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Using Analytical Hierarchy Process (AHP) for Prioritizing and Ranking of Ecological Indicators for Monitoring Sustainability of Ecotourism in Northern Forest, Iran

Godratollah Barzekar[1], Azlizam Aziz[2], Manohar Mariapan[2], Mohd Hasmadi Ismail[2], Syed Mohsen Hosseni[3]

1 - PhD student in the Faculty of Forestry, Universiti Putra Malaysia, MALAYSIA
2 - Department of Forest Management, Universiti Putra Malaysia, MALAYSIA
3 - Faculty of Natural Resources and Marine Science, Tarbiat Modares University, IRAN

Abstract. Ecotourism has been identified as a form of sustainable tourism which is expected to contribute to both conservation and development. Unfortunately, due to inadequate environmental assessment, many ecotourism destinations tend to be both hazardous and self-destructive. Indicators are an important tool to provide a means toward sustainability. Among all different aspects of indicators, ecological indicators are significant for monitoring and evaluating sustainable management of ecotourism. In this study criteria and indicators were identified by using the Delphi approach through an expert panel from different fields. At the end of the process, a consensus of 9 criteria and 61 indicators was reached. For prioritization and ranking the Analytical Hierarchy Process (AHP) and Expert choice software was used. The 9 criteria include identified :1- Conservation of Natural resources & biodiversity2- Maintenance of sceneries ,natural &physical features 3-Conservation of soil & water resources 4- Maintenance of heritage & cultural diversity 5- existence of legal, institution, legislation and policy frameworks for empowering Ecotourism 6- promoting economic benefits & poverty alleviation7- Educational affairs and public awareness 8- Maintenance of hygiene& tourist safety 9- Tourists & local people satisfaction. The results showed that, out of the 9 criteria, the first three, which we labeled as Ecological criteria and comprised 21 indicators, stood as the top highest priority. We also continued the ranking of indicators with related criterion and then all of the indicators were ranked and prioritized by AHP method and using of expert choice software.

Key words: Ecological Indicator, Analytical Hierarchy Process (AHP), Monitoring, Sustainable Ecotourism.

Introduction

Northern forest of Iran is blessed with rich biological diversity, endemic and endangered species, spectacular panorama and sceneries landscape and its masterpieces of natural creative forms of an ancient forest. This forest contains the most important and significant natural habitats for in-situ conservation of biological diversity. Ten thousand domestic tourists visit this area annually, and if their presences are not accompanied by sound management and assessment, it may cause of the deterioration and devastation of the environment (WHINAM & CHILCOTT, 2003). Hence, there is a need for prioritizing and ranking of criteria and indicators for a sustainable management of ecotourism. According to KOTWAL *et al.* (2008) one of the most important indicators for ecotourism

monitoring is the ecological indicators (KOTWAL *et al.*, 2008).

Since the 1990s after the introduction of the concept of sustainable development by the Brundtland commission (WCED, 1987) environmental protection became a major issue all over the world. Tourism as an economic activity has an unavoidable effect on the environment of tourism destinations. As the environment is an essential asset to the tourism industry, the protection and conservation of environmental resources should be the top priority in the tourism industry (LIM & MCALEER, 2003). Sustainable development is seen as a tool for social equity and a procedure for achieving balance between natural resources conservation and development (LIM & MCALEER, 2004). Ecotourism has been recognized as a form of sustainable tourism which is expected to contribute to both conservation and development (TSAUR & LIN, 2005). Widespread and global concern over the state of the environment and the impact of human activities on natural ecosystem calls for long-term and high quality, datasets for detecting and understanding environmental changes (PARR *et al.*, 2003).

Unfortunately, due to inadequate environmental assessment and audits, many ecotourism destinations tend to be both hazardous and self destructive (TSAUR & LIN, 2005) thus it is necessary to identify a set of indicators for monitoring ecotourism sustainability. The criteria and indicators can become useful tools to determine parameters of a sustainable management (GOUGH *et al.,* 2008; RAISON *et al.,* 2001). In reality, the criteria and indicators must try to simplify the complexities of the world by providing manageable information to help understand the decisions and management of activities in the field (PENG *et al.,* 2002). Chapter 40 of agenda 21 urges all countries, governmental and non-governmental organization to identify effective indicators at the national and international level for sustainable development (BARRERA-ROLDAN & SALDIVAR-VALDES, 2002). In a relatively short period of time about 150 countries had adopted specific criteria and indicators for sustainable management (HICKEY & INNES, 2008). These criteria and indicators are important because 150 of the countries with a total of 97.5% of forest area were involved in the processes of formulating regional and international criteria and indicators (WIJEWARDANA, 2008).

