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Ecological capability evaluation of Ghara-Ghach dam area to establish a tourism region

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Abstract

There are various methods and models for land evaluation. These methods are classified according to the number of used resources. The best resources capabilities or potentials and land use can be found by analyzing one of the main resources, in the lands close relations to ecologic resources exist. Soil has a great potential for introducing the studied region specifications. Hence, it challenges the mistaken belief stating: "soil is only valid for agricultural applications and it is weak in measuring developing and planning domain." The present study is done with the aim to achieve the best land use according to a single-factor (soil) model for tourism planning. A soil map was obtained using a combination of conventional and digital soil mapping methods. In conventional process soils were mapped using aerial photo interpretation and physiographic methods and in digital process an elevation model and satellite images were used. Based on the field works and laboratory analyses, the soil map included 13 soil units resulting 176 delineations. Tourism region needs more essential requirements rather than recreation area. Thus, an ecological capability evaluation model developed by Bagheri Bodaghabadi (2016) was employed to evaluate all delineations of the soil map using GIS. Finally, the best environmental planning was presented to design the study area for tourism usage. The results also showed there are moderate to high suitable classes for all tourism purposes, resulting the study area has potential to develop a tourism region. The most important limiting factors in the area include soil depth, slope and coarse fragment of soil. It was also suggested to use local models to evaluate the ecological capacity in the small area.

***Keywords**:* Single-factor evaluation; Soil map; Tourism; Land evaluation; Land use planning

1. Introduction

The evolutionary trend of human communities indicates that human needs have always changed with gradual evolution of human beings, and hence, different communities have acknowledged the necessity of land use during the history. These changes used to occur in the past due to various and separate decisions made by different people. However, in today's populated and complex world, changing the land use is often done together with "land use planning (LUP)". In fact, planning for land use or land use planning directs the decisions about operating the land in the way that in addition to providing highest income, these resources are preserved for using the future generations. Using the experience of others, studying the history of ancient people and their uses of land and the required reflections will help our future a lot. Olssen (1984) states: "we should carefully study the environment and the past human abuse of land in Iran, because these extreme examples will be increasingly a part of the strategic scenarios in other nations of the region and elsewhere". Another example has been presented in a part of the book of "Geography Alive 10 for the Australian Curriculum" entitles of "What happens when we divert water?" In this part, it has been mentioned how Iranian's have caused that Lake Urmia was dried up by their awful management in water use (Price *et al*., 2013). Land evaluation –sometimes known

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as ecological capability evaluation (ECE) – is a critical step in land-use planning (Bagheri Bodaghabadi *et al*., 2015). Ecological capability evaluation is derived from sets of environmental data that are effective in economic productivities of human beings from environment, having specific usage according to human economic activities. Evaluating land ecologic capability is simultaneous evaluation and classifying the potentials and the quality grade of land. In fact, ECE provides basic information for selecting the most suitable scenario of land uses, for the designers and planners. There are various methods for ecologic evaluations. The difference of different methods is due to variety of created ecological models (Rossiter, 1996). It is indeed due to ecologic differences that different methods are established for land ecologic capability evaluation (Makhdoum, 1999). Ecologic capability evaluation methods can be different in various areas. However, what acts similarly in all these methods is evaluation by using comparative logical principles, which include having or not having the potential relative to a criterion, scale, regulation or a standard. Ecologic capability evaluation models in Iran or other countries are developed according to a general and comprehensive view for all the lands in that country. Thus, they are not usually used for local or limited areas and/or they will not provide acceptable outputs if they are used. Therefore, environmental planning for developments in regions with small areas is not effective enough with the existing ecologic regulations and models in Iran, and many ecologic capability evaluation factors are ineffective in this area. This is due to similarity of many factors in a limited area. For instance, climatic and altitude changes in a small area are limited and negligible. On the other hand, in addition to considering natural conditions, the presented regulations consider some economic matters for many models. For instance, the factor of slope, which is important in many models, is important for the hardness of work and economic matters, in addition to the conservation and stability of slope. Thus, economic aspects and hard work are justified in a limited area, the slope will be less important. In the other words, by considering the conservation of natural resources, activities can however be done in high slopes. According to the mentioned, models or methods which developed locally can help manager to make the best decision for land use planning better than ones developed in general or nationally.

Adhami Mojarrad (1989) described a single-factor evaluation using soil factor that is suitable just to evaluate the lands for agricultural areas and presents acceptable results, but cannot perform accurate assessments for other land uses. Makhdoum *et al*. (1999) also explained single-factor evaluation using soil factor in Iran is implemented by FAO method framework for agricultural purposes. This method is not exactly classified among the dual-factor methods, and it cannot either be considered among multi-factor or single-factor methods. The reason is that the principle of evaluation in this method is based on the soil parameters, only. Furthermore, identifying other existing factors is necessary to determine the other land uses. For example Yaghmaeian Mahabadi *et al*. (2012) and Hamzeh *et al*. (2014) have investigated land suitability for some crop using soil map. Against of the mentioned allegations, there are a lot of works in which soil surveys have been used for non-agricultural applications. Some examples are soil survey for urban development (Lindsay, 1973), application of soil and interpretive maps to non-agricultural land use in the Netherlands (Westerveld, 1973) and soil survey and interpretation procedures in mountainous Waterton lakes national park, Canada (Coen, 1973). Although, these investigations and soil survey applications have been started since 1970, soil surveys at 2016 are still unknown for land use planning in developing countries such as Iran.

Murphy *et al*. (2004) analyzed the soil and its potential in Land and Soil Capability (LSC) classification method. LSC classification has been developed to provide a capability assessment based not only on physical land characteristics but also on soil limitations and the management of these to mitigate land degradation and associated off-site environmental impacts. LSC proved the role of soil in sustainable management of natural resources and land evaluation. Using LSC in New South Wales, it was showed that complete identification of soil properties and management of soil data can help researcher for land evaluation. In this work, LSC method was known as a valuable tool for sustainable use of land resources and land management (Office Environment and Heritage, 2012).

It has been proved current ECE models needs to improve. Jokar *et al*. (2015) prepared a revised model for ecological capability evaluation for centralized ecotourism. They compared Makhdoum Ecological model and a revised model. Results showed that the revised method was better than Makhdoum model, due to more flexibility in classes. They also have explained the revised method compared to Makhdoum model reduces high effect of some criteria such as soil with five indicators against those important criteria including one indicator.

Based on Persian language terminology, in a lot of researches the word “recreation” has been known as tourism. Although tourism regions need some essential requirements including: recreation area (the both intensive and extensive recreations), landscapes and green area, residential area (buildings) and etc, researches based on Makhdoum model usually have been done for specific usage of recreation instead of tourism region. For example Firuzi *et al*. (2013) studied the ecological capacity of Shahid Abbaspour dam area for tourism region, but intensive and extensive recreations were evaluated, only. Gashtasb *et al*. (2014), Karimi *et al*. (2014) and Parchianpoor and Kalantari (2011) have also investigated the same researches in which the ecological capacity of “recreations” has been evaluated not tourism region. On the other hand, based on Makhdoum model, the current situation is evaluated for recreations and it does not actually present the capacity of the land which illustrates the potential for development. Thus for example it is completely possible an area with no vegetation cover is evaluated in an unsuitable class but it can have capacity to develop forest or green area.

Unfortunately, there is no proper understanding of soil map units, even for some soil scientists, and many researchers confuse about the soil map unit and the soil taxonomic unit. The soil taxonomic unit is only prepared based on the soil genesis and soil properties. In addition to the properties of soil, there are other factors in a soil map considered, such as native vegetation, slope, aspect, erosion, etc. and it is prepared according to management point of views (Bagheri Bodaghabadi, 2011). On the other words, soil map units can be designed with different compositions of soil taxonomic units and mapping inclusions. This flexibility permits the design of map units that will be most useful for the purposes of a specific survey as well as for the attainment of as much uniformity in mapping as possible (soil survey staff, 1993) Therefore, a soil map can present map units in which soil properties, geology, slope and etc. are approximately homogeneous. Instead of multi-factors approach, the single-factor evaluation is done by one factor. Thus, to obtain acceptable results, this factor should have relations with other land characteristics or ecologic resources to present an estimate about other resources. In this point of view, if a soil map is prepared accurately and with management purposes, although it apparently contains a single-factor, comparing with a multi-factor evaluation, it can play the role of multi-factor evaluation since it consists of five soil forming factors, including climate, topography, parent material or geology, organisms or biological factors such as plants, and time (Bagheri Bodaghabadi, 2011).

Evaluation and classification of land and environment is done by comparing the environmental or ecological properties of the land and ecological evaluation criteria. As mentioned before, one of the most important limitations of these models is their generality (non-locality) for the developing small region and planning. Therefore, using local models, which in addition to maintaining the principal of evaluation methods can locally provide appropriate results, can help managers and planners as well.

Although different applications should be considered to establish a tourism region and zoning should be done according to the ECE of each zone, no peculiar attention is paid to the ECE in many tourism regions. Thus, the aim of this study was to evaluate the ecological capability of the Ghara-Ghach dam area, to establish a tourism region based on a single-factor model of soil, developed by Bagheri Bodaghabadi (2016). It is emphasized in this research tourism region contains some important usage needed for tourists including residential locations (loadings), landscapes or green areas, forestry, range, extensive recreation, intensive recreation and conservation areas.

2. Materials and Methods

2.1. Study area

The study area is 645.7 ha in size. It is located between in the longitude of 549680 to 554050 and the latitude of 3482250 to 3487100 (UTM, zone39N) in the west side of Ghara-Ghach dam lake, in Semirom region of Isfahan province, central Iran. The climate of this region is classified into semi-arid (border to Mediterranean), semi-cold dry and cold semi-arid regions according to De Martonne (De Martonne, 1926), Emberger (Emberger, 1930), and Koppen (Köppen, 1936) methods, respectively. The minimum, average and maximum annual temperature of the region are -23 ˚C, 8.5˚C and 39.5 ˚C, respectively. Mean annual precipitation of the area is 421mm. The length of freezing in the year is 198 days, usually occurring in cold seasons (September to March).

2.2. Soil map

A 1:1000 soil map was created using a combination of conventional and digital soil mapping methods. In conventional process soils were mapped using airphoto interpretation and physiographic methods (Esfandiarpoor and Bagheri Bodaghabadi, 2005) and in digital process an elevation model (derived from a 1:500 topographic map), satellite images (in pixel size = 25 cm) and a digital geological map were used. In field works, 147 observation points were analyzed, described and sampled in the study area (Fig. 1), and then 44 soil profiles were selected and the related samples that included 103 soil samples were sent to the laboratory. The required physical and chemical analyses were done on the soil samples according to standard methods (Sparks *et al*., 1996 and Klute, 1986). The soil properties determined included: soil horizon thickness, percentage of organic matter, texture (percentage of clay, silt and sand), rock fragments (2–75 mm), Atterberg limits, Unified soil classification, EC (dSm^{-1}), pH, total carbonates, N, P, K, Ca^{2+}, Mg^{2+} and CEC. Based on Soil Taxonomy (Soil Survey Staff, 2014), the soil moisture and temperature regimes of the area are xeric border to aridic and mesic, respectively. The dominant soils in this area are Entisols and Inseptisols. The soil map included 176 delineations which grouped in 6 soil families, and 7 family phases (Table 1).

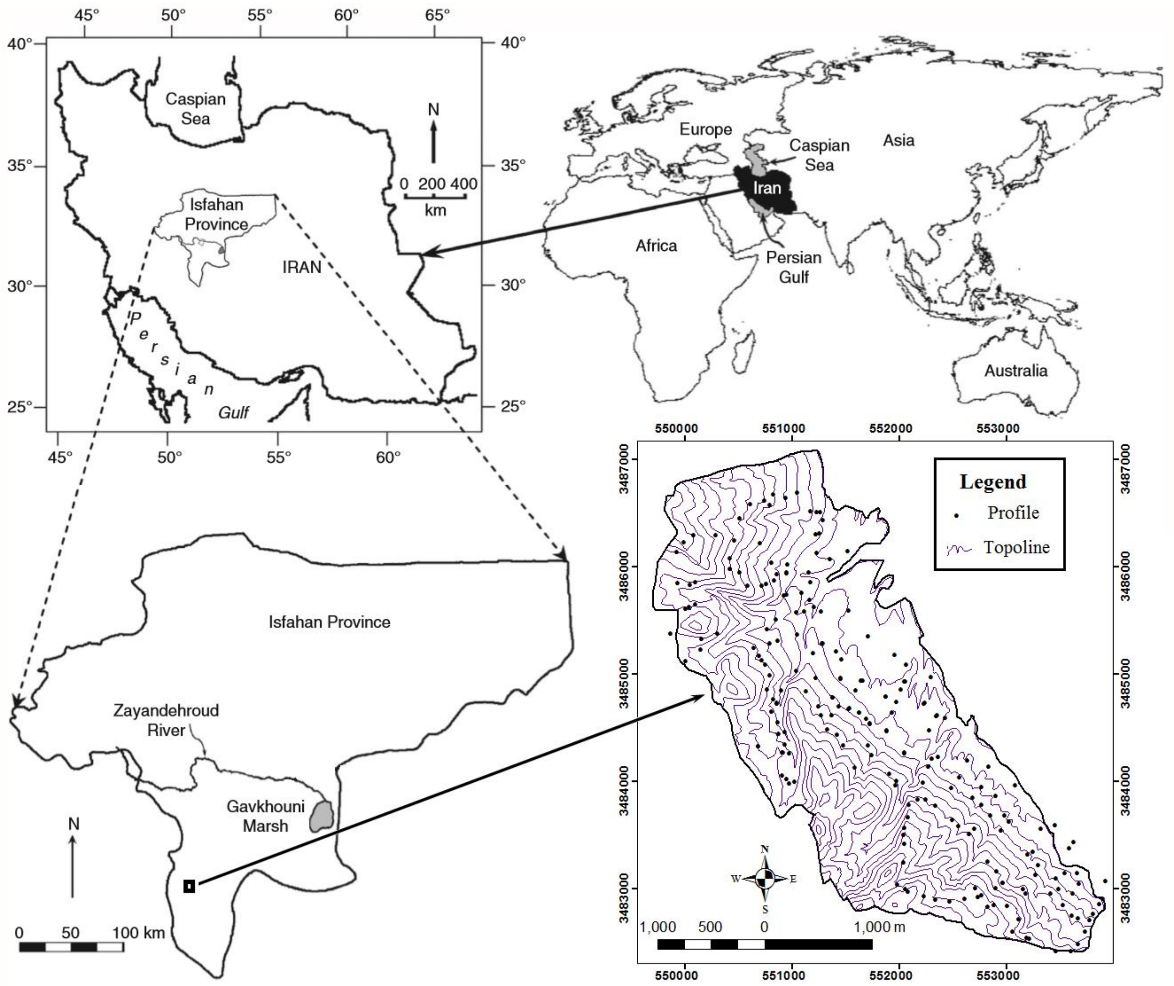

Fig. 1. Observation points and topo-lines of the study area (original in 1:500 scale)

Table 1. Soil classifications based on the Soil Taxonomy (Soil Survey Staff, 2014)

Soil symbol	Soil family	Subgroup	Order
A	Loamy skeletal, Mixed, Superactive, Calcarouse, Mesic	Lithic Xerorthents	Entisols
A-p1*	Loamy, Mixed, Superactive, Calcarouse, Mesic	Lithic Haploxerepts	Inceptisols
A-p2	Loamy skeletal, Mixed, Superactive, Calcarouse, Mesic	Lithic Haploxerolls	Mollisols
B	Loamy skeletal, Mixed, Superactive, Calcarouse, Mesic	Typic Xerorthents	Entisols
C	Fine loamy, Mixed, Superactive, Calcarouse, Mesic	Calcic Haploxerepts	Inceptisols
C-p1	Fine loamy, Mixed, Superactive, Calcarouse, Mesic	Typic Haploxerepts	Inceptisols
C-p2	Loamy, Mixed, Superactive, Calcarouse, Mesic	Typic Haploxerepts	Inceptisols
D	Fine loamy, Mixed, Superactive, Calcarouse, Mesic	Typic Calcixerepts	Inceptisols
D-p	Coarse loamy, Mixed, Superactive, Calcarouse, Mesic	Typic Calcixerepts	Inceptisols
E	Fine, Mixed, Superactive, Calcarouse, Mesic	Typic Calcixerepts	Inceptisols
F	Fine loamy, Mixed, Superactive, Calcarouse, Mesic	Calcic Haploxeralfs	Alfisols
F-p1	Fine, Mixed, Superactive, Calcarouse, Mesic	Calcic Haploxeralfs	Alfisols
F-p2	Clay skeletal, Mixed, Superactive, Calcarouse, Mesic	Calcic Haploxeralfs	Alfisols

*p= family phases

2.3. Single-factor (soil) evaluation

Since map units are only evaluated with considering a main factor in the single-factor evaluation method, this factor should appropriately be related with other land resources or ecologic resources, to obtain the estimates of other resources by its evaluation. As mentioned before, soil as a single-factor can play a role as multi-factors in ECE. Thus, the obtained 1:1000 soil map was used as an input layer in ArcGIS10.2. Then a single-factor model developed by Bagheri Bodaghabadi (2016) was employed in GIS to do the ECE. The indices and criteria of the single-factor evaluation model are given in the Table 2 for loading (very light, light, moderate and heavy), recreation (intensive and extensive) and conservation applications. It is worth noting that ECE for forest and range land uses have done using standard method of Soil and Water Research Institute, bulletin no. 212 (SWRI, 1991).

2.4. Land use system map

After land evaluation for different applications and to select the best ones in the land and organizing them, prioritization possess is done to map the location of the best uses. In other words, the final output of land evaluation maps is a map for the best uses or system of land use. This map can be used for executing programs and management of land use.

2.5. Rules of determining priorities for land uses

Determining priorities in land uses is either qualitative or quantitative. Qualitative method is used in this study. Final map for site zoning was obtained using map overlay technique in GIS and employing the following rules with regards to the class of each usage:

1- General principle for prioritization: The most important priority belongs to the usage with the least manipulations in existing conditions and present usage, with the most stable situation and highest profits.

2- Exception principle in prioritization: The effective factors in determining the priority are political conditions, social conditions and economic conditions, respectively. For instance, green areas with native vegetations should be provided in the vicinity of buildings, even if there is no soil and/or building is prohibited in the vicinity of streams or lakes, even with suitable soil for loading.

3- Regarding the regional conditions, if the current land use is for gardens, it is suggested for the priority to be the garden, even if more appropriate classes of usage are available.

4- If they make no problems for future, and in other words have stable usage, the uses that are more economically profitable have higher priorities. For instance, it is possible that transforming some of the pasture sections to residential usage has higher profitability for some years, but the land will lose its tourism potential for future. Thus, residential usage in those parts cannot be given high priority and other types of uses should be considered in that regard.

Table 2. Ecological evaluation criteria for different ecological models (applications) in hill-land regions (adopted from Bagheri Bodaghabadi, 2016)

Ecological model		Factor	CLASS 1	CLASS 2	CLASS 3	CLASS 4	CLASS 5
Loading potentials	Very Light	Slope (%)	20	30	40	50	>50
		Depth (cm)	>25	10-25	<10	-	-
		Bearing Capacity	-	-	-	-	-
		Gravel (%)	30	50	>50	-	-
		Shrinkage Potential	very low	low	moderate	high	very high
	Light	Slope (%)	12	20	30	40	>40
		Depth (cm)	>50	25-50	10-25	10-25	<10
		Bearing Capacity	-	-	-	-	-
		Gravel (%)	20	40	60	>60	
		Shrinkage Potential	very low	low	moderate	high	very high
	Moderate	Slope (%)	9	16	25	30	>30
		Depth (cm)	>80	50-80	25-50	10-25	<10
		Bearing Capacity	high	moderate	moderate to low	-	-
		Gravel (%)	20	40	60	>60	
		Shrinkage Potential	very low	low	moderate	high	very high
	Heavy	Slope (%)	5	10	20	25	>25
		Depth (cm)	>120	80-120	50-80	25-50	<25
		Bearing Capacity	very high	high to moderate	moderate to low	-	-
		Gravel (%)	20	40	60	>60	
		Shrinkage Potential	very low	low	moderate	high	very high
Intensive Recreation		Slope (%)	10	20	30	40	>40
		Depth (cm)	50-80	25-50	10-25	10-25	<10
		Soil Texture	L/SL	S/LS	CL/SiL/SCL	C/SiC/SC	-
		Gravel (%)	20	40	60	>60	
		Erosion	no or very slight	slight	moderate	severe	severe
		Fertility	very good	good	moderate	poor	very poor
		Forest/Range class	1 and 2	3	4	5	6
		Permeability (in/hr)	>0. 06	<0. 06	-	-	-
Extensive Recreation		Slope (%)	15	25	35	50	>50
		Depth (cm)	4	5	>5	-	-
		Soil Texture	L/SL	S/LS	SiL	CL/SCL	C/SiC/SC
		Gravel (%)	40	60	>60	-	-
		Erosion*	slight	moderate	severe	-	-
		Fertility**	moderate	poor	very poor	-	-
		Forest/Range class	3	4	5	6	-
Conservation		Landuse	main stream, forest, spring	-	second stream, rockout crop	-	-
		Slope (%)	-	>50	35	20	<20
		Depth (cm)	-	<10	10-25	25-80	>80
		Erosion*	severe	moderate	-	slight	no or very slight

*: definitions in soil survey manual (Soil Survey Staff, