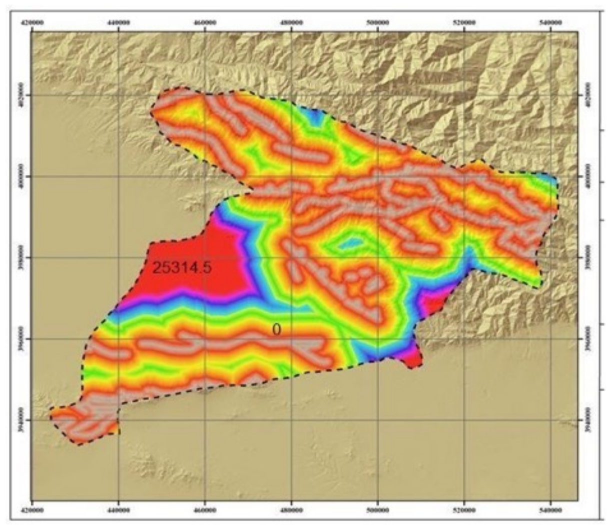

Figure 12. Mapping of distance from faults in zone of study

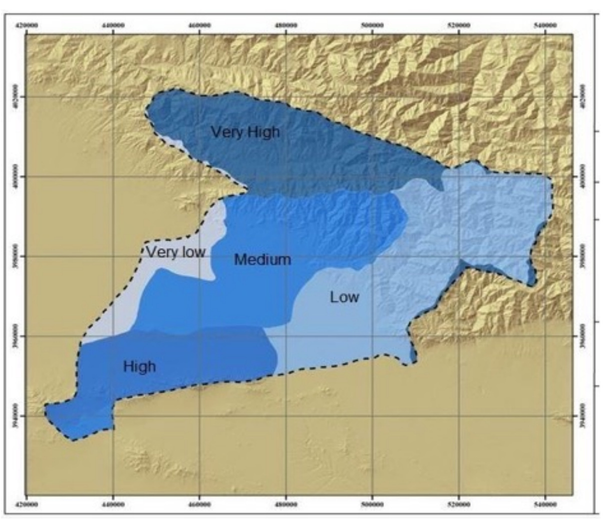

Figure 13. Mapping of Water utility available in zone of study

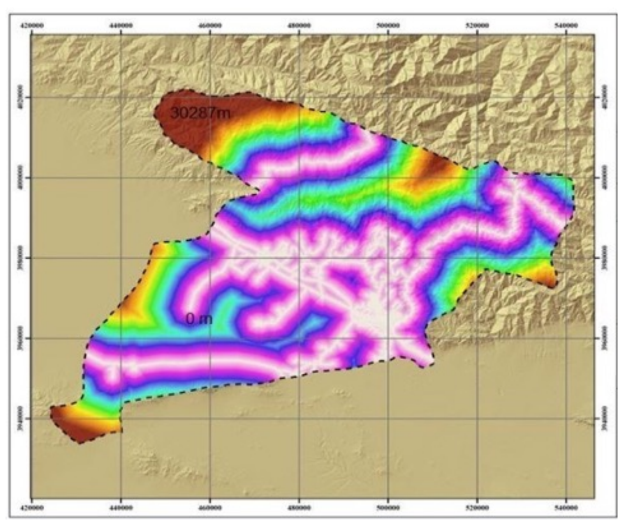

Figure 14. Mapping of distance from roads in zone of study

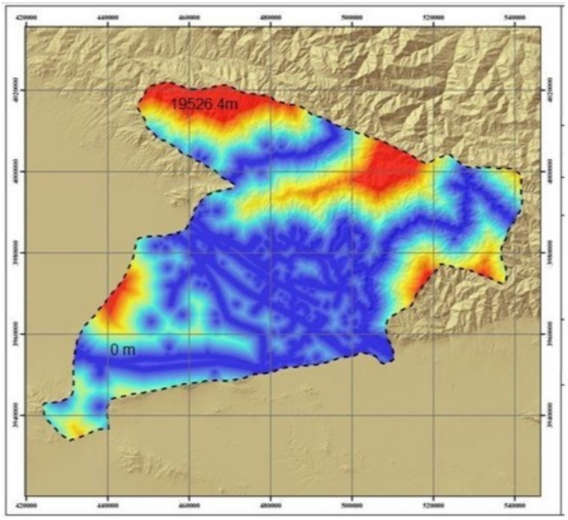

Figure 15. Mapping of distance from facility in zone of study

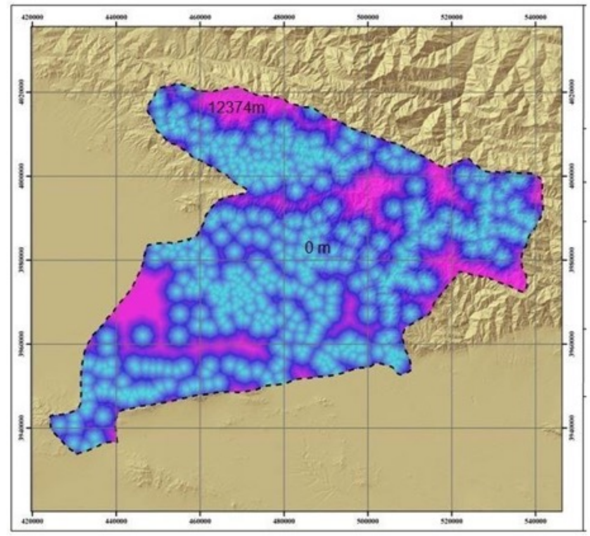

Figure 16. Mapping of distance from settlements in zone of study

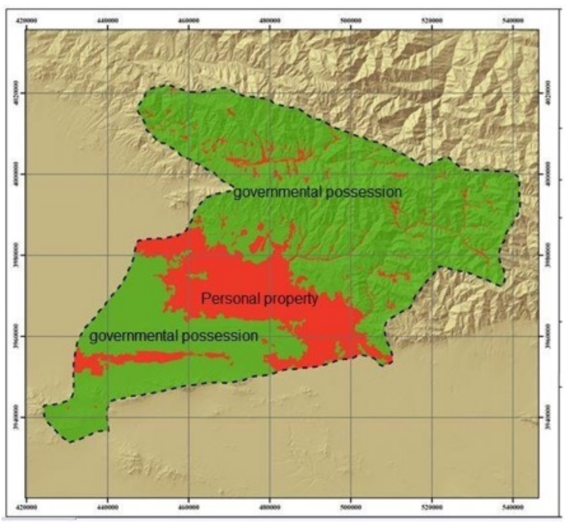

Figure 17. Mapping of Ownership types in zone of study

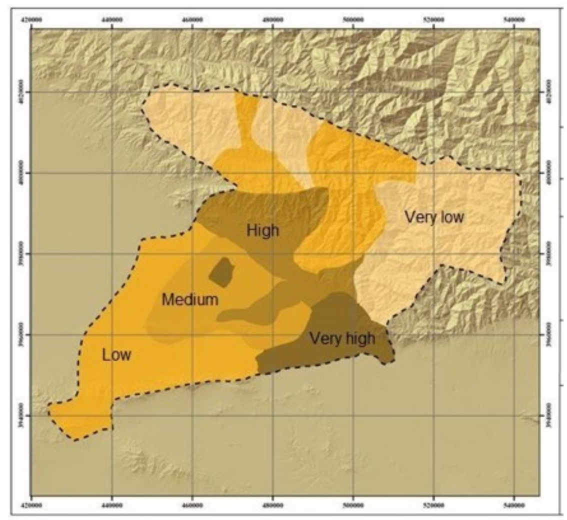

Figure 18. Mapping of population density in zone of study

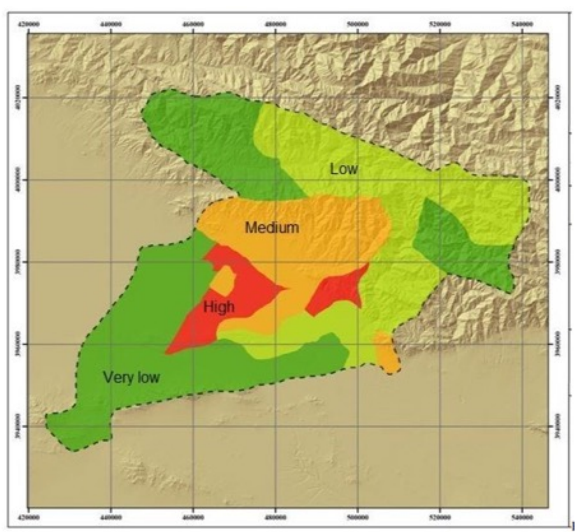

Figure 19. Mapping of the unemployment rate in zone of study

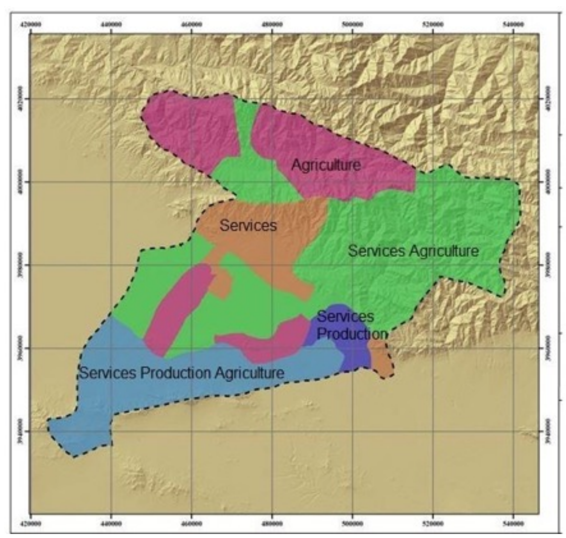

Figure 20. Mapping of Most jobs in zone of study

4- Standardization Criteria, Sub-criteria and target Indicators:

The values in the different layers of the standard maps must be converted into comparable and proportionate units. In this study, fuzzy method was used for standardization. To do this, it is necessary to determine the threshold values of the criteria, the type and form of the membership function, so the standardization was carried out in the numerical domain 1-0. This means that the number 0 has the lowest merit and the one with the highest merit for areas susceptible to industrial development. All maps related to indicators with a cell size of 10 meters were converted to the Raster format. In this study, the fuzzy index sets were fuzzy using the sets of fuzzy functions (Table 2). In order to fuzzy most of the indices, sigmoidal functions were used. In some indices, there is no relationship between values and none of the sigmoidal functions. In this case, User-Defined Functions are more commonly used (Moeinaddini, 2010). In this study, the qualitative sub-criteria were based on the set of functions defined by the fuzzy user. In Figure 21, the control points used in the sigmoidal functions are shown. When the values of the indices are uniformly increased or decreased, only two control points are defined in the fuzzy set, while the values of the indices are symmetric, each of the four control points is defined in the fuzzy set (Baranyi, 2004). The discontinuity of the data in the layers leads to problems in the final map; hence the proper solution for mapping the susceptibility to landslide, creating layers with binary values (0 and 1) for each class of an independent parameter (Kanungo et al. 2006). In order to have the range of values between 0 and 1, the standardization procedure was used using Equation 5.

$$X_{Standard} = \frac{X - X_{Min}}{X_{Max} - X_{Min}} \qquad (5)$$

5- Weighing results and prioritization of criteria, sub-criteria and target indices using F.AHP fuzzy hierarchy analysis method

Once the criteria have become comparable and standardized, the weight and relative importance of each one should be determined for the purpose. Önüt (2010) states that by generalizing the method of pair comparison, methods are presented in which fuzzy numbers are used to express the relative weight of the criteria against the target, the sub criteria to the criterion and the options to the criteria and sub-criteria. Among these, the methods proposed by Wang (2008), Chamodrakas (2010), Torfi (2010), Chatterjee (2010), Ballı (2009), Wang (2012) and Özdağoğlu (2007) can be pointed out.

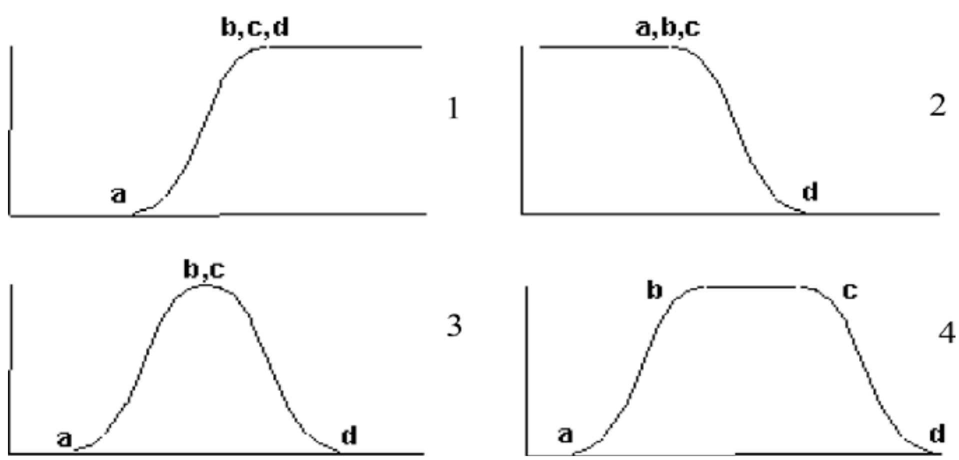

Figure 21. Control points in Sigmoidal functions (1- Uniform increase; 2- Uniform reduction; 3 and 4 - Symmetric curve)

Table 2. Control points to standardize the indicators along with the shape and type of fuzzy membership function

Criterion	Indicators	Control Points				Fuzzy Membership Function	Type Membership Function
		a	b	c	d		
Ecological	Temperature	8.9	*	*	2.17	Increasing linear	Sigmoidal
	Climate	Very humid	*	*	Dry	User defined	User defined
	Slope	50% up	*	*	0	Decreasing linear	Sigmoidal
	Height	4099	*	*	1089	Decreasing linear	` Sigmoidal
	Land use capability	Mountains rocky lands	*	*	Plains	User defined	User defined
	Formation type	Clay, Marl, Plaster	*	*	Sandstone, Limestone	User defined	User defined
	Vegetation cover density	100	*	*	0	Decreasing linear	Sigmoidal
	Land use cover	Protected area	*	*	Waste range	User defined	User defined
	Seismicity	Very High	*	*	Very low	Decreasing linear	Sigmoidal
	Distance from faults	0	*	*	25314.5	Increasing linear	Sigmoidal
	Available water	Very low	*	*	Very High	Increasing linear	Sigmoidal
Economical	Distance from roads	30287	*	*	0	Decreasing linear	Sigmoidal
	Distance from installations	19526.4	*	*	0	Decreasing linear	Sigmoidal
	Distance from cities	12374	*	*	0	Decreasing linear	Sigmoidal
	Ownership type	Personal	*	*	Governmental	User defined	User defined
Social	Population density	Very low	*	*	Very High	Increasing linear	Sigmoidal
	Unemployment rate	Very low	*	*	Very High	Increasing linear	Sigmoidal
	Employment prevails	Farmer	*	*	Service production	User defined	User defined

a: Very low desirable equal to 0
d: Very high desirable equal to 1
b&c: Desirable between 0 and 1

These methods provide a series of systematic approaches for choosing options and judging issues using the concepts of fuzzy set theory and hierarchical structure analysis.
Step 1: Build a hierarchical structure for the problem.
Step 2: Preparation of the Likert spectrum questionnaire to rank the indices relative to the sub-criteria as well as the sub criteria for the criteria and, finally, ranking the criteria against the target.
Step Three: Summing up the results of the questionnaires to define fuzzy numbers for performing paired comparisons (Tables 3-5)
Step 3: Determine the matrices of the pair comparison and apply the group judgments (relation 1) (using Table 5) (Önüt et al., 2010).

$$A = \begin{bmatrix} 1 & a_{12} & \rightarrow & a_{1n} \\ a_{21} & 1 & \rightarrow & a_{2n} \\ \downarrow & \downarrow & \rightarrow & a_1 \\ a_{n1} & a_{n21} & \rightarrow & 1 \end{bmatrix} \tag{6}$$

Table 3. Fuzzy Numbers Matching Priority and Importance in Paired Comparisons

Triangular fuzzy number	Linguistic expression to determine the preferred option or importance of the benchmark and index
$(\frac{5}{2}, 3, \frac{7}{2})$	Absolute priority or absolute importance
$(2, \frac{5}{2}, 3)$	Preference or importance is much stronger
$(\frac{3}{2}, 2, \frac{5}{2})$	Priority or stronger importance
$(1, \frac{3}{2}, 2)$	Preference or low importance
$(\frac{1}{2}, 1, \frac{3}{2})$	Preference or importance is almost equal
(1, 1, 1)	Preference or importance is exactly equal

Step Four: Calculate the relative weights of the criteria and sub-criteria (from the Cheng Development Analysis Method) (Önüt et al., 2010).

Table 4. Ecological Criteria Group

Sub Criteria	Climate	Topography	Geology	Land use	Environmental hazards	Water	Weight
Climate	(1,1,1)	$(2,\frac{5}{2},3)$	$(2,\frac{5}{2},3)$	$(2,\frac{5}{2},3)$	$(\frac{7}{2},4,\frac{9}{2})$	$(3,\frac{7}{2},4)$	0.27
Topography	(0.33,0.4,0.5)	(1,1,1)	(0.33,0.4,0.5)	(0.4,0.5,0.66)	(0.2,0.22,0.25)	(0.2,0.22,0.25)	0.05
Geology	(0.33,0.4,0.5)	$(\frac{5}{2},3,\frac{7}{2})$	(1,1,1)	$(\frac{3}{2},2,\frac{5}{2})$	(0.4,0.5,0.66)	(0.2,0.22,0.25)	0.12
Land use	(0.33,0.4,0.5)	$(\frac{3}{2},2,\frac{5}{2})$	(0.4,0.5,0.66)	(1,1,1)	(0.22,0.25,0.28)	(0.2,0.22,0.25)	0.07
Environmental hazards	(0.22,0.25,0.28)	$(4,\frac{9}{2},5)$	$(\frac{3}{2},2,\frac{5}{2})$	$(\frac{7}{2},4,\frac{9}{2})$	(1,1,1)	(1,1,1)	0.22
Water	(0.25,0.28,0.33)	$(4,\frac{9}{2},5)$	$(4,\frac{9}{2},5)$	$(4,\frac{9}{2},5)$	(1,1,1)	(1,1,1)	0.27

Table 5. Economic Criteria Group

Sub Criteria	Infrastructure facilities	Ownerships	Weight
Infrastructure facilities	(1,1,1)	$(3,\frac{7}{2},4)$	0.78
Ownerships	(0.25,0.28,0.33)	(1,1,1)	0.22

In order to reach the collective opinion of the experts and their consensus, a questionnaire was developed for weighting the indices and completed by 30 specialists. Then, the weight of the criteria and the compatibility rate of each questionnaire were calculated and the questionnaires with lower compatibility rates they were selected from 0.1 and were accepted and their weight was calculated.

Table 6. Social Criteria Group

Sub Criteria	Demography	Type of Activity	Weight
Demography	(1,1,1)	$(\frac{1}{2},1,\frac{3}{2})$	0.52
Type of Activity	(0.66,1,2)	(1,1,1)	0.48

6- Integration of criteria, sub-criteria and target indicators based on the weight obtained from F.AHP analysis.

After standardizing the criteria maps and determining the weight of the factors, to choose the best option (location) or pixel based on their ranking, weighted linear combination (WLC) (Drobne and Lisec, 2009) and cluster analysis (Scott and Knott, 1974). In order to identify areas susceptible to industrial development, it was used. First, each index is multiplied by its corresponding weight and then summed up by the sum of the results of the plot map of the study area for industrial user. Figures 22 to 36 show the results.

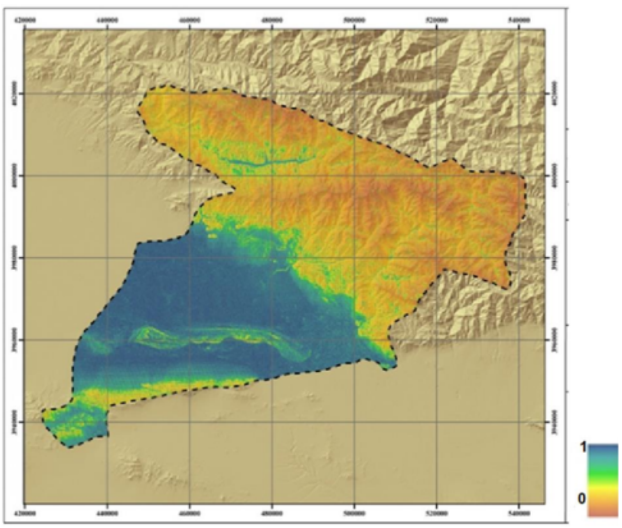

Figure 22. Desirable of topography for industrial development in zone of study

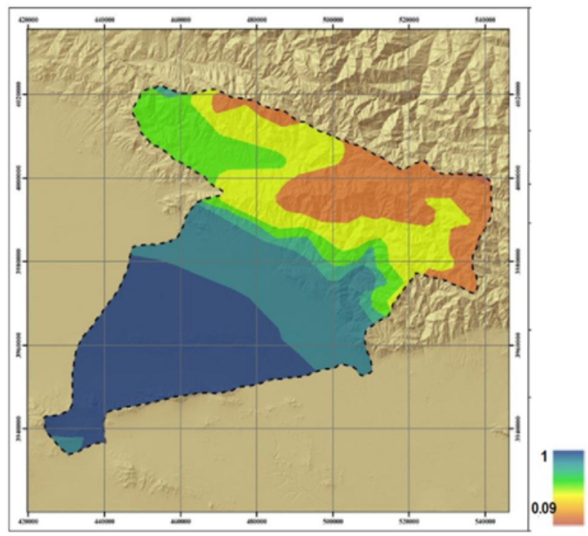

Figure 23. Desirable of climate for industrial development in zone of study

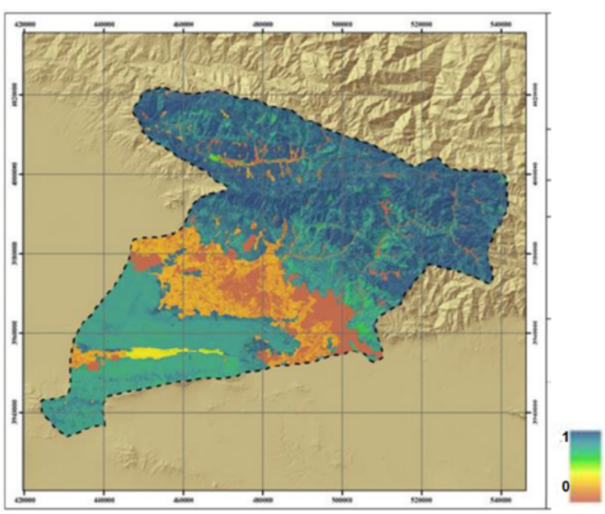

Figure 24. Desirable of land use for industrial development in zone of study

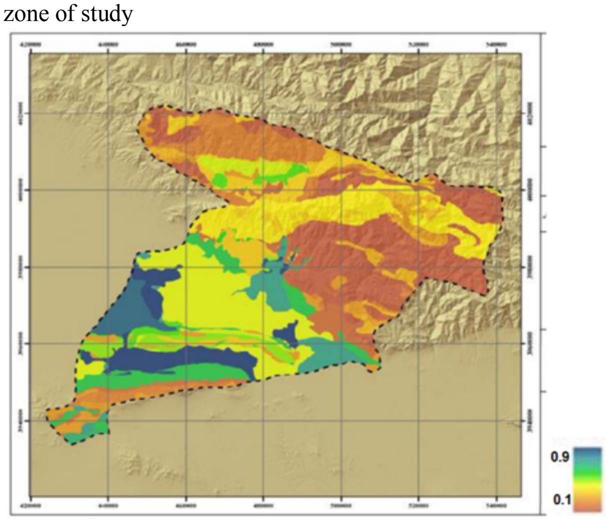

Figure 25. Desirable of geology for industrial development in zone of study

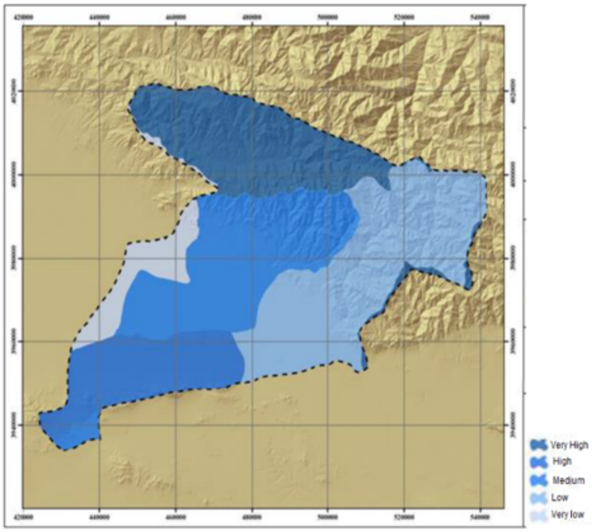

Figure 26. Desirable of available water for industrial development in zone of study

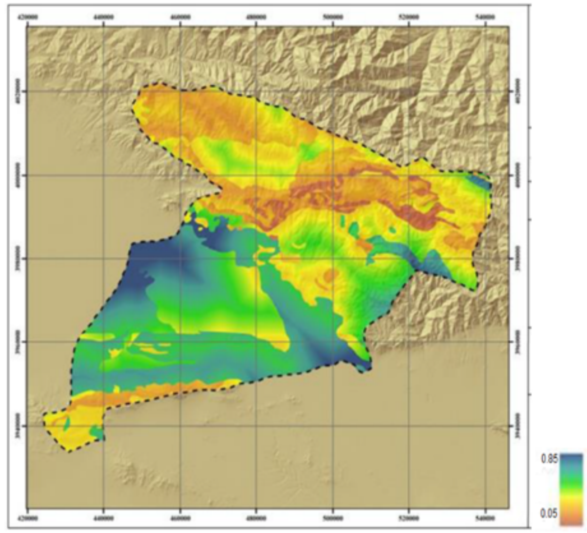

Figure 27. Desirable of environmental hazards for industrial development in zone of study

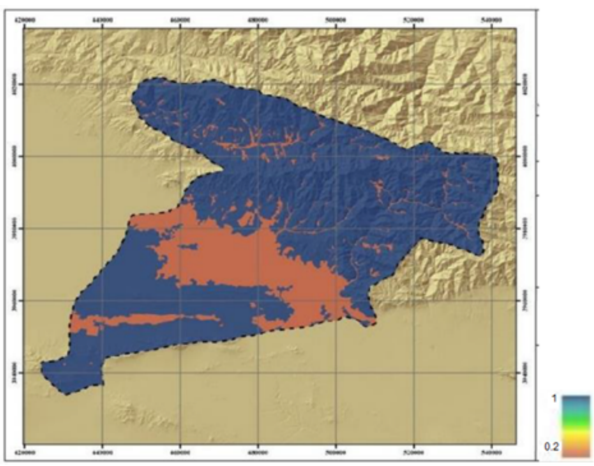

Figure 28. Desirable of ownerships type for industrial development in zone of study

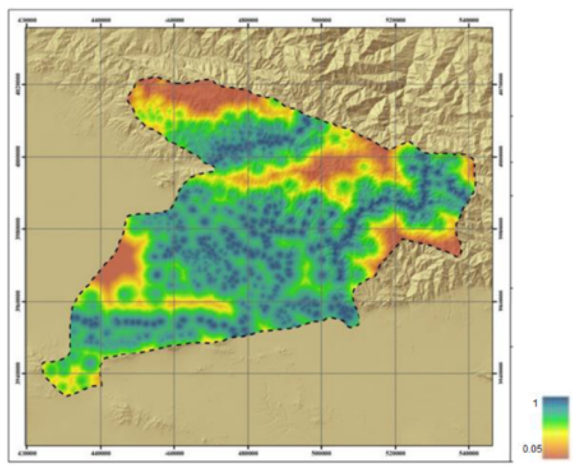

Figure 29. Desirable of Infrastructure facilities for industrial development in zone of study

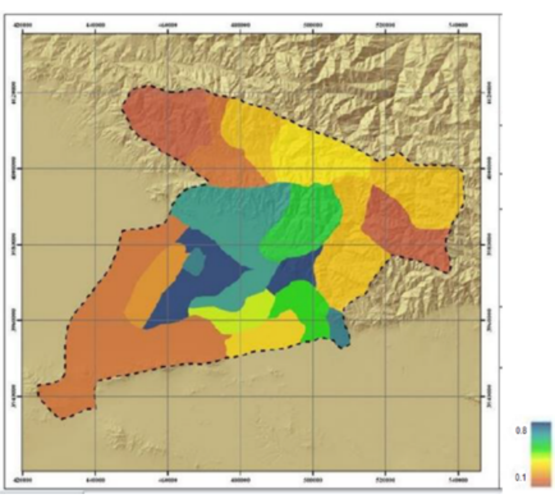

Figure 30. Desirable of demography for industrial development in zone of study

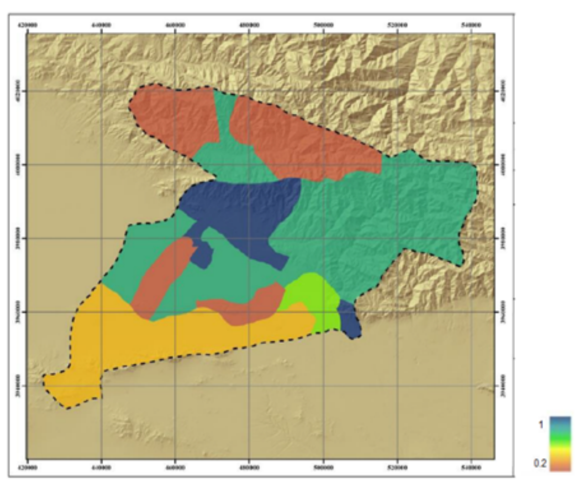

Figure 31. Desirable of the most jobs for industrial development in zone of study

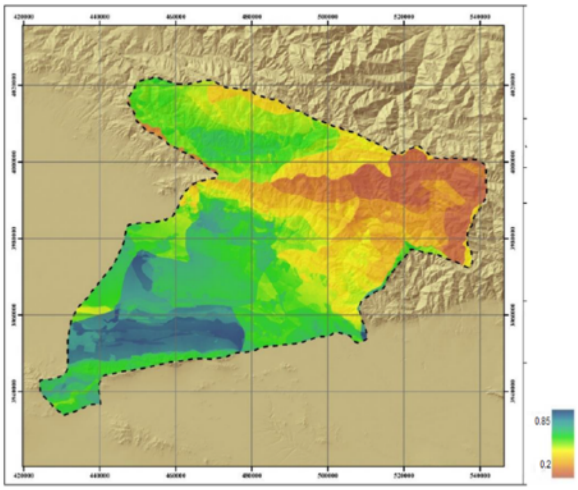

Figure 32. Desirable of ecological attributes for industrial development in zone of study

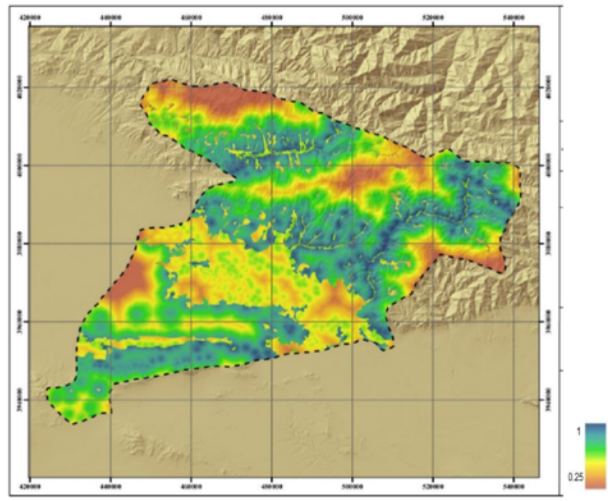

Figure 33. Desirable of economical attributes for industrial development in zone of study

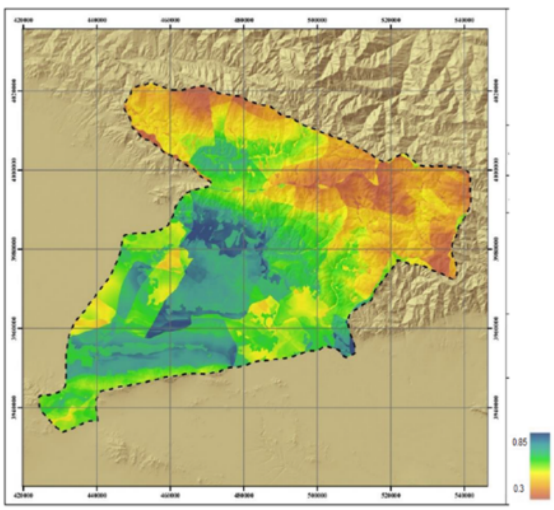

Figure 34. Desirable of social attributes for industrial development in zone of study

