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Site Suitability Evaluation for Ecotourism Using GIS & MCDM: A Case Study of Bazangan Lake Watershed, Iran

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ABSTRACT: The criteria affecting ecotourism development were identified using Delphi Questionnaire and expertise opinion. Then, the main- and sub-criteria were compared pair wisely. The weight of each level of the hierarchy was judged using Expert Choice Software. Finally, the required map layers were weighted and all of the weighted criteria maps that had already been prepared in the scale of 1:250000 were converted from vector format into the raster to be overlaid in GIS. Slope, vegetation cover, landscape and ecotourism infrastructures was recognized as a key factor in ecological land capability evaluation of the study area. Processing data by GIS, the map of suitable, averagely suitable, and unsuitable zones for ecotourism development were prepared. The results revealed that out of the entire study area, 229 ha (59%) has a suitable capability, 77.5 ha (20%) has a medium suitability and 84 ha (21%) has a poor capability for ecotourism development.

***Keywords*:** Site Suitability Evaluation, AHP, GIS, Ecotourism, MCDM, Bazangan Lake.

INTRODUCTION

Recreation and tourism in national parks and other protected areas have increased rapidly across the world in the past decade (Balmford, et al. 2009). Among numerous definitions the general scientific agreement is that ecotourism represents a sustainable form of tourism which is realized in preserved natural areas with the aim to educated visitors, protect the environment and contribute directly to the economic development and improvement of the quality of life of local population.(Ljubomir et al.2016). Many efforts have been conducted to determine the benefits of visitors who visit recreation areas of forest and national parks.(ZARGHI et al 2014). Tourism which has sustainable natural resource is called ecotourism(Dashti et al 2013).Ecotourism has a strong connection with sustainable tourism. Sustainability depends on the relationship between tourism and environment. Suitable management for ecotourism development is essential in order to conserve and maintain the biological richness of the area as well as economic upliftment of the local people. In addition, ecotourism can be defined as an opportunity to promote the values in the protected areas and to finance related stakeholders (Ok 2006)Ecotourism has become one of the fastest growing industry sectors (Jones 2005; Olafsdottir 2013). Iran has a long history of nature protection.(ZARGHI et al 2015). It is a significant topic, which has been identified as a sustainable tourism form expected to contribute to both environmental conservation and economy development. Thus it is recognized as a sustainable way to develop regions with abundant tourism resources.(Weaver et al.2007)A large number of studies have examined the effects of tourism on the physical environment, vegetation, and wildlife in terrestrial systems.(Hall et al 2006). Much less attention has been paid to freshwater ecosystems, e.g. lakes, rivers/streams (Hadwen 2007). There have been also only few practical assessments of the eco-tourism status at specific locations due to partly standardized and yet developed evaluative criteria(Jeong 2014)In ecotourism, three important criteria must be considered: Appeals should be nature oriented; Tourists' reciprocal relationship should be focused on learning and

education; and Managers of those environments should take measures in line with ecological, socio-cultural and economical sustainability.(Weaver et al.2007).From current local development modeling, the emphasis on second homes of a local community is to conserve local resources and to increase local benefits. It focuses the close association between ecotourism and local residents who are one of the essential stake-holders groups (experts and non-experts, all interest groups(Byrd 2009; Ryan et al 2002).Ideally, ecotourism should satisfy different measures such as protecting biological and cultural diversity trough protection of biological environment and promoting sustainable use of biodiversity with the least effect on the environment(Ryngnga 2008) .In this regard, ecotourism evaluation is an important tool for sustainable development of tourism in a given region (Ceballos-Lascurain 1996).In recent years, a wide range of techniques and methods in combination with GIS have been applied when evaluating and zoning of ecotourism potentials (Table 1). The analytical hierarchy process (AHP) incorporated with the GIS technology produces a flexible way of combining various criteria in the siting process(Pavlikakis et al2003).Combination of analytical hierarchy process (AHP) and GIS integrates decision support method with powerful imagery and mapping abilities, allowing drawing map of land proportion usage. MCDA is a powerful tool that supports complex decision making. More recently ,MCDA has been combined with multidisciplinary expert evaluations and stakeholder input for sustainable management planning(Brown et al 2001). Previous studies have demonstrated that public participation in the MCDA process can help bring stakeholders towards consent by defining criteria and weightings before results are developed and identifying areas of commonality between stakeholders(Bernard et al 2011 ; Brown et al 2001; Sheppard et al 2005; Valencia et al2010). Therefore, the current research makes efforts to identify ecotourism potential destination in Bazangan Lake using AHP and GIS because, having a beautiful and virgin natural environment, this lake has high potential in terms of nature tourism. It is able to appeal many tourists if proper attention is paid and appropriate investment is performed. In fact, to investigate nature tourism capacity in Bazangan Lakeusing AHP and GIS, after determining the potential of tourism destinations of the lake , the present study aims at paving the way for tourism development based on nature tourism. In recent years, a wide range of techniques and methods in combination with GIS have been applied when evaluating and zoning of ecotourism potentials. In several research papers for the identification of ecotourism criteria andpotential sites for ecotourism Remote Sensing (RS) and GIS are used(Deylar et al 2010;Paerta 2013; Samanta 2015). Several authors agree that the AHP method can be improvedin combination with other methods. Dashti et al. apply Multiple Criteria Evaluation (MCE) for the selection of suitable sites for eco-tourism in Qeshm Island, Iran. Criterion layer is standardized with fuzzy logic, while a suitability map for tourism was created usingGIS − supported Weighted Linear Combination (WLC)(Dashti et al 2013).

Bali et al(2015).have developed a simple SDSS model based on AHP, Fuzzy, and GIS for optimized ecotourism site selection in the Caspian Hyrcanian Mixed Forests eco-region[28].However, Hajehforoosh-nia et al. used multi-criteria evaluation (MCE) and multi-objective land (MOLA) for the purpose of zoning wildlife sanctuary of the Ghamishloo region in Iran. In the part of MCE – AHP and WLC were used. The final result of their study is the division of wildlife sanctuary area in four zones: conservation, recreation, rehabilitation and cultural zone (Hajehforoosh et al 2011). This paper addresses a scientific approach to determine suitable land for healthy residential area development. This approach will help in revision of policy and preparation of development plans in the study area and for other area as well.

Table 1. The applied methods for ecotourism planning.

The applied methods for ecotourism planning.

References	Solution method
(Delavar et al., 2010(Delavar et al 2010)	Remote Sensing and GIS techniques
(KheikhahZarkesh et al., 2011)(Kheikhahzarkesh 2011)	GIS, AHP, SMCE, MADM
(Bunruamkaew and Murayama, 2011)	GIS, AHP
(Alaeddinoglu and Can, 2011)	GIS, SPSS
Koschke et al., 2012)	GIS, Likert scale
(Pareta, 2013)	Remote Sensing and GIS techniques
(Ohadi et al., 2013)	GIS- Overlaying the map layers
Dashti et al., 2013)	GIS, AHP, Fuzzy, WLC
(Mahdavi and Niknejad, 2014)	GIS, AHP, Fuzzy, Delphi Method
(Dhami et al., 2014)	GIS, AHP, Fuzzy, WLC
(Jeong et al., 2014)	GIS, AHP, MADM, OWA
(Mobaraki et al., 2014)	GIS, AHP
(Ahmadi et al., 2015)	GIS, Overlaying the map layers
(Bali et al., 2015)	GIS, AHP, WLC, Fuzzy, Delphi
Samanta and Baitalik, 2015)**[43Rem**	Remote Sensing and GIS techniques

Materials and Methods:

Site characteristics:

Bazangan Lake is located at N 36°18.48', E 060°28.53' between Mashhad and Sarakhs in north east of Iran (Figure 1). Its surface area is 690,000 m2(69 hectare), altitude 860 m and maximum depth 12 m in high water years(Gholami et al 2007; Behroozi 2007). Bazangan wetland is an important habitat for birds, especially as a nesting site for some native and migrating species(Behroozi 2007).

Figure 1. Satellite image of lake

In order to identify the suitable locations for ecotourism in the case study area, we determined a substantial multi-disciplinary evaluation process with multiple sets of criteria as shown in flowchart (Figure 3) The aim of this study is to propose a reliable zonal model that can serve as a useful tool for strategic decision-making process in planning the development of ecotourism in the region of Bazangan Lake. Upon interviewing the experts, the collected data were processed and the aggregation of their opinions was made. On the basis of the previous studies, professional expert opinions and the natural characteristic of the region of “Bazangan Lake”, 8 criteria were selected in this study and they are grouped into 3 clusters which are crucial for evaluating and zoning the ecotourism potential of the region of Bazangan lake. The selected criteria with a brief description and the references of the authors who used them in similar studies are presented in Table 2. The method of defining the zones of land suitability classes for the development of ecotourism in Bazangan lake has been shown in figure 4.

