Determining the ecological potential and power of Roudan city for ecotourism application using Multi Attribute Decision Making (MADM)

Fatemeh Mahdavi[1]*, Mohsen Dehghani[1]and Danehkar Afshin[2]

[1]. Islamic Azad University, Bandar Abbas Branch, Iran
[2.] Tehran University,Faculty ofthe Natural Resources, Department ofFishery and Environment, Iran

ABSTRACT

To assess the ecological potential is to realize the potential capacity of the land within the framework of feasible applications meeting all the expectations. Optimized utilization of the resources and attractions of the tourist destinations requires planning and doing this depends on a comprehensive and exact identification of the planning topic, namely the attractions. In this article, we have dealt with determining the ecological potential and capacity of Roudan city for the application of ecotourism and selection of the most appropriate ecotourism development places using multi-attribute decision making method (MADM). In this regard, 9 parameters and 28 sub-parameters were selected as the studied parameters through the identification of 11 parameters and 36 sub-parameters from different sources and evaluating them using Delphi technique. Then, the selected parameters were weighed and prioritized using Analytical Hierarchy Process (AHP) and assisting from the EX software. Finally, the geo-spatial layers' map for the selected parameters was prepared using ARC GIS10 in GIS environment and then they were overlapped and combined with each other after applying the importance coefficient and the regions apt to nature excursion development were identified. According to the obtained results, the parameter of natural excursion resources as the most important parameter and the human settlements as the least important parameter amongst 9 parameters were identified. In addition, the results showed that regions with low degree of potential with 141323.5 hectares and 43.4 percent of the total lands have allocated most of the land area in city of Roudan. 9.1 percent of the total land area of this city including 29711.3 hectares has high potential, 57327.9 hectares of the city level equivalent to 17.6 percent have average potential and about 97344.4 hectares equivalent to 29.9 percent are covered by the lands lacking the potential for ecotourism development.

Keywords:evaluating the ecological strength, Tourism- Multi-attribute decision making method,Roudan city, Geographical information system

1. INTRODUCTION

Tourism is a process which has existed with all its specific forms from the ancient times so that the mental, cultural, social and economic demands of the human beings can be met. One of the growing branches of this industry is named as ecotourism.

Today's tourism has become one of the main levers of economic and social development in many parts of the world [1]. The tourism in the regions should be based on the sustainable development to preserve the nature as well as preserving the region's historical and cultural heritage as well as the intellectual application of the natural resources. Ecotourism development aligned with eco-environmental potential of the land as an effective tool and approach plays a major role in sustainable development, promoting the life standards of human society and maintaining the natural equilibrium [2].

Assessment of ecological potential is an effective step and suitable tool in order to direct the present activities and functions done for the land toward a sustainable development [3]. Minowa and Phua[4] have planned for the forested areas of Kinabalu region in Country of Malaysiafor the purpose of preservation and ultimately, they selected two regions with preservation value using multi-attribute decision making method, cluster analysis method and a geographical information system. Using the multi-attribute decision making method, OK [5] studied the sites suitable for ecotourism in Ignidai forests of Keirkolarie province located in the West North of Turkey on basis of 28 attributes and finally, he identified 19 ranges suitable for developing tourism. He selected the options of horse riding, shooting, water sports and fishing as the most convenient tourism development options. Tsuar et al. [6] identified assessment parameters for tourism sites using Delphi technique. The local people, tourists and managers were interviewed and finally, the sustained ecotourism parameters system was defined for managing the tourism sites studied in Taiwan. Bender [7] developed parameters and attributes for evaluating the ecotourism destinations in Virginia, United States of America using the questionnaire method of Delphi and weighing linear combination method. Finally, the results of the study has resulted in creating an assessment system including 9 parameters to assess the conditions of tourism destinations and a system including 7 parameters to evaluate the way of managing the tourism destination. Effat and Hegazy[8] zoned the region of Suez located in Egypt using the multi-attribute decision-making and

cartographic models for expansion of tourism. Finally, they presented the map of sites appropriate for tourism in 3 offshore development, excursion and cultural development sections. BabaieKaffakie et al. [9] studied the assessment of ecological potential of 1000 hectares of forests located in Bon city in Kurdistan province by means of multi-attribute decision making method based upon geographical information systems. The results showed that the studied region had the potential for forestry, pasturing, ecotourism, bee-keeping, dry-farming, Irrigation farming, gardening and agriculture and the current application of the lands have not been in accordance with the ecological factors and does not correspond with the achieved potential for approximately more than 70 percent of the scope being studied. Pirmohammadi et al. [10] evaluated the ecological capacity of SamanAraf Cham Hajji of Kakareza forest (Lorestan Province) using tourism model and benefiting from the geographical information system for the ecotourism application and finally, they divided the studied range into preservation regions, first class focused outing, second potency focused outing, first class extensive outing. SoleimanMahini et al. [2] evaluated the ecotourism potential of Behshahr city using the multi-attribute evaluation method by means of geographical information system and they found that out of the total land area of the city, about 82400 hectares of the land has a limited capacity, about 4500 hectares of the land has high capacity, about 55000 hectares has an average capacity and about 2600 hectares of the land have a weak capacity for the extensive ecotourism.

One of the ways for identifying and evaluating the ecological capacity of each region is the application of the multiple attribute decision making method (MADM) and compared to other indices, it has identified the sites with the ecotourism potential in city of Roudan and ultimately, it suggests the places suitable for ecotourism development in that city.

2. MATERIALS AND METHODS

The under study range (land area)

The studied range in this study is the Roudan city located at the East Hormozgan Province which is situated at the geographical coordinates ranging from 56 degrees and 50 minutes to 57 degrees and 29 minutes of eastern geographical longitude and from 27 degrees and 5 minutes to 27 degrees and 59 minutes of northern geographical latitude. The distance from the Roudan city (capital of the city) to Bandar Abbas is approximately 100 km/s. The land area of this city is 3044.4 square kilometers and consists of 4 districts, 3 cities and 10 rural areas. Figure 1 demonstrates the geographical condition of city of Roudan and its administrative divisions in Hormozgan province.
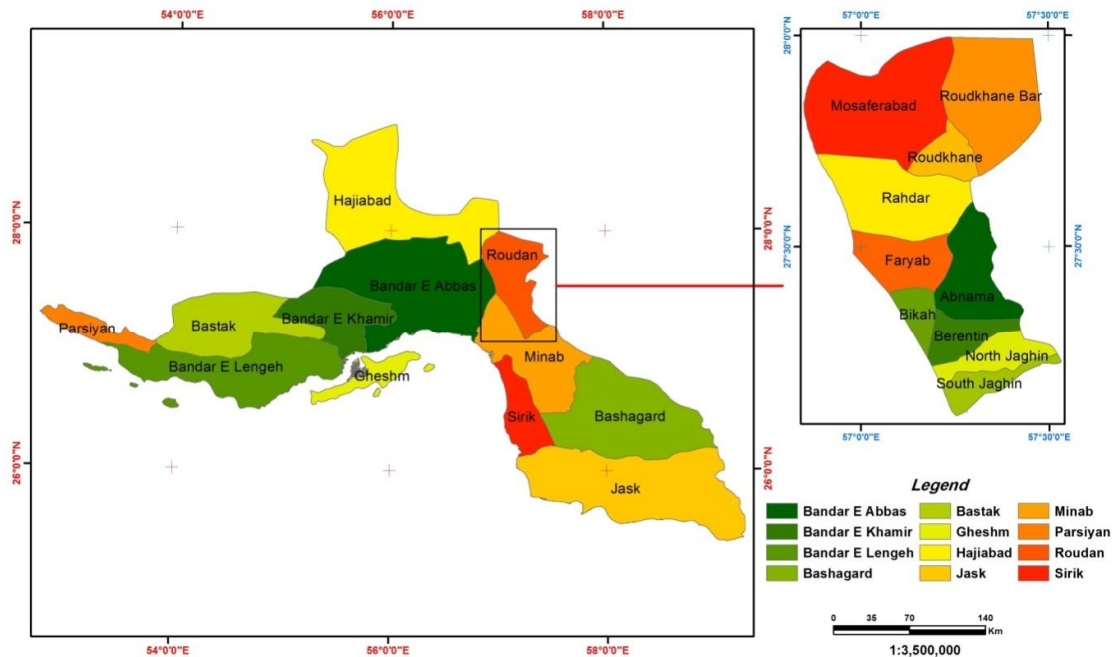

Figure 1. The situation of Roudan city in Hormozgan Province

Research's Methodology

Taking the nature and methodology used in terms of the theoretical basics into account, this research is considered as one of the descriptive studies and it is of applied type in terms of the effect and relationship and in line with this, we can summarize the methodology of the research as follows:

A- Identifying and selecting the parameters of tourism development: To obtain the appropriate selection criteria for tourism sites, first of all, different parameters used for selecting these sites by different local and foreign authorities were gathered by means of a documentary review. Brown et al. [11] used three major economic, social and ecological criteria in order to select the tourism sites. Nouri et al. [12] used the parameter of recreation to access the sites suitable for tourism. Kit Sieve et al. [13] used 10 parameters of population, number of stores, active agricultural regions, and regions with fallow agriculture, number of beds of the hotels, phosphate concentration, nitrate's concentration, aluminum's concentration and the phytoplankton concentrate in order to plan for tourism. Batacharia et al. [14] used the parameters of health of ecosystem preservation, preservation of cultural heritages, ability of the environment in order to develop ecotourism, tourists' satisfaction, Winning capacity, the public participation and generated awareness to do this. Makhdoom[15] made use of parameters of slope, stone and soil, geographical direction, water, plant, climate and weather in order to select the arenas suitable for the concentrated and extensive recreations. The official deed of ecotourism has indicated the parameters of climate, physical appearance, and resources of water, environment's quality, vegetation, wildlife, the economic and social parameters, historical and cultural appearance, physical appearance and the managerial aspects in order to select the tourism sites [16]. Felcher[17] has used the parameters of local field and regional field, area of the region, accessibility, the land's shape, physical attributes, the adjacent lands' use, and proximity to the natural regions, quality of visibility, animals, vegetation and water. Ardekani[18] has benefited from the parameters of free water surface, distance from the land faults, distance from the sea, distance from the human applications, vegetation, type of land application, demands for recreation, security, the landscape and immunity in order to determine the spots of ecotourism. Therefore, 11 major parameters and 36 sub-parameters were selected and finally, the chosen parameters were assessed after being made consistent with the different studies conducted for selecting the sites associated with different tourism arenas.

B- Evaluating the selected parameters and formulating the final parameters: The experts' opinion poll method or Delphi2 method in relation with tourism was used for evaluating formulated tourism parameters and determining their relative importance for tourism development. In line with this, first of all, the Delphi questionnaire based upon 11 main parameters and 36 secondary parameters were prepared and formulated. Then, the mentioned questionnaire was sent in order to be completed by the targeted population for 39 specialized individuals from the universities and scientific institutes and the related administrative bodies. Finally, the completed questionnaires were analyzed using SPSS software and the final attributes of ecotourism development including 9 major parameters and 28 secondary parameters were identified and formulated.

C- Creating hierarchical structure and determining the parameters' relative weight: Creating a hierarchical structure is the first step taken for studying AHP3 problem where the problem's levels are in relation with each other by a regular and logical order and the complicated systems maybe best comprehensible with the formation of these levels and analyzed to their constituting components. In fact, the analysis hierarchical process (AHP) is a graphical display of a real problem where the general target of the problem lies in the top level and the parameters and options lie in the next layers [19].

The appropriate method for creating the hierarchy is to define the general objective and complete analysis of the problem. For this relationship, in order to create a hierarchical structure, first of all, the total objective of the research which includes determination of the ecological potential and capacity of Roudan city was determined for the purpose of tourism application and then, using the main parameters and their sub-parameters, the hierarchical tree was created, and, in the next step, using matrix method and making some pair comparisons the relative importance of the parameters and sub-parameters were determined that in this relationship, the questionnaire based upon the pair comparison matrix was firstly formulated and was made available for the experts to give their viewpoints about them. Then, the collected questionnaires entered into Expert Choice software and the consistency rate of the completed questionnaires was reviewed. Taking the existence of consistent judgments of the experts into account and mixing them with geometric mean method of the questionnaires, the relative weight of parameters was determined. It is necessary to mention that all the calculations in relation with consistency rate and parameters' weight parameters were done by the Expert Choice11. According to the calculations, the consistency rate was obtained equal to 0.0037 and since it is less than 0.1, the completed questionnaires enjoy a desirable level of consistency.

D- The major and secondary parameters: Measuring the major and secondary parameters with the objective of determining ecological capacity of Roudan city has been considered as the most essential stages of research. After selecting the major parameters and sub-parameters and passing through all the stages in relation with their selection and obtaining their relative weights during the previous stages, they should be measured. Therefore, by considering the parameters' types, in terms of spatial or non-spatial parameters, the drawing of each parameter was prepared using the considered parameter's data in the GIS software applications.

E- Incorporating parameters and determining the regions apt to tourism: After determining the parameters, they were incorporated with each other and the regions suitable for tourism development were determined:

$$R.E.T = 0.114 \times Cl + 0.116 \times W.R + 0.116 \times Co + 0.101 \times Wl + 0.129 \times N.R + 0.107 \times H.R + 0.121 \times F.T + 0.089 \times H.P + 0.108 \times T$$

Where:

H.P- *Parameter of human settlements*   R.E.T- *Regions suitable for tourism development*
Cl- *Weather and Climate parameter*   W.R- *Water resources parameter*
Wl- *Wildlife and habitat parameter*   T- *Parameter of tourism season*
F.T- *Tourism infrastructure parameter*   H.R- *Parameter of human recreational sites*
N.R- *Natural recreational resources parameter*   Co- *Vegetation parameter*

3. RESULTS

The findings of this research have been given in two separate sections; in the first section, the findings related to parameter selection and their relative weight and in the second section, the findings related to parameter determination and the regions apt to tourism development.

A- Findings related to the parameter selection and their relative weight: Considering the library studies and referrals to various sources, 11 main parameters and 36 sub-parameters were selected and using Delphi method, they were processed by 39 questionnaires completed by the experts in SPSS software.

The Review of the completed questionnaires demonstrates that the natural recreational parameter with the importance degree of 77 percent is considered as the most significant parameter and the parameter of soil with 39 percent importance degree is the least significant parameter among 11 selected parameters. Considering the low importance of topography and soil parameters from the viewpoints of the experts, they were omitted from the calculations, and finally, the number of the major parameters of the research reduced to 9 parameters. Diagram 1 shows the relative importance of the parameters from the point of view of the experts.
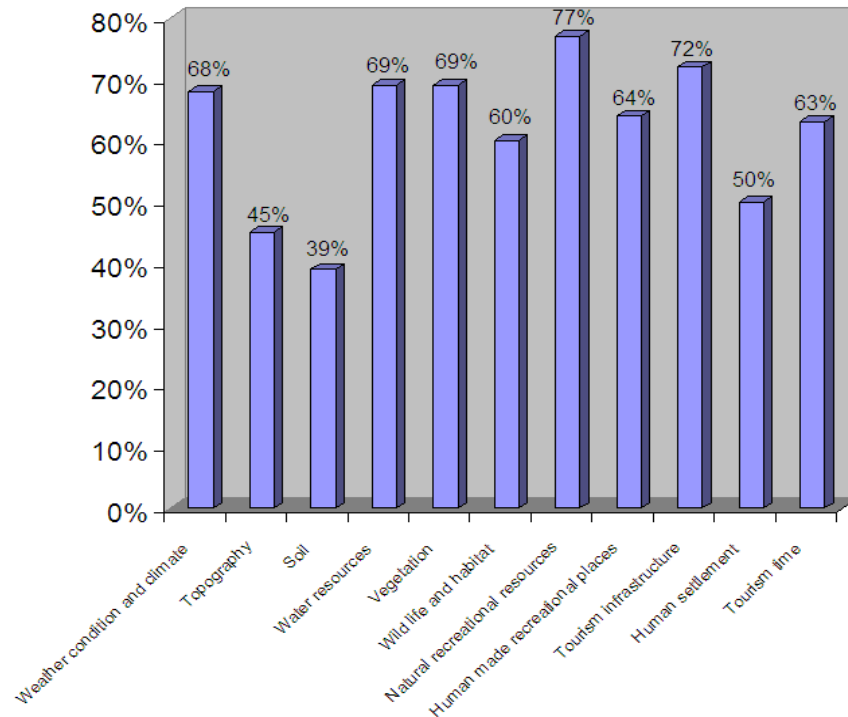

Diagram1. The relative importance of the parameters assessed by means of Delphi questionnaire

The results of the processing of completed questionnaires in sub-parameters' section demonstrates that the accessibility sub-parameter having 76 percent of importance level is the most significant sub-parameter and the number of sunny days sub-parameter having 48 percent of degree of importance are considered as the least significant sub-parameter among 36 sub-parameters according to the experts. Taking the average relative importance of the sub-parameters as 50 percent average amount, the sub-parameters the relative importance of which were below the average one, were omitted from the calculations. Thus, 9 sub-parameters out of 36

