Recreational zoning of Natural forest parks using Analytic hierarchy process and geographic information system (Case study: Talar Forest Park, Qaemshahr, Iran)

Seyedeh Mehrmanzar Sohrab*, Jafar Oladi-Ghadikolaiee and Hamid Jalilvand

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Abstract

Natural forest Parks are complex ecosystems. Using dual purposes of conservation and tourism can be possible by a balanced relationship between human activities and nature. Assessment of ecological potential is one of the ways to establish this balance; this assessment had been done in Talar Forest Park in Qaemshahr, in North of Iran using AHP and GIS. For identify the criteria and sub-criteria we used the Delphi method. The sub-criteria in order of importance were determined as rainfall, temperature, slope, number of sunny days, aspect, water resources, altitude, humidity, landscape, distance from routes, vegetation diversity, soil, wind, distance to inside routes, geology, resources and facilities, negative factors, vegetation density, distance from population centers, nearby attractions and the density of the surrounding villages. The results of recreational zoning demonstrated that 13.47%, 26.22%, 21.38%, 20.6% and 18.33% of the area had very high, high, average, low and very low recreation potential, respectively.

Key words: Forest park, Planning, AHP, GIS

Introduction

To presentation and implementation of development strategies, the identification of geographic and environmental potential of the area can allow the planners to determine the regional development strategies according to the area potentials and offer programs tailored to local conditions (Noori and Avargani. 2006; Hall and Page. 2014; Kianisadr et al. 2019). Preservation and development of natural resources are essential for human use in the district of urban and its extensive suburb environment with emphasis on recreation and natural and manmade green spaces development (Miller et al. 2015). The recreational use of the land can help to maintain, restore and develop the natural resources. However, if the recreational use of environmental resources were implemented without planning and monitoring, it would cause many negative effects (Drazkiewicz et al. 2015). Therefore, some solutions should be considered to avoid negative and undesirable complications to the environment due to the tourists entry to the area (Mayer. 2014). The natural environment has a limited ecological potential for human use, the assessment of ecological potential as the core of environmental studies with prevention of crisis would provide a good platform for environmental planning (Mahboobi Aghdam et al 2010). Zoning is a technique for minimizing damages of natural resources, by which we can delay damage time and cater for opportunities to make necessary decisions (Tavakoli. 2019). The most common method of zoning method in Iran is the system analysis method (Makhdoum. 2010) which cannot meet some of the factors influencing the recreation potential such as water resources, landscape, and local accessibility, social and economic situation. However, regarding the different importance of factors influencing the recreation capability, the combination of information layers in every model cannot have accurate results regardless of the weight values of each of these layers (Masoodi et al. 2016; Padash et al. 2016). Some models involved in this process, which provide a more accurate representation of the land use, are linear statistical models of Fuzzy, Analytic Hierarchy Process (AHP), Analytic Network Process (ANP), and Artificial Neural Networks (e.g., RAZAVI. 2014; ALIANI et al. 2016; WATMOUGH et al. 2017). The results derived from empirical work suggest that the method based on pair comparison is one of the effective techniques in spatial decision-making including approaches based on GIS (Malczewski.1999; Althuwaynee et al. 2016; Ostad-Ali-Askari et al. 2018).

AHP is one of the acceptable decision-making methods, which is widely used (Feng, 2017). This method is most effective in forest

Seyedeh Mehrmanzar Sohrab*

M.Sc. graduated of Forestry, Faculty of Natural Resources, University of Agricultural Science and Natural Resources, Sari, I. R. Iran.

Jafar Oladi-Ghadikolaiee and Hamid Jalilvand

Prof., Dep. of Forestry, Faculty of Natural Resources, University of Agricultural Science and Natural Resources, Sari, I. R. Iran.