Nowadays, ranking and prioritizing of criteria and indicators have turned into a serious debate in the world, the technique of prioritization are used together with the criteria and indicators under the general title of multi-criteria decision making methods (MENDOZA & PRABHU, 2006). The Analytical Hierarchy Process (AHP) is the most important and widespread decision making tool (OMKARPRASAD, 2004). The AHP method which was developed by SAATY (1980), has been used extensively in almost all the applications related to the multiple criteria decision making (MCDM) in the last 30 years. VAIDYA & KUMAR (2006) found that there were more than 150 articles studying the AHP combined with general applications. Besides being applied to the finance sector (STEUER & NA, 2003), the AHP was adopted in the education, engineering, government, industry, management, manufacturing, personal, political, social, and sports (VAIDYA & KUMAR, 2006). The wide application of AHP is due to its simplicity, ease of use, and great flexibility. In recent years, the idea of sustainable ecotourism management has attracted a lot of attention but, in spite of the existence of high ecological, economic and social values of forests, forest management in Iran does not take advantage of criteria and indicators (GOUSHEGIR *et al.,* 2009). Thus this study emphasizes prioritization and ranking of ecological indicators that can monitor ecotourism sustainability in protected watershed.

Material and methods

*Study Area***.** The study area located in western part of Mazandaran province in Northern of Iran (Fig. 1). The area lies between 36°19′22″ to 36°45′25″ Northern latitude and 50°21′06″ to 50°23′30″Eastern longitude. The whole area is 77563 hectares, which includes 32761 ha designated as core

zone (biosphere reserve) and 44802 ha as a buffer zone. The altitude at the lowest point is 100 m and the highest point about 4851 m and the entire region endowed with natural resources. This watershed is a protected area and it is under consideration to be registered as a biosphere reserve by the Forest, Range and Watershed Department of Iran (AMIRI, 2008). The region is very attractive and has a potential for recreational and ecotourism due to beautiful sceneries, spectacular landscapes, lush and rolling rivers, streams, different plant communities, religious and historical monuments, snow-capped mountains, natural glacier and blooming valleys and is a paradise for nature lovers, conservationists, botanists, zoologists and environmentalists. The area has attracted large numbers of tourists in the peak in the season from June to September.

Delphi technique. KAYNAK & MACAULEY (1984) described the Delphi method as a unique technique for eliciting and refining group judgment. This technique, developed in early 1950's by RAND corporation, is a method for structuring a group communication process in a way that allow individuals to deal with a complex problem (LINSTONE & TUROFF, 1975).

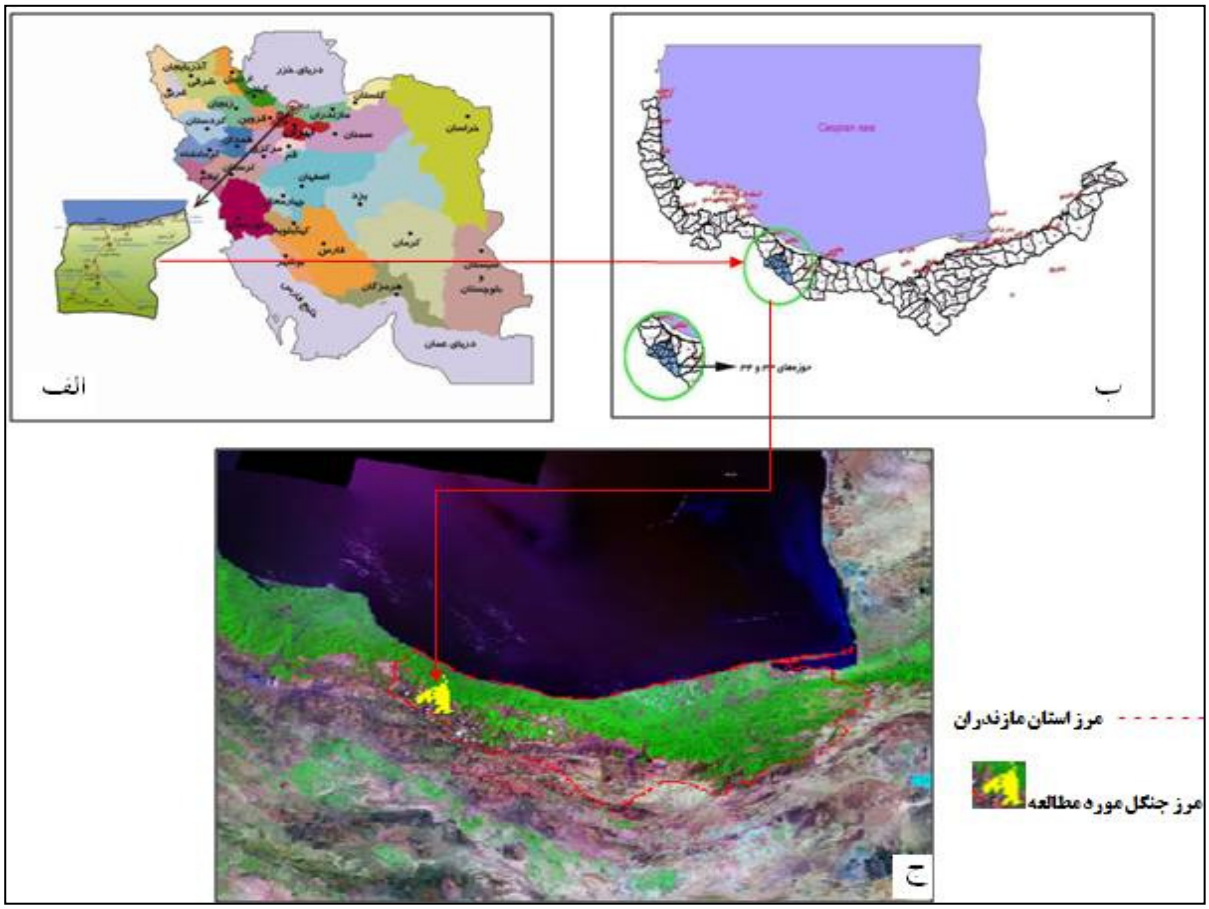

Fig. 1. Study area - Dohezar & Sehezar watersheds in Iran

The aim of Delphi surveys is to obtain the advice of panel members ,and whenever possible to reach a consensus (RICHERY *et al.*, 1985).the carefully selected experts answer questionnaire in two or more rounds. At the end of each round the researcher provides an anonymous summary of panel member's suggestions from the previous round. Finally the process is stopped after reaching stability of result by determining mean or median scores.

The Delphi technique was used to identify criteria and indicators for ecotourism sustainability and it was completed in two rounds. For this purpose the assessment team organized which

consisted of ten members. The members of team included 5 experts with PhD degree and 5 others with MS and BS degree. All team members are very familiar with field of research and also to study area.

Analytical hierarchy process. The Analytic Hierarchy Process (AHP), a well-known approach, was applied to solve MCDM problems (SAATY, 1980). AHP is a scoring model that depends on subjective managerial entered data on Multiple Criteria. These inputs are changed into scores that are used to assess each of the possible alternatives (HANDFIELD *et al.,* 2002). POH *et al*. (2001) stated that AHP as a qualitative and quantitative approach can be used to determine the priority and weight of each performance criteria and indicators through paired comparison of attributes. Weighting of the criteria and indicators was carried out via the analytical hierarchy process (AHP). This process is one of the most renowned and famous techniques in multi-criteria decision making, which was innovated and established by SAATY (1970).

There are different methods to measure the importance of coefficient (weight) for criteria and indicators; one of the traditional ones is the pair-wise comparison. In this method criteria and indicators are compared with each other and the degree of importance for each criterion or indicator is specified with respect to each other. For this purpose we can use the standard manner which is proposed by SAATY (1970). The procedure of this method focuses on two factors at a time and their relation to each other. The relative importance of each factor is rated by a measurement scale to provide numerical judgments corresponding to verbal judgments. The instrument used in this study was adopted from SAATY (1980), and the scale of the pairwise comparison is showed in Table 1.

For weighting of C&I, all of the tables related to criteria and indicators for comparison were prepared and then distributed among panel members and they were requested to rank the C&I based on Table 1.

Inconsistency rate is a mechanism through which the validity of respondent's responses was evaluated using a matrix comparison mechanism. This mechanism specified the reliability of response gained from respondents with respect to the comparison of criteria and indicators. For computing inconsistency ratio, duo to number of respondents is more than one; we computed geometric means. Inconsistency ratio in AHP method must be less than 0.1 (TZENG *et al.,* 2002). If the inconsistency ratio is more than 0.1, the process may warrant recomputed by user (CHANGA *et al.,* 2007).

Table 1. Saaty's Pairwise comparisons for Criteria and Indicators (C&I)

Intensity of importance	Verbal Judgment of preference
1	Equally importance
3	Moderate importance
5	Strong importance
7	Very strong importance
9	Extreme importance
2,4,6,8	Intermediate values between adjacent scale values

Results and Discussion

Nine criteria and 61 indicators were identified by experts through two rounds of the Delphi process. These criteria and indicator were then ranked and prioritized by expert panel member through AHP. The weight of the criteria determines the importance of the criteria against each other leading to the attainment of the goal of sustainable management on ecotourism. The geometrical means was entered into the tables related to pair wise comparison of the C&I. After finishing the above procedure the C&I was ranked by Expert Choice software.

There were 9 criteria for sustainable management of ecotourism was identified and the weight and inconsistency ration is showed in Table 2.

Table 2. List of criteria for sustainable management of ecotourism.

Criteria	Weight
1. Conservation of Natural resources & biodiversity	0.278
2. Conservation of soil & water resources	0.180
3. Educational affairs and public awareness	0.036
4. Tourists & local people satisfaction	0.023
5. promoting economic benefits & poverty alleviation	0.058
6. Existence of legal, institution, legislation and policy frameworks	0.079
7. Maintenance of heritage & cultural diversity	0.116
8. Maintenance of hygiene& tourist safety	0.034
9. Maintenance of sceneries, natural &physical features	0.197
Inconsistency ratio:	*0.06*

With regard to the results of AHP method and using expert choice software, three criteria (criteria number 1, 2 and 9) which encompass ecological indicators; have been arranged to the amount of relative importance. Criterion 1: Conservation of natural resources & biodiversity with 27.8%; Criterion 9: Maintenance of sceneries, Natural & physical features with 19.7% and Criterion 2: Conservation of soil & water resources with 18% occupied the top priority among other criteria. This procedure continued for indicators which belong to three of the above criteria and the prioritizing & ranking have been set for them based on the above mentioned manner and the result is illustrated as the following: Criterion 1: Conservation of natural resources & biodiversity and constitute 9 indicators which show in Table 3. Criterion 2: conservation of soil & water resources, and constitute 7 indicators which show in Table 4. Criterion 3: Maintenance of sceneries, natural & physical features and constitutes 5 indicators which show in Table 5.

As show in Table 6, based using AHP and expert choice software,the first 3 criteia which are the environmental criteria stood as the top priority among all 9 criteria.

Table 3. Indicators related to Criterion 1

Criterion 1: Conservation of natural resources and biodiversity	Weight
1.1. Extent of protected area	0.295
1.2. No of protected water resource (rivers, marsh, streams, etc…)	0.044
1.3. No of rare, threatened, vulnerable & endangered species	0.147
1.4. Existence & implementation of Action plan for conservation	0.109
1.5. Existence of different plant types (forest and range)	0.061
1.6. Diversity of plants and wildlife	0.085
1.7.Existence of zoning and comprehensive management system	0.202
1.8. Extent of damaged area duo to human activities	0.031
1.9. Existence & implementation of EIA program in recreational zones	0.025
Inconsistency ratio:	*0.05*

Table 4. Indicators related to Criterion 2

Criterion 2: Conservation of soil and water resources	**Weight**
2.1. Amount of erosion & sediment	0.378
2.2. Amount of contamination materials in waters	0.210
2.3. Amount of fluctuation water resources	0.153
2.4. Extent and percentage of uncovered lands	0.075
2.5. Control of domestic (dairy cattle) animal in range & forest	0.056
2.6. Extent and percentage of afforested area	0.034
2.7. Amount of density for road and pedestrian in watershed	0.095
Inconsistency ratio:	*0.05*

Table 5. Indicators related to Criterion 3

Criterion 3: Maintenance of sceneries, natural & physical features	**Weight**
3.1. Existence of management plan for protection of spectacular landscape	0.429
3.2. Extent and no of specific natural plant communities	0.289
3.3. Existence of management plans for conservation of riparian zones	0.083
3.4. Growth rate of incompatible construction in region	0.49
3.5. Existence of plan for protection of topography & geological features	0.151
Inconsistency ratio:	*0.06*

Table 6. Weight and rank of criteria related to sustainable management of ecotourism

Criteria's title	**Weight**	**Ranking**
Conservation of natural resources & biodiversity	0.278	1
Maintenance of Sceneries, natural & Physical features	0.197	2
Conservation of soil and water resources	0.180	3
Maintenance of heritage and cultural diversity	0.116	4
Existence of Legal, institutional, legislation and policy framework	0.079	5
Economic benefits and poverty alleviation	0.058	6
Educational affairs and public awareness	0.036	7
Maintenance of hygiene & tourist safety	0.034	8
Tourist & local people satisfaction	0.023	9

Table 7 to 9 shows the prioritized ecological indicators in relation to the different environmental criterion. The 21 ecological indicators, 9 indicators belong to Criterion 1: Conservation of natural resources & biodiversity, 7 indicators to Criterion 2: Conservation of soil & water resources and 5 indictors to criterion 3: Maintenance of Sceneries, natural and physical features.

Conclusion

Northern forests of Iran have high ecological, economics and social values, but no definite criteria and indicators have been developed to monitor these forests in order to assess it, especially in ecotourism dimension. The absence of factors has prevented managers from understanding whether the forest is experiencing sustainability or not (GOUSHEGIR *et al*., 2009).

The studies of KOTWAL *et al*. (2008) and GOUGH *et al.* (2008) indicate that ecological indicators play a crucial role in sustainability and need to be covered by social and economical indicators.

Table 7. Weight and rank of indicators related to Criterion 1: Conservation of natural resources & biodiversity

Indicator's title	Weight	Ranking
Extent of protected area	0.295	1
Existence of zoning and comprehensive management system	0.202	2
No of rare, threatened, vulnerable & endangered species	0.147	3
Existence & implementation of Action plan for conservation	0.109	4
Diversity of plants and animals	0.085	5
Existence of different plant types (forest and range)	0.061	6
No of protected water resource (rivers, marsh, streams, etc…)	0.044	7
Extent of damaged area duo to human activities	0.031	8
Existence & implementation of EIA program in recreational zones	0.025	9

Table 8. Weight and rank of indicators related to Criterion 2: Conservation of soil & water resources

Indicator's title	Weight	Ranking
Amount of erosion & sediment	0.378	1
Amount of contamination materials in waters	0.210	2
Amount of fluctuation water resources	0.153	3
Amount of density for roads and pedestrian in watershed	0.095	4
Extent and percentage of uncovered lands	0.075	5
Control of domestic (dairy cattle) animal in range & forest	0.056	6
Extent and percentage of afforested area	0.034	7

Table 9. Weight and rank of indicators related to Criterion 3: Maintenance of Sceneries, natural and physical features

Indicator's title	Weight	Ranking
Existence of institutional & policy framework for ecotourism in region	0.429	1
Existence of legal obligations, incentives for promoting ecotourism	0.289	2
Existence of legal frameworks for participation of all stakeholders	0.151	3
Existence of collaboration among different related organization	0.083	4
Existence of approved national plan for sustainable tourism	0.049	5

Identification, ranking and prioritizing of criteria with related indicators can provide this opportunity for us to monitor and evaluate ecotourism sustainability precisely for forest watersheds of Northern Iran. Though the Analytical Hierachy Process is based on the knowledge and experience of experts (KUSWANDARI, 2004). It can still be a good choice because it is a quantitative method and can be modified regarding the charachterestics of Northern forest of Iran (GOUSHEGIR *et al.,* 2009). MENDOZA & PRABHU (2000) made use of multiple criteria decision making techniques (rating, ranking and pairwise comparison) a decision tools for assessing criteria and indicators designed to evaluate sustainable forest management.

The results of this survey showed that the applied technique for ranking and

prioritizing was very effective and impressive. The ranking and prioritizing of ecological indicators provide us with an opportunity with regard to the pivotal and crucial role they play in the sustainable management of ecotourism in The Northern forest of Iran. Among the 9 criteria which have been distinguished ,three of them which are: (1) Conservation of natural resources and biodiversity; (2) Maintenance of sceneries, natural and physical features and (3) Conservation of soil and water resources were the top priority among the criteria. This indicated that the importance of these criteria which encompass affiliated ecological indicators which are suitable for monitoring and evaluating ecotourism's sustainability in the Northern forest watershed of Iran. The ecological resources are the basic resources for attaining sustainable deveopment in economical, social and cultural dimensions; it is essential and vital to attain a precise and effective indicators for monitoring of sustainable management of ecotourism. Ranking and prioritizing provides opportunities to monitor ecotourim sustainability, trend of tourists activities and sustainable management and prevent damage and irreversiable alteration to ecotourism resources.

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