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Land Suitability Evaluation for Tourism Development in Desert Areas (Case Study: Eastern Regions of Isfahan Province)

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Abstract

Purpose- Today, tourism has become the largest industry in the world with both direct and indirect socio-economic effects. Given the diverse climatic conditions and limited water resources for agriculture in Iran, among various forms of tourism, tourism in desert areas with a multifaceted approach can narrow the gap caused by environmental constraints and play an important role in the development of different areas such as eastern regions of Isfahan province, which have many tourist attractions. In this research, we try to identify and evaluate land suitability for tourism development in counties located in desert areas of Isfahan province.

Design/methodology/approach- In this research, the multi-criteria evaluation (MCE) method was used in the GIS environment. Considering the variety of criteria used, before preparing the final map of land suitability, selected criteria were categorized in different groups with regard to topography, climate, land covers and animal species diversity, environment, hazards, socio-economic aspects (infrastructure and tourist attractions). Then, land suitability classes in each of the mentioned groups were identified. In the following step, the maps produced in each of these groups were given to the relevant experts to generate the final map of the land suitability according to the current situation, weigh the selected criteria based on the AHP paired comparison, and implement the results of this comparison in the GIS environment through applying weighted linear combination (WLC) method.

Findings- The results of multi-criteria evaluation showed that the study area has highly suitable lands in almost all assessment groups, and there were no specific human and natural constraints in this area. The result of the final land suitability map also showed that 21044 square kilometers of the total area (nearly 30 percent) were ranked in the very suitable and suitable classes, indicating high capacity and capabilities or minimum natural and human constraints for tourism development in the region.

Practical implications- Making use of the capabilities of desert areas in eastern regions of Isfahan province and providing the necessary conditions for tourism development with regard to the particular natural and human conditions of this region can offer the best available, affordable, and effective alternatives in the short term to tackle the current problems based on the principles of sustainable development in these areas. The problems include socioeconomic inequalities between developed and underdeveloped regions of Isfahan province, limited water resources for development of agricultural activities, and low ecological capacity of the region for some activities especially in vulnerable communities.

Key words- Land potential, desert tourism, multi-criteria evaluation, Weighted Linear Combination (WLC), Geographic Information System (GIS), Eastern regions of Isfahan.

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1. Introduction

The tourism industry, as a lucrative and inexpensive industry, is one of the key components of sustainable development in areas where there are such capabilities, and is also known as invisible exports (Rezvani, 1995). Ecotourism, unlike other types of tourism, including mass tourism, which merely emphasizes on benefits of tourism, has a multidimensional nature (Higham, 2007). This form of tourism makes human leisure activities possible mainly in nature and is based on targeted travels together with cultural, spiritual, observation impressions and the study of natural attractions and enjoying various natural phenomena (Rezvani, 2003). In general, this form of tourism is a responsible journey to natural areas, protects the environment and improves the well-being of local people (Fennell, 2008).

Desert tourism is a relatively new type of ecotourism. To walk in desert regions and enjoy desert attractions, vegetation, animal life, morphological forms, sports activities and other attractions have created a special type of tourism called desert tourism (Hashemi & Ramesht, 2014; Jomepour & Nemayandeh, 2012).

Iran, situated in the dry regions of the world, has an average rainfall of 252 millimeters, and about 65 percent of its area is in arid and semi-arid regions with annual rainfall of less than 150 millimeters (Jomepour & Nemayandeh, 2012, p. 48). This vast area is mostly desert. The characteristics of desert areas include: annual rainfall of less than 50 mm which is mainly in inappropriate time; as it may not rain for many years and vegetation becomes very poor in such areas. Desert is the land strongly affected by salt in a way that the growth of crops such as wheat, barley, cotton, date and pistachio and the like is unlikely; however, it is possible that salt resistant plants grow in deserts, in this case they are called desert pastures (Kardavani, 1995).

Any investment in desert and arid regions initially seems to be illogical which may end in failure; the same way, investment in tourism and ecotourism development in desert areas has been neglected (Shariaat Panah & Estelaji, 2008).

These seemingly unimportant areas have valuable natural and human attractions, which proper planning and management while preserving the environment can change them into a source of sustainable economic development and employment.

The study of the geographical situation of Isfahan province in central Iran shows that the eastern regions of the province, including Nain, Ardestan, Aran and Bidgol, Khor and Biyabanak, Isfahan and Natanz, with an area of 71368 square kilometers, comprise nearly 66% of the total area of the province.

These arid and semi-arid areas with a minimum altitude of 596 meters, and a very gentle slope and warm and dry climate can make ground for ecotourism. Preliminary study of the geography of the region shows that the problem of water scarcity and environmental constraints on agricultural development, related activities and sustainable rural development in general has posed a serious challenge to the regional development. On the other hand, based on existing evidence, already formulated strategies and executive guidelines have so far failed to reduce rural poverty, unemployment, migration, and also have failed to ensure food security and environmental sustainability. Therefore, ecotourism development as a clean and inexpensive industry, can be one of the best alternatives for removing environmental constraints on agriculture in this vulnerable and environmentally fragile area, and will improve the welfare of the local community, environmental protection and ultimately the sustainable development.

Therefore, in order to optimize the management of the environmental resources in the eastern areas of Isfahan province, and to develop tourism in these desert areas, using the various planning techniques in the GIS environment, the present study attempted to investigate and answer these important questions: What are the most important criteria and factors affecting the development of tourism in desert areas of eastern Isfahan? To what extent the desert areas in eastern Isfahan have the essential capacity to develop tourism? What are the most suitable zones or areas for tourism development in desert areas of eastern Isfahan?

The review of the literature on previous studies, and in particular the application of a multi-criteria evaluation method in assessing the suitability and capabilities of the land for the development of desert tourism showed that no similar research has been conducted in this field. Table-1 summarizes

some of the most relevant foreign and domestic studies.

Table 1. literature on previous studies
(Source: Research findings, 2018)

Research findings	Data analysis tools	Authors, the year research was conducted	Title of the research
Areas suitable for development of ecotourism were divided into four suitability classes: 1-highly suitable, 2-moderately suitable, 3- marginally suitable, 4-not suitable. The results showed GIS plays an important role in ecotourism planning and the proposed methods for identifying the suitable locations proved very useful.	GIS, AHP	Bunruamkaew, K. & Murayam, Y. (2011)	Site suitability evaluation for ecotourism using GIS & AHP: A case study of Surat Thani province, Thailand
The result of this study showed that nearly 35.58 % of the total area has high potentials, and 19.80 % has no potentials for ecotourism development.	GIS, AHP, WLC	Dashti et al. (2013)	Application of GIS, AHP, Fuzzy and WLC in island ecotourism development (A case study of Qeshm Island, Iran)
A total of 35 zones with high potentials, 137 zones with average potentials and four zones with weak potentials were identified. It was found that out of the total area of the county, 82,400 hectares have some limitations, about 4,500 hectares have high potentials, 55,000 hectares have moderate potentials and 2600 hectares have weak potentials for ecotourism.	GIS, AHP, WLC	Salman et al. (2009)	Evaluation of ecotourism capacity in Behshahr County based on multi-criteria evaluation method using GIS.
The study results showed that only about 12% of the basin have the capacity to develop tourism in a permissible manner. About 46 % of development capacity is available only conditionally while considering ecological aspects, and in the remaining 42 % tourism development is prohibited under any circumstance.	GIS, AHP	Behniyafar and Mansouri Daneshvar (2010)	Zoning with multi-factor evaluation approach and using the AHP model for tourism development in GIS environment: : A case study of Golmakan Basin
The results showed that about 41.7 % of the entire area, have sufficient environmental capability for development of tourism activities in combination with other development activities and 34.8 % have sufficient environmental and ecotourism capability for tourism development.	GIS & multi-criteria decision analysis method	Mansouri et al (2012)	Evaluation of tourism development potentials based on functional zoning and multivariate method (Case study: Mashhad-Kalat road)
By combining layers, it was found that 31.14 % of the total area of the city had very high and high suitability for ecotourism activities.	GIS & Fuzzy	Sharifi and Bostani (2015)	Ecotourism zoning using fuzzy model: A case study of Shiraz County
The results showed that out of total area of 686.598 km^2, about 52.01 km^2 is highly suitable for development of ecotourism, 98.26 km^2 is suitable, 169.03 km^2 is relatively suitable, 210.65 km^2 not suitable, and 156.08 km^2 was quite unsuitable for development of ecotourism.	GIS & genetic algorithms	Maghsoudi et al. (2015)	Optimal site selection for ecotourism development in Kavir National Park using GIS and Genetic Algorithms
The results showed that areas with a marginal suitability comprised 43.4 % of the total land area; 9.1 percent of the total area of the city was highly suitable, 17.6 % was moderately suitable and 29.9 % of the total area of the city was not suitable for ecotourism development.	GIS Multi-criteria decision-making methods-Delphi	Shakeri Zadeh and Mahdavi (2015)	Ecological potential of Rudan County for ecotourism using multi-criteria decision making method
The results showed the criteria of tourist attractions and the risks, respectively with the weight of 0.4064 and 0.0429 got the highest and lowest scores. Furthermore, based on the final map of the suitable lands, 49,503 hectares are highly suitable for ecotourism development and have received the top priority for building a tourist village.	GIS & AHP	Ranjbar Ferdouei et al. (2017)	Land suitability evaluation in Maranjab area for locating tourism villages
Based on the research findings, three districts in north (Karedeh Dehestan), west (Torghabeh, Shandiz and Chal Valley) and south (Malek Abad) have been identified as highly suitable areas for development of ecotourism.	AHP & WL	Akbari Ghouchani et al. (2017)	Site suitability analysis for ecotourism using fuzzy multi criteria evaluation in GIS environment: A case study of Mashhad County

2. Research Methodology

2.1 Geographical Scope of the Research

The study area of this research includes 6 counties of Nain, Ardestan, Aran and Bidgol, Khor and Biyabanak, Isfahan and Natanz located in eastern regions of Isfahan province (Fig. 1). According to the statistical data of national census conducted in 2016, this area has a population of 2411095 people living in 802 rural settlements and 31 urban settlements (Statistical Center of Iran, 2016). The counties in the eastern region of Isfahan province have many historical and cultural attractions, special vegetation, animal species diversity, many rural tourist destinations, special tourism areas, animal preserves, non-hunting areas, and most importantly, special desert landscapes such as sandy hills which can become one of the important tourist hubs for desert tourism.

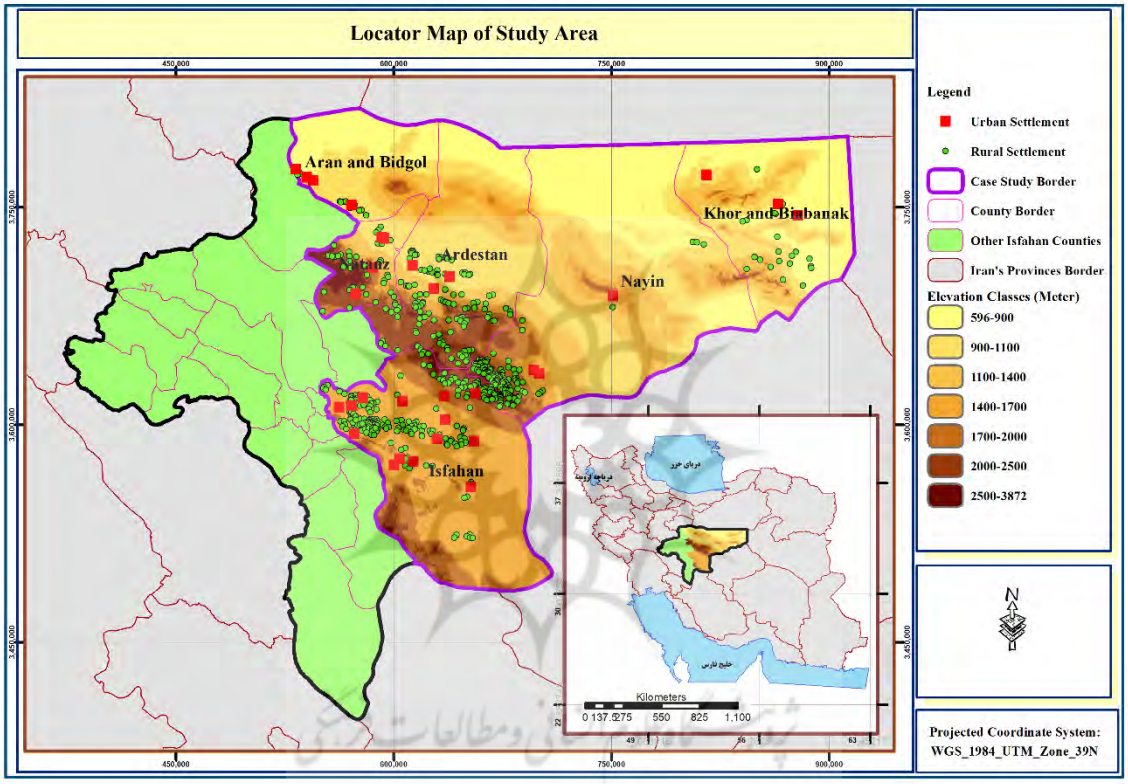

Figure1.Geographical situation of the study area
(Source: Research Findings, 2018)

2.2 Methodology

This research is an applied one conducted in a descriptive-analytical method. To analyze the data, the multi-criteria evaluation method was used in GIS environment. WLC is one of the most important methods for multi-criteria evaluation. It is one of the basic methods used more than other methods for land suitability evaluation (Lafortezza et al., 2008; Malczewski, 2006; Malczewski & Rinner 2005). The WLC-based approach can be operationalized using any GIS system that has overlapping capabilities (Malchovsky, 2013, p. 339). In contrast to the Boolean operation, this method which is easy to implement in raster and vector data, is a compensatory method. That is, low scores in a proportion can be offset by higher scores of the other proportional criterion (Chen et al., 2001; Malczewski, 2004; Sante-Riveira et al., 2008). In order to process the data, after the identification of the criteria, their sub-criteria are standardized according to different methods, and then based on one of the weighing methods, weights of these criteria are determined, and finally after the above-mentioned operations, standardized weight criteria, are overlapped in GIS and the final map can be developed (Malchovsky, 2013).

In this research, the linear fuzzy standardization method has been used to standardize the data. The theory of the fuzzy set introduced by Lotfi Zadeh

is an alternative to the Boolean set. The membership of an object is finite in a Boolean set; a fuzzy set consists of a set of objects with degrees of membership. Such a set is characterized by its membership functions, in which for each object a degree of membership is defined between 0 and 1 (Zadeh, 1965). Based on the WLC method, the evaluation parameters should be compared and weighted. A paired comparison method is used to weigh the criteria. The paired comparison method was developed in 1980 by Saaty in the AHP framework. In this method, to rank the preferences in relation to a pair of criteria, a scale of 1 to 9 is used (Malczewski & Rinner, 2016). To determine the weight of the criteria, 20 experts in relevant organizations as well as researchers at the universities of the province were interviewed. The formal validity of the questionnaire was confirmed by some experts and professors. The reliability of the questionnaire was also measured using Cronbach's alpha, which was 0.71, indicating an acceptable reliability of the questionnaire.

After determining the weight of the criteria, the weights were attributed to the criteria, and the data preparation process, including their rasterizing in the GIS environment, for the final overlap was performed; in this process, all layers based on a specific pixel size of 30*30 meters, were made from the DEM layer of the region. After completing this process and preparing the data, the land-use suitability model was created in the GIS modeling environment. Eventually, after the implementation of the model and data processing, the final map of the land-use suitability for tourism development was developed and analyzed in following classes: highly suitable, suitable, marginally suitable, not suitable, highly unsuitable (Figure 2).

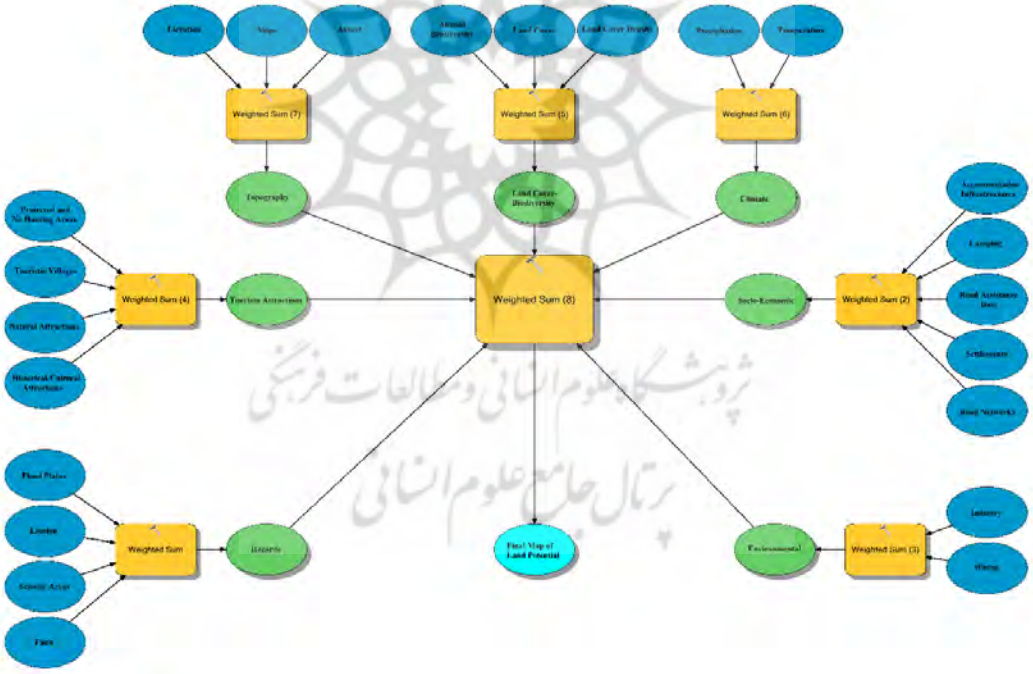

Figure2.Land suitability model for tourism development in desert areas
(Source: Research Findings, 2018)

2.3. Variables and indicators

Based on the initial investigation in the study area and the review of literature, 23 criteria were defined for the evaluation of ecotourism in the desert regions in Eastern Isfahan; Table-2 summarizes the variables and the criteria.

Table 2. Evaluation criteria and their format
(Source: Research Findings, 2018)

Row	Criteria	data type	Row	Criteria	data type
1	Altitude	Raster	13	Mines	vector
2	Slope	Raster	14	Industries	vector
3	Slope Directions	Raster	15	Road networks	vector
4	Average annual temperature (°C)	Raster	16	Urban and rural settlements	vector
5	Average annual rainfall (ml)	Raster	17	Emergency road services	vector
6	Percentage of crown land cover	vector	18	Camping	vector
7	Land cover	vector	19th	Infrastructure of residence (traditional residences)	vector
8	Animal species diversity	vector	20	Earthquake prone areas	vector
9	Man-made historical-cultural attractions	vector	21	Severity of soil erosion	vector
10	Natural attractions	vector	22	Faults	vector
11	Tourist destination villages, Special tourism areas	vector	23	Flood plains	vector
12	Non-hunting and preserved areas	vector			

3. Research Findings

As discussed in the methodology, one of the steps in the WLC method for overlapping the data in the GIS environment is the standardization of sub-criteria. In this study, linear methods were used for continuous data such as slope, temperature, distance and other continuous data; in other layers that have discrete nature, such as land covers and flood plains, given the importance of descriptive data of these layers, for each terrain a score between 1 to 9 was assigned, and then these scores were normalized by fuzzy standardization method between 0 and 1. Following the standardization of sub-criteria, these criteria were grouped in several categories according to their similarity. The purpose of this grouping, first of all, is to identify land suitability for tourism development in each of these factors, and secondly, to summarize the criteria to facilitate the final overlap and prepare the final map of land suitability. Next, the results of the maps produced from each of these factors are described and analyzed.

3.1. Topography

In Table-3, topographic criteria, descriptive data, fuzzy membership values and their weights are shown. In each group, weighing the criteria, given their close importance compared to each other, all items were assigned the same weight; for example, in the group of land covers and animal species diversity criteria (Table-7), for land covers, crown cover percentage and animal species diversity have the same weight of 0.333. This is true of most groups of criteria, so this rule is also applicable in the criteria for other groups. The result of overlapping three topographic criteria are illustrated in Fig. 3, and the statistical data of this figure is presented in Table-4.

Table 3: the range of classes/ descriptive data, values of fuzzy membership and weight of topographic criteria
(Source: Research Findings, 2018)

Criteria	Quantitative characteristics/ descriptive data	Scores	Values of fuzzy membership	Final Weight
Altitudes (m)	596-3872	-	0-1	0.333
Slope (percent)	0-361	-	0-1	0.333
Slope Directions	South -South East-South West	3	0	0.333
	East-West	5	0.33	
	North	7	0.66	
	Even-North East-North West	9	1	

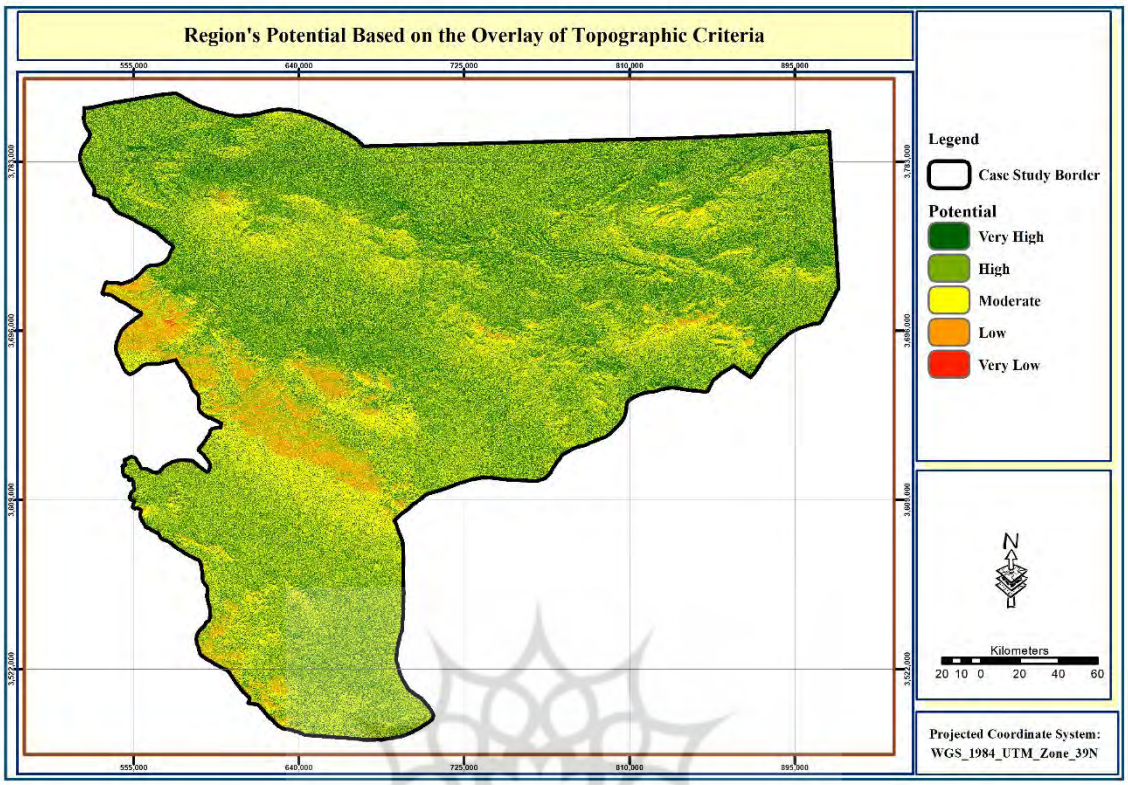

Figure3. overlap of topographic criteria
(Source: Research Findings, 2018)

Table4. Statistical data of the topographic criteria map
(Source: Research Findings, 2018)

Suitability	Area (km2)	Percentage of area
very high	21248.37	29.77
high	19434.17	27.23
medium	28529.26	39.98
low	2142.34	3.00
very low	9.66	0.01

The overlap of topographic layers shows that nearly 57% of the area topographically have very high and high potential for desert tourism development, or encounter minimal restrictions. According to these results, only 3% of the entire area has low capabilities. No land is in the very low level of suitability; therefore, in terms of the topographic properties, the study area is highly suitable for development of desert tourism.

3-2 Climate

The climate criteria include the annual average temperature and precipitation (Table-5). In terms of two climate elements (average temperature and precipitation), 4.5% of the area has very high and high suitability (Table 6), a region which is located in higher altitudes in the west of the study area. Climatically, nearly 75% of the area is in very low and low classes for tourism development; this is due to arid areas and low altitudes, especially in the vast areas of the East; however, in the regional assessment of these two climate elements, this vast region has a very low potential for tourism development; nevertheless, the involvement of other compensatory measures in other areas can moderate climate constraints.

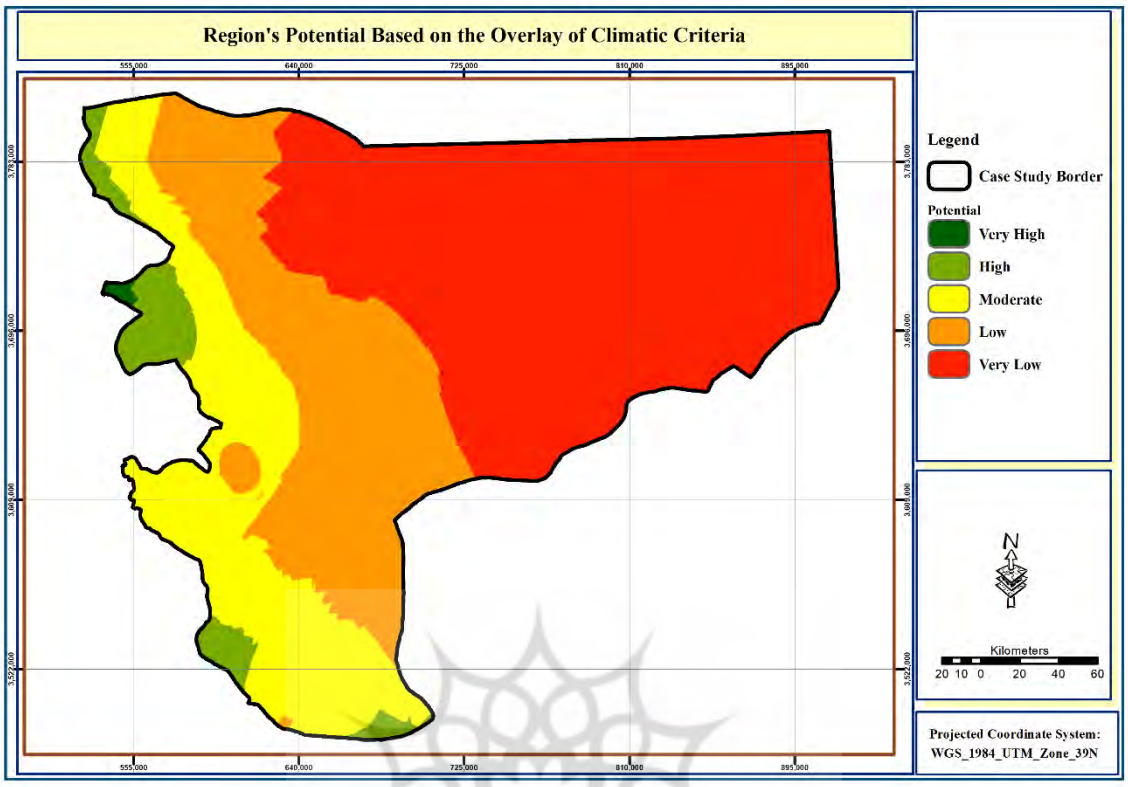

Figure4. Overlap of climate criteria
(Source: Research Findings, 2018)

Table 5. The range of classes/ descriptive data, Scores, values of fuzzy membership and the weight of climate criteria
(Source: Research Findings, 2018)

Criteria	Qualitative characteristics/ descriptive data	Scores	Values of fuzzy membership	Weight
average annual temperature (°C)	6.80-19.80	-	0-1	0.5
Average annual precipitation (mm)	75-542.47	-	0-1	0.5

Table 6. Statistical data of the climate criteria
(Source: Research Findings, 2018)

Land suitability classes	Area (km2)	Percentage of area
very high	144.19	0.20
high	3144.22	4.41
medium	14266.36	20.00
low	18162.55	25.46
very low	35623.37	49.93

3.3. Land covers and animal species diversity

In the context of land covers and animal species diversity, a major part of the study area has moderate suitability (see Table 7). Nearly 2 % of the area has a very high potential for tourism development The rest of the land has very low and low suitability for tourism development. Given the nature of these criteria, adequate land cover and animal species diversity in some parts of the area may be very valuable. As can be seen (Fig. 5), these regions are scattered in different areas.

Table 7. The range of classes/ descriptive data, scores, values of fuzzy membership and the weight of land cover and animal species diversity
(Source: Research Findings, 2018)

parameters	Qualitative characteristics/ descriptive data	Scores	Values	Weight
Percentage of crown land cover	without any cover	1	0	0.333
	10%>	3	0.25	
	10-25%	5	0.5	
	25-50%	7	0.75	
	50-75%	9	1	
Land covers	Uncovered lands, sand, water bodies, swamps, river beds, urban areas	1	0	333/0
	Irrigated agricultural lands, salty lands	3	0.25	
	Rainfed agricultural lands, low-density forests and grasslands	5	0.5	
	dense forest and meadows	7	0.75	
	desert, man-made forests, trees and shrubs, woodlands, sandy areas	9	1	
Animal species diversity(Areas within 5 km buffer)	0- 0.20	-	0-1	0.333

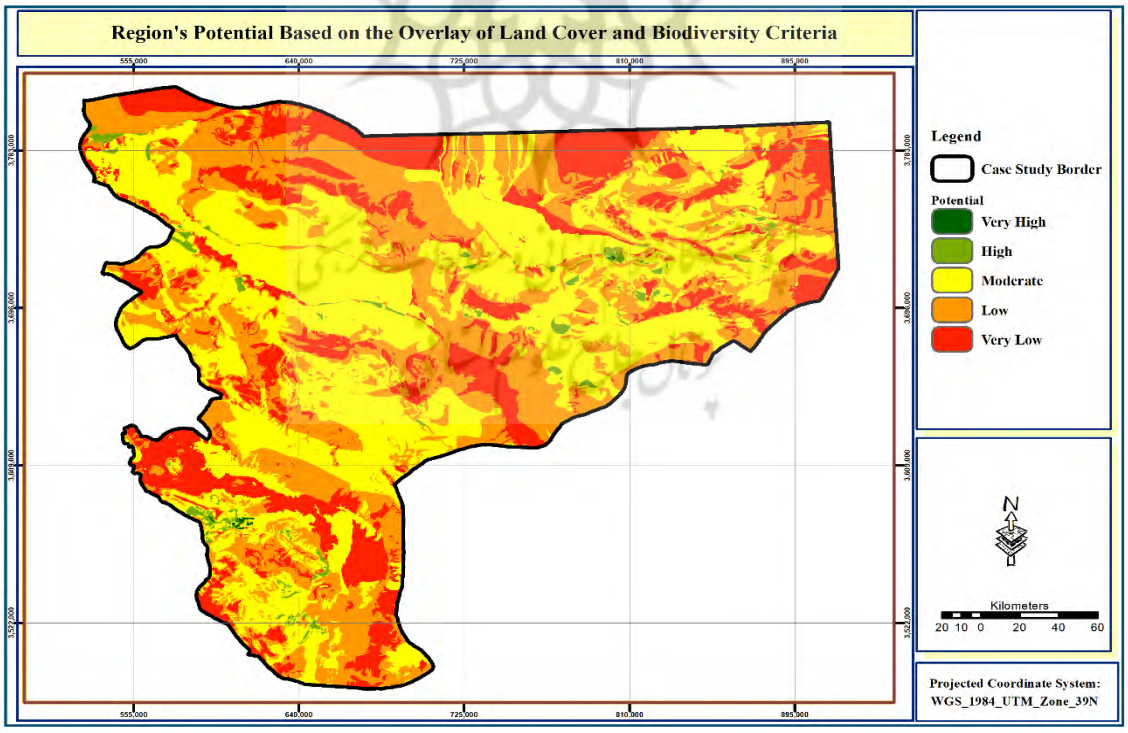

Figure 5. Overlap of the criteria of land covers and animal species diversity
(Source: Research Findings, 2018)

Table 8. Statistical data of criteria map of land covers and animal species diversity
(Source: Research Findings, 2018)

land suitability classes	Area (km2)	Percentage of area
Very high	40.04	0.06
high	940.51	1.32
moderate	29827.88	41.79
low	25343.26	35.51
very low	1526.56	21.32

3.4. Hazards

Hazard criteria include distance from earthquake prone areas, soil erosion rate, distance from faults and flood plains (Table-9). Based on the data extracted from the fig.6 and Table-10, in the study area, with regard to hazardz, there are no significant restrictions on the development of tourism, as nearly 43 percent of the area are in high and very high land suitability classes. Only about 4 % of the study area, due to potential hazards, is in low suitability class (Fig. 6).

Table 9. The range of classes/ descriptive data, scores, values of fuzzy membership and the weight of hazard criteria
(Source: Research Findings, 2018)

Criterion	Qualitative characteristics/ descriptive data	Scores	Values of Membership	Weight
distance from the earthquake prone areas (M)	0-52799	-	0-1	0.25
Severity of soil erosion	Lands with partial soil erosion	9	1	0.25
	Combining lands with partial soil erosion and land with low erosion- lands with low erosion	7	0.75	
	Combining lands with low erosion and moderate erosion-lands with moderate erosion	5	0.5	
	Combining lands with moderate erosion and lands with high erosion	3	0.25	
	Lands with high erosion	1	1	
Distance from the faults (m)	0-62786		1-0	25/0
Flood plains	Flood plain area	1	0	25/0
	Other areas	9	1	

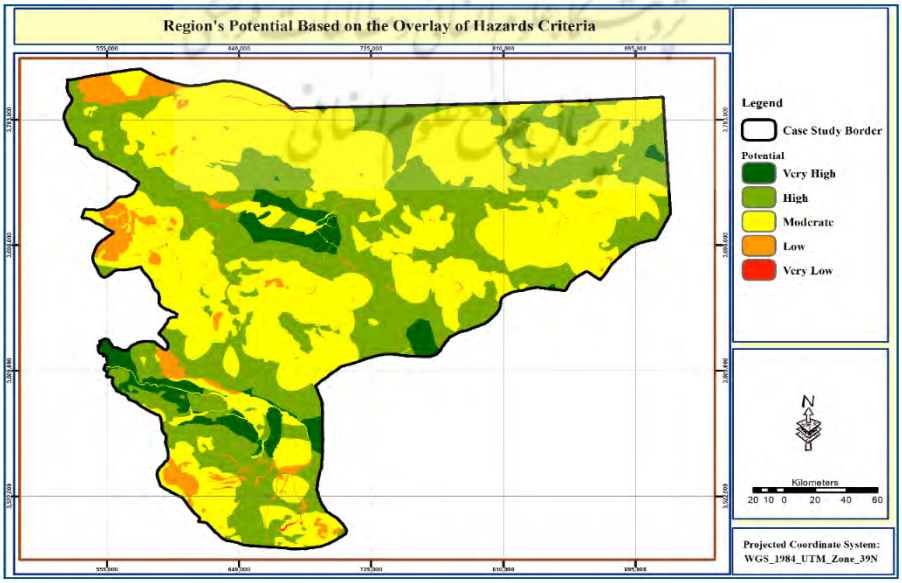

Figure 6. Overlap of hazard criteria
(Source: Research Findings, 2018)

Table 10. Statistical data of the map of hazard criteria
(Source: Research Findings, 2018)

Land suitability classes	Area (km2)	Percentage of area
very high	3649.83	5.31
high	27375.39	38.48
moderate	36893.80	51.85
low	3144.16	4.42
very low	87.18	0.12

3.5. Environmental

In terms of compatibility with the surrounding uses (including industries and mines), 46% of the area is in very high and high suitability classes for tourism development (Table-12). Areas in low and very low suitability classes are in the western region which is highly populated and has many human settlements (Fig .7). These lands comprise nearly 2 percent of the total area; the remaining area is moderately suitable for tourism development.

Table 11: The range of classes/ descriptive data, scores, values of fuzzy membership and the weight of environmental criteria (compatibility with surrounding uses)
(Source: Research Findings, 2018)

Criteria	Qualitative characteristics/ descriptive data	Scores	Values of fuzzy Membership	Weight
Mines	Areas of mine excavation	1	0	0.5
	Other areas	9	1	
Distance from industries (m)	0-91992	-	0-1	0.5

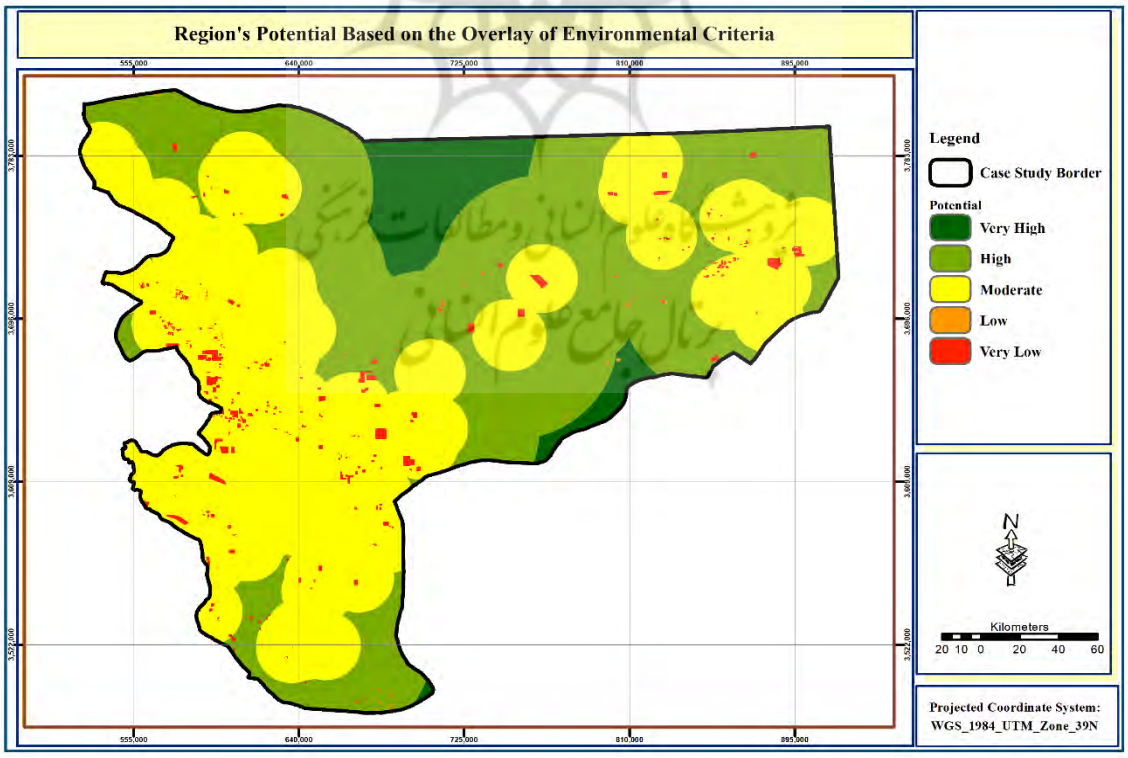

Figure 7. Overlap of environmental criteria (compatibility with surrounding uses)
(Source: Research Findings, 2018)

Table 12. Statistical data of the map of environmental criteria
(Source: Research Findings, 2018)

Land suitability classes	Area (km2)	Percentage of area
Very high	4752.20	6.66
high	28596.56	40.07
moderate	37047.26	51.91
low	38.42	0.05
very low	934.31	1.31

3.6. Socio-economic

Various criteria have been used in assessing the socio-economic characteristics of land suitability (Table-13). Their overlap shows great suitability. As more than 72% of the area is in high and very high land suitability classes. Meanwhile, only less than 9% of the area is in low and very low land suitability classes (Table-14). A look at the map drawn from this overlap (Fig.8) shows there is a wide range of infrastructure for tourism development which make tourism development for in this area economically feasible.

Table 13: The range of classes/ descriptive data, scores, values of fuzzy membership and the weight of environmental criteria and the weight of socio-economic criteria (infrastructure and access to services)
(Source: Research Findings, 2018)

Criteria	Qualitative characteristics/ descriptive data	Scores	Values of fuzzy membership	Weight
Access to the road networks (m)	0-100795	-	0-1	
Proximity to human settlements (cities & village) (m)	0-105907	-	0-1	
Access to road services (m)	0-111915		0-1	
Camping access (m)	0-117590		0-1	
Access to residential infrastructure (traditional residences)	0-155780		0-1	

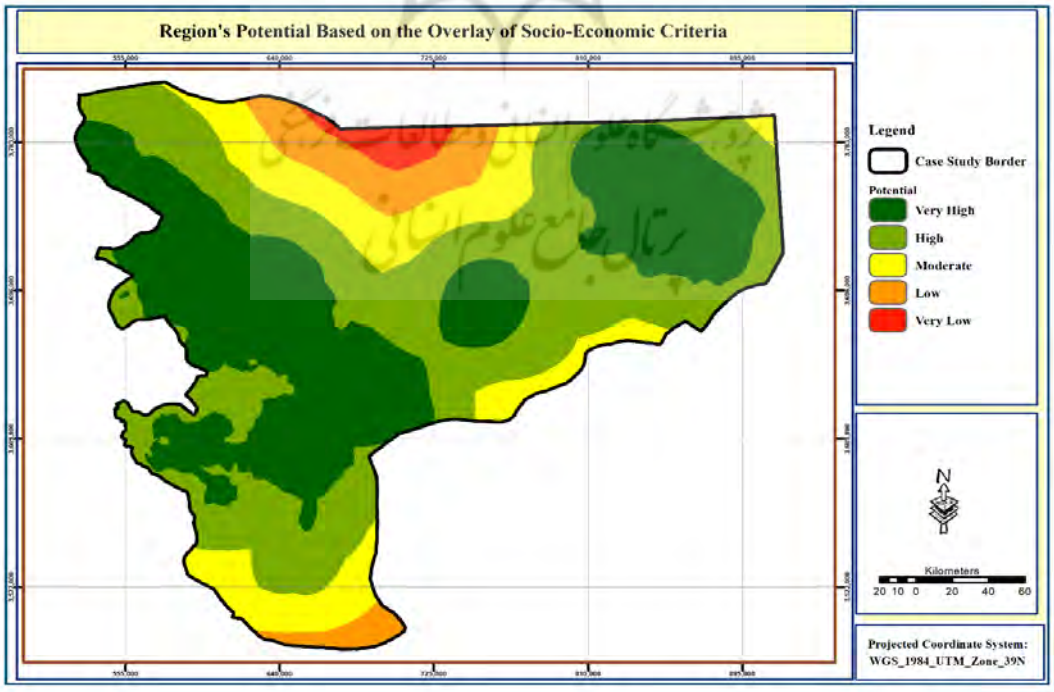

Figure 8. overlap of socio-economic criteria
(Source: Research Findings, 2018)

Table 14. Statistical data of the map of socio-economic criteria
(Source: Research Findings, 2018)

Land suitability classes	Area (km2)	Percentage of area
very high	27702.31	38.82
high	27203.67	38.12
moderate	10544.36	14.77
low	4665.80	6.54
very low	1252.61	1.76

3.7. Tourist attractions

Tourist attractions of the region, together with other conditions and factors can play a determining role in the development of tourism in every region of the study area. In this part, very comprehensive and varied criteria have been used (Table-15). Their overlap (Fig.9) and the results obtained from this overlap (Table-16) show that the study area is in high and very high land suitability classes for tourism development. As nearly 33 percent of the land in the area is in high and very high classes in the field of tourism attractions which compared to the area is a very high figure, such attractions may be an important reason to identify this region as an area highly suitable for tourism development, which is also what the study seeks.

Table 15. The range of classes/ descriptive data, scores, values of fuzzy membership and the weight of tourist attractions criteria
(Source: Research Findings, 2018)

Criteria	Qualitative characteristics/ descriptive data	Scores	Values of fuzzy membership	Weig ht	Criter ia
Distance from man-made historical-cultural attractions (M)	Inns, museums, registered ancient bathrooms, registered mosques and Bazars, pilgrim houses, registered houses and schools, castles, cisterns, archaeological sites, palaces, monasteries and so on.	0-106857	-	0-1	
Distance from natural attractions (m)	A wide variety of natural attractions	0-91844	-	0-1	
Tourist destination villages, Special tourism areas	Tourist destination villages, Special tourism areas	0-99090	-	0-1	
preserved and non-hunting areas	preserved and non-hunting areas	preserved and non-hunting areas	9	1	
		other areas	1	0	

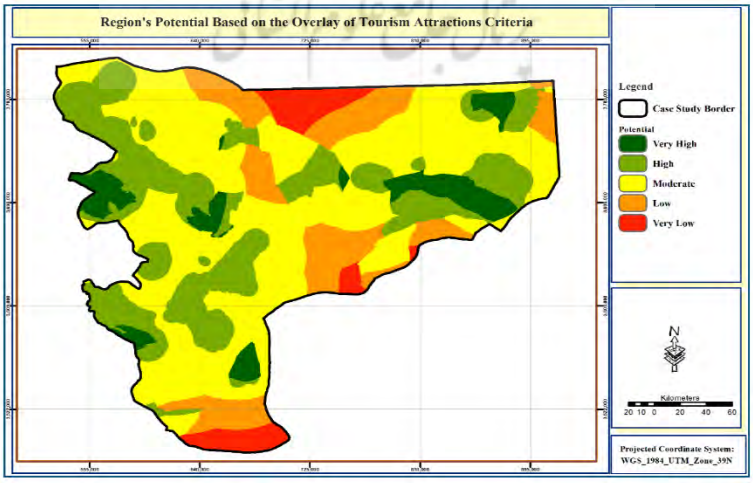

Fig 9. overlap of tourist attractions criteria
(Source: Research Findings, 2018)

Table 16. Statistical data of the tourist attractions criteria map
(Source: Research Findings, 2018)

Land suitability classes	Area (km2)	Percentage of area
very high	5328.05	7.47
high	19028.30	26.66
moderate	32863.07	46.05
low	10332.85	14.48
very low	3816.49	5.35

3.8. The final map of land suitability

In the last part of the study, making use of different maps, we tried to identify and investigate regional suitability classes in the field of natural, human and socio-economic characteristics and tourist attractions. After mapping each group of criteria and factors, and explaining the situation in each of the groups, at this stage, the final outputs of land suitability maps were overlapped with each other to develop the final map of tourism development. In developing this map, maps of the criteria and factors produced in the previous steps together with a questionnaire of factors and criteria were used to interview the experts and scholars. The questionnaire was developed based on paired comparison and experts' assessment of the produced maps, and the final weight of the determinants of tourism development in the eastern province of Isfahan was determined by the AHP method. The results of this questionnaire, summarized in Table 17, show that according to experts, the various tourist attractions with a weight of 0.333 are the most important factor or suitability class to develop tourism in desert areas of Eastern Isfahan. Land covers and animal species diversity with a weight of 0.171 are another important factor from experts views. The third most important factor from experts view is the hazard score of 0.128. At the next level, socioeconomic, environmental, topographic and climatic criteria got the highest scores respectively. Based on the WLC method, the scores determined on the main factors in the GIS environment were employed and the final map of land suitability was developed for tourism development (Figure 10).

Table17. Coefficient of importance of the main factors effective on tourism development in desert areas
(Source: Research Findings, 2018)

Main factors	Tourist attractions	Land covers-animal species diversity	Socio-economic	topography	Hazards	Climate	environmental	final weight
tourist attractions	1	3.5	5	4.5	2	2.5	2.5	0.33
Land covers-animal species diversity	0.268	1	1	1	3	2.5	2.5	0.171
Socio-economic	0.2	1	1	2	1	2	1	0.116
topography	0.222	1	5	1	0.5	1	0.5	0.073
Hazards	0.5	0.333	1	2	1	3	1	0.128
Climate	0.4	0.4	0.5	1	0.333	1	0.5	0.068
environmental	0.4	0.4	1	2	1	2	1	0.114

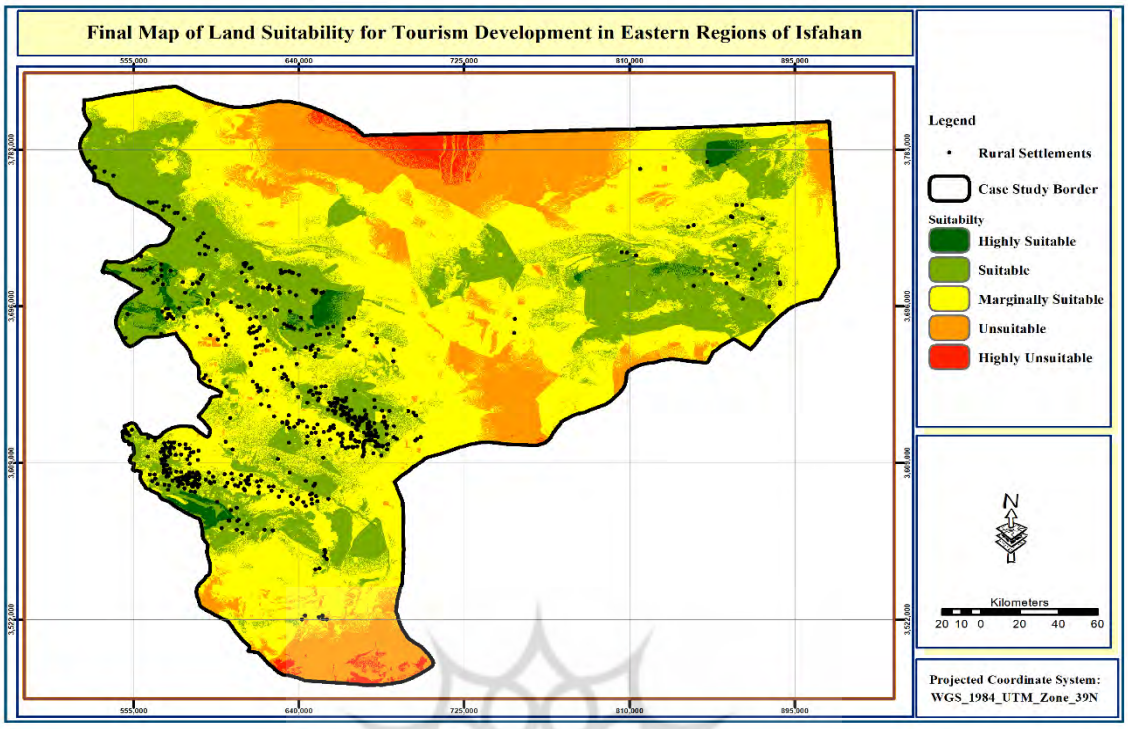

Figure 10. Final map of land suitability analysis for tourism development in the eastern regions of Isfahan
(Source: Research Findings, 2018)