*Email: mehrmanzar.sohrab@gmail.com

management than other methods and the number of applications is still rising (e.g., Schmoldt et al. 2013; Dwivedi et al. 2016). The advantage of this method includes the ability of a more logical weighing of factors influencing the evaluation process, quantity and quality valuations, priority ranking of different factors in order of importance, simple scoring of different classes of each factor, repetition the process several times to achieve better results, more accurate multi-criteria evaluation (MCE) and representing a model with more factors (Shirvany. 2009; Kolanuvda et al. 2016). This study aims to use more factors appropriate to the area condition including water resources, landscape, accessibility, social and economic condition of local people and negative factors in order to achieve a more accurate zoning of the mentioned forest park using AHP.

Materials and Methods

One of the tourism potentials of Mazandaran province is Talar Forest Park (154 Ha) (36° 23' 21" to 36° 24' 30" and longitude of 52° 49' 58" to 52° 50' 11"). The park area in located in district No. 55, Series 2, parcel 5 of forestry plan of Babolkenar, which is not a part of any forestry plan and had no forest harvesting (Fig.1). The forest type is classified as Aestisilvae, which is originally from the Tertiary and early Quaternary. The main soil type is Calcaric Regosols based on F.A.O classification and Mixed, Xeric, Mesic with Clay – Loam texture. The major tree species are Hyrcanian or temperate deciduous broad - leaved including 40% of Carpinus betulus, 25% of Parotia persica, 10% of Quercus castanifolia, 5% Gleditschia caspica and 20% of other species. The climate is temperate humid according to the using De Martonne climate index.



Fig. 1: A Location of the Talar Forest Park

In this study, topographic maps (1:25000) was used to identify sources and to extract the required layers and maps of soil, geology, diversity and density of vegetation, hydrographic network, access routes, the guide map of the park prepared by Administration of Natural Resources and Watershed of Mazandaran and city council of Qaemshahr. In addition, the meteorological information and reports in Meteorological Organization Region and meteorological stations in Gharakhil, Babolkenar and Qaemshahr were also used and then to determine the access routes in the park, the location of landscape positions, water resources and facilities (bower, public restrooms, etc.), the Global Position System (GPS) has been used. To revise and classify the maps, the spatial analysis and zoning of the study area the Arc GIS 10 software was used. In addition, the SPSS and Auto CAD 2013 soft wares have been used to perform statistical analysis, draw charts and prepare maps respectively. Analysis of the analytic hierarchy was also done in Expert choice 2000 software. The recreation zoning of the forest park was accomplished using AHP and in eight steps: determining the major goals, identifying the existing condition, determining the data and effective parameters, evaluating the characteristics of the study area, data collection and preparation, providing the maps and its standardization weighting maps, combining the maps and preparing the final zoning maps (Chandio et al. 2011; Dhami et al. 2014, 2017). The required weight of each factor is evaluated using a paired comparison matrix of known criteria and their preference rate for each criterion is measured towards the other (Ullah and Hafiz. 2013; Dhami et al. 2017). The Delphi method was used to identify the criteria and sub-criteria affecting the existent recreational zoning in the area (Salehnasab et al. 2016; Zhao et al. 2018).For this purpose, a questionnaire containing all the criteria usable in recreational zoning was prepared and distributed among a group of Delphi including recreation specialists, experts and authorities (Salehnasab et al. 2016; Troppinen et al. 2017). In addition, according to the field visits, interviews with local officials and study of basic information about the area, some sub- criteria were added (Gul et al., 2006; Babaie-Kafaky et al. 2009; Salehnasab et al. 2016). In the next step, the main goals, sub-goals, decision criteria and alternatives were identified (HSU et al. 2010; Padash et al. 2016). So the resources of the park had been identified and prepared into maps. For this purpose, digital maps and geo - referencing of the manually scanned maps were layered in GIS. In order to combine the map of affecting, each of the information layers with an equal distance were reclassified from 1 to 9 and higher values were allocated to the classes of study criterion which were created after the classification and had higher recreation capability accordance with existent standards (Padash et al. 2016). All maps were converted to coordinate system of UTM, Zone 39 North in raster format with a cell size of 5 m. To determine the degree of importance of each of the layers affected recreation zoning, AHP method was used. the comparison of the degree of importance towards each other (relative weights) was done based on a 9 - point continuous scale, according to Table 1 and by the experts of tourism, recreation and park managing and by entering relative weights contained in the matrix into Expert choice (2000) software, the weights effective criteria and sub- criteria to Talar Forest Park were calculated.

| Table 1. Scale of the degree of importance for pair comparisons | | | | | | | | | | | |
|---|-------------|--------|--------|-----------------|--------|--------|-------------|---------------|--|--|--|
| 1/9 | 1/7 | 1/5 | 1/3 | 1 | 3 | 5 | 7 | 9 | | | |
| Extraordinary | Very strong | Strong | Medium | Equal | Medium | Strong | Very strong | Extraordinary | | | |
| | High impor | tance | | less importance | | | | | | | |

| Ta | abl | e 1: | Scale | of | the | degree | of | importance | for | pair | compa | irisons |
|----|-----|------|-------|----|-----|--------|-----|------------|-----|------|-------|---------|
| | | | | | | | ~ ~ | | | r | r - | |

Finally, by combining and overlaying the sub- criteria maps in the GIS environment, which were standardized and had a raster format with 5 m pixel size and UTM coordinate system, the recreational zoning map was prepared. The value of each cell of the obtained map indicated the relative capability of that cell for recreation.

Results

The results of the weighted criteria represented that the highest weights were related to the climatic criteria weighting (0.477), geomorphological (0.288), environmentally (0.154) and Social - economic (0.081) (fig. 2).



Fig. 2. Comparison of the importance of used main criteria in recreational zoning of Talar Forest Park

The effective sub-criteria in order of importance in zoning of Talar Forest Park were as following: rain (19.7), temperature (12), slope (11.66), number of sunny days (9.3), aspect (7.78), water resources (5.90), altitude (5.18), humidity (4.436), landscape (3.99), distance from access routes (3.90), vegetation diversity (2.88), soil (1.53), wind (2.16), distance from the access routes within the park (1.80), geology (1.53), facilities (1.31), negative factors (1.19), vegetation density (0.86), distance from population centers (0.71), nearby attractions (0.68) and density of surrounding villages (0.39) (Fig.3).



Fig. 3. Results of weighting and pair comparisons between effective sub-criteria in recreational zoning of Talar Forest Park.

Results of affecting criteria weighting is calculated in accordance with Table 2. The inconsistency rate of conducted judgments in this study was obtained under 0.1, which is reliable. Also 13.47% (23.81 ha), 26.22% (46.34 ha), 21.38% (37.8 ha), 20.6% (36.44 ha) and 18.33% (32.41 ha) of the park area had potentials of very high, high, average, low and very low, respectively to plan for a variety of recreation activities. Therefore, Talar Forest Park had a desirable condition in terms of recreation capacity because more than half of the park area had a recreation potential of average to high (Fig. 4).

| | Final weights (%) | | sub-criteria | Weights from AHP | Criteria | |
|------|-------------------|-------|----------------------|------------------|-------------------|--|
| 0.05 | 19.7 | 0.413 | Rain | 0.477 | Climatic | |
| 0.05 | 12 | 0.252 | Temperature | | | |
| 0.05 | 9.3 | 0.195 | N of sunny days | | | |
| 0.05 | 4.436 | 0.093 | Humidity | | | |
| 0.05 | 2.162 | 0.046 | Wind | | | |
| 0.05 | 11.66 | 0.405 | Slope | 0.288 | Geomorphological | |
| 0.05 | 7.776 | 0.270 | Aspect | | | |
| 0.05 | 5.184 | 0.180 | Altitude | | | |
| 0.05 | 1.526 | 0.093 | Soil | | | |
| 0.05 | 1.526 | 0.053 | Geology | | | |
| 0.04 | 5.8982 | 0.382 | Water resources | 0.154 | Environmentally | |
| 0.04 | 3.9886 | 0.259 | Landscape | | | |
| 0.04 | 2.878 | 0.181 | Vegetation diversity | | | |
| 0.04 | 0.8624 | 0.056 | Vegetation density | | | |
| 0.04 | 0.6776 | 0.044 | Nearby attractions | | | |
| 0.04 | 1.1858 | 0.077 | Negative factors | | | |
| 0.05 | 3.8961 | 0.481 | Access routes | 0.081 | Social - Economic | |
| 0.05 | 1.7982 | 0.222 | Access routes within | | | |
| 0.05 | 1.3122 | 0.162 | facilities | | | |
| 0.05 | 0.7047 | 0.087 | Population centers | | | |
| 0.05 | 0.3888 | 0.049 | Surrounding villages | | | |
| | 100 | 4 | | Total | | |

Table 2. Effective criteria in recreational zoning of Talar Forest Park and obtained weights from the matrix of criteria paired comparison by AHP.



Fig 4. Map of the recreational zoning of Talar Forest Park using AHP method.

Discussion

The results indicated that this area has a high potential for recreation and ecotourism activities. According to the recreational zoning map, the zones with very high, high, average, low and very low recreational potential were selected and introduced as first, second, third, fourth and fifth priority, respectively for planning and development of recreation activities. Of course, better results would be expected using various and more accurate criteria. In analysis method, the slope is considered as the most important factor, so that other parameters would be refused and the evaluation process would be stopped due to the inappropriate slope of the environmental unit for recreation (Esmaeili Sari et al. 2003; Shirvany. 2009; Karami. 2010; Makhdoum. 2010). However, despite using slope as an important factor in recreation evaluation in many studies, it was concluded that the importance and value of criteria and sub - criteria were depended on the conditions of the study area (Fa Rajzadeh and Karami. 2004; Kumari et al. 2010). Talar Forest Park is appropriate for recreation planning in all seasons especially spring and summer. Mahmoudi and Danehkar (2010) in their study stated that the climate and weather were the most important environmental factor affecting recreation. Salehnasab et al. (2016) were found to be climate is the most important factor for assigning a forest park to the studied area.

Talar Forest Park does not have much variety and the elevation difference does not exceed 150 meters (220 to 370 m above sea level), so, the total area has a convenient elevation for recreation planning (Barzehkar. 2005; Karami. 2010; Chandio et al. 2011). However, due to the low elevation difference, less variation in the topography was seen.

There is no limitation on the soil texture and depth because the area has only one class of deep loamy soil and this type of soil is the most suitable one for recreation planning. Due to the uniformity of soil condition, the soil factor had no impact in choosing suitable zones for a variety of recreation activities. Thus, the sub-criterion of soil was considered as a constant factor in the recreational zoning of Talar Forest Park. However, it must be understood that the soil factor in the next step of recreation evaluation, which is the planning and development of recreation zones, would be more effective (Pirmohammadi et al. 2010; Dhami et al. 2017). According to the results of the geological features of Talar Forest Park, approximately 98.6% of the park area is geologically a part of limestone, sandy marl with some conglomerate areas and only 1.4% of the remaining is a part of areas with marl bedrock, limestone and silt. Thus, given the predominance of limestone, there were no geological constraints for recreation planning in the study area. The result of vegetation diversity map of the area indicated that 60% of the study area was suitable for recreation activities.

The results of distribution of water resources showed that the most water resources were focused in the southern part of the park, which had a more potential to attract tourists. While, the northern part lacked of water supply facilities and requires planning to increase the water resources availability in order to increase the potential to attract tourists and decrease the excessive visitors and environmental damage in the southern part of the park. The study area in terms of outside and inside accesses has a very good condition and there are no restrictions in planning various types of recreation activities. Talar Forest Park has also a very proper condition in terms of proximity to population and commercial centers as well as residential areas. In addition, due to the proximity to Azad University, Qaemshahr branch, this area has an appropriate position to attract more tourists. It has a medium status in terms of facilities and there are only facilities such

as bower, two public restrooms, chapel and rubbish bins. While the football and volleyball court and sentry box in the southern part of the park are considered abandoned and unused due to lack of proper care and management.

Recreational facilities should be established within the park area to prevent the population density at a certain point and damage to the natural environment, which is in agreement with Yarahmadi (2010).

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