

Indoor winter recreational site selection in arid and semi arid mountainous regions

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Abstract— As regards Iran is among the arid and semi arid countries having a hot, dry climate characterized by long, hot, dry summers and short, cool winters, winter sports have been considered the most popular interest by Iranian people. Selection of the best areas in respect of environmental principles is an inevitable fact which should be carried out before establishing recreational infrastructures. Considering this kind of studies is very complicated and involves wide ranges of criteria, selecting an appropriate method to handle such wide and heterogeneous data is essential. This study aims to introduce the best potential indoor winter recreational sites using fuzzy logics and analytical hierarchy process method. Results shows how effective the fuzzy logic is in site selection process.

Keywords- recreational site selection; fuzzy membership, Boolean logic, weighted linear combination.

I. INTRODUCTION

Ecological capability evaluation can be an effective step for land use planning studies. Ecological land evaluation can be performed for this purpose that the maximum unity and compatibility of land use with potential capability of land in a specified scale (usually is considered in a watershed level) is obvious. Suitability and desirability of a specific land use for land can be evaluated using two physical and economic aspects. It should be noted that the economic analysis won't be needed while a particular land use is risky and potentially dangerous for the ecosystem (1-2). In other words, socio-economic assessment takes into consideration only if the land stage of the ecological set for the specified user is granted. In selected areas as recreational places the following the general principle should be observed:

- The first reason to site selection should be users' satisfaction.
- The second principle refers to the relationship between resources of recreational sites and its productivity. Although welfare of promenade visitors is dependent on factors like the beautiful landscape, ecologically appropriate resources (climate, soil and water, the land, flora and fauna, good quality access roads, water current, and even Bowers equipped with the necessary equipment and so on) but certain physical factors are limited the quality of recreational sites.

- Fulfilling the objectives of planners and managers

Study ahead aims to perform a site selection study in order to establishment of indoor recreational sites for winter

sports using Fuzzy logics and analytical hierarchy process methods.

II. MATERIAL AND METHODS

A. The study area

Taleghan is a mountainous area located in 120 kilometers northwest of Tehran city between latitudes $36^{\circ} 05' 17.45''$ - $36^{\circ} 20' 45.93''$ N and longitudes $50^{\circ} 39' 33.39''$ - $51^{\circ} 11' 26.5''$ E. Sharp slopes and high altitude are important characteristics of the region. The average height of Taleghan Basin is 2665 meters above sea level (maximum and minimum heights are 4400 meters and 1080 meters respectively). About half of whole area has slopes over 40 percent. Dominant aspect of Taleghan Basin is East West and atmospheric precipitations vary between 250 and 1000 mm per year. Number of snow days varies between 21 to 34 days per year, usually starting from November and continues until the middle of the May.

B. Selecting of criteria

At first step required data for performing of site selection analysis were determined by interviewing with expertise as well as internal and international literature reviewing. These criteria include soil, geology, habitats, slope, aspect, elevation and vegetation density. Afterward all selected criteria were divided in to two categories of factors and constraints based on measuring units, i. e. all criteria maps which had been prepared on the basis of quantity measures like slope, elevation were considered as factors. On the other hand the ones which had been presented based on qualitative measures such as geology were determined as constraint.

C. Standardization

As regards criterion maps are prepared in different measuring scale in order to comparing them with each other they should be converted in to the equal measuring scale (0-1) or (0-255) (3-4). In study ahead for Standardization of factor maps linear standardization method which is based on fuzzy logic was applied Eq. 1 as well as Boolean Method was used for constraint maps (5-9).

$$x_i = \frac{(R - R_{\min})}{(R_{\max} - R_{\min})} * 255 \quad (1)$$

D. Weighing of factor maps

In order to assigning appropriate importance to each factor nine point scale pair wise comparison matrix presented by Saaty, 1980 (9-12) was applied.

TABLE I. JUDGMENT SCALE FOR PAIR-WISE COMPARISONS (13)

Descriptions	Scale
Equally preferred	1
Equally to moderately	2
Moderately preferred	3
Moderately to strongly	4
Strongly preferred	5
Strongly to very Strongly	6
Very Strongly preferred	7
Very Strongly to extremely	8
Extremely preferred	9

E. Overlaying

In next step all factor and constraint maps were overlaid using weighted linear combination method (WLC) (14-15, 1). $S = \sum w_i x_i \prod c_j$ (2)

Where;

S= suitability

W_i= weight of factor i

x_i= dimensionless value of factor i

c_j= constraint map

Π= multiply mark

Considering small sites in area are not economically justifiable for recreational investment a minimum area was defined to determine the final suitable sits using ZLS (Average desirability for pixels of each zone) method (Eq. 3) (7-8).

$$S = \frac{\sum (L_i)_z}{n_z} \tag{3}$$

Where,

S= regional desirability of the area

(L_i)_z= desirability of i pixel at z zone

Z_n= number of pixels comprised z zone

III. RESULT AND DISCUSSION

A. Hierarchal structure

After determining of criteria, all factors were structured in a decision tree. The hierarchal structure of factors is illustrated in figure 2.

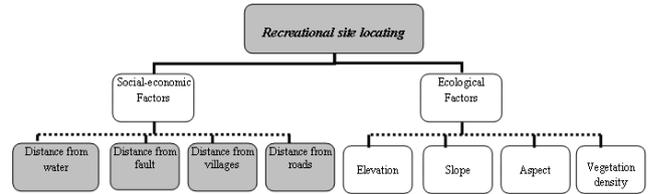


Figure 1. the hierarchy structure of factors

B. Standardization of factors

One of the most important steps in standardization of map criteria using fuzzy dimensionless method is determining the control point. According to the site selection porous (winter recreational use) as well as hillside direction the most appropriate inflection points were defined. Figs 3 and 4 demonstrates fuzzy membership curve for standardization of aspect criterion as important factor of recreational site selection.

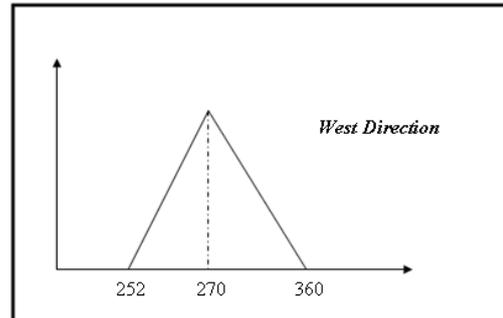


Figure 2. The monotonically decreasing linear function of aspect criterion in west direction

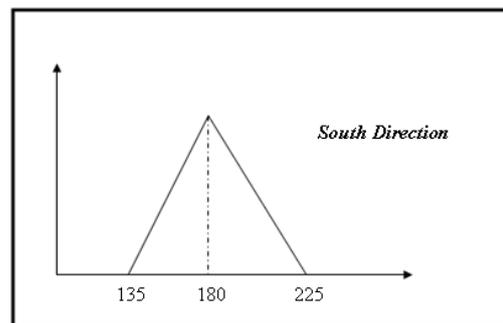


Figure 3. The monotonically decreasing linear function of aspect criterion in south direction

C. Constraints standardization

Boolean Method was used for standardization of constraint criterion maps including soil, geology and habitats. Figure 5 demonstrates soil map standardized using Boolean Method.

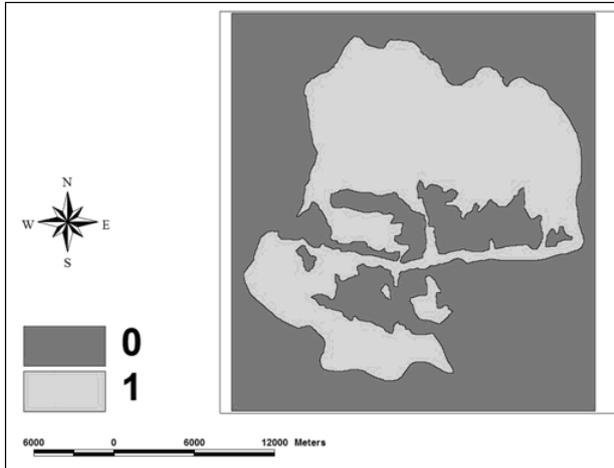


Figure 4. The standardized Boolean map of soil.

D. Weighing of factors

In study ahead factors were weighted using Delphi Method. For this purpose some questionnaire was prepared. The obtained results for socioeconomic actors are as follow:
 diswater = 0.2060
 disroad = 0.0956
 disvillage = 0.0481
 disgosal = 0.6503
 acceptable is CR = 0.08

E. The final site selected map

Suitability degree and area of indoor winter recreational zones are given in Table 2.

TABLE II. SUITABILITY DEGREE AND AREA OF INDOOR WINTER RECREATIONAL ZONES

ID	Minimum suitability	Maximum suitability	Suitability mean	Area (ha)
93	180	231	195.62	14.94
121	180	231	195.61	14.58
221	180	204	186.94	10.35
290	180	241	199.89	5.22
352	180	221	190.07	12.51
375	180	226	194.59	7.92
408	180	227	195.34	13.86

IV. CONCLUSION

Results suggest that only 0.209 % of whole area equal to is suitable for establishment of winter recreations sites.

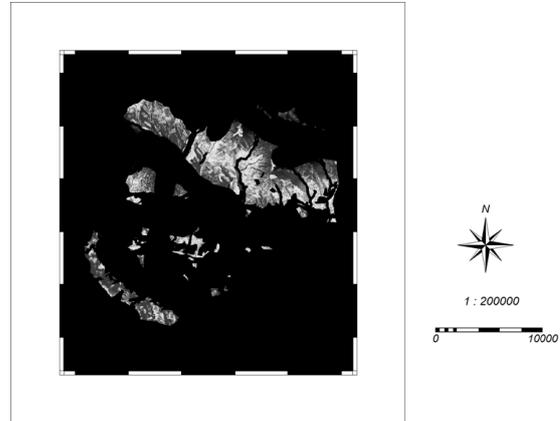


Figure 5. The suitability map for implementation of indoor recreation for winter sports.

After considering 5 ha as minimum area for establishing recreational stations final position of indoor recreational sites were determined (Fig. 6).

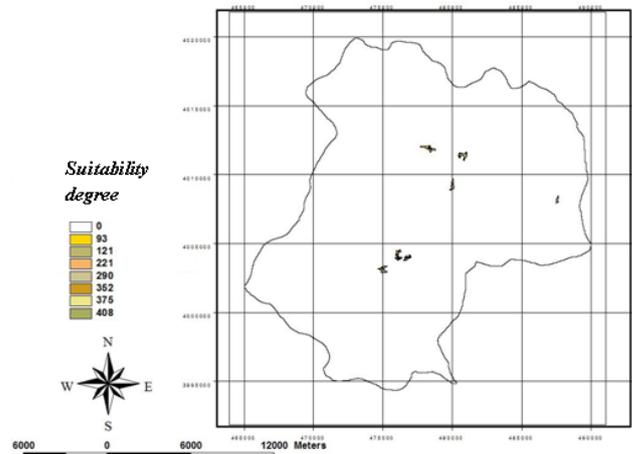


Figure 6. The final suitability map for implementation of indoor recreation for winter sports.

Despite of small area these sites are so popular for people who live in semi arid regions. These sites will be so noteworthy because of the unique scenery as well as proximity to the capital city of Tehran. Also this paper shows how applicable fuzzy logic and GIS are in handling site selection analysis. Combining heterogeneous criteria maps, considering of various stakeholders' interest and applying qualitative criteria would be possible using Analytical Hierarchy Process.

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