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Assessment of Ecotourism Potential Using Fuzzy Analytic Hierarchy Process (FAHP) and Geographic Information System (GIS) in Do Hezar, Mazandaran Province, Iran

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ABSTRACT

The present research was done to identify and map ecotourism suitability and potential using fuzzy analytic hierarchy process (FAHP) and geographic information system (GIS) in Do Hezar watershed, Hyrcanian forests, north of Iran. Assessment of ecotourism suitability for study area could lead to improving economic situation of people and better conservation of natural resources. The analysis process was performed to produce an ecotourism suitability map, using 12 criteria selected using questionnaires completed by 50 specialists and experts in the fields of ecotourism and natural resource management. These criteria included roughness elevation, slope, rainfall, lithology, soil, land use, distance from rivers, distance from roads, distance from villages, distance from fault, and vegetation density, that were demonstrated to be related to land use planning for ecotourism. The FAHP was applied to determine weights of criteria. The weighted map was overlaid and ecotourism potential was determined on the map. The results indicated that 52.4% of the area of Do Hezar watershed has high and very high potential for development of ecotourism site. The FAHP methods were useful to determine and identify ecotourism suitability areas in order to develop ecotourism planning in the study area.

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1. Introduction

Tourism and especially ecotourism are one of the main industries in the world (Aminu et al., 2013; TIES, 2009), which will undoubtedly be the most profitable trade in the 21st century. Different countries are trying to improve their economic situation by introducing their tourist attractions. Today, tourism and ecotourism have led countries around the world to invest heavily in this sector due to its high income (Lenao and Basupi, 2016; Honey, 2009; Remblay, 2006). Mazandaran province is one of the poles of ecotourism in the north of Iran. The capabilities of this region in the field of emerging ecotourism industry including its special geographical location and having a pleasant climate, especially in spring and summer, and enjoying the natural scenery become this region as one of the administrative tourism areas especially in Do Hezar region.

Do Hezar region is one of the most pristine ecotourism areas in northern Iran. Therefore, there is a field for the development of tourism activities in the region, and also no study was done in this area about the ecotourism suitability and potential classification, the research in this field, and the evaluation of region for ecotourism potential to attracting more and more tourists seems necessary. Ecotourism, as an approach, can be beneficial for any region and its inhabitants and leads to protection of nature. This type of tourism occurs only in natural areas and plays a positive role in protection of these areas (Fennel, 2003; Brown et al., 2016; Dhami et al., 2014). Ecotourism is a new concept in tourism that was initially sparked by the idea of reconciliation with real nature and was proposed by the natural tourism community as a necessity for tourists to protect the natural heritage while traveling to natural regions (Thampi, 2005).

Ecotourism is strongly associated with sustainable tourism. On the other hand, sustainable development also depends on the relationship between environment and tourism. Sustainable ecotourism is a positive way to reduce excitement and tension created by the interactions between tourism industry and visitors, environment and host communities (Sharpley, 2006; Liu et al., 2017). The results of implementation and development of ecotourism can increase importance of the protected areas and ecosystems and increase their economic value, generate direct revenue for the protected areas, provide direct and indirect revenue for local communities, and also cause formation of coherent organizations to monitor areas (Xu et al., 2017; Akhtar et al., 2016; Wishitemi et al., 2015; Badri et al., 2015). On the other hand, ecotourism involves many activities that can have harmful effects on environment, including air, water, and soil pollution, land use change, as well as landscape degradation and reduction of environmental and aesthetic values and their harmful effects on biological resources, destruction of wildlife habitats, hunting and trade of the endangered species, and destruction of planetṡ cover (Rhormens et al., 2017; Song and Kuwahara, 2016; Chiu et al., 2014). There are some studies about ecotourism and natural environments, including ecotourism and sustainable development (Bahaire, 1999; Tsaur et al., 2006; Bunruamkaew and Murayam, 2011; Fennell, 2014), lifestyle characteristics (Iversen et al., 2016; Mehmetoglu, 2007), and effects of tourists' on natural environment and sensitive areas (Orams, 1996; Karanth and DeFries, 2011). One of ways to solve problems and reduce pressure caused by tourism activities on environment is evaluating environmental resources and capabilities of tourist areas, if these assessments are not done, irreparable damage will occur to community and environment. For preserving biodiversity of environmental resources and also, cultural heritage and economy of people living in the region, proper management is required for development of ecotourism (Wall, 1997). In addition, ecotourism can be used to promote value of the protected areas and financing of relevant stakeholders (Ok, 2006). Then, pressure caused by human activities on natural resources is increased and on the other hand, the limited natural resources for recreation, lack of proper ecotourism plans, and lack of proper planning cause ecotourists not to use many natural attractions and on the other hand, imbalance in population density and natural resources destroys any areas. Therefore, recreational planning in this type of tourism is not only considered as a tool to improve social and economic levels of the peopleṡ life, but also due to conservation functions, recreation as a management solution experiencing in natural environments, also provides the basis for dynamic protection of natural resources (Boo, 1990; Burton, 1997; Honey, 1999; Laurance et al., 2006; Dixon et al., 1993). One of the basic strategies to minimize the harmful effects of humanṡ activity and strengthen the positive effects of ecotourism in geographical areas is land use planning, considering natural talents and potentials for ecotourism and also a purposeful selection of geographical locations to implement appropriate programs (McCabe and Johnson, 2013; Solnet et al., 2014; Tang et al., 2017; Jiang and Ritchie, 2017; Marais et al., 2017; Nilashi et al., 2019). As a result, assessing ecotourism potential of geographical areas is an important step before ecotourism planning (Githinji, 2006). Assessment of criteria and indicators is the first step in identification of ecotourism potential in natural environments (Malczewski, 2004). The geographic information system (GIS) is among the appropriate tools used to assess ecological potential of the land geometrically, topologically, and thematically (Ghorbanzadeh et al., 2019; Karimzadeh, 2017; Liu et al., 2017). The ability of this system in relation to simultaneous processing of spatial information, statistics, integration of different maps, and also production of maps with new information has led to its application in assessing ecological potential especially in ecotourism (Aminu et al., 2013). Multi-criteria decision analysis (MCDA) methods based on GIS are a suitable decision-making framework for local planning and a new approach to analysis of potential of ecotourism in natural resources (Shokati and Feizizadeh, 2019; Ghorbanzadeh, 2020; Wei, 2012; Chhetri and Arrowsmith, 2008; Arrowsmith and Inbakaran, 2002), especially in ecotourism. The fuzzy analytic hierarchy process (FAHP) method determines relative weights of the criteria and sub-criteria, reference weights of each option, and the final weight. In multi-criteria decision making, combination of GIS and MCDA capabilities