The statistical data acquired from the final map of land suitability (Table-18) show that in very high suitability class 1.6% of the area was explored, and in high suitability class, 27.89% of the study area was explored. In sum, both classes with 21044 square kilometers account for nearly 30 percent of the total area (Fig. 10), which is a very high figure and a sign of the capabilities to develop tourism in the desert areas of the Eastern Isfahan. Regardless of the land suitability in the moderate class, if the emphasis is placed only on the capabilities of these two areas which have the least restrictions, together with principled planning, the development of tourism in the region would reach the desired objectives, which includes positive socio-economic, and environmental effects.

Table 18. Statistical data of the final map of land suitability for tourism development
(Source: Research Findings, 2018)

Land suitability classes	Pixel count	Area	Percentage of area	Minimum values	Maximum values	Mean
very high	860931.96	1152.06	1.61	0.66	0.76	0.68
high	12935567.72	19892.71	27.89	0.56	0.66	0.59
marginally suitable	20793190.04	36585.95	51.29	0.46	0.56	0.52
not suitable	5770954.06	124844.42	17.50	0.36	0.46	0.42
very unsuitable	458959.41	12200.65	1.71	0.26	0.36	0.34

Geographic distribution of land in the study area shows a special focus on the eastern and northwestern areas. In other areas, the focus of capabilities in most areas, especially in the central regions of the area is clearly visible. Considering the application of various socioeconomic factors

in the evaluation process and the research findings about available tourism capabilities in this region, it seems that the development of tourism in desert regions of Eastern Isfahan, is feasible as an inexpensive, essential and high priority industry.
In order to understand the dimensions of tourism development impacts on rural settlements in the study area, the layers of rural settlements and their populations were overlapped with the proposed land suitability classes; based on the data extracted from this overlap, through the use of the spatial join tools in the ArcGIS software, there are 388 rural settlements equivalent to nearly 48% of all settlements and the population in very high and high suitability classes. The results confirm the direct impact of tourism development on nearly 48 percent of the population and rural settlements in this area; on the other hand, in the marginally suitable class, nearly 51 percent of rural settlements and population are located, which are also directly and indirectly affected by development of tourism. Therefore, tourism development has double effects on many settlements in the region and can stimulate their sustainable development.

Table 19. Number of villages and population of rural settlements in the proposed land suitability classes

(Source: Research Findings, 2018)

Land suitability classes	Number of villages	Percent of villages	Population	Percent of population
very high	6	0.75	675	0.29
high	382	47.63	112421	47.60
marginally suitable	410	51.12	123011	52.09
not suitable	3	0.37	39	0.02
very unsuitable	1	0.12	16	0.01
Total	802	100	236162	100

4. Discussion and conclusions

In this study, using a multi-criteria evaluation method in the GIS environment, we tried to identify and analyze the land suitability classes for tourism development in counties located in desert areas of eastern regions of Isfahan province. For this purpose, a comprehensive review of literature and the study of geographic features of the region, effective criteria for evaluation process have been used. Thus, at the outset, by establishing related factors and criteria, the suitability of the region in each of the factors and groups of criteria was examined. The result showed that topographically, nearly 57% of the area, are in very high and high land suitability classes for tourism development. In the area of the climate factors, there are very low and low capabilities. In terms of land covers and animal species diversity, limited but valuable areas have been identified for tourism development. The results of the study showed that the region has no restrictions on the hazards and 43% of the total area are in very high and high suitability classes. In terms of environmental criteria, nearly 47% of the area are in very high and high suitability classes for tourism development. The overlap of socio-economic parameters also showed that a major part of the study area has very high suitability. In the group of tourist attractions as one of the most important and influential factors in the development of tourism, the results showed there are vast and varied capacities for tourism development, as more than a third of the area is in the very high suitability class for tourism development.
After evaluating each of the factors and groups, the output maps of the criteria are weighted by experts in a paired comparison method. The result of weighing showed that various tourist attractions, land covers, and animal species diversity and hazards respectively weighting 0.333, 0.17, and 0.89, are the most important factors affecting the development of desert tourism in eastern areas of Isfahan province. At the next level, socio-economic, environmental, topographic and climate criteria have the highest scores. The result of overlapping the criteria based on the linear weight composition also showed that a total of 21044 square kilometers, 30 percent of the total area are

in high and very high suitability classes for tourism development.

It is important to know that nearly one-third of the lands in this area are in a very high suitability class or encounter the minimal natural and human constraints. The eastern areas of Isfahan province is a region with special geographic features and diverse tourist attractions; however, many regions in the area, despite many attractions, are still deprived and in poor conditions, and lag behind developed areas of the province, including the urban areas of Isfahan. Therefore, making use of high potentials in desert tourism in these areas can be a significant and decisive factor in reducing the gap between the human communities of this region and developed areas of the province. Compared to other regions of Isfahan province, the eastern region is a very dry one with limited water resources for developing agricultural activities. Given the high levels of water stress in the area and the negative impacts of recent droughts and based on the principles of sustainable development in these areas, it seems that mainstreaming of tourism development strategies is among the best available, inexpensive and effective alternatives in the short term to tackle the current problems, especially in vulnerable rural communities. In contrast to some desert areas of Iran, which are among the most marginal and remote areas far from population centers, the eastern areas of Isfahan province have a very good accessibility to the largest population centers of Iran, namely the urban area of Isfahan; this can be of great importance to the development of tourism in different aspects and provides one of the largest and most basic opportunities for the development of desert tourism in the area, the lack of which if there were other developmental conditions, could have been a serious obstacle to the development of tourism in the area.

The final map of zoning the land suitability classes for the development of desert tourism in the study area shows that geographic distribution of lands has a particular concentration in the east, northwest, and central regions.

In general, we may conclude that almost all conditions for development of desert tourism in the study area are provided; therefore, it is suggested to place development of tourism in this region at the top of future development plans. Further, by applying more detailed criteria, and introducing specific tourism functions for each of these potential areas, the tourism development can ensure the sustainability of human and natural resources. On the other hand, this could moderate some of the environmental constraints on the development of activities such as agriculture, and compensate for the disadvantages caused by recent droughts and climate changes.

Acknowledgments: The present study is the result of a research project entitled *"Evaluation of Land Potentials for Tourism Development Using Multi Criteria Evaluation Method, GIS and Planning Models (Case Study: Eastern Regions of Isfahan Province)"* and we appreciate this from Payame Noor University, which provided the cost of implementing this research project.

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چکیده مبسوط

۱. مقدمه

صنعت گردشگری به عنوان یک صنعت پرسود و ارزان، یکی از اجزای اساسی توسعه پایدار کشورها برای مناطقی که زمینه‌های توسعه آن را دارند، به شمار می‌رود؛ به طوری که آن را صادرات نامرئی نیز نامیده‌اند. اکوتوریسم یکی از بخش‌های گردشگری است. این شکل از گردشگری سفری مسئولانه به مناطق طبیعی است که از محیط‌زیست حفاظت می‌کند و باعث بهبود رفاه مردم محلی می‌شود. بخش وسیعی از کشور ایران را نواحی بیابانی، نیمه بیابانی و کویری تشکیل داده که در نگاه اول ناحیه‌ای بی‌حاصل جلوه می‌کند و هرگونه سرمایه‌گذاری در آن را در ظاهر، منجر به شکست نشان می‌دهد. به طوری که حتی به لحاظ گردشگری و اکوتوریسم نیز مورد غفلت و بی‌مهری واقع شده است. مطالعه وضعیت جغرافیایی استان اصفهان نشان می‌دهد منطقه شرقی استان نزدیک به ۶۶ درصد کل مساحت استان را به خود اختصاص داده‌اند؛ این منطقه خشک و نیمه‌خشک با حداقل ارتفاع ۵۹۶ متر، شیب بسیار پایین، خصایص خاص اقلیمی همراه با ویژگی‌ها و عوارض منحصربه‌فرد کویری، می‌تواند زمینه توسعه اکوتوریسم و گردشگری کویری را در این بخش از استان فراهم نماید. این در حالی است که در کنار این پتانسیل‌ها، مسئله کمبود آب و محدودیت‌های محیطیِ موجود برای توسعه کشاورزی و فعالیت‌های مرتبط، توسعه پایدار روستایی و در مجموع برون‌رفت از توسعه‌نیافتگی منطقه‌ای را با چالش‌های جدی مواجه ساخته است. بنابراین، توسعه اکوتوریسم به عنوان یک صنعت ارزان و پاک با ظرفیت‌هایی فراوان، می‌تواند از بهترین گزینه‌های تعدیل محدودیت‌های محیطی برای کشاورزی و کم آبی در این منطقه آسیب‌پذیر و با شکنندگی بالایِ اکوسیستمی به شمار آید و موجبات بهبود رفاه جامعه محلی، حفظ محیط‌زیست و نهایتاً توسعه پایدار این مناطق را فراهم سازد.

