Journal of Research in Ecology

An International Scientific Research Journal

ISSN No: Print: 2319 –1546; Online: 2319– 1554

Original Research

Identifying the environmental criteria of nature-based tourism in arid lands of Iran by Delphi-AHP method

Authors:
Mirhosseini SA

Institution:
Department of Environment, Islamic Azad University, Maybod, Iran.

ABSTRACT:

In this article, the appropriate indexes and criteria to measure the progress towards the sustainability of ecotourism in the desert regions by a survey based on descriptive and analytical method cum feedback from the experts using Delphi method and then, prioritizing the criteria were done with AHP model. The study area of Yazd province in the center of Iran with an area of 131,000 km^2 is the third great province of Iran, of which 65 percent includes the desert lands. To have ecotourism planning in the arid and desert regions, after investigating and collecting the external and internal references, seven main criteria and 26 sub-criteria were achieved. The obtained criteria used to determine the most appropriate ecological criteria for locating the nature-tourism areas in the central desert regions of Iran, were weighed and prioritized. For this, AHP questionnaire was prepared for the environment and tourism experts and 30 cases of individuals were selected. The results of questionnaires in the EXPERT choice software were weighed. The results showed that the main ecological criteria included tourism resources, wildlife, water resources, limiting factors with inconsistency rate of 0.01, with the highest priority and the sub criteria included tourism resources, diversity of wildlife species, earthquake likelihood, water quality, population wild life. The sub-criteria of chemical and physical properties of soil, vegetation (quality), water resources, wind and rain also are the last five priorities for planning ecotourism in central deserts of Iran with the inconsistency rate of 0.05 and thus it has been selected.

Keywords:

Ecotourism, site selection, desert, AHP, Yazd

Corresponding author:
SA Mirhosseini

Article Citation:
Mirhosseini SA
Identifying the environmental criteria of nature-based tourism in arid lands of Iran by Delphi-AHP method
Journal of Research in Ecology (2016) 4(2): 159-168

Dates:
Received: 20 July 2016 **Accepted:** 23 July 2016 **Published:** 29 Aug 2016

Web Address:
http://ecologyresearch.info/documents/EC0127.pdf.

Journal of Research in Ecology

INTRODUCTION

Ecotourism is done on the important areas in the natural regions across the world. Today, ecotourism as the stable form of tourism, with increasing growth, plays an effective role in societies' sustainable development. Simultaneously, the nature -tourism provides income for protection and economic benefits of communities living in remote and rural locations (Drumm and Moore, 2002). The importance of ecotourism in international perspective reached to the extent that the United Nations named 2002 as the International Year of Ecotourism (Weaver, 2001). The principles of sustainable tourism can be defined as (World Tourism Organization, 1988). The strategic management of all renewable resources, in a way that economic, social and aesthetic needs to meet with a form that cultural integrity, essential ecological processes, ecological diversity and life-preserving systems to be maintained. Ecotourism as a form of sustainable tourism, which helps to protect and develop, is well known unfortunately, due to inadequate environmental assessment, many tourist places proceed to instability and self-destruct (Lin *et al.,* 2006). Therefore, selection of appropriate places of ecotourism with particular attention to the environmental conditions of each region appears to be necessary.

Deserts due to low production and simple structure compared to other ecosystems, are among the most fragile ecosystems (Pascal, 2006). Iran has a considerable extent of the desert and semi-desert climate and these areas have no way than development in the progress times. Precipitous development regardless of environmental issues in these areas, has non-compensable results. Tourism development in these areas, especially nature-tourism compared to other industries which needs to be developed less, is one of the ways to use the potential capabilities of these regions.

Theoretical principles

Tourism in its place will have adverse effects on the natural environment, thus, a comprehensive and scientific look is the essentials needed for the nature and tourism planning in these areas. The development of selection criteria in these areas and their prioritization in each ecosystem is an important step in this direction. Several criteria by the relevant organizations to identify

Table 1. Selection criteria for the nature- tourism places

Criterion	Sub-criterion	Description
Climate	Rain	-
	Temperature	-
	Sunlight	-
	Wind	-
	Relative Humidity	-
Wildlife	Diversity	-
	Population	-
	Distribution	-
	Sensitivity of species	According to the classification of list (IUCN, 1994)
Promenade importance	Tourists' ideas	Satisfaction of tourists' visiting, facilities on accom-modation, local products
	Recreation resources	-
Water resources	Resource Type	-
	Amount of resource	-
	Water quality	-
Soil properties	Physical characteristics	-
	Chemical properties	-
	Biological characteristics	-
Vegetation	Density	-
	Diversity	-
	Extent	-
	Combination	-

the appropriate areas for nature-tourism were developed, despite the high value is only in a general guidance level and for each region depending on its ecosystem conditions and the target should be removed from the general state and adapted with the environment. Selecting the suitable ecotourism areas as well as any other choice, it is essential to the use of criteria which determines the different angles of given conditions and long-term impact of the choice. With this perspective during the comparative studies, suitable criteria for locating the ecotourism areas have been identified and then collected in a new format.

Kitsiou *et al.. (*2002), used 10 criteria kit, including the number of stores, fallow agricultural areas, the number of beds in hotels, sandy beaches, the concentration of phosphate, nitrate and ammonium and phytoplankton concentration. Brown *et al.*. (2001) used the three main criteria (i.e. economic, social and ecological). Bhattacharya and Kumari (2004) also used criteria such as preserving the cultural legacies, ability of the environment in the development of the ecotourism, ecosystem health preservation, the created awareness, public participation and entrepreneurship in local communities, tourist satisfaction and winning capacity

Fletcher (2001) prepared the criteria such as the area, accessibility, land shape, physical and applied properties of adjacent lands, adjacent to the natural regions, quality of vision, vegetation and water for the ecotourism development

Tsaur (2006) identified and introduced the environmental management indices for ecotourism in the natural reserves of China. In this research, ecotourism administrative indices in natural reserves based on the pressure - state – response model was used. Environmental indices (such as number of rare species, population of rare species, reserve quality), social indices (such as local population associated in the ecotourism activity) and economical indices (such as annual revenue of reserve, annual income of the local community) were accounted and addressed. Li (2004) have addressed the environmental management indexes in the natural resources of Tianmushan (located in China). He investigated 12 indexes in three ecological, economical-social and infrastructural categories (Li, 2004). Pascal (2006) have noted the criteria for specific geological profiles, climate, desert flora and wild flowers, old, large or unusual plants, Caravans or other desert migrations, native residents, oases and protected areas. For this purpose, it has been taken into account the criteria for environmental, social, psychological, legal and administrative factors (WTO/IUCN/UNEP, 2002). Numerous studies in Iran in relation to identify the criteria and indicators of tourism in different ecosystems were done, for example, Nouri *et al.* (2007) used the three main criteria of conservation history, recreation and threat factors to assess the ecotourism potency. The priority of criteria such as the slope, rocks and soil, the geographical direction, water, vegetation, climate and weather were identified for focused-tourism and in this application (Makhdoom and Darwishsefat, 2003).

Iran's national tourism document has divided the criteria in to 11 categories, including the main criteria such as climate, physical features, water resources, environmental quality, vegetation, wildlife, economic, social and cultural-historical and administrative features and the management of historic (Danehkar *et al.,* 2006).

The criteria such as the height of the open sea, slope and direction of land, comfort climate, geology, soil, vegetation, land use, outing demand, landscape, security and distance from surface-waters, roads, historical and cultural centers, human settlements, faults, mines, sea, ports, airport, specific facilities for selecting ecotourism hotspots (Ardekani, 2007). According to all of these studies, criteria of selecting the ecosystem fields in Iran, is in a new context and used for all regions and local ecosystems, including 12 major criteria and 41 sub-criteria were collected and organized (Sepasi *et al.,* 2009) which are shown in Table 1. There have been few

Table 2. The way of preference weighing in pair-wise comparison matrix

Identical importance	1
Relatively prioritized/preferred	3
High preference/priority	5
Very much preference/priority	7
Extraordinary preference/priority	9
Interstitial values	2,4,6,8

practical assessments of the status of ecotourism at specific locations, partly because standardized, evaluative criteria have yet to be developed. Thorough measurements of all aspects and implications of ecotourism are almost impossible to acquire given the multitude of interrelated variables involved (Wall, 1996).

This study for selection and prioritization of appropriate criteria for ecotourism and determining their importance to select suitable areas of ecotourism in the desert and semi-desert ecosystems in AHP method was performed. The process of hierarchical analysis (Analytical Hierarchy process-AHP) was invented by Saaty in 70s (Saaty, 1980). AHP is used to extract the relative scales from pair -wise comparison of discrete and continuous data. These comparisons may be used for actual measurements or may reflect the relative weight of priorities (Saaty, 2004). The characteristic weights are assigned to the map layer and are processed in a GIS environment. This method is defined as the Spatial Analytical of Hierarchy Process (SAHP) (Malzewski, 1999).

SAHP by analyzing the complex issues and problems, converts them to a simple form and solves them. Then, it was used in the evaluation and planning by different researchers. Among the last things that were done using this method, is the study of Bojorquez *et al.* (2001). They used this method in evaluating the appropriateness of land use in Mexico. Yang *et al. (*2008) also used the AHP method and remote sensing in GIS, and have offered the land-usage management system in the city of Changsha, China (Yang *et al.,* 2008).

METHODOLOGY

Yazd province in terms of geographical coordination was placed in 29° degree and 35 minute to 35° degrees and 7 minutes in north and 52° degree and 50 minute to 58° degree and 16 minute in eastern (Figure 1). Yazd province with an area of about 131,551 square kilometers (third largest province of country in terms of area) and its population is about 880,000 people and located in the Central Plateau of Iran. It has an average rainfall of 107 mm per year, annual average temperature of 18° C and relative humidity between 30 to 35 percent. Yazd province is one of the areas with arid climate, natural attractions, historical and cultural potential of attracting tourists 86 % of its land area to the extent of 110000 km^2 is composed of desert and plain lands. The important desert areas of Yazd includes Anjir valley desert (east and west), Siahkooh desert (north and east), Abarkooh Desert (east), Marvast (center).

For identifying the appropriate criteria and to choose the ecotourism places (using similar ideas in Iran and world Table 1) similar ideas were used. In this stage in desert and semi desert regions using the AHP method and were weighted and prioritized. AHP method is one of the comprehensive methods desigend for multi-criteria decision making. Because, it makes possible to order the issue hierarchically. Also, it takes into the consideration the various quantitative and qualitative criteria. Various options are involved in the decision making process and provides the sensitivity analysis on the following criteria and sub criteria. Furthermore, it is based on the pair-wise comparison which facilitates the calculations judgment. Also, it showed the amount of consistency or

Table 3. Random Index (RI) for a number of different criteria

Number of Criteria	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.45

Table 4. Pair-wise comparison of the main criteria

Criteria	Climate	Water	Soil	Wildlife	Vegetation	Restrictive	Tourism resources
Climate	1	-	-	-	-	-	-
Water	1	1	-	-	-	-	-
Soil	0.23	0.18	1	-	-	-	-
Wild life	0.55	0.98	0.14	1	-	-	-
Vegetation	1	0.61	0.32	0.35	1	-	-
Restrictive	1	1	0.19	0.83	0.69	1	1
Tourism resources	0.42	0.64	0.12	1	0.28	1	1

inconsistency of the decision that is one of the superior advantages of this process in the multi-criteria decision making. On the other hand, it has a strong theoretical basis and established based on the axioms principle, These process are described during the steps:

- Making an hierarchical one
- Comparing the decision making elements in the pair-wise comparison model form for determining the criteria and sub criteria with important coefficients
- Weight calculating
- System consistency

Building the hierarchy

First step of AHP is drawing a graphical representation from the issue and by it our goal is obtained and the appropriate criteria for achieving the purpose and desired devices to be showed. In fact, in this stage, different levels of analysis are illustrated hierarchically and graphically. In the first level, there is a goal that is identifying the ecotourism criteria in this research. In the second level, the criteria by which our purposes be achieved, should be diagnosed. In this article to reach this purpose, we used of 10 natural criteria. In the third level, related indices to each one these criteria are written and the total number of these indices is 42.

Comparing the decision elements pair-wise

AHP elements in each level are compared together and weighed pair-wise. Comparing and weighing of elements are recorded in a KÎK matrix. Pair-wise comparison in the form of evaluating the element of column compared to the row element were done, using a distance scale from 1 to 9. If the given value is more, it indicates more importance and priority of the row element to the column element. Such that the value of '9' indicates more importance or priority and value of '1' indicates the same priority and importance (Table 2). It should be mentioned that the pair -wise matrix is an inverse matrix. This means that, if the compared value of row element (a) compared to the column element (b) is equivalent to 9, then the compared value of column element (b) compared to (a) is equal to $\frac{1}{9}$ (Saaty, 2004).

Calculating the weight in the analytical hierarchy process

Calculating the weight in the analytical hierarchy process separately in two parts are discussed below:

- Local priority
- Overall priority

Calculating the local priority by least squares method

In the mode of consistency (generally per every 'I' and 'j')

$$a_{ij} = W_i / W_j \quad \text{OR} \quad W_i = a_{ij} W_j \qquad \textbf{equation 1}$$

$$MINZ = \sum_{i=1}^{n} \sum_{j=1}^{n} \left(a_{ij} W_j - W_i \right)^2$$

Table 5. Pair-wise Comparison of Climate sub-criteria

Climate	Temperature	Sun-light	Wind	Rain
Temperature (°C)	1	-	-	-
Sunlight (lux)	0.13	1	-	-
Wind (m/s)	0.13	0.66	1	-
Rain (cubic metre)	0.2	1	1	1

Calculating the consistency rate (CR3)

The consistency rate in the AHP method is an index that showed the compatibility between them. This rate indicated the degree of accuracy in the valuation of pair-wise comparisons. If the rate is equal to or less than 0.1, the valuation and comparisons of scan are good and proper, otherwise, valuation and pair-wise comparisons should be redone or modified.

The consistency rate is done by calculating the consistency index (CI4) and the following equations is obtained:

$CI=\lambda max-n/n-1$ **equation 2**

In above equation 'λmax' is the eigen vector element and 'n' is the number of criteria. The eigen vector is obtained by the following equation:

λmax= weights column x **equation 3**

Valuation matrix row / criteria weight

'λmax' should be calculated for all of criteria and then CI can be obtained in relation to their total in equation (2). Other required index is the Random Index (RI) that is proportional to the number of criteria which is obtained from Table (3) and finally the inconsistency rate is calculated from the equation (3):

$CR=CI/RI$ **equation 4**

In this research, EXPERT Choice 11 software was used and all calculation were calculated by this software. For this purpose, the survey questionnaire of experts (AHP questionnaire) including the criteria and sub criteria was prepared and offered to 20 persons of experts. The selected experts were simultaneously dominant to the environmental sciences, ecotourism and desert and semi-desert regions, with at least five years experiences. Therefore, preferred value of criteria and sub-criteria was determined through pare-wise comparison of them. The determined values were entered in Expert Choice 11 software and inconsistency coefficient of criteria and sub-criteria were calculated by it. Only when the inconsistency coefficient were lower than 0.1, it is used in the process of decision.

RESULTS

From the perspective of main criteria, administrative factors with the weight of 0.179, tourism with the weight of 0.174 and wildlife with the weight of 0.152, have occupied the first to third priorities and the criteria of soil with the weight of 0.02, economical aspects with the weight of 0.056 and vegetation with the weight of 0.61, have filled the final priorities.

Water resources criteria, with the weight of 0.105, restrictive with the weight of 0.102, climate with the weight of 0.079 and the social aspects with weight of 0.070 were in the middle positions. Table 4 and Figure 3 shows the prioritization of main criteria with the inconsistency of 0. 01.

Climate parameters include temperature with a weight below 0.685, radiation (direct sunlight) and precipitation (rain) with a weight of 0.112 and wind with a weight of 0.091 and inconsistency level of 0. 02 with respect to the target were prioritized. Table 5 and Figure 4 indicate the weights and ranks of these criteria.

Table 6. Pair-wise comparison of water resources sub-criteria

Water	Water quality	Source rate	Source type
Water quality	1	-	-
Source rate	0.33	1	-
Source type	0.17	0.2	1

Table 7. Pair-wise comparison of the soil sub-criteria

Soil	Physical properties	Chemical properties	Biological properties
Physical properties	1	-	-
Chemical properties	0.2	1	-
Biological properties	0.5	1	1

Table 8. Pair-wise comparison of wildlife sub-criteria

Wild life	Diversity	Population	Distribution	Sensitivity of species	Habitat quality
Diversity	1	-	-	-	-
Population	0.28	1	-	-	-
Distribution	0.25	0.33	1	-	-
Sensitivity of species	0.23	0.26	0.28	1	-
Habitat quality	0.31	0.16	0.31	0.8	1

The biological properties of soil with the weight of 0.61, physical properties of soil with the weight of 0.225 and chemical properties with the weight of 0.166 with inconsistency rate of 0.09 have been arranged. Table 7 indicate the weighting and prioritization of soil sun-criteria.

After weighing and prioritizing the sub-criteria of wildlife area, the inconsistency ratio was 0.10 and the orders of priorities are as follow:

Diversity with a weight of 0.453, population with a weight of 0.172, distribution with a weight of 0.244, sensitivity of wildlife species with a weight of 0.067 and habitat quality with the weight of 0.064 were given Table 8.

Diversity with the weight of 0.304, density of the vegetation with the weight of 0.409, vegetation extent with the weight of 0.159, habitat quality with the weight of 0.06 and with the inconsistency ratio of 0.05, respectively were the priorities of the vegetation sub-criteria in the region (Table 9).

Limiting sub criteria with the inconsistency coefficient of 0.10 were performed and seismicity with the weight of 0.452 and credibility with a weight of 0.250 were in the first and second place of priorities, and specific applications with the weight of 0.158 and unsanitary areas with the weight of 0.139, in the third and fourth place of priorities (Table 10).

Finally, after applying the criteria coefficients which are associated with the purpose that the desert ecotourism is in the central regions of Iran, by obtaining the inconsistency rate equivalent with 0.03, the sub-criterion of the recreation sources with the weight of 0.113, diversity of the wildlife with the weight of 0.069, earthquake likelihood with the weight of 0.085, water quality with the weight of 0.066 and population (wild life) with the weight of 0.067 assigned the first and fifth priorities to themselves and the temperature, diversity of vegetation, erodibility, aesthetic attraction respectively with the weight of 0.066, 0.049, 0.047, 0.038 were placed in the 6^{th} to 10^{th} places .

Sub-criterion of sun light and rain with the weight of 0.009, the amount of water source with the weight of 0.008, the wind with the weight of 0.007, the quality of vegetation habitat, the physical properties of soil with the weight of 0.005 and the chemical properties of soil with the weight of 0.003; occupied with 10 positions, the type of water source, the diversity of vegetation, erodibility, the wild life distribution, biological characteristics of soil, sensitivity of species and and extent of vegetation with the weights of 0.035 to 0.016, allocated the intermediate priorities to themselves (Table 11).

Table 9. Pair-wise comparison of Vegetation Sub-criteria

Vegetation	Density	Diversity	Area	Habitat quality
Density	1	1	-	-
Diversity	1	1	-	-
Area	0.22	0.62	1	-
Habitat quality	0.26	0.37	0.45	1

DISCUSSION

Iran has the considerable extent of desert and semi-desert climate and development in these areas are inevitable. Requirement to the special management in the