Table 2. Flowchart of Ecological Capability Evaluation for Ecotourism using Multi Criteria Decision Making Method

9	Extremely preferred
7	very strongly preferred
5	Strongly preferred
3	Moderately preferred
1	Equally preferred
2,4,6,8	Between scales preferred

A pair-wise comparison matrix for calculation criteria numerical weights has been indicated.(Figure 2 & Figure 3)

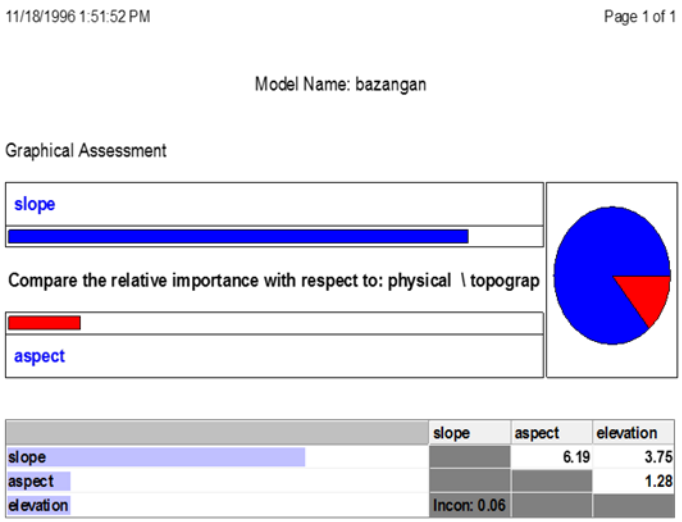

Figure 2. Inserting the presented scores by an expert for topography sub criteria in expert choice software

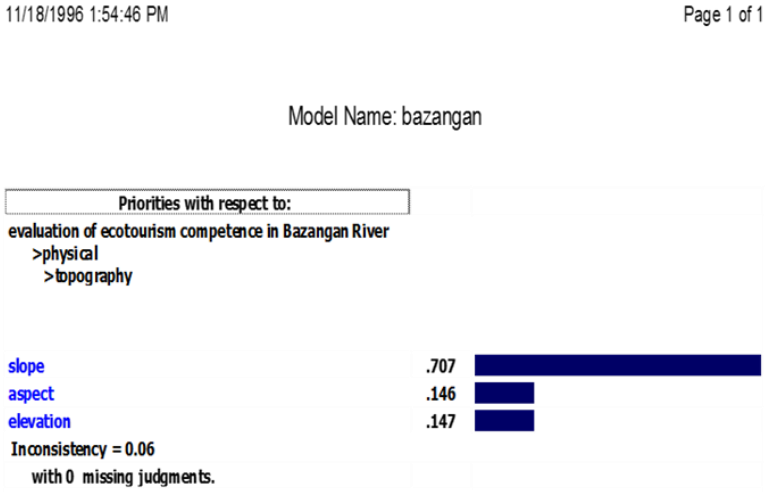

Figure 3. Combining Topography Sub criteria scores by expert

The used criteria and sub criteria in the studied area have been shown in tables3-8

Table 3. List of criteria for evaluation of ecotourism competence in Bazangan lake

Criteria	Weight
1.topography	0.371
2.climate	0.341
3.soil	0.288
4.biological	0.267
5.socio-economical	0.252

Table 4. Indicators related to Criterion 1

Criteria	Weight
1.1.slop	0.707
1.1.1.slop 0-2%	0.357
1.1.2.slop.2-5%	0.273
1.1.3.slop 5-10%	0.167
1.1.4.slop 10-15%	0.104
1.1.5.slop 15-65%	0.062
1.1.6.slop more than 65%	0.036
1.2.aspect	0.146
1.2.1.N	0.226
1.2.2.S	0.176
1.2.3.E	0.162
1.2.4.W	0.135
1.2.5.P	0.301
1.3.elevation	0.147
1.3.1.elevation 0-200	0.198
1.3.2.elevation 200-400	0.224
1.3.3.elevation 400-600	0.208
1.3.4.elevation 600-800	0.183
1.3.5.elevation 800-1000	0.188

Table 5. Indicators related to Criterion 2

Criteria	Weight
2.1.temperature	0.608
2.1.1. temperature 18-21° C	0.521
2.1.2. temperature 21-25° C	0.315
2.1.3. temperature 25-30° C	0.164
2.2.percipetation	0.392
2.2.1.percipetation 150-200	0.105
2.2.2.percipetation 200-250	0.258
2.2.3.percipetation 250-300	0.637

Table 6. Indicators related to Criterion 3

Criteria	Weight
3.1.erosion	0.632
3.1.1. high	0.196
3.1.2. low	0.386
3.1.3. moderate	0.418
3.2.texture	0.368
3.2.1.sand	0.151
3.2.2.low-depth loom- silt	0.410
3.2.3.shallow loom	0.439

Table 7.Indicators related to Criterion 4

Criteria	Weight
4.1.vegetation cover	0.433
4.1.1. cover 24-30%	0.055
4.1.2. cover 30-44%	0.144
4.1.3. cover 45-50%	0.372
4.1.4. more than 50%	0.429
4.2.landscape	0.567
4.2.1.mountain	0.176
4.2.2.river	0.694
4.2.3.plain	0.130

Table 8. Indicators related to Criterion 5

Criteria	Weight
5.1.distance from city	0.272
5.1.1.distance 200-1000	0.536
5.1.2.distance 1000-2000	0.311
5.1.3.more than 2000	0.153
5.2.distance from village	0.156
5.2.1.distance 250-500	0.591
5.2.2.distance 500-1000	0.272
5.2.1.distance 1000-2000	0.137
5.3.ecotourism infrastructures	0.572
5.3.1.less than 300m	0.424
5.3.2. distance 300-500 m	0.377
5.3.1.more than 500 m	0.199

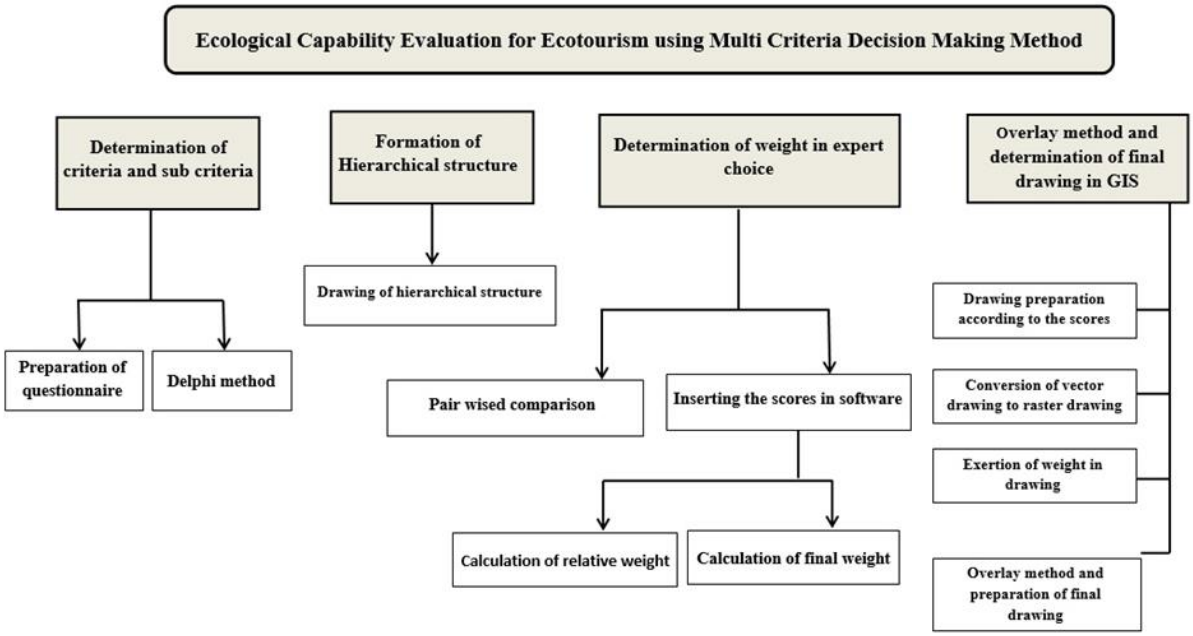

Figure 4. Schematic diagram for Ecological Capability Evaluation for Ecotourism using Multi Criteria Decision Making Method in Bazangan Lake

Regarding research topic nature and goals, dominant research method is descriptive-analytical. Firstly, to evaluate ecotourism capacity of Bazangan Lake, various climatologically, geological, hydrological, topological maps and access maps have been prepared. The identification of the criteria is a complex and important process of grouping and defining the factors which are very important for evaluating land suitability classes. First, initial data for assessing ecotourism potential of the studied region has been collected and were assessed by lots of environmental professors and experts in universities for approval .Theses criteria were submitted to Delphi group in three physicochemical, biological and Socio-economic questionnaire in order to receive their agreement and disagreement with the relevant criteria . those criteria which obtained more than %50 were acknowledged as the acceptable criteria. In the research 8 main criteria and 44 sub-criteria were identified. In this regard, according to hierarchical structure , criteria and sub-criteria, the most important factors in biological , physic-chemical and Socio-economic environment were determined.