۲. مبانی نظری تحقیق

اکوتوریسم که اختصار واژهEcological Tourism است به عنوان یکی از بخش‌های گردشگری- برخلاف سایر جنبه‌های توریسم ازجمله توریسم انبوه [۱] که در آن صرفاً به سود ناشی از گردشگری تأکید می‌شود - دارای محتوایی چندبعدی است. این شکل از گردشگری فعالیت‌های فراغتی انسان را عمدتاً در طبیعت امکان‌پذیر می‌سازد و مبتنی بر مسافرت‌های هدفمند توأم با برداشت‌های فرهنگی، معنوی، دیدار و مطالعه از جاذبه‌های طبیعی و بهره‌گیری و لذت‌جویی از پدیده‌های متنوع آن است. تحرک‌بخشی به توسعه اقتصادی در سطح ملی و محلی، تنوع‌بخشی به اقتصاد، کسب سود، ایجاد زیرساخت‌ها، ایجاد سرمایه و بنیه مالی برای مدیریت و حفاظت از مناطق طبیعی، ایجاد عدالت اقتصادی در راستای حفاظت از منابع طبیعی، افزایش آگاهی و بینش افراد جامعه در مورد محیط‌زیست و حفاظت از آن، حفظ فرهنگ‌ها و ... همگی از قابلیت اکوتوریسم به شمار می‌آیند. شاخه نسبتاً جدیدی از اکوتوریسم، گردشگری مناطق بیابانی و کویری است. گردش در بیابان‌ها و نواحی کویری و مشاهده جاذبه‌های کویری، پوشش گیاهی، حیات جانوری، اشکال مورفولوژیک، انجام فعالیت‌های ورزشی و بازدید از سایر جاذبه‌های آن‌ها، نوع خاصی از گردشگری را به وجود آورده که «گردشگری کویر» نامیده می‌شود.

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۳. روش تحقیق

محدوده مطالعه این پژوهش شامل ۶ شهرستان نائین، اردستان، آران و بیدگل، خوروبیابانک، اصفهان و نطنز واقع در شرق استان اصفهان است. این ناحیه با وسعتی نزدیک، ۶۶ درصد کل مساحت استان اصفهان را شامل می‌شود. متوسط ارتفاع این ناحیه ۱۲۷۶ متر است. متوسط شیب این منطقه نیز ۱۰/۹۱ درصد است. بر اساس اطلاعات آماری سال ۱۳۹۰، این محدوده با ۵۸۲ سکونتگاه روستایی و ۳۱ سکونتگاه شهری، ۲۴۱۱۰۹۵ نفر جمعیت داشته است. این پژوهش با توجه به هدف، از نوع کاربردی و از نظر روش تحقیق از نوع توصیفی- تحلیلی، است. برای تجزیه و تحلیل داده‌ها، از روش ارزیابی چندمعیاره در محیط سیستم اطلاعات جغرافیایی استفاده شده است. از مهم‌ترین روش‌های ارزیابی چندمعیاره می‌توان به روش ترکیب خطی وزنی اشاره کرد.

۴. یافته‌های تحقیق

نتیجه همپوشانی پارامترهای توپوگرافی نشان می‌دهد که نزدیک به ۵۷ درصد این ناحیه دارای توانمندی بسیار بالا و بالا برای توسعه گردشگری کویری است. به لحاظ دو عنصر اقلیمی میانگین دما و بارش، ۴/۵ درصد محدوده دارای توانمندی بسیار بالا و بالاست. از لحاظ اقلیمی، نزدیک به ۷۵ درصد محدوده توانمندی بسیار پایین و پایینی برای توسعه گردشگری کویری است. در زمینه پوشش زمین و تنوع گونه‌های جانوری، بیشتر مساحت دارای توانمندی متوسط است. در زمینه مخاطرات نیز محدودیت چندانی مشاهده نمی‌شود؛ به طوری که نزدیک به ۴۳ درصد کل مساحت منطقه دارای توانمندی بسیار بالا و بالایی است. به لحاظ سازگاری با کاربری‌های مجاور، ۴۶ درصد مساحت محدوده توانمندی بسیار بالا و بالایی برای توسعه گردشگری کویر دارد. در ارزیابی توانمندی به لحاظ ویژگی‌های اجتماعی – اقتصادی، ۷۲ درصد مساحت این منطقه دارای توانمندی بسیار بالا و بالایی است. نتایج مربوط به جاذبه‌های گردشگری نشان می‌دهد نزدیک به ۳۳ درصد زمین‌های منطقه دارای توانمندی بسیار بالا و بالایی در زمینه برخورداری‌های از جاذبه‌های گردشگری است. نتیجه اعمال نظر کارشناسان و متخصصان در تهیه نقشه نهایی توانمندی زمین نشان می‌دهد که: جاذبه‌های متنوع گردشگری با وزن ۰/۳۳۳، مهم‌ترین عامل یا توانمندی برای توسعه گردشگری کویر در منطقه است. پوشش زمین و تنوع گونه‌های جانوری با وزن ۰/۱۷۱ عامل مهم دیگری است. سومین عامل مهم نیز معیار مخاطرات با امتیاز ۰/۱۲۸ است. اطلاعات آماری حاصل از نقشه نهایی توانمندی زمین نشان می‌دهد در کلاس بسیار مناسب ۱/۶ درصد و در کلاس مناسب ۲۷/۸۹ درصد زمین‌های محدوده مطالعه قرار گرفته است. در مجموع این دو کلاس نزدیک به ۳۰ درصد کل مساحت محدوده را به خود اختصاص داده‌اند.

۵. بحث و نتیجه‌گیری

در پژوهش حاضر تلاش گردید با به‌کارگیری روش ارزیابی چندمعیاره در محیط سیستم اطلاعات جغرافیایی، توانمندی‌های زمین برای توسعه گردشگری کویر در شهرستان‌های شرقی استان اصفهان شناسایی و تحلیل شود. جهت انجام این کار با مطالعه جامع ادبیات و ویژگی‌های جغرافی منطقه، پارامترهای مؤثر در ارزیابی شناسایی و در روند ارزیابی بکار گرفته شدند. می‌توان گفت تقریباً تمامی شرایط برای توسعه گردشگری کویر در این منطقه فراهم است؛ لذا پیشنهاد می‌شود توسعه گردشگری کویر در این منطقه اساس و در رأس برنامه‌ریزی توسعه آتی این منطقه قرار گیرد و در مناطق پتانسیل دار شناسایی‌شده، با به‌کارگیری پارامترهای جزئی‌تر دیگری و همچنین تعریف کارکردهای خاص گردشگری برای هر کدام از این مناطق مستعد، موتور حرکت توسعه به حرکت درآورده شود و بدین طریق پایداری منابع انسانی و طبیعی در این مناطق تضمین گردد.

کلید واژه‌ها: توانمندی زمین، گردشگری مناطق کویری و بیابانی، ارزیابی چندمعیاره، ترکیب خطی وزنی، سامانه اطلاعات جغرافیایی، مناطق شرقی اصفهان.

تشکر و قدردانی

پژوهش حاضر خروجی طرح پژوهشی با عنوان "ارزیابی توانمندی-های زمین برای توسعهٔ گردشگری کویری با کاربرد روش ارزیابی چندمعیاره، GIS و مدل‌های برنامه‌ریزی (مطالعه موردی: مناطق شرقی استان اصفهان)" و بدین وسیله از دانشگاه پیام نور که هزینهٔ اجرای این طرح پژوهشی را تأمین کرد، قدردانی می‌کنیم.

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