has a key importance (Phua and Minowa, 2005). Combination of GIS with FAHP has many advantages for site selection, zoning, and environmental assessments and using these methods in suitable areas, one can establish a variety of activities in the fields of ecotourism suitability, potential, and site selection (Bunruamkaew and Murayam, 2012; Petz et al., 2014; Nino et al., 2017; Prueksakorn et al., 2018). Therefore, in this research, ecotourism potential is studied in a watershed in northern part of Iran. Iran has hundreds of attractive and spectacular places, and this advantage can be used to improve its economy. According to studies by the United Nations world tourism organization (UNWTO) and United Nations educational, scientific, and cultural organization (UNESCO), Iran is one of the top ten countries in the world with tourist attractions. Then, a lot of studies have been done about tourism in Iran, such as tourism and nature conservations (Ghoddousi, 2018), rural and urban tourism (Masih et al., 2018; Khodadadi, 2016a), tourism and sustainability (Hashemi and Ghaffary 2017; Reihanian et al., 2012), site selection of domestic tourism (Pezeshki et al., 2019), medical tourism (Moghimehfar, 2018) and finally, ecotourism (Zabihi et al., 2020). Accordingly, this study was designed aimed at modeling and mapping of ecotourism using a combination of GIS and FAHP methods. GIS in combination with FAHP methodology has proved itself as more flexible and effective rather than other methods in most previous studies (Vishwakarma et al., 2016; Liu et al., 2017; Alaqeel and Suryanarayanan, 2018, Mahdavi and Niknejad, 2014; Shamsoddini and Fahlyiani, 2016; Balist et al., 2019; Khodaian et al., 2014; Bazmara et al., 2017; Fekrizad and Vossoughi, 2017). The aim of this study, the evaluation and zoning of ecotourism potential of Do Hezar region Using Fuzzy Analytic Hierarchy Process (FAHP) and Geographic Information System (GIS) based on 15 criteria (including topographies, socio-economy, and natural) was done using GIS; finally, the zoning map of areas prone was produced to ecotourism development of this area.

2. Material and Methods

2.1. Regional Setting

The study area was located between northern parts of Iran and central parts of Alborz Mountains in Ramsar County. Its altitude ranges from 386 to 4,157 m above sea level at Sialan peak. This watershed is located near to the Caspian Sea, and from climatology viewpoint, it is classified as a temperate and mild area in summer in low-altitude to mountainous regions and also it is cold in high -altitude regions. The annual mean precipitation ranges between 567 - 976 mm and monthly mean temperature is equal to 26.1°C in July and January, respectively, and annual mean temperature reaches 16.5°C (Meteorological Station of Ramsar County, 2020). This area is extremely beautiful and has exquisite views of mountains, grasslands, high plains, and forests. Snow exists in snow clad mountains like Khashachal and Sialan peaks. Sialan peak can be considered the easternmost and the highest peak in the west-east ridge which includes the main peaks of Samamos, Khashachal, Kandigan, and Sialan. This ridge starts from the south of Samamos peak and continues to the east to Sialan peak and Se Hezar Valley. The northern slopes of Sialan peak are located in the Tonekabon region; hence, the northeastern slopes reach the valley of Se Hezar and the northwest slopes reach the valley of Do Hezar. Its southern slopes also overlook the city of Qazvin and the Alamut Valley in the southern part of the study area. The Do Hezar watershed covering an area of 292 km^2 is located in unique environments in Hyrcanian forests and has a great bio and geodiversity. Caspian Hyrcanian mixed forests are a habitat in the broad-leaved mixed forest of the southern coasts of the Caspian Sea. This forest is one of the most valuable forests in the world which is known as a natural museum (Browicz, 1989). At the 43rd meeting of the UNESCO World Heritage Committee in Baku, the capital of the Republic of Azerbaijan, the Hyrcanian forests were included in the World Heritage List with the consent of the committee members. According to the same source, this is the twenty-fourth case of Iran's historical and natural heritage included in the UNESCO list (Hosseini, 2019). Its vegetation cover of forest area includes alder, boxwood, oak, maple, beech, spruce, and Astragalus (Anonymous, 2005; Akhani et al., 2010). The mountains and forested areas of Mazandaran province have long been the habitat of valuable species of mammals. Meral, Shoka and brown bear are the leading species of mammals in the northern Hyrcanian forests. Biodiversity of

Mazandaran province is considered. Other special species of mammals include the yellow deer, wild sheep, peacock, leopard, wolf, lynx, wildcat, sheng, and fox. Animals like bears, leopard, wolf, pig, deer herds can also be seen in this area. The main river in this watershed is the Do Hezar River which is joined to Se Hezar River and forms Cheshmeh Kileh or Marz River. Cheshmeh Kileh originates from the heights of the Alamut, Takht-e-Soliman, and Kandovan mountains that is the largest river of Tonekabon in Mazandaran province of Iran. According to the census done by the statistical center of Iran (SCI) in 2016, population of study area was equal to 2,326 people (883 households). Hence, potentials for winter sports, mountaineering besides landscape, hiking, climatic beauty and nature therapy, rich biodiversity, wildlife sanctuaries, ethnic and sociocultural diversity, and adventure tourism activities make this watershed attractive for national and international tourists.

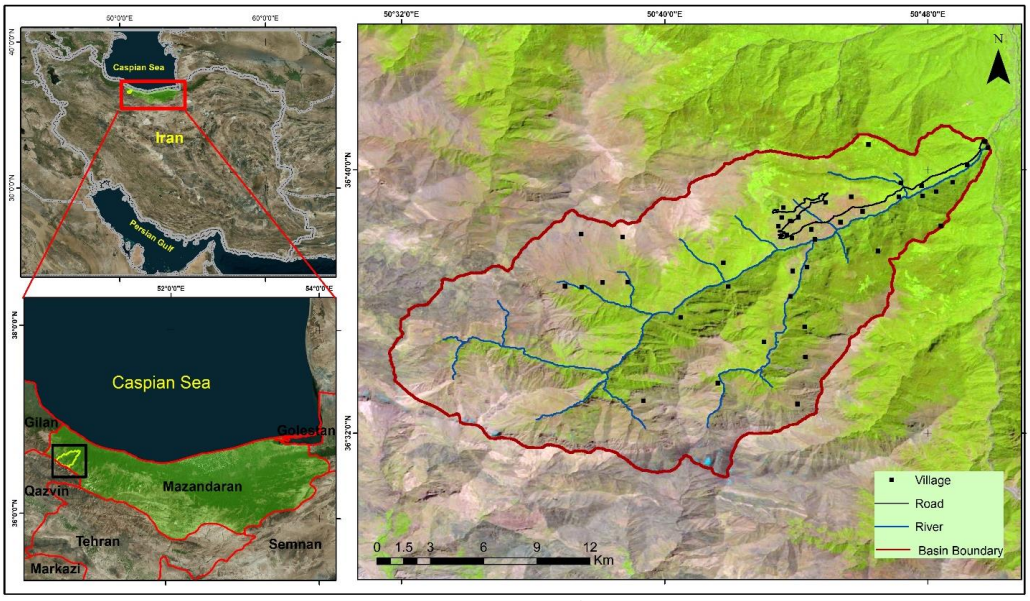

Fig. 1. Geographic location of the study area

2.2. Methodology

This descriptive-analytical study was performed using quantitative models, in which environmental and socio-economic factors were used as effective criteria in evaluating suitable ecotourism sites. This research consists of four stages, including, 1) Determining and selecting suitable criteria, 2) determining priority of factors (weights), 3) producing map layers and determining the best method for analysis (FAHP and GIS) and finally, 4) generating ecotourism potential map in Do Hezar watershed. In this research, factors, such as roughness elevation, slope, rainfall, lithology, soil, land use, distance from rivers, distance from roads, distance from villages, distance from fault, and vegetation density were selected (Table,). In the next step, FAHP model was used to determine the areas with ecotourism potential areas. In a fuzzy hierarchical analysis, a questionnaire using 9 linguistic variables based on the fuzzy method, was completed by 50 expert specialists in the fields of ecotourism and tourism sciences in 2020. Most of them were employees in organizations and universities related to the environment, geosciences, and cultural heritage (Table 1).

Table 1. Characteristics of the experts participated in interviews

Gender				**Scientific expertise**	
Female	**Male**	**Academic level**			
35%	65%	Ph.D.	75%	Geography (including Geomorphology, Regional planning, Rural geography)	30%
		Masterś degree	20%	Geology	20%
		Bachelorś degree	5%	Tourism management	40%
				Environmental planning	10%

2.2.1. Producing Map Layers

Topographic data were extracted from digital elevation model (DEM) (ALOS-PALSAR, 12.5 m) and roughness, slope, and elevation were produced in the GIS. Elevation class, slope, and roughness layers were also extracted from these data. Design and construction of ecotourism sites will be possible in places having a slight slope, and the increase in slope is considered as one of limitations in establishing ecotourism sites. Topographic roughness is one of the indices that can be used to show unevenness of the ground, especially in mountainous areas (Riley et al., 1999; Jenness, 2004). Topographic roughness is used to determine ecotourism suitability and has an inverse relationship with ecotourism (Kumari et al., 2010). Increasing topography roughness in surface has a negative effect on development of ecotourism and reduces the possibility of establishing ecotourism sites in an area, so study of this index is very important. Topography roughness is obtained from digital elevation model using Eq. (1).

$$R = \frac{H\ mean - H\ min}{H\max - Hmin} \quad (1)$$

Lithological units extracted from Geology map of Ramsar and we can find some unis such as Recent loose alluviums, Siltstone, limestone, conglomerate, Sandstone, Shale, Massive limestone, dolomite, Volcanic rock, Trachite to syenite, granitoid, porphyritic basalt to andesibasalt, Gabbro and microgabro with tholeitic trend in study area. Ecotourism includes biological, non-biological, and cultural attractions. Biodiversity, diversity of wildlife and plant species are among important elements in making an area as an ecotourism site. The normalized difference vegetation index (NDVI) was used to extract vegetation density in the study area. Red and infrared bands in this index and Eq. (2) are used for calculation of this index.

$$NDVI = \frac{NIR - VIS(red)}{IR + VIS(red)} \quad (2)$$

Villages and roads were digitized from 1:50000 topographic map. Cultural heritage is one of the main factors to attract tourists in one region. The Do Hezar watershed and its villages have traditional culture regarding language, folklore, food habitat, dress pattern, religions, etc. Thus, rural areas were selected for location of ecotourism site in Do Hezar watershed. The cultural characteristics of each region are among important capacities to attract tourists from inside and outside the country. The Do Hezar watershed has cultural values and heritage, such as language, communitys dress pattern, ancient and traditional foods, religion, etc. Therefore, access to residential areas and villages is important for development of ecotourism in the Do Hezar watershed. Access to water resources, such as rivers, which has a great environmental and ecotourism value, can be considered as one of important attractions in development of ecotourism in the watershed under study. Map of streams and rivers in the study area was extracted from ALOS-PALSAR DEM using the Arc Hydro application in ArcGIS software. This layer was extracted from 1:100000 Land use map produced by Forest, Range, and Watershed Management Organization. Land use of the study area is divided into dense forest, moderate -density forest, low- density forest, mixed (moderate -density forest and good range), mixed (moderate -density forest and good range) and finally, (moderate -density range and garden). This layer was obtained from Soil map of Mazandaran Province including Alfisols and Mollisols types of soil (Fig. 2).

Fuzzy Hierarchical Analysis Process (Chang)

Hierarchical Analysis Process (AHP) was first introduced by (Saati, 2004), a multi-criteria decision-making tool with many applications. AHP has been used since its invention as a tool in the hands of decision-makers and researchers in multi-criteria decision making, but the traditional AHP still cannot reflect the human mindset. Traditional AHP cannot express the exact value of decision makers' opinions in comparing different options (Moradzadeh Fard et al., 2012). To solve the above problems, we use FAHP to determine the coefficients of criteria. This study uses FAHP which was first introduced by Chang (1996, Chang.)

Fuzzy logic model

Fuzzy logic is actually an extension of Boolean logic. In fuzzy logic, the membership of an element in a set is defined by a value in the range from one (full membership) to zero (non-membership) (Malek et al., 2011). Fuzzy membership functions are a one way to determine the weights of desired criteria, to use fuzzy membership functions in GIS. In this method, for fuzzy criteria (Saffari and Akhdar, 2012).

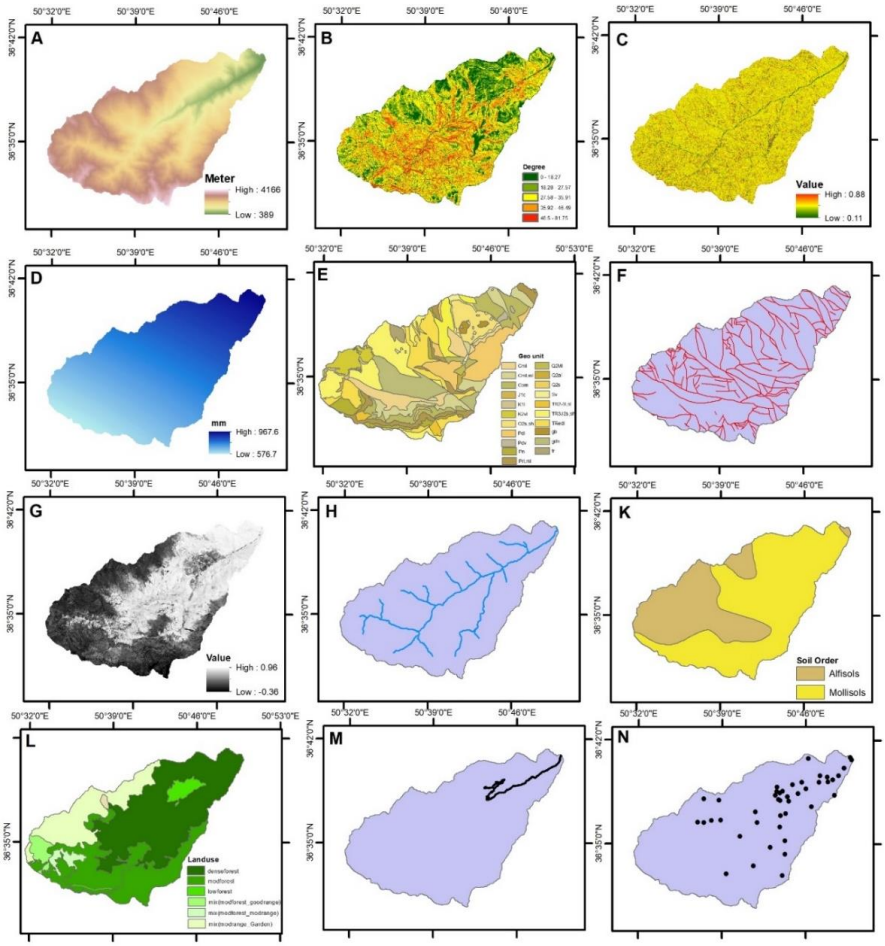

Fig. 2. The layers selected for developing ecotourism potential in Do Hezar watershed A: Elevation, B: Slope, C: Roughness, D: Rainfall, E: Lithology, F: Fault, G: Vegetation density, H: River, K: Soil, L: Land use, M: Road, and N: Villages

3. Results

This research was done to determine ecotourism potentials and suitability in the Do Hezar watershed using the FAHP model and GIS software. According to the experts' view, the criteria for ecotourism in the study area were evaluated and weighted. A set of information layers, such as natural criteria like slope, aspect, altitude, roughness, vegetation, precipitation, lithology, distance from fault, and distance from stream besides, socio-economic criteria, such as distance from residential areas and road used in this research and their effect was evaluated on ecotourism suitability. Topographic layers (slope, aspect, altitude, and roughness) natural parameters (vegetation, rainfall, lithology, distance from rivers, and distance from fault) and socio-economic layers (distance to roads and distance from villages) were considered in this research. Weighing of these layers was done in the GIS environment. The classes of criteria and sub-criteria in ecotourism evaluation process of the study area are shown in Table 2.

In the next stages, questionnaires were prepared for the paired matrices and were used in the FAHP and then, fuzzy comparison matrix of pairs of different specialists was combined and the method proposed by Satie and Baldwin (1980) was used to determine compatibility of each matrix. According to opinion of ecotourism experts and specialists, the effect and value of the criteria in identifying the potential of ecotourism are different and a variety of weights should be considered for each of criteria and sub-criteria. For this purpose, the FAHP method was applied to determine weights of the criteria using MATLAB software version 2014 (Table 3). In the FAHP method, the natural criterion has the most impact (0.48) on ecotourism suitability among the main criteria. Between topography criteria slope (0.43), between natural criteria vegetation density (0.21), and in socio-economic criteria distance from road (0.47) have the highest weight and impact on ecotourism, respectively.

Table 2. Criteria and sub-criteria classification and modalities of fuzzy function

Indices	Modalities of Fuzzy Function	Criteria	Sub criteria
Topography		Elevation (m)	389-1144
			1144-1899
	Decreasing		1899-2655
			2655-3410
			3410-4116
		Slope°	0-10
	Decreasing		10-30
			>30
		Roughness	0.11-0.27
			0.28-0.42
	Decreasing		0.43-0.58
			0.59-0.89
Natural		Rainfall (mm)	577-655
			656-733
	Decreasing		734-811
			812-889
			889-968
		Lithology	Recent loose alluviums
			Siltstone, limestone, conglomerate , Sandstone, Shale,
			Massive limestone,
	Increasing		dolomite,
			Volcanic rock, Trachite to syenite, granitoid, porphyritic basalt to andesibasalt
			Gabbro and microgabro with tholeitic trend
		Distance from Fault (m)	0-200
			200-400
	Increasing		400-600
			600-800
			800>
		Vegetation Density (NDVI)	0-0.17
			0.18-31
	Increasing		0.31-0.5
			0.51-0.69
			0.7-0.96
		Distance from River (m)	200-500
			500-1000
	Decreasing		1000-1500
			1500-2000
			2000>
		Soil	Alfisols
	Decreasing		Mollisols
		Land use	Dense Forest
			Mod Forest
			Low Dense forest
			Good Range
	Decreasing		Mod Range
			Agriculture
			Residential Area
Socio-economic		Distance from Road (m)	0-1000
			1000-2000
	Decreasing		2000-3000
			3000-4000
			4000>
		Distance from Villages (m)	0-200
			200-400
	Decreasing		400-600
			600-800
			800>

Table 3. Pairwise comparison matrices and fuzzy weights

Main Criteria								
	Topography	Natural	Socio-economic				Fuzzy weight	Priority
Topography	(1,1,1)	(1, 2, 3)	(1, 2, 3)				0.19	3
Natural	(0.33, 0.5, 1	(1,1,1)	(1, 1, 1)				0.48	1
“Socio-economic	(0.33, 0.5, 1)	1, 1, 1)	(1,1,1)				0.33	2
Topography								
	Elevation	Slope	Roughness				Fuzzy weight	Priority
Elevation	(1,1,1)	(0.3,0.5,1)	(1,1,1)				0.24	3
Slope	(1,2,3)	(1,1,1)	(1,1,1)				0.43	1
Roughness	(1,1,1)	(1,1,1)	(1,1,1)				0.32	2
Natural								
	Rain Fall	Lithology	Distance to Fault (m)	Vegetation Density (NDVI)	Distance to River (m)	Soil	Land use	Fuzzy weight	Priority
Rain Fall	(1,1,1)	(0.33, 0.5, 1)	(0.33, 0.5, 1)	(0.33, 0.5, 1)	(1,2,3)	(0.33, 0.5, 1)	(1,2,3)	0.11	6
Lithology	(1,2,3)	(1,1,1)	(0.33, 0.5, 1)	(0.33, 0.5, 1)	(1,2,3)	(0.33, 0.5, 1)	(0.33, 0.5, 1)	0.16	3
Distance to Fault (m)	(1,2,3)	(1,2,3)	(1,1,1)	(0.33, 0.5, 1)	(1,2,3)	(1,2,3)	(0.33, 0.5, 1)	0.07	7
Vegetation Density (NDVI)	(0.33, 0.5, 1)	(0.33, 0.5, 1)	(0.33, 0.5, 1)	(1,1,1)	(0.33, 0.5, 1)	(0.33, 0.5, 1)	(1,1,1)	0.21	1
Distance to River (m)		(1,1,1)	(0.33, 0.5, 1)	(1, 2, 3)	(1,1,1)	(0.33, 0.5, 1)	(1, 2, 3)	0.17	2
Soil	(1,2,3)	(1,2,3)	(1,2,3)	(0.33, 0.5, 1)	(0.33, 0.5, 1)	(0.33, 0.5, 1)	(1,1,1)	0.12	5
Land use	(1,2,3)	(0.33, 0.5, 1)	(0.33, 0.5, 1)	(1,2,3)	(0.3,0.5,1)		(1,1,1)	0.15	4
Socio-economic									
	Distance form Road (m)	Distance to Villages (m)						Fuzzy weight	Priority
Distance from Road (m)	(1, 1, 1)	(1, 2, 3)						0.47	2
Distance from Villages (m)	(0.33, 0.5, 1)	(1, 1, 1)						0.53	1

2.2.2. Ecotourism Suitability Map of Do Hezar Watershed

Using FAHP method, potential map was produced to identify suitable areas for ecotourism in Do Hezar watershed as represented in Fig. 3. The method used in this research allows us to map suitable areas for ecotourism in Do Hezar watershed and ecotourism suitability map for ecotourism development was obtained from overlaying 12 criteria in Do Hezar catchment (Fig. 3).

4. Discussion

The ecotourism potential map was weighted and prepared based on different layers and their characteristics in the GIS environment. In addition, the potential of ecotourism was divided into five classes, including very high suitable, highly suitable, moderately suitable, low suitable, and very low suitable.

4.1. Very low Suitable for Ecotourism

Areas with low and very low suitability are located in southern parts of watershed, and about 6.8% (19.8 Km^2) of area is classified into this category for the development of ecotourism activities (Fig. 5) (fig. 4). These regions contain a lack of village and accessibility such as road for tourists. In the topography criteria view, these areas have high altitudes, steep slopes, and increase roughness. Natural parameters are not suitable for ecotourism sites. Very low suitable for ecotourism regions are located in an area where vegetation density is very low according to NDVI and dominated vegetation are low forested and moderate range. Precipitation is less than 600 mm and hard rock such as limestone and near to fault is another characteristic of these area. The areas with very low ecotourism suitability are not suitable for development of tourism activities due to intense human activities as well as loss of vegetation and environment.

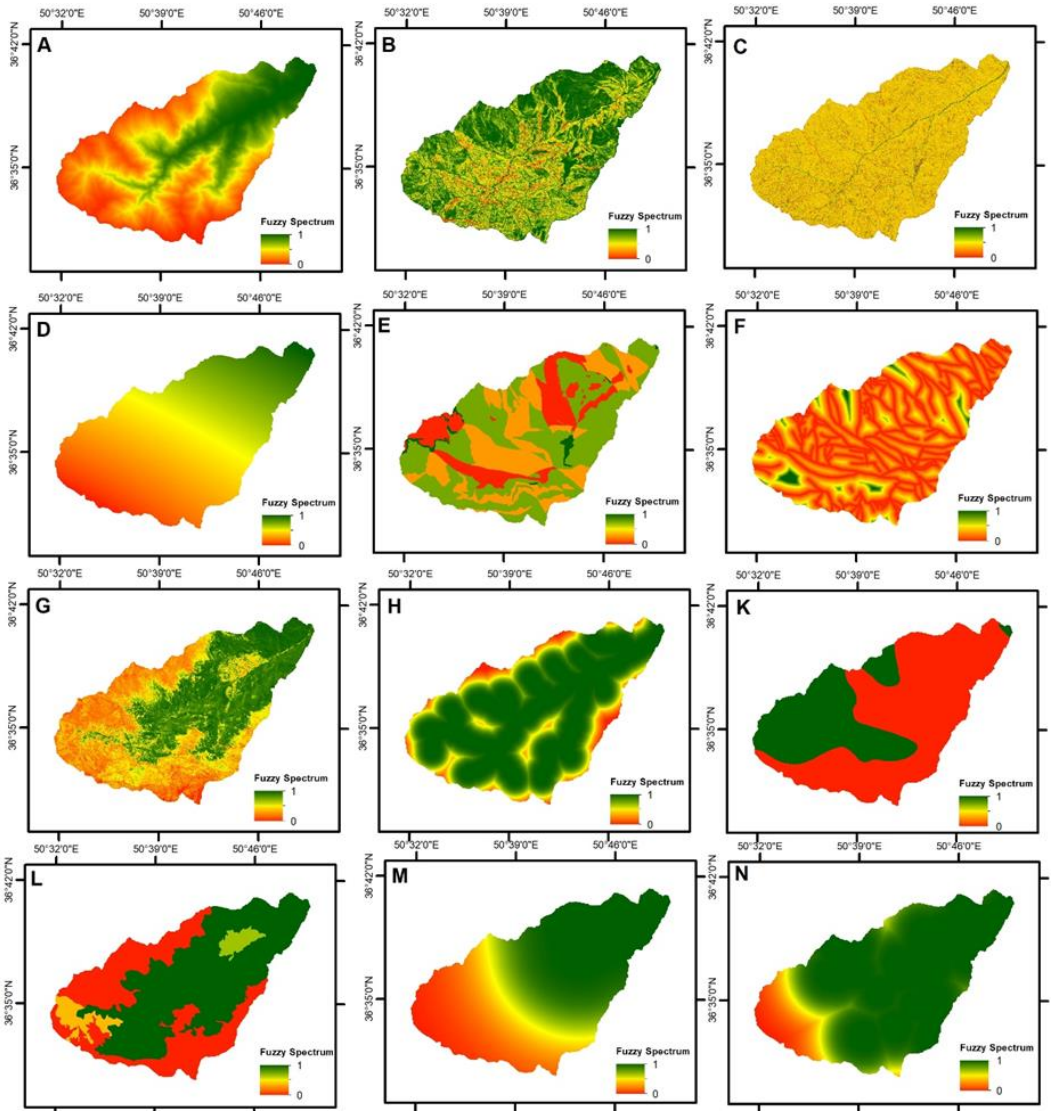

Fig. 3. Criteria used by FAHP to determine ecotourism suitability in Do Hezar watershed: A) Elevation, B) Slope, C) Roughness, D) Rainfall, E) Lithology units, F) Distance from fault, G) Vegetation density, H) Distance from river, K) Soil, L) Land use, M) Distance from road, N) Distance from villages.

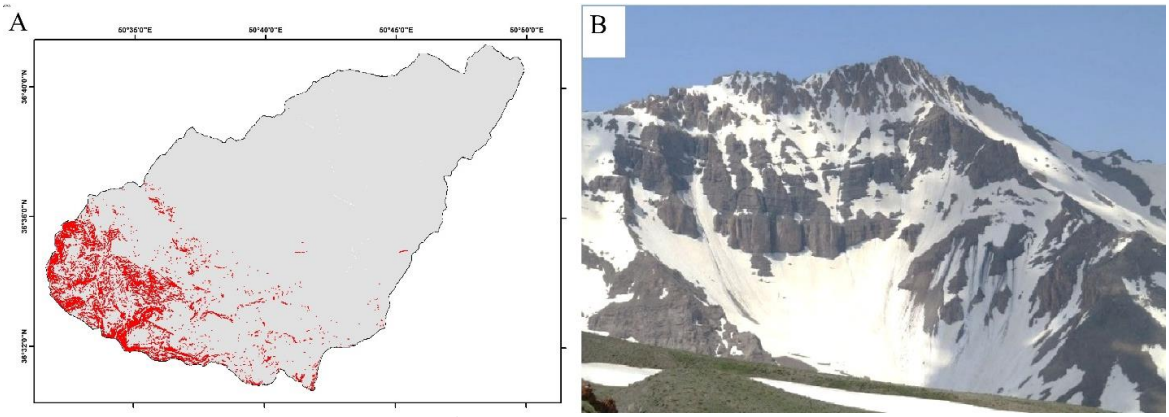

Fig. 4. A) Distribution of very low suitability in study area, B) Khashachal Peak

4.2. Low Suitable for Ecotourism Regions

Besides, only 17.9% (52 1 Km^2) of the catchment area is located in low suitability regions (fig. 5). These areas are closer to the main river with more precipitation. But other criterion such as vegetation, distance to road and villages are mostly the same as very low suitability regions. In areas with low ecotourism suitability, development should be

done in appropriate ways with the minimal negative effect on natural resources. In these areas, physical construction can be done, such as establishing restaurants, green hotels, public facilities, and lodge.

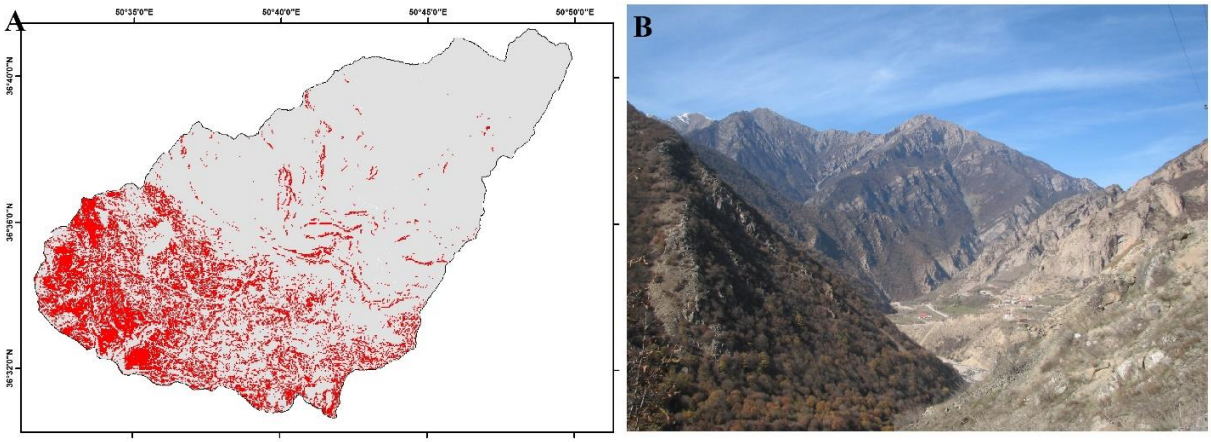

Fig. 5. A) Distribution of low suitability in study area, B) Noosha Region

4.3. Moderate Suitable for Ecotourism Regions

More than 23% (67 Km^2) of the study area is located in the moderate category in terms of ecotourism suitability (Fig. 6). The spatial distribution of this area via the south and south west part of the study area. The Vegetation in these regions is denser than very low and low suitability areas. Hence the precipitation increased, and some parts of this area are located in the low forested areas and good range boundaries. The slope is gentler, and altitude and roughness are lower. Some villages can be found in these regions. In areas with moderate ecotourism suitability, it is possible to develop ecotourism activities, but construction activities should be done through assessment of its environmental effects. Also, these areas can be considered for passive ecotourism activities, such as bird watching, trekking, camping, and any activity that is associated with minimal construction activities. Finally,

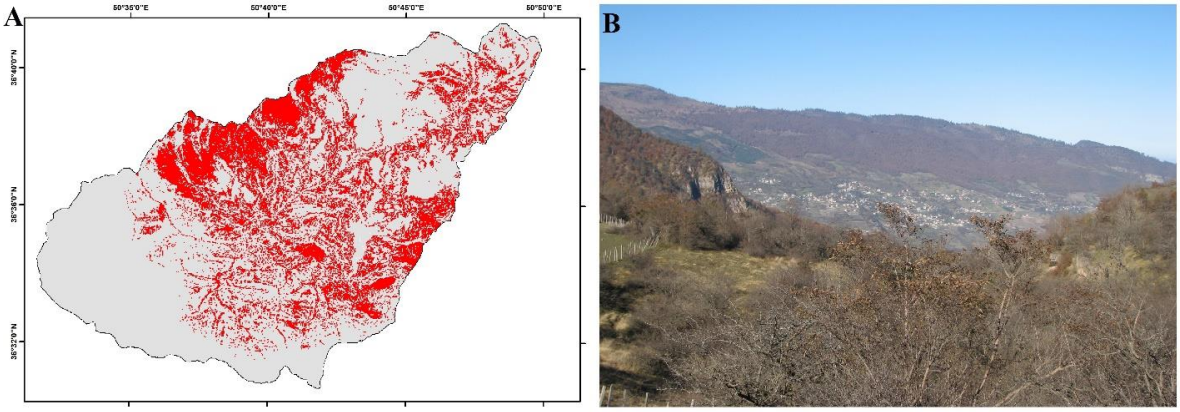

Fig. 6. A) Distribution of moderate suitability in study area, B) Asal Mahaleh Region

4.4. High Suitable for Ecotourism Regions

Areas with high ecotourism suitability are located in northern, northeastern, and northwestern regions of study area. This area of this regions contain 24.7% (79.1 Km^2) of the watershed and it has a high value for ecotourism development (fig. 7). In these areas, there are valuable areas for the development of ecotourism activities, and the reason for this high suitability can be attributed to low altitude, very high forest density, proximity to the river, more rainfall, and proximity to socio-economic facilities, such as villages and roads.

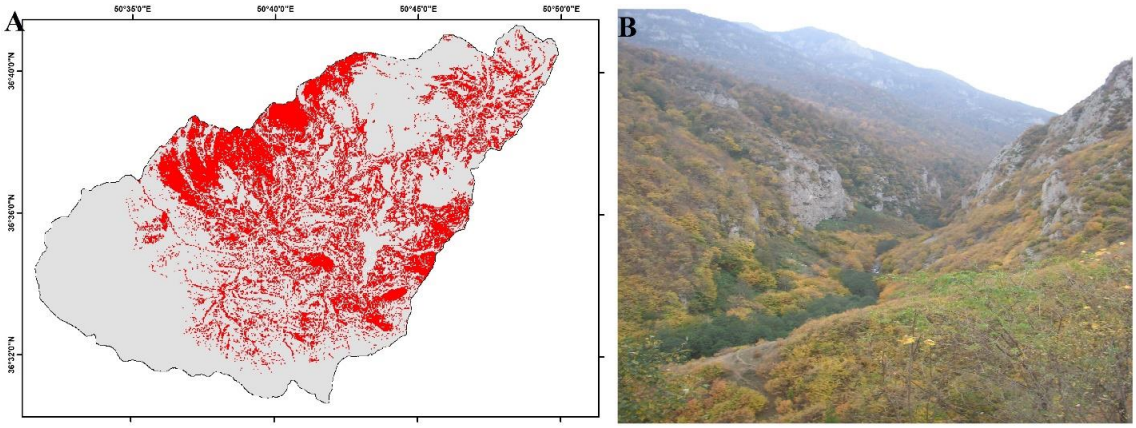

Fig. 7. A) Distribution of high suitability in study area, B) Mian Kouh Region

4.5. Very high Suitable for Ecotourism Regions

This study's results showed that about 25 % (73.8 Km^2) of Do Hezar watershed has a very high value for ecotourism development (fig. 8). Areas with medium, high, and very high ecotourism suitability are located in northern, northeastern, and northwestern regions of study area. In these areas, there are valuable areas for the development of ecotourism activities, and the reason for this high suitability can be attributed to low altitude, very high forest density, proximity to river, more rainfall, and proximity to socio-economic facilities, such as villages and roads (Fig. 6). According to analysis of the ecotourism suitability in the watershed under study, the classes with high and very high potential for ecotourism are very sensitive areas in terms of environment and development of tourism activities should be considered regarding natural capacities and environmental characteristics. These areas can be used as the main areas for development of ecotourism, but in these areas, a limitation must be provided as well as certain guidelines for optimal use of these areas. An example of these guidelines could be determining number of tourists and their duration of access to these areas. Activities that can be designed for this watershed include educational and scientific activities, trekking and visiting sites.

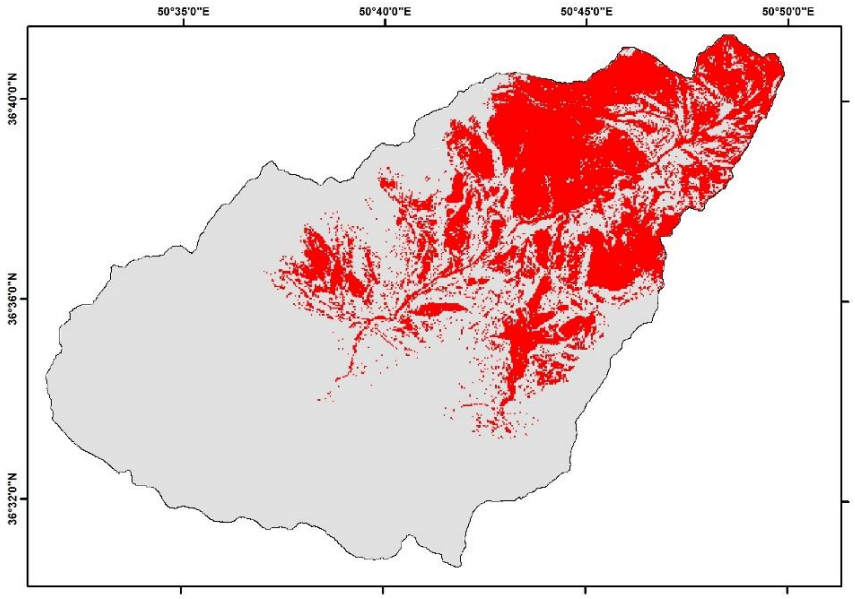

Fig. 8. Distribution of very high suitability in study area

Fig. 9. A) Daryasar region and Sialan Peak, B) Do Hezar Valley, C) Do Hezar River, D) Forests of Do Hezar watershed

The results showed the fact that the potential of ecotourism in the study area is unevenly distributed in different areas and the reason can be attributed to distribution of natural and socio-economic elements in this area.