Weight and score in expert choice:

The AHP is one of the most extended Multi-Criteria Decision Making (MCDM) techniques. The development of weights is based on a pair-wise comparison matrix. The comparisons concern the relative importance of two criteria involved in determining suitability for the stated objective.

This method provides a structural basis for quantifying the comparison of decision elements and criteria in a pair wise technique. The weights are based on expert scores which has been shown in L(local priority). As it has been indicated in figure3 The total number of criteria and sub criteria makes 1. Due to overlay ,all the sub criteria layers were converted into raster and then were described as 1)proper recreational zones2)improper recreational zones 3)average recreational zones. Weighted overlay method was use to assess the layers and the final integrated map was created to describe the most proper and improper recreational zones.

Data:

The related criteria and sub criteria as seen in figure 3 were created and kept as GIS layers. As it has been shown distance from river, vegetation cover ,slope and ecotourism infrastructures were classified as the highly influential factor in ecotourism in Bazangan Lake. To obtain importance weights for each criterion, a pairwise comparison method developed by Saaty (1980) was used to rank the criteria with regard to each objective. The pairwise comparison method employs an underlying continuous scale (Table 5), with values from 1 to 9, to rate the relative preferences for two criteria. The value 1 indicates that two criteria are ‘equally’ important, and the value 9 implies that one criterion is ‘extremely’ more important than the other (Gerber et al. 2008; Malczewski et al. 2003). For each objective, a matrix of pairwise comparisons was built, and the eigenvector associated with the largest eigenvalue of the matrix was computed and normalized. In addition, a consistency ratio was calculated to check the transitiveness of the pairwise comparisons. The consistency ratio (CR)is designed in such a way that if $CR < 0.10$, then the ratio indicates a reasonable level of consistency in the pairwise comparison matrix. If, however, $CR \geq 0.10$, then the ratio values are indicative of inconsistent judgments; in such cases, one should reconsider and revise the original values in the pairwise comparison matrix (Malczewski et al. 2003). Maps of the criteria in the studied area have been indicated .(figure 5-10)

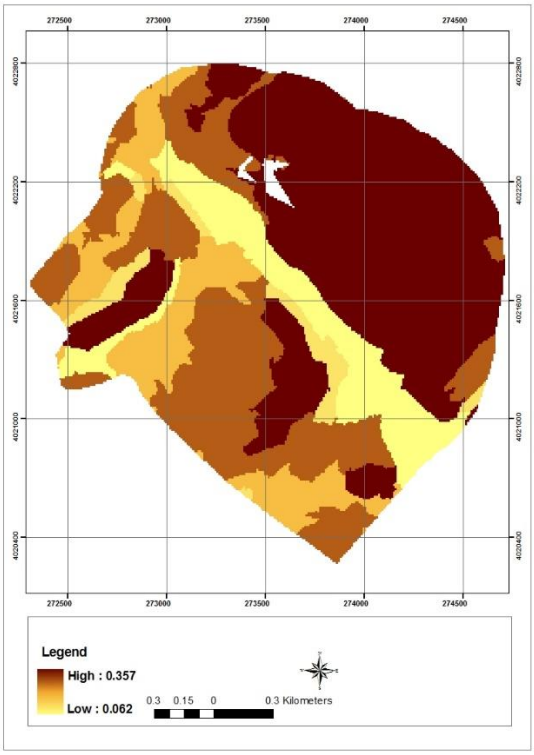

Figure 5. generated Map of slope classes

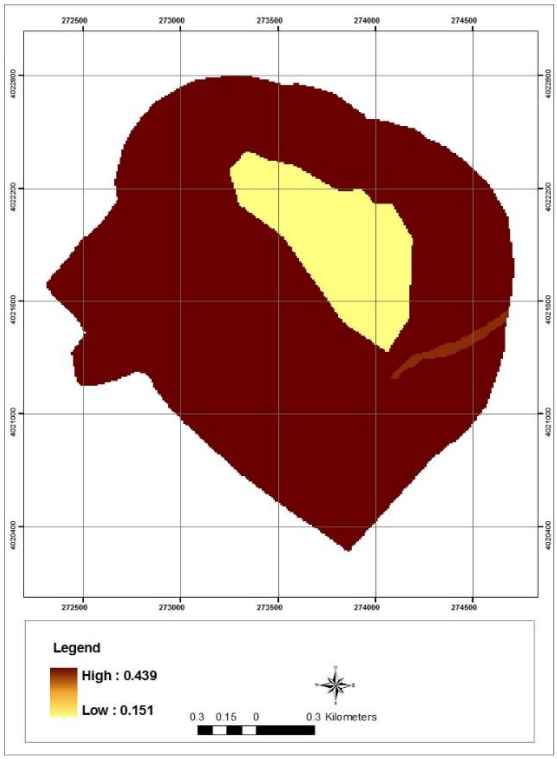

Figure 6. generated map of Soil

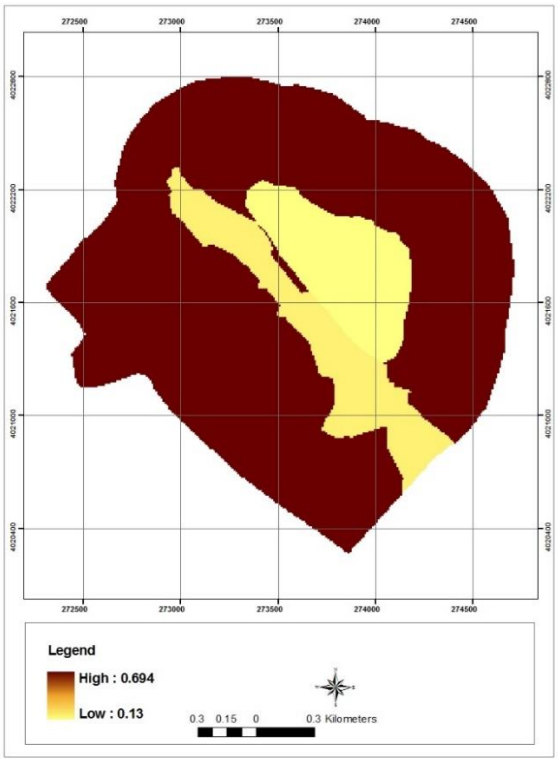

Figure 7. Generated Landscape drawing

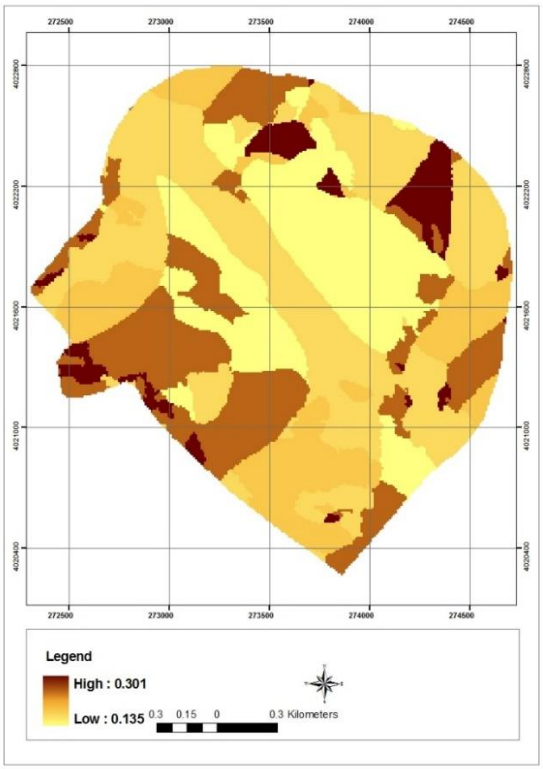

Figure 8. Generated Aspect drawing

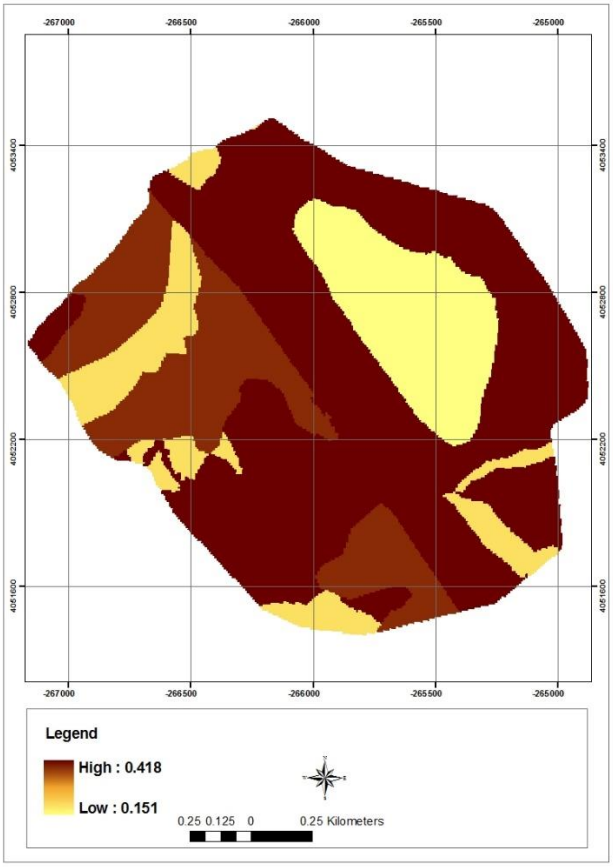

Figure 9. Generated Erosion drawing

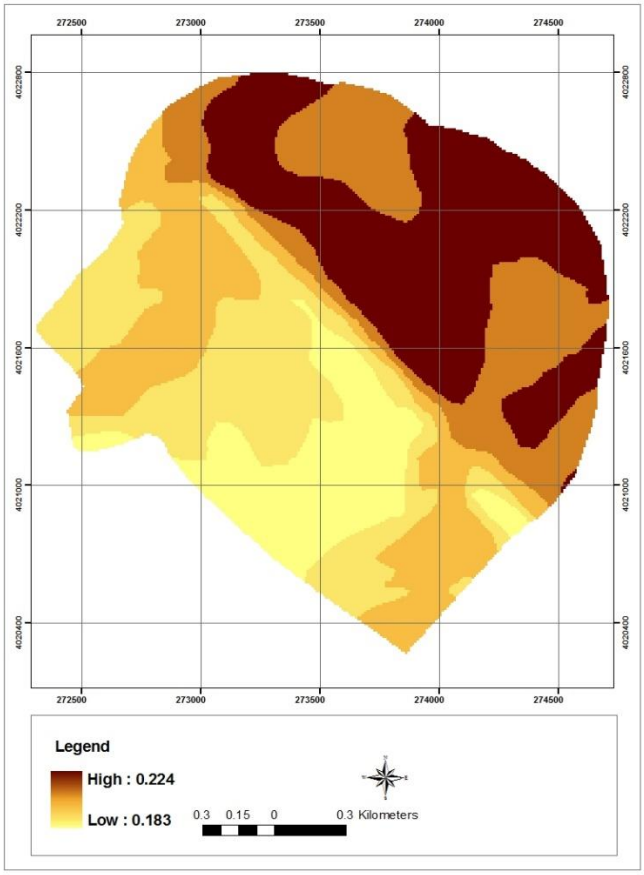

Figure 10. Generated Hypso drawing

Two components are central to ecotourism: the landscape and the people. Accordingly, Kusler (1991) argues that ecotourism must have a strong “people element” and therefore, ecotourism establishes a harmonious symbiotic relationship between sightseeing visit and environmental protection(Hongshu et al 2009). Satisfied Ecotourists bring success to the businesses(Hadwen 2007).

According to Newsome et al(2013) “Ecotourism’ can be understood in terms of 5 fundamental characteristics: It is based on the natural environment; Ecologically sustainable; Environmentally educative (Enjoyable and meaningful experiences, Knowledge and awareness, Expectations of Eco tourists); Locally beneficial (Support, services and products (local employment), Tourist satisfaction (Quality, safety and business Viability)” Reynolds and Braithwie(2001) claimed that Eco tourists’ satisfaction is influenced by physical attributes including tangible and intangible factors of the tourism site including facilities, design and weather. Actual and intension to recommend ecotourism landscapes and revisits are measures of tourists’ satisfaction (Baker et al2000;Pearce 1998). This centrality of people is also evident in the goals of ecotourism to bring benefits to local people and protect the natural and cultural heritage upon which the tourism is founded. As it has been indicated gentle slope can lead to better ecotourism activities such as mountain climbing, fishing , biking and trekking. In this article, the studied area was divided into 6 sub-criteria. Eco-tourists choose slopes between 0-20 degrees for their activities specially for fishing and tenting.

This study underlined the relationship between the vegetation cover with tourist demand . as it has been indicated the tourist tend to explore in areas with high vegetation cover(more than 50% and 45% to 50%%)

Conclusion:

Data in maps are divided to present 3 sustainability classes for ecotourism land evaluation namely ,highly suitable (59%)moderately suitable (20%) and not suitable(21%). From the sustainability map for ecotourism as seen

in figure …. ,it was found that the area of highly suitable(229 ha) is about 59%. The area of moderately suitable (77.5) is about (20%). only a few percentages 84 ha (21%) are classified as not suitable respectively.(figure11 & table 9)

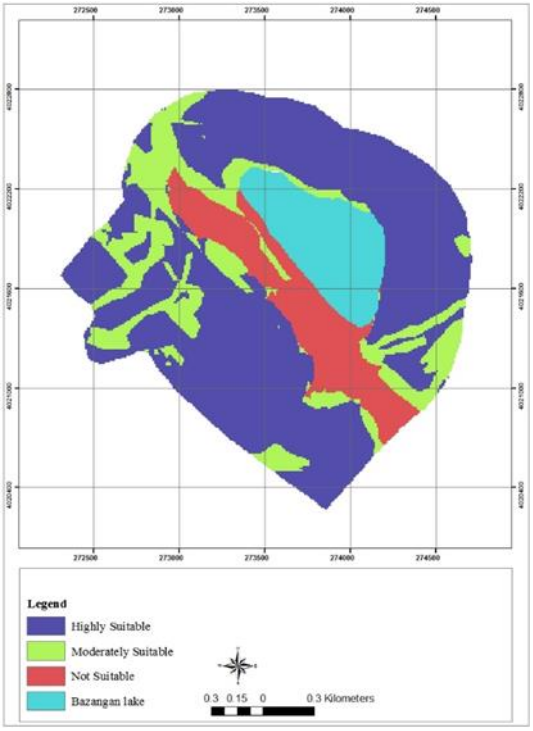

Figure 11. Site Suitability Map of the Study area for Ecotourism

With regards to the analysis of the results and ecotourism requirement, the typical sites recommended are summarized based on 3 classes. (1) S2 'moderately ecotourism potential' category allows for mild development but with high consideration on construction work and detail assessment of environmental impact. These areas can still be considered for ecotourism attractions due to passive tourist activities such as camping, fishing , bird watching, site seeing and any activities with minimum development or inference to the site. (2) S3 'highly suitable for tourism development' category includes areas with low sensitivity and available for exploitation. Still, development should be conducted in an appropriate manner with respect to minimizing development impact. Physical structures such as green hotels, lodge, restaurants and public convenience facilities are needed to support ecotourism in these areas. (3) N 'currently not suitable' category includes areas with several impacts of development and degraded environment. The development of ecotourism is further enhanced by geospatial approaches(Tewodros 2010). This study is an integrated approach of ecotourism development by identifying ecotourism sites and constructing methodology to assess the ecotourism sustainability by matching the characteristics of an area with those attributes most appropriate for ecotourism.

Ecotourism planning using multiple criteria evaluation with GIS was in used in Yan Chau Tong and closest ambient. In this study by using MCE process we clarified suitable are for conservation and recreational are which contains (camping, snorkel diving, heritage visit, hiking) and for each kind of land use suitable criteria was suggested(Fung et al 2007).

This method has been proven beneficial for supporting decision-making for planning tourism facilities and ecotourism resource utilization for sustainable development. Combination of GIS capabilities with MCDM techniques involves the phases of intelligence, design and choice (Malczewski 1999). However, a fundamental problem of decision theory is how to derive the relative weights of the criteria. Thus, one disadvantage of this method is the inherent subjectivity of assigning preference values between criteria and its complexity in the computation of the criteria weights (Tewodros 2010). The results of this study may only work in the prevailing situation of ecotourism in Bazangan Lake . However, the same principles may be also applicable elsewhere. There are a number of ways in

which future research could strengthen the validity of the findings. Implement activities of the selected ecotourism suitable sites must be continued and more concrete.

Table 9. final classification of studied area for ecotourism according to AHP method (total surface :390ha)

Class	Surface (ha)	Percentage
Moderately	77	20%
Not suitable'	84	21%
Highly suitable	229	59%

Previous studies like (Kotwal et al. 2008), point out that ecological indicators need to be covered by social and economic indicators. The Delphi approach is one of better methods to select indicators (Hai et al 2009). The results obtained indicate that the Delphi technique with participation of Iranian local experts was the effective tool for soliciting and selecting sets of criteria and indicators. The study shows that it is possible to define a set of indicators for monitoring ecotourism sustainability in Northern forest of Iran.(Barzekar 2011)

The study under the name Methods of Spatial analysis in GIS was done. That in research it was clarified that WLC process can be performed by GIS overlaying capability. Overlaying techniques in GIS shows that external map is combination criteria of map(Burrough 1990).

The following actions should be taken in order to improve the status of ecotourism in the studied area:
1- Capability evaluation for site selection for creation of camping and recreational centers.
2- Creation of natural infrastructures in order to develop the educational recreational and ecotourism activities such as fishing and trekking.
3- Doing EIA studies prior to implementation of recreational and ecotourism programs.
4- Doing studies for determination of special routs for visitors in natural area via GIS.

The results can show as a guideline and support for ecotourism planning. The use of GIS and MCE techniques impressively helps ecotourism planning. MCE is a sound device for ecotourism planning, since it takes into consideration the various criteria that have a significant impact on the decision. MCE has also effectively been applied the most suitable areas for the different activities with specific sets of criteria.

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