selected sub-parameters were omitted and another sub-parameter was added to them. Ultimately, the number of the sub-parameters was reduced to 28 parameters in order to determine research objectives. Diagram2(a, b) demonstrates the relative importance of the selected sub-parameters from the experts' viewpoints.
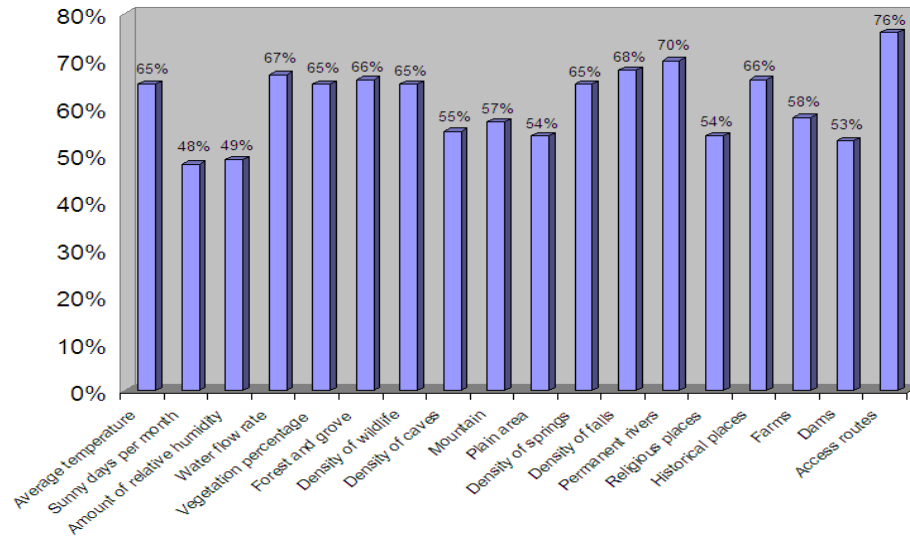

Diagram2a. Diagram of Importance degree of sub-parameters assessed using Delphi questionnaire
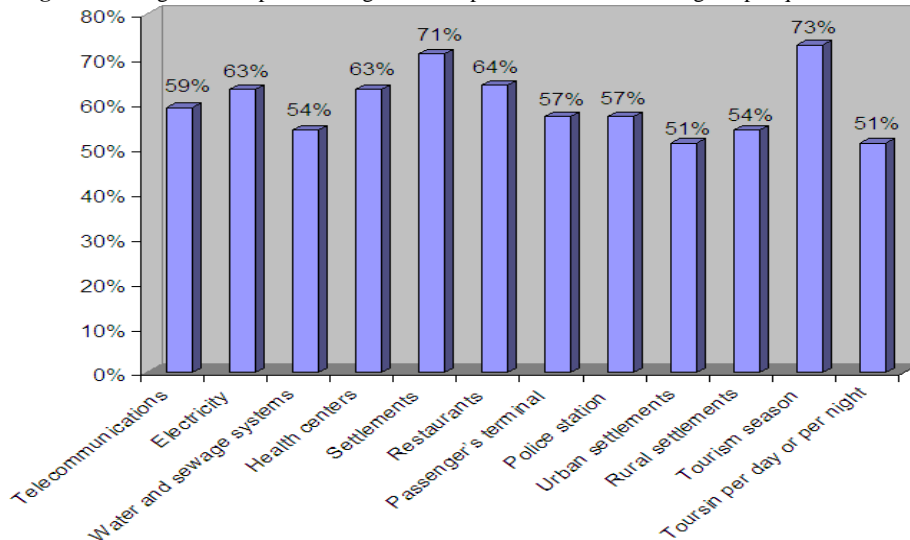

Diagram2b. Diagram of importance degree of sub-parameters assessed using Delphi questionnaire

To calculate the relative weight of parameters and sub-parameters selected from the Delphi method, we used AHP questionnaire and by this method, the questionnaire was formulated and all the collected data entered into Expert Choice software. Then, the relative weights of parameters and sub-parameters were estimated. The Table 4 shows the relative weight of the calculated parameters on the basis of AHP questionnaire and use of the Expert Choice software. Therefore, the natural recreational resources' parameter with 12.8 percent has the highest weight and the human settlements' parameter has the least weight with 8.9 percent of weight. Also, the parameter of tourism infrastructures having 12.1 percent, water resources and vegetation having 11.6 percent of weight and the weather and climate having weight of 11.4 percent are ranked next, respectively.

B- Findings related to determination of parameters and regions apt to tourism: One of the major stages of the research's conduct is to measure 9 main parameters and 28 sub-parameters in order to determine the ecological potential of city of Roudan. Considering these parameters being spatial or non-spatial ones, their information layers were provided in GIS benefiting from ArcGis10 software. Since there is a large number of drawings and information layers of parameters and sub-parameters, we have withdrawn from stating all these layers in this article. When the parameters were determined using their relative weight, they were combined with each other, and finally, the regions apt to tourism were identified. Table 1 demonstrates the surfaces of the lands having the capacity or potential for tourism development in Roudan city. In addition, Figure 2 demonstrates the regions having various capacities in terms of tourism development in this city.

Based on the drawing obtained, 29711.3 hectares of the city's lands have high development potential, 57327.9 hectares of these lands have average development potential, 141323.5 hectares are of low potential for tourism development and 97344.4 hectares of the lands lack the tourism development potential.

Table 1. Ecological potential of the lands of city of Roudan for tourism development

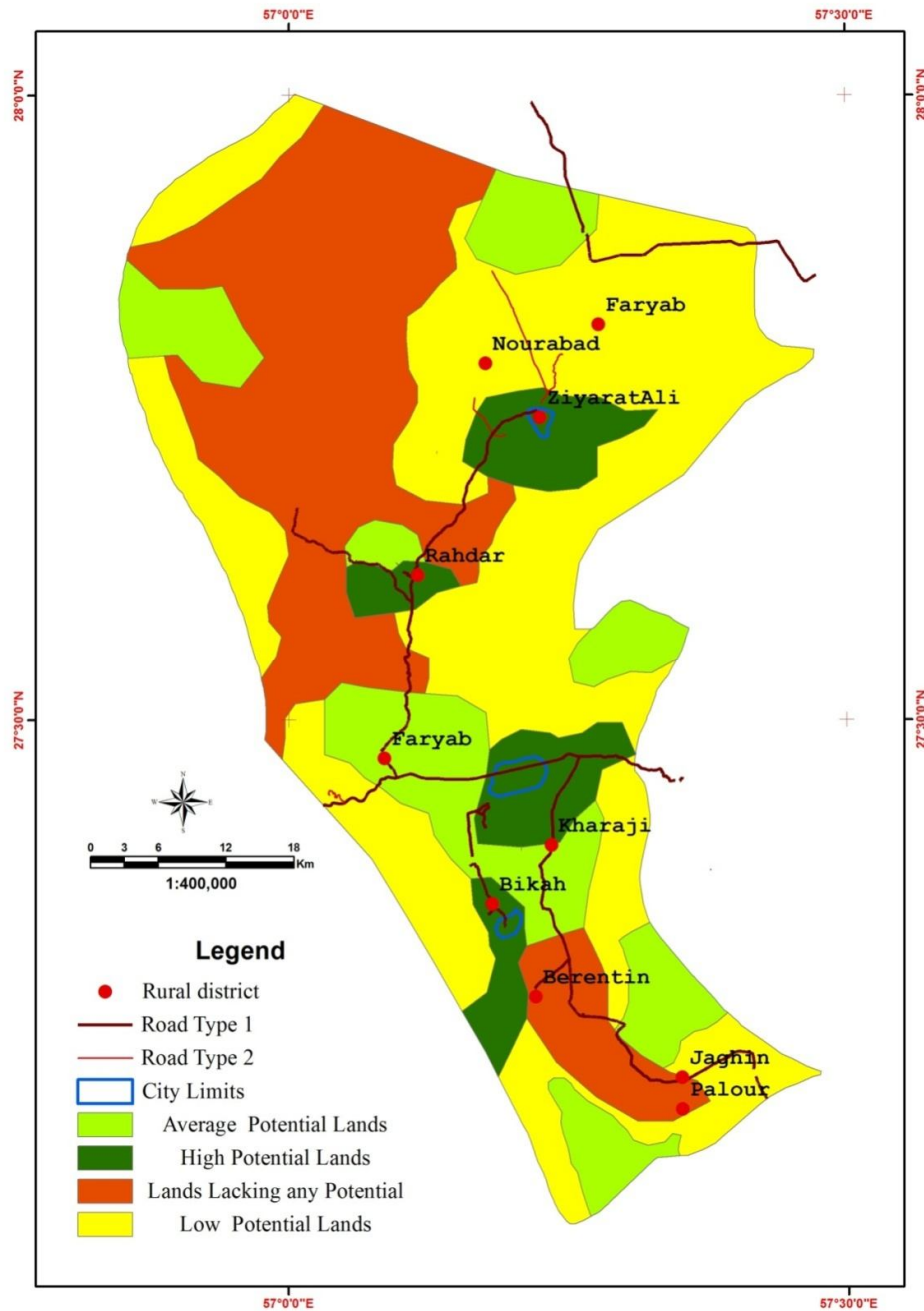| No.	Area (Hectares)	Layer's name	Percent
1	29711.3	High potential lands	**9.1**
2	57327.9	Average potential lands	**17.6**
3	141323.5	Low potential lands	**43.4**
4	97344.4	Lands lacking potentials	**29.9**

Figure 2. Assessment of tourism development's potential in Roudan city

Priorities with respect to:
Eco tourism

Inconsistency = 0.00037
with 0 missing judgments.

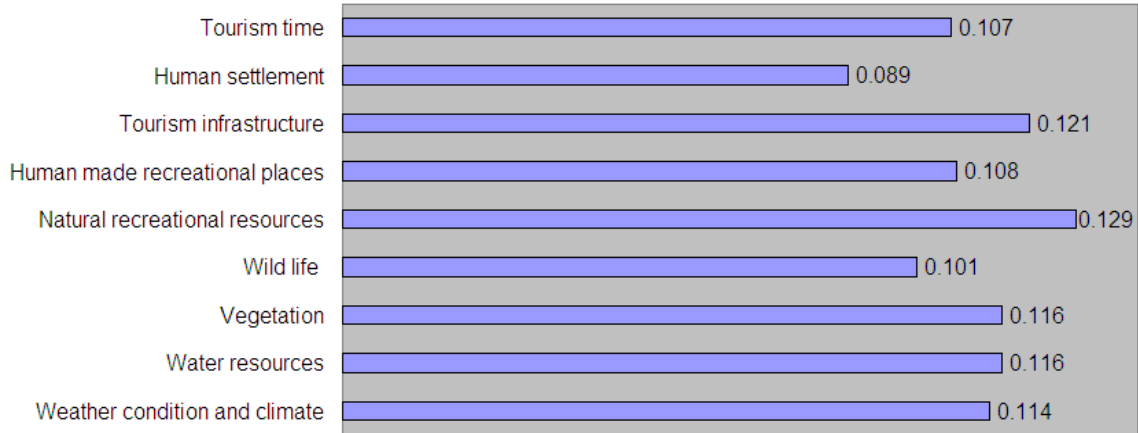| Parameter	Value
Tourism time	0.107
Human settlement	0.089
Tourism infrastructure	0.121
Human made recreational places	0.108
Natural recreational resources	0.129
Wild life	0.101
Vegetation	0.116
Water resources	0.116
Weather condition and climate	0.114

Diagram 4. The relative weight of the parameters calculated by means of Expert Choice software

4. DISCUSSION AND CONCLUSION

The results of this study, which is an attempt for reviewing the parameters experienced in Iran and throughout the world aiming at localizing it for the site selection application for the ecotourism in the city of Roudan, demonstrated that both parameters and sub-parameters extracted from different resources are applied for identifying the regions suitable for ecotourism in city of Roudan including 9 main parameters and 28 sub-parameters. Reviewing the general results of this study and comparing it with the results of other similar studies made with respect to evaluating the ecological potential for the purpose of tourism application, we understand that in most conducted researches, smaller number of attributes has been used compared to this research. The study of the attributes used for different results demonstrates that the attributes have been applied in the research's calculations without any assessments, while, in this study, the attributes' relative importance was calculated after being assessed by means of Delphi method and then, they entered into the research calculations. The studies showed that the natural recreational resources having 77 percent of relative weight has enjoyed the highest degree of importance and in practice, 56.4 percent of the experts and respondents have identified this parameter as one with the very high level of importance, 25.6 percent of the experts identified it as the parameter having high importance for selecting ecotourism's suitable regions amongst the natural ecosystems. Based on the obtained results, the regions having a low potential level with 141323.5 hectares and 43/4 percent of the total lands have allocated most land area of the lands in Roudan city to itself. 9.1 percent of the total area of the city including 29711.3 hectares has high potential, 57327.9 hectares from the surface of the city equivalent to 17.6 percent has average potential and about 97344.4 hectares equivalent to 29.9 percent of the lands lack the potential for ecotourism development. According to the results and the implementation of the regions apt to tourism in the geographical information system and other existing information, it is clear that the central regions and the regions close to perennial streams have the most potential in terms of ecotourism application and the reason for this to happen is the concentration of tourism targeted villages of Abnama, ZiaratSeyedSoltan Mohammad, Ziaratali and so on in this district of the city. The study of the map of the regions apt to development of tourism in the city of Roudan indicates consistency of high potential regions with the current utilization from these regions including the pilgrimage and touring status of Abnema and SeyedSoltan Mohammad villages as tourism sites and villages that are placed amongst the high capacity regions in the obtained map. Besides, the existence of the natural resources in the city was identified as the most important determining attribute of the regions. Amongst the most important resources and facilities of the city, one can mention to the existence of perennial streams of Roudan and Jaghyn which were considered as the important factors of tourist attraction. It is suggested that the researches study the ecological potential and capacity of the other regions of Hormozgan province in terms of the ecotourism application.

REFERENCES

1. Bahreini, S.H. &JahaniMoghaddam, H. 2004.Benefiting from the potential capacities of the regions for tourism development of the Oil Museum Park of MasjedSoleiman, ecology, No.35, pages 33-50.
2. SoleimanMahini, A. et al. 2009.Evaluating the ecotourism potential of Behshahr city based on the multi-attribute evaluation method using GIS, environmental science and technology, eleventh volume, no.1.
3. Ranjbari. R., Danehkar,A.&Riazi,B. 2009. Evaluation of the ecological potential of Nayband's offshore-onshore national park in province of Boushehr for recreational and environmental science & technology purposes, eleventh volume, no. 4.
4. PhuaMui-Howand Mitsuhiro Minowa.2004. A GIS-based multi-criteria decision making approach to forest conservation planning at a landscape scale: a case study in the Kinabalu Area, Sabah, Malaysia. Landscape and Urban Planning 71(2005): 207–222. Available online: www.sciencedirect.com.
5. Ok, K. 2005. Multiple Criteria Activity Selection for Ecotourism Planning in Igneada. Turk J Agric For 30(2006) 153-164. Available online: www.sciencedirect.com.
6. Tsaur,S.H., Y.C., Lin,and J.H.,Lin.2006.Evaluating ecotourism sustainability from the integrated perspective of the recourse, community and tourism. Tourism Management, 27(4):640-653.
7. Bender, M., Y.2008.Development of criteria and indicator for evaluating forest – based ecotourism destinations: A Delphi study.M.Sc. Thesis of West Virginia University.
8. Effat H.&Hegazy,M.N. 2009. Cartographic modeling and multi criteria evaluation for exploring potentials for tourism development in the Suez governorate, Egypt. Society and Environment, Stuttgart University of Applied Sciences. Available online: www.sciencedirect.com
9. BabaieKafaky, S. et al. 2009. Ecological Capability Assessment for Multiple-Use in Forest Areas Using GIS- Based Multiple Criteria Decision Making Approach. American Journal of Environmental Sciences 5(6): 714-721.
10. Pirmohammadi. Z.Feghhi. J., ZahediAmiri. Gh.D.&Sharifi, M. 2008. The application of GIS in evaluation of ecological potential for tourism application, fourth geology and environment national forum in Islamic Azad University, Islamshahr branch.
11. Brown, K. et al. 2001. Trade –off analysis for marine protected area management.Journal of Ecological Economics, Volume 37:417-434.
12. Nouri, J. et al.2007.Evaluation of ecotourism potential in northern coastline of the Persian Gulf.Journal of environ Geol.
13. Kitsiou, D., et al.2002. Multi- dimensional evaluation and ranking of coastal areas usingGIS and multiple criteria choice methods.Journal of The science of Total Environment, volume 284:1-17.
14. Bhattacharya, p. et al. 2004. Application of criteria and indicator for sustainable Ecotourism, submitted for the IASCP biannual conference on the commons in an age of Global transitionchallenges, Risk and opportunities at Oaxaca,Mexico.
15. Makhdoum. M.2002.Land use planning foundation. Tehran university publication, fifth print, No.2203.
16. Danehkar, A, MAhmoudi, B. &Mosadeghi, R. 2006, Formulation of principles of ecotourism activities' design and development (in spots) second report of formulation and introduction of parameters and principles for developing and measuring development of ecotourism site, tourism national deed's studies, final edition.
17. Fletcher, S. 2001. Planning policy and development guidelines for ecotourism development within the northern rivers New South Wales region, Prepared by nature Tourism Task Force.
18. Ardekani, T. 2007. Provision and compilation of a sustainable tourism plan in Chabahar's gulf based on the environmental parameters, thesis of environment's natural resources engineering master's degree, natural resources faculty, Tehran university.
19. Ghodsipour, S.H. 2008.Analytical hierarchical process (AHP), Tehran, Amir KabirUniversity of technology.