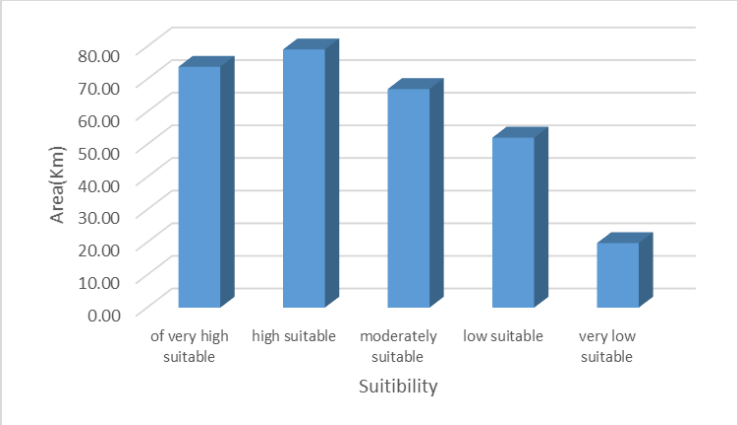

Fig. 10. Area of ecotourism suitability in Do Hezar watershed

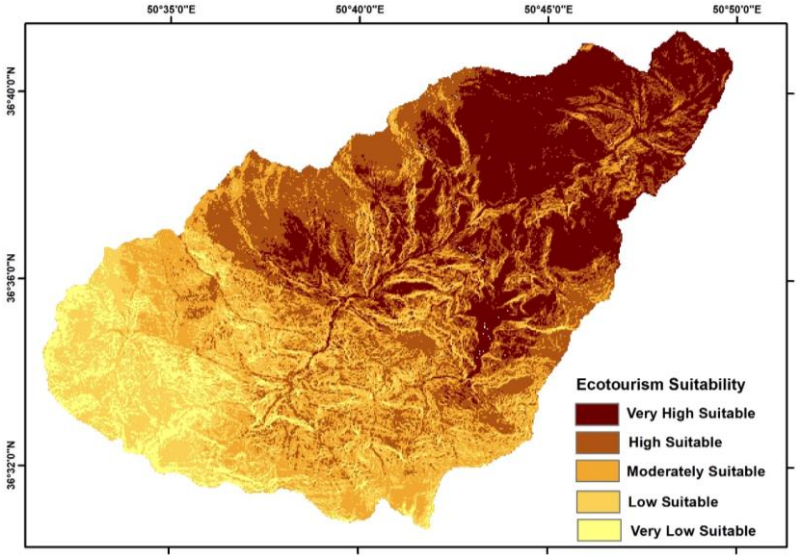

Fig. 11. Ecotourism suitability map in Do Hezar watershed

5. Conclusion

Today, the tourism industry, especially ecotourism, as a new approach to the development of human and community coexistence, for economic productivity, has found a special and appropriate situation in the development of regions. Therefore, the areas with natural landscapes due to geographical and environmental conditions in terms of climate, topography, and hydrology create special attractions for tourists. As a result, it is necessary to pay attention to this branch of tourism industry (ecotourism) because the treasure trove of existing ecotourism potentials can turn these areas into tourism hubs in the vast geographical area to strengthen the Realize tourism networks in the region. This process view of ecotourism development in the Do Hezar region is possible with planning. Favorable natural conditions are one of the main factors for the development of ecotourism. In the meantime, Do Hezar district is one of the areas with a lot of potential for ecotourism development. In fact, the suitable geomorphological, climatic conditions, access to water resources as well as proximity to population points, and easy access have made this region have suitable conditions for the development of ecotourism industry. This study aims to evaluate the areas prone to ecotourism development in Do Hezar watershed using GIS and AHP methods. FAHP method has the ability to use the opinions of experts in the evaluation process. Another advantage of the Fuzzy hierarchical analysis process method is its flexibility so that in this method, as many criteria and indicators as needed can be used in the process. The first step in this study was to identify the criteria and factors affecting ecotourism using the structure of hierarchical analysis in geographical environment. GIS was used to evaluate and determine suitable lands for tourism use. Using Geographic Information System (GIS) technology as a superior and efficient technology in the study of environmental change and resource management which provides up-to-date information for management purposes. Because various indicators and criteria are effective to determine the appropriate location of each user, so using GIS can analyze this volume of data with high speed and accuracy. The diversity of information and the complexity of simultaneous analysis of thematic and spatial information has led to the widespread use of GIS to solve land allocation problems. Our results showed that the catchment area of Do Hezar is very important due to the environment, wildlife and wildlife, and ecotourism development. Many criteria influencing ecotourism and also the analysis methods for the development of ecotourism potential in Iran were identified. FAHP method was used, and obtained suitability map showed that using this method based on GIS had provided a very powerful tool for land managers and ecotourism planners to determine suitable areas for the development of tourism sites. This study's results showed that more than 52.4% of the Do Hezar watershed has a high and very high potential for ecotourism development, and if the area with medium potential is also added, it will increase to 77.4%. Such potential enhances the environmental resilience of landscape by increasingly appreciating ecotourism activities in the municipality, with local planners and managers having an appropriate strategy for sustainable revitalization of land use. The existence of rivers and mirages, beautiful scenery, and proximity to the Caspian Sea coastline are the most important strengths to attract Eco-tourists to this region. Besides, in future increasing the number of visitors to the areas, regardless of the potential of these areas has caused many problems and environmental damage; therefore, the requirement for effective and efficient management of tourists in the areas is felt more than ever. One of the effective strategies to prevent and reduce tourism problems in the study areas is to pay attention to the potential of these areas along with determining the range of tourism. Not only will this lead to future generations, but it will also preserve these areas for the effective and efficient use of these areas which is a step towards the sustainable development of region, creating a balance between resource use and demand.

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