Table 10. Paired comparison of the restrictive criteria

Restrictive	Seismicity	Credibility	Special usages	Contaminated areas
Seismicity	1	-	-	-
Erodibility	0.38	1	-	-
Specific usages	0.33	1	1	-
Contaminated areas	0.5	0.28	1	1

desert as a fragile ecosystem on the one hand and industrial development, water scarcity and droughts on the other hand, will increase the necessity of a comprehensive planning in these areas. Such planning would allow the researcher and decision maker to know the effects of pressures on the environment without awareness of the environment details. Using the criteria is a manner that now used in several studies. Several criterias to assess the tourism planning of marine park in Hong Kong were suggested by Yang *et al.* (2008). This study was done only for introducing the prioritization of selection criteria of ecotourism in desert and semi desert areas that has been done and ecotourism criteria usages in other natural ecosystems and such as forests, mountains, steppe, islands, coastal and wetlands ecosystems need some independent investigation. It is weighted and prioritized that the nature-based tourism criteria in arid areas using the Delphi method and concluded that the sub-criteria of aesthetic appeals, such as social security, sensitivity of wildlife species, recreation sources, water source quality, infrastructure, local economic interests, cultural - historic resources and the amount of water source, are the first ten priorities of planning (Danehkar and Haddadiniya, 2009). Much proximity is seen among these priorities with the results of this study and can be said that some small differences are based on the differences between two studies and natural-tourism or ecotourism. Makhdoom (2006) reported that the ecological resource as the base of assessing the ecological capability and stated that these resources are for usage in the intensive and extensive tourism.

In this model, land slope was in the first place of priority, soil and rock properties in second place and third place is for the geographical location. Water resources, vegetation and climate are the next category.

In the criterion of physical properties of land, land slope and direction of slope are in the first to third priority places and sub criteria like distance from the sea, distance from the urban residential centers and distance

Table 11. Weighting and prioritization of sub-criteria regarding the purpose

Priorities	Sub-criteria	Weighting	Prioritization	Sub-criteria	Weighting
1	Recreation Resources	0.128	14	Tourism idea	0.025
2	Diversity of wildlife	0.112	15	Area vegetation	0.018
3	Earthquake	0.085	16	Sensitivity of wildlife	0.017
4	Water quality	0.083	17	Biological characteristics of soil	0.016
5	Population of wildlife	0.067	18	Habitat quality	0.016
6	Temperature	0.066	19	Sun light	0.011
7	Diversity of vegetation	0.049	20	Rain	0.011
8	Erodibility	0.049	21	The extent of vegetation	0.011
9	Aesthetic appeal/attractions	0.044	22	Amount of water	0.011
10	Kind of water resource	0.038	23	Vegetation (quality)	0.011
11	Distribution of wildlife	0.036	24	wind	0.009
12	Density of vegetation	0.034	25	Physical characteristics of soil	0.006
13	Contaminated areas	0.026	26	Chemical characteristics of soil	0.004

from the road are the first three priorities of the distances and privacies criteria. (Ardekani 2007; Li, 2004). In this study, soil properties were in the lowest place from the viewpoint of sub-criteria, Also, the social security, sensitivity of wildlife species, aesthetic appeals, outing sources, ups and downs, environmental hazards, water quality, infrastructure, tourists' votes and habitat quality, were identified as top ten priorities (Sepasi, 2009; Weaver, 2007).

Identifying the outing capability of jungles in Lordegan city, it was believed that the climate and weather were the most important environmental factors affecting the outing and recreation and in the next step accessibility, availability and water resources quality, slope and its direction, jungle vegetation percentage, soil, outing attraction and landscape respectively have the most effect on the process of evaluating the outing capability. Promenade demand and present land use have the determining role in the process of evaluating the promenade capability such that all the environmental conditions were affected by it. These comparisons showed that despite the similarities and even equality of the used criteria in the different projects, due to the differences in the studied ecosystem, the different criteria were considered and used.

Criteria adaptation with regard to the ecosystem should be emphasized by various scholars. Makhdoom (2006) in the book of land logistics infrastructure explicitly refers to the application of ecological models to assess environment, models mentioned for Iran. Depending on the location of the study, data identification and the use of land, it is necessary that a special model for the issue of evaluation within the framework of Iran ecological models to be built. Rykiel (1996) had also clearly mentioned that for the environmental assessment model, the model parameters and model structure and target, should carefully be considered .

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