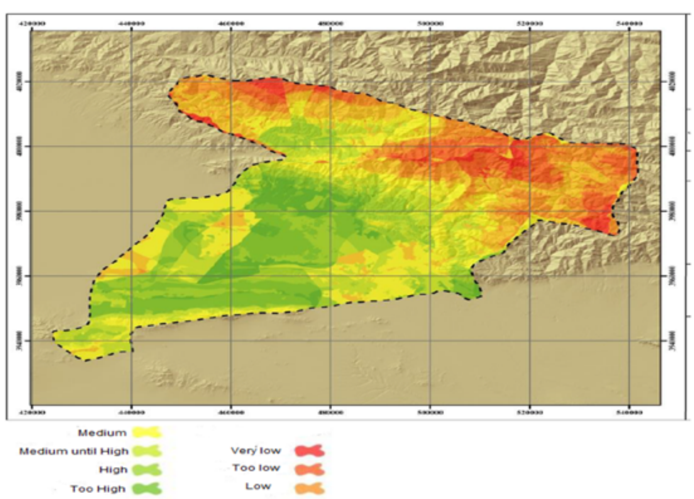

Figure 35. Desirable for industrial development potential in zone of study

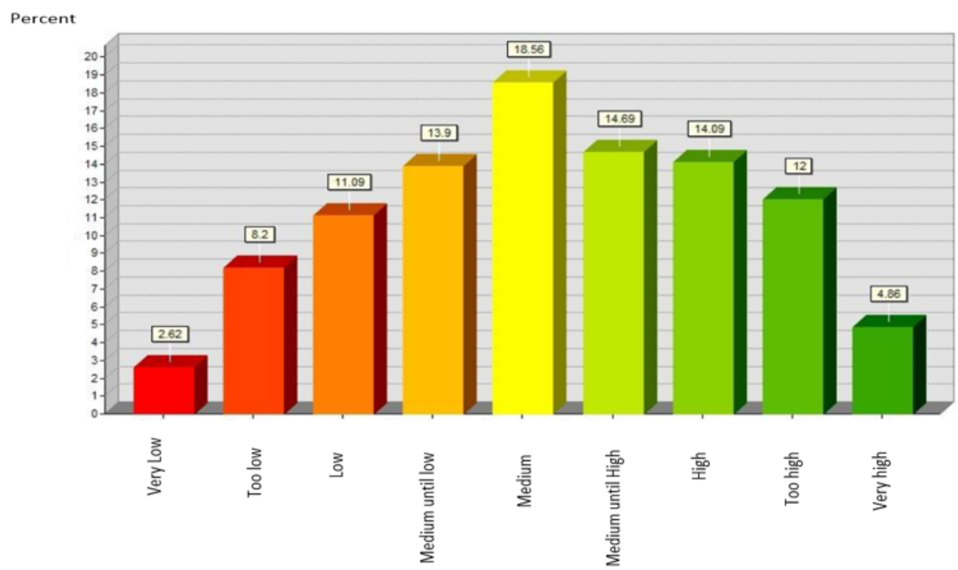

Figure 36. Chart of industrial development potential in Alborz province

Considering that the mapping from the integration of indices is continuous under criteria and target criteria, it is difficult to identify potential zones of industrial development. in this research, in order to determine optimal zones for industrial development, the final map was used in order to determine the final map of integration based on gradient change in five categories including A - Very suitable, B - Appropriate, C - Medium - D - Inappropriate, E - Very inappropriate. The final map (figure 37) indicates that about 4% of the research area has a first-class capacity for industrial development. Approximately 12 percent of the level of the Alborz province is arranged with a degree of power of 2 degrees and about 14 percent of the area with a third degree capacity for industrial development (Figure 38). And finally, the areas with the potential for industrial development cover about 30% of the region.

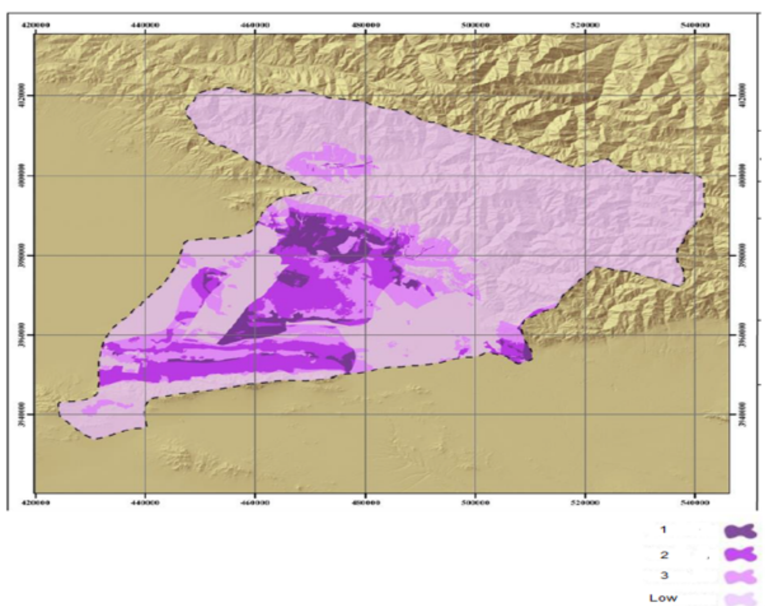

Figure 37. Ranking of industrial development potential in Alborz province

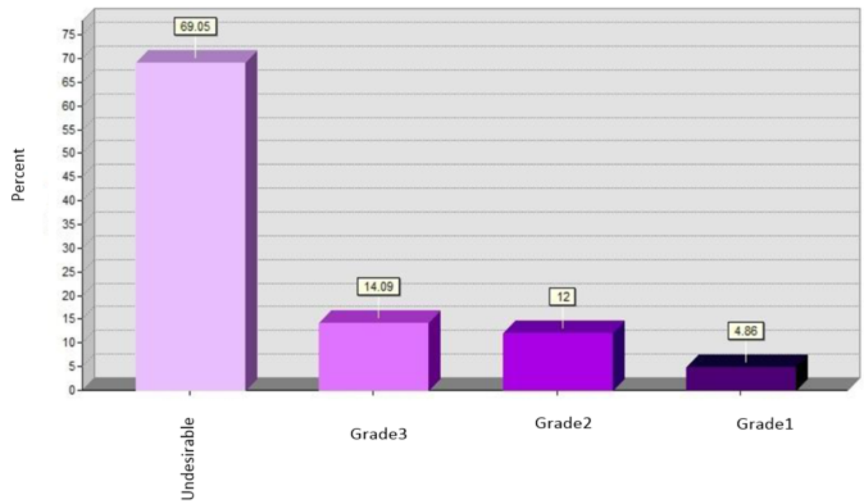

Figure 38. Ranking percent for industrial development potential area in Alborz province

Optimizing the Factors Affecting Industrial Development in Alborz Province Using Fuzzy Algorithms to Achieve Optimal Model:

Fractal algorithms are divided into different categories based on the type of method used to solve problems. Some of these algorithms are categorized based on nature inspired or abnormal. Some are based on a population of answers or only on the basis of an answer to the optimal answer to the problem. Since the models of such algorithms are so implemented to achieve the best possible solution, the issue of uncertainty in their implementation is fully taken into account and facilitates effective decision-making. These algorithms include optimization algorithms for ant colony, colony of bees, particle overcrowding optimization, geopolitical optimization, genetic algorithm, evolutionary programming, evolutionary strategy, genetic programming, search Distinction, Difference Evolution, Musicians, Colonial Competition. In this research, the genetic algorithm and the ability of a new algorithm called the Imperialist Competitive Algorithm (ICA), based on human and social evolution, have been used to determine the optimal pattern. Genetic algorithm (GA) is a special type of evolutionary algorithm that uses biological techniques such as inheritance, biology mutation, and Darwinian selective principles to find the optimal formula for predicting or matching the algorithm. Genetic algorithms are often a good option for regression-based prediction techniques. The advantage of this is that its implementation is simple and does not require complicated problem solving procedures, and the main problem is the high cost of its execution. Meanwhile, an algorithm is much shorter and more efficient than the systematic procedures required to run it. The colonial competition algorithm, by imitation of the social, economic, and political evolution of countries and by mathematical modeling, parts of this process provide algorithms in a regular manner that can help solve complex optimization problems. In fact, this algorithm looks at the optimization problems in the form of countries and tries to improve these solutions during the repetitive process and ultimately to answer the optimal problem. The most important advantage of the colonial competition algorithm than other algorithms is to innovate and to be new at the same time to be known, its competitive ability is well-known algorithms and its flexibility. Results of Optimization of Criteria, Sub-criteria and Indicators Determined by Genetic Algorithm (Tables 7 to 9):

Table 7. Weighting for sub criteria in ecological criteria group

Sub criteria	Climate	Topography	Geology	Landuse	Hazards	Water	Weight
Climate	(1,1,1)	$(2,\frac{5}{2},3)$	$(2,\frac{5}{2},3)$	$(2,\frac{5}{2},3)$	$(\frac{7}{2},4,\frac{9}{2})$	$(3,\frac{7}{2},4)$	0.21
Topography	(0.33,0.4,0.5)	(1,1,1)	(0.33,0.4,0.5)	(0.4,0.5,0.66)	(0.2,0.22,0.25)	(0.2,0.22,0.25)	0.47
Geology	(0.33,0.4,0.5)	$(\frac{5}{2},3,\frac{7}{2})$	(1,1,1)	$(\frac{3}{2},2,\frac{5}{2})$	(0.4,0.5,0.66)	(0.2,0.22,0.25)	0.11
Landuse	(0.33,0.4,0.5)	$(\frac{3}{2},2,\frac{5}{2})$	(0.4,0.5,0.66)	(1,1,1)	(0.22,0.25,0.28)	(0.2,0.22,0.25)	0.15
Hazards	(0.22,0.25,0.28)	$(4,\frac{9}{2},5)$	$(\frac{3}{2},2,\frac{5}{2})$	$(\frac{7}{2},4,\frac{9}{2})$	(1,1,1)	(1,1,1)	0.16
Water	(0.25,0.28,0.33)	$(4,\frac{9}{2},5)$	$(4,\frac{9}{2},5)$	$(4,\frac{9}{2},5)$	(1,1,1)	(1,1,1)	0.49

Table 8. Weighting for sub criteria in economic criteria group

Sub criteria	Iinfrastructure facilities	Ownership	Weight
Iinfrastructure facilities	(1,1,1)	$(3,\frac{7}{2},4)$	0.78
Ownership	(0.25,0.28,0.33)	(1,1,1)	0.34

Table 9. Weighting for sub criteria in social criteria group

Sub criteria	Demography	Type of activity	Weight
Demography	(1,1,1)	$(\frac{1}{2},1,\frac{3}{2})$	0.75
Type of activity	(066,1,2)	(1,1,1)	0.68

Using weighting functions (WLC), the effective measures for industrial development were combined according to the weights obtained from the genetic optimization algorithm. The results of the field of power show various degrees for industrial development. Based on the results, about 138 thousand hectares from the province of Alborz based on this model have the potential for industrial development, with the highest level related to industrial development grade 3 (Table 10 and Figures 39 and 40). Results of Optimization of Criteria, Sub-criteria and Indicators Determined by Colonial Competitive Algorithm in tables 11 to 13.

Table 10. Potential of area for industrial development in Alborz province by Genetic Algorithm model

Decision model	Grade1(hectare)	Grade2(hectare)	Grade3(hectare)	Sum(hectare)
Genetic algorithm	15669.2	57591.7	64752.8	138013.7

Table 11. Weighting for sub criteria in ecological criteria group

Sub criteria	Climate	Topography	Geology	Land use	Hazards	Water	Weight
Climate	(1,1,1)	$(2,\frac{5}{2},3)$	$(2,\frac{5}{2},3)$	$(2,\frac{5}{2},3)$	$(\frac{7}{2},4,\frac{9}{2})$	$(3,\frac{7}{2},4)$	0.23
Topography	(0.33,0.4,0.5)	(1,1,1)	(0.33,0.4,0.5)	(0.4,0.5,0.66)	(0.2,0.22,0.25)	(0.2,0.22,0.25)	0.42
Geology	(0.33,0.4,0.5)	$(\frac{5}{2},3,\frac{7}{2})$	(1,1,1)	$(\frac{3}{2},2,\frac{5}{2})$	(0.4,0.5,0.66)	(0.2,0.22,0.25)	0.09
Land use	(0.33,0.4,0.5)	$(\frac{3}{2},2,\frac{5}{2})$	(0.4,0.5,0.66)	(1,1,1)	(0.22,0.25,0.28)	(0.2,0.22,0.25)	0.12
Hazards	(0.22,0.25,0.28)	$(4,\frac{9}{2},5)$	$(\frac{3}{2},2,\frac{5}{2})$	$(\frac{7}{2},4,\frac{9}{2})$	(1,1,1)	(1,1,1)	0.16
Water	(0.25,0.28,0.33)	$(4,\frac{9}{2},5)$	$(4,\frac{9}{2},5)$	$(4,\frac{9}{2},5)$	(1,1,1)	(1,1,1)	0.43

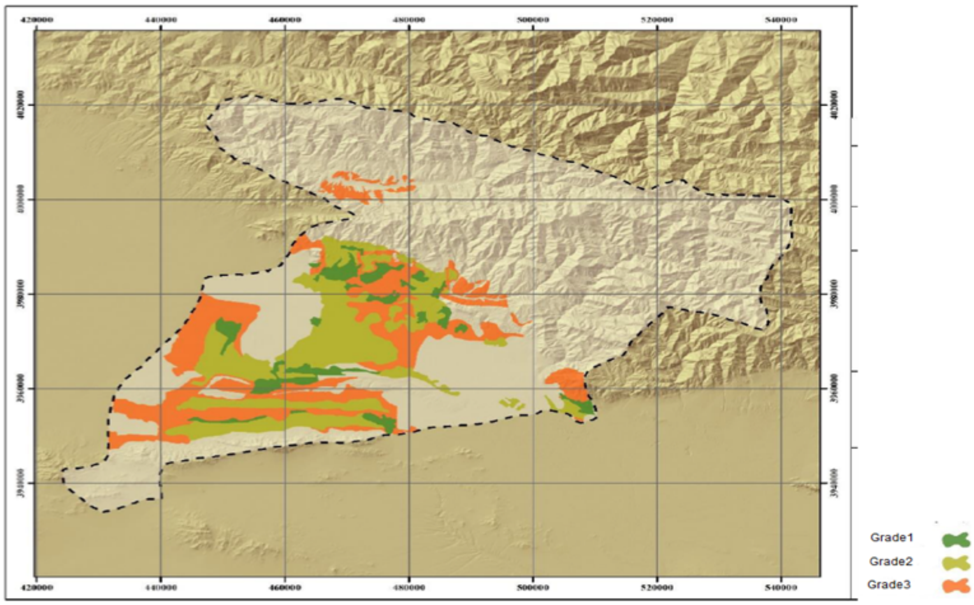

Figure 39. Mapping of Potential for industrial development in Alborz province by Genetic Algorithm model

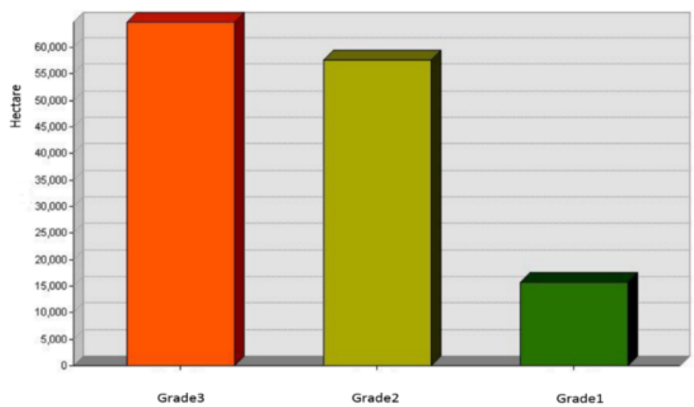

Figure 40. Chart for Abundance of potential grades for industrial development in Alborz province by Genetic Algorithm model

Table 12. Weighting for sub criteria in economic criteria group

Sub criteria	Iinfrastructure facilities	Ownership	Weight
Iinfrastructure facilities	(1,1,1)	$(3,\frac{7}{2},4)$	0.89
Ownership	(0.25,0.28,0.33)	(1,1,1)	0.26

Table 13. Weighting for sub criteria in social criteria group

Sub criteria	Demography	Type of activity	Weight
Demography	(1,1,1)	$(\frac{1}{2},1,\frac{3}{2})$	0.63
Type of activity	(066,1,2)	(1,1,1)	0.52

This step was combined with the weighting overlay functions (WLCs), the effective measures for industrial development, based on the weight obtained from the colonial competition optimization algorithm. The results of the optimal zones show the power in various degrees for industrial development. Based on the results, about 140,000 hectares of the province of Alborz based on this model have the potential for industrial development, the highest level of which is related to industrial development grade 2 (Figures 41 and 42, Table 14)

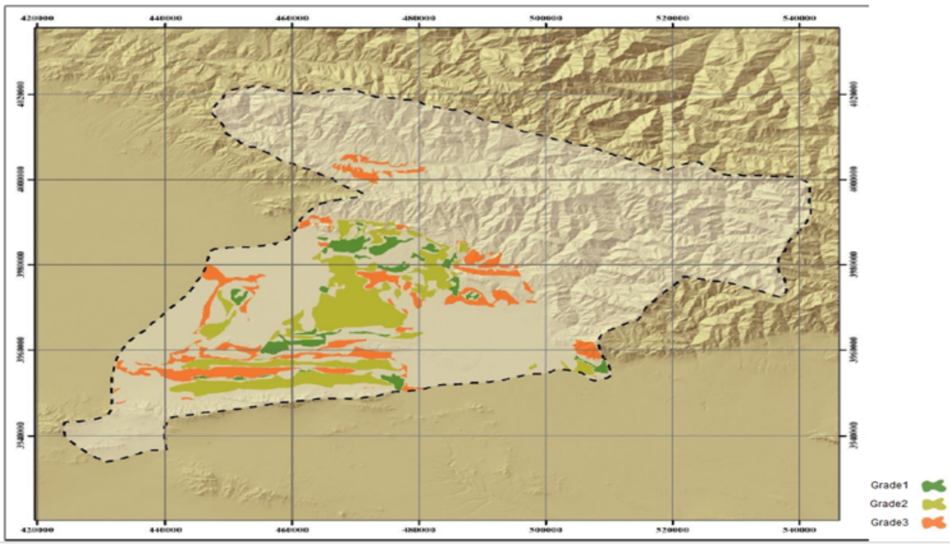

Figure 41. Mapping of Potential for industrial development in Alborz province by Imperialist Competitive *Algorithm* model

Table 14. Potential of area for industrial development in Alborz province by Imperialist Competitive Algorithm model

Decision model	Grade1(hectare)	Grade2(hectare)	Grade3(hectare)	Sum(hectare)
Imperialist Competitive *Algorithm*	18785.1	67090.6	53338.3	139214

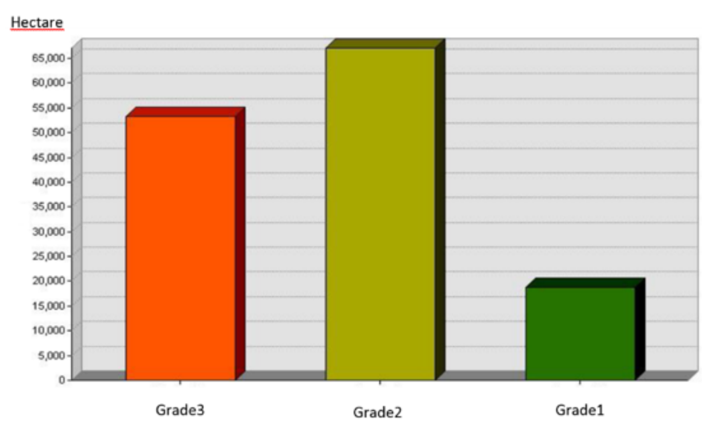

Figure 42. Chart for Abundance of potential grades for industrial development in Alborz province by Imperialist Competitive Algorithm model

In the present study, compared to the results of three models derived from the analysis of fuzzy hierarchy, genetic algorithm and colonial competition algorithm regarding the amount of area allocated for industrial development in the Alborz province, as well as from the integration of models in order to achieve the optimal model for industrial development is the study area (Tables 15 and 16, Figures 43 and 44).

Table 15. Results from Decision Models

Decision Model	Grade 1 Hectare	Grade 2 Hectare	Grade 3 Hectare	Sum Hectare
Ecological model of country Land use planning with Makhdoom model	12694.1	69352.9	46465.4	128512.4
Model Fuzzy Analytic Hierarchy FAHP	24910.4	61451	72180.7	158542.5
Model of Imperialist Competitive algorithm	18785.1	67090.6	53338.3	139214
Genetic Algorithm Model	15669.2	57591.7	64752.8	138013.7

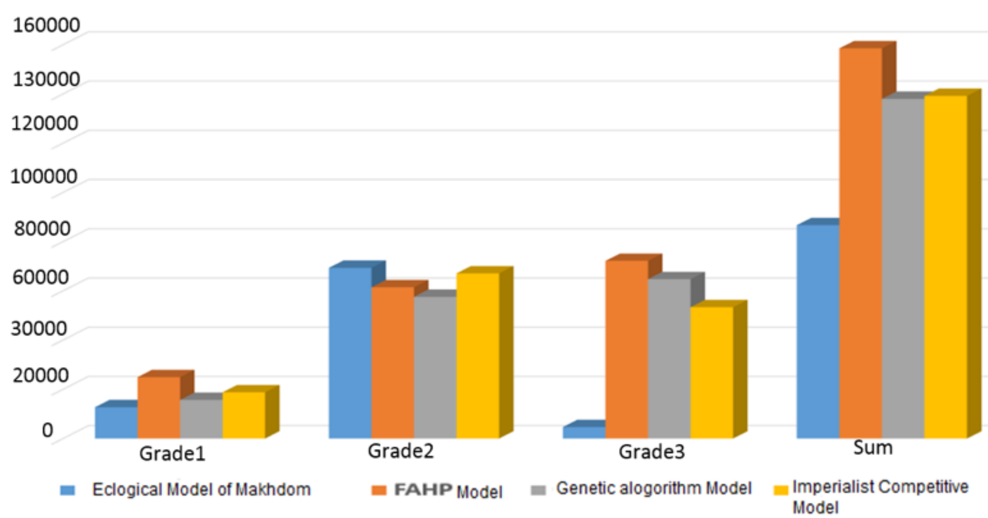

Figure 43. The results of the Decision Models are relative

Table 16. Results from Incorporation Decision Models

Incorporation Decision Model	Grade 1 Hectare	Grade 2 Hectare	Grade 3 Hectare	Sum Hectare
FAHP+ICA	15955	49521.8	40435.3	105912.1
FAHP+GA	12099.9	38106.3	34572.4	84778.6
GA+ICA	10363.7	40449.1	27236.6	78049.4
FAHP+GA+ICA	9430.2	34478	22826.1	66734.3

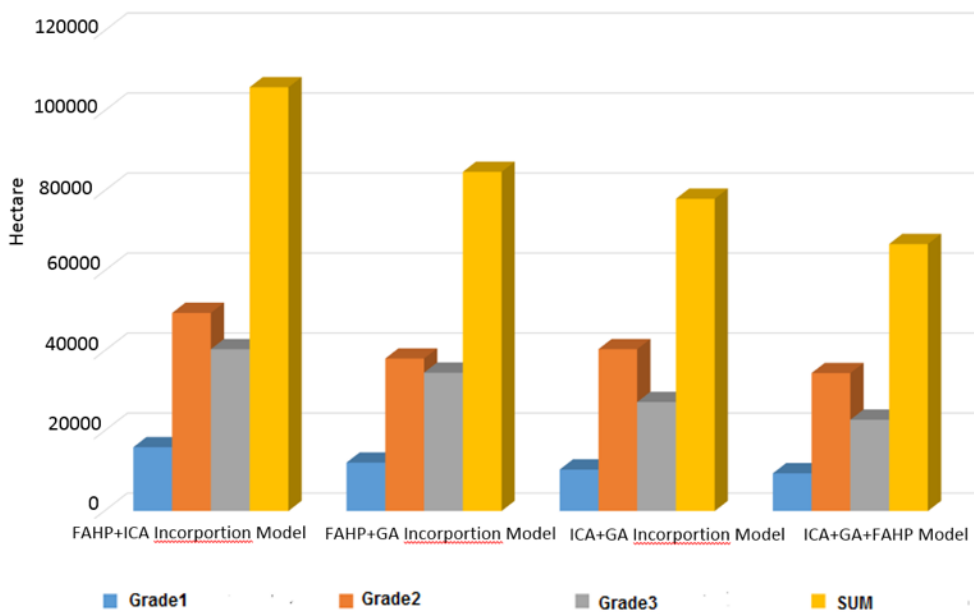

Figure 42. The results of the Incorporation Decision Models are relative

Conclusion

The findings show that in the model of colonial competition algorithm, about 140,000 hectares of Alborz province have the potential for industrial development, with the highest level of power of degree 2. Also, in optimized model of genetic algorithm, about 138 thousand hectares of Alborz province have the capacity for industrial development; the highest level is about grade 3 power. Extensible area for all levels of power in the model of colonial competition algorithm is more than the fuzzy hierarchical analysis model. Also, the industrial development able area for all levels of power in the fuzzy hierarchical model is more than the genetic algorithm model. Finally, the expandable area for all levels of power in the model of the colonial competition algorithm is slightly more than the genetic algorithm model. In the table 17 below (+), the sign of an increase in the arena level (-) is a sign of a decrease in the arena level.
According to the results of model comparison, the proposed model is the result of overlapping of three models of fuzzy hierarchy analysis and genetic optimization algorithms and colonial competition, which overlapping results in reducing the model error and optimizing the area of the Alborz province for development. It is an industry that has the integrity and uncertainty. In the optimal model, more than 66,000 hectares of research area for industrial development is potent. The area of the arenas with potential for industrial development in the research area of the proposed model has been optimized and decreased in comparison with the land use model prepared by the Alborz Governorate in 2014. The results are available in Tables 18, 19 and 20. The Figures 45 and 46 show the result model on map.

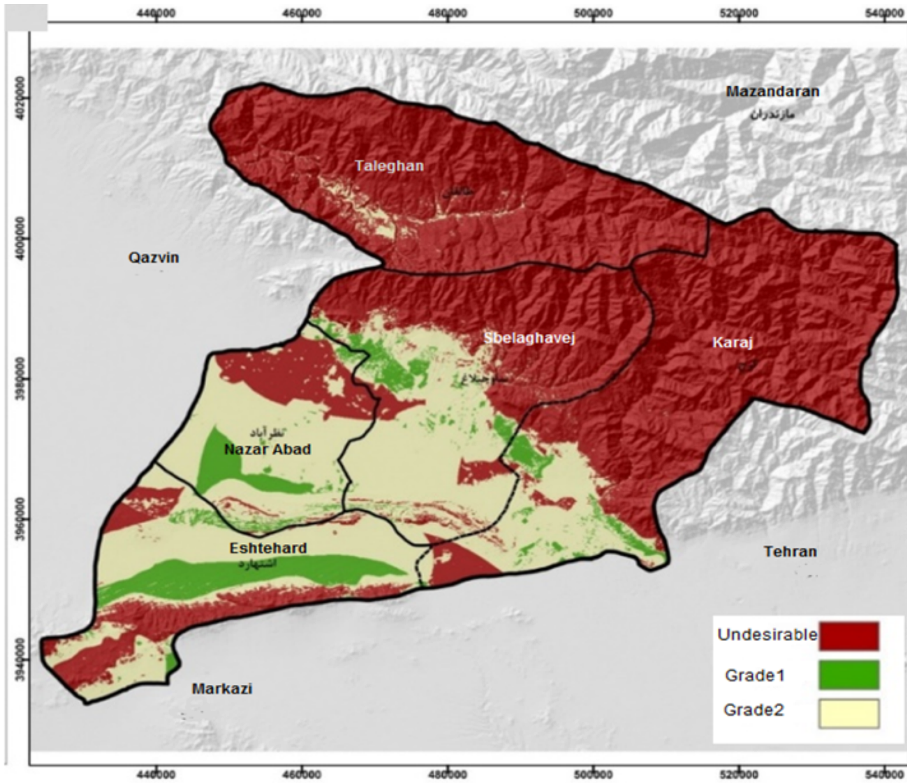

Figure 45. Zoned provincial (Makhdoom) model

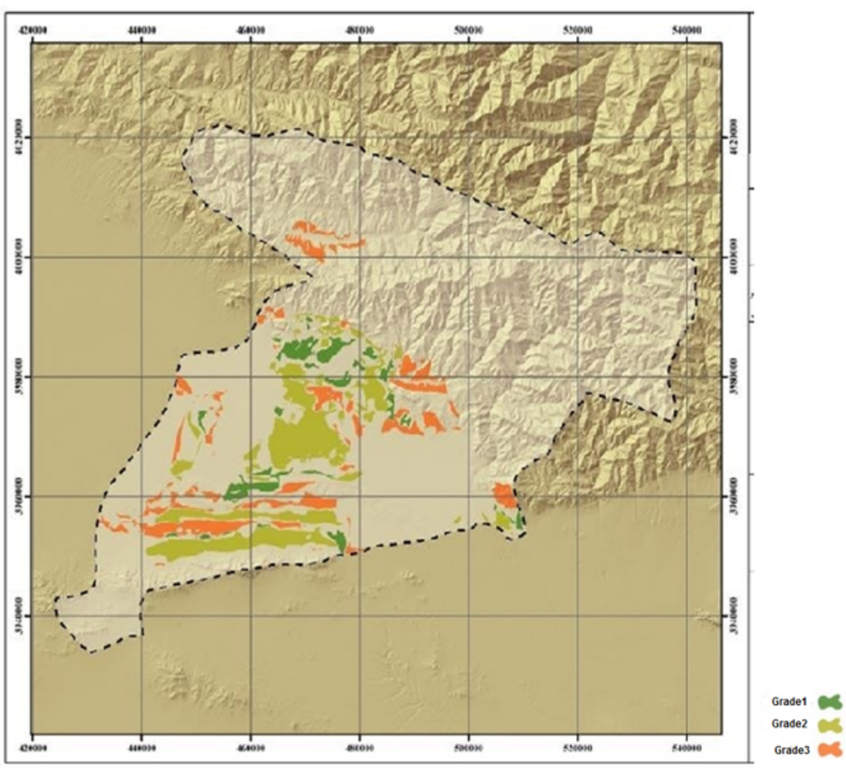

Figure 46. Presented model from incorporation of ICA+GA+FAHP models

Table 17. The results of comparing all decision models relative to each other

Decisions model	Grade1 Hectare	Grade2 Hectare	Grade3 Hectare	Sum Hectare
Makhdom				
FAHP	+	-	+	+

Decisions model	Grade1 Hectare	Grade2 Hectare	Grade3 Hectare	Sum Hectare
Makhdom				
ICA	+	-	+	+

Decisions model	Grade1 Hectare	Grade2 Hectare	Grade3 Hectare	Sum Hectare
Makhdom				
GA	+	-	+	+

Decisions model	Grade1 Hectare	Grade2 Hectare	Grade3 Hectare	Sum Hectare
FAHP				
ICA	-	+	-	-

Decisions model	Grade1 Hectare	Grade2 Hectare	Grade3 Hectare	Sum Hectare
FAHP				
GA	-	-	-	-

Decisions model	Grade1 Hectare	Grade2 Hectare	Grade3 Hectare	Sum Hectare
ICA				
GA	-	-	+	-

Decisions model	Grade1 Hectare	Grade2 Hectare	Grade3 Hectare	Sum Hectare
ICA + FAHP				
GA+ FAHP	-	+	-	-

Decisions model	Grade1 Hectare	Grade2 Hectare	Grade3 Hectare	Sum Hectare
ICA + FAHP				
GA+ ICA	-	-+	-	-

Decisions model	Grade1 Hectare	Grade2 Hectare	Grade3 Hectare	Sum Hectare
GA + FAHP				
GA+ ICA	-	+	-	-

Decisions model	Grade1 Hectare	Grade2 Hectare	Grade3 Hectare	Sum Hectare
GA& FAHP&ICA				
GA+ ICA+FAHP	-	-	-	-

Table 18. The results of comparing all decision models relative to each other

Model	Grade1 Hectare	Grade2 Hectare	Sum Hectare
Zoned provincial (Makhdoom) model			
The proposed model: The incorporation of Genetic + FAHP+ICA	-	-	-

Table 19. Total of area Potential for industrial development in Alborz province by Makhdoom model.

Province	Grade1 Hectare	Grade2 Hectare	Sum Hectare
Alborz	33638	152982	186620

Table 20. Total of area Potential for industrial development in Alborz province by presented model

Presented model	Grade1 Hectare	Grade2 Hectare	Sum Hectare
from incorporation of ICA+GA+FAHP models	9430.2	34478	43908.2

The innovation of this research is the use of intelligent meta-intelligence algorithms for colonial and genetic competition to optimize the model that has so far not been used with the purpose of this study. And such a comparison has been made for the first time in this research to determine the power and the field. Also, this compilation method has not been carried out in any research yet. Two colonial and genetic competition algorithms have been used separately in this research, but to overcome weaknesses, their integration has been used to obtain an optimal model. The proposed model is a fuzzy optimal model and its decision-making power is much higher and riskier. That is, the industrialization classes provided are definitely at the implementation stage providing more maneuverability for decision making. Because the ecological model of the country's response to the ground gives another response, as with local groups and field visits, its weaknesses are overcome. With the test done in this study, given that genetic algorithms and colonial competition are intelligent, the errors are minimized, especially in combining their results. Also, in ecological model, Makhdoom's method does not apply expert opinions such as wetland index in Alborz province which is not present but, in the model, presented indices of the province are used.

The results of this study indicate that the use of genetic algorithms and colonial competition in optimizing the industrial development model for each area of the country have a good application and the integration of their results in the preparation and presentation of industrial development models with the least error and has more flexibility and the possibility to optimize the native criteria of the study field in a smart structure. This method makes it possible to assign optimal weight to the specified criteria. The combination of the results of these two algorithms in modeling makes analyzes to be less risky and more flexible than Boolean logic. According to Boolean logic, there is more flexibility. Also, the use of the algorithms is simple because of the ease of use and multiplicity of repetitions to achieve the best goal in the process of manufacturing highly intelligent industrial positioning models and have a higher decision-making capability due to the fuzzy range of 1-0. With these algorithms, more reliable responses can be obtained and the advantages of this systematic repeatability method are that their repeated implementation allows the optimal weighing in accordance with fuzzy logic to locate potential areas prone to industrial development with a range of proportions Attention is drawn to the ecological, economic, and social criteria of the native area of the study, and a wide range of decision makers can use the results of this method analysis to provide industrial location models by changing the criteria and optimizing their weight and

making the result easy To observe Optimizing the weight of the criteria in this way provides the basis for judgment and provides an agreement between experts, stakeholders and decision makers.
Suggestions:

1. Power maps are mainly based on the capabilities of the earth, in which social, political, and economic factors are not taken into account and the consequences, despite the existence of laws, codes, and environmental assessment notices, are not clear. The Strategic Environmental Assessment, approved and approved by the 5th and 6th Development Plans, should be used for industrial development policy in Alborz Province.
2. Infrastructure factors and human resources are important to industrial development. The maps produced in future studies should be explored using these two factors.
3. In order to really plan for planning, it is suggested that the optimal model presented as a model and native model be used to allocate the province's areas to investors for the establishment of industries, because while preserving the environment and using the capacity of the province, applicants Rescued from the wanderings and accelerates the accountability of executive and regulatory bodies for licensing the establishment and operation.
4. Since the optimized model represents the priorities for the establishment of various types of activities and industrial groups taking into account the indigenous criteria of the province, it is proposed to allocate the area for the establishment of industrial settlements and to focus industrial activities on the basis of responding to applicants. This model is being implemented to avoid inappropriate and disproportionate loading of the industry and the emergence of environmental problems and concerns while creating economic prosperity in the province.
5. Since the province of Alborz is one of the important agricultural poles due to its geographical location and its agricultural capacities, it is recommended to give priority to the development of conversion industries of agricultural products and food industry in the optimal model. The priority is to issue a license to deploy the industry to investors with this industrial group.
6. Regarding the issue of the ban on the establishment of industry in the area of 120 km from Tehran and the immediate vicinity of the province of Alborz, on the one hand, and excluding the province's area from the ban on the establishment of industries in the 120 km radius of Tehran, according to the provisions of the Decree No. 62020/47992 dated 4/3/13, The 2012 Cabinet of Ministers, and the high volatility to create industrial units, are proposed to be used to organize the distribution and distribution of industrial groups in the province relative to land allocation to create industrial areas with the priority of activity from the native optimal model provided.
7. It is recommended to use the technique of providing the optimal model provided as a native model for locating other uses and areas (provinces) in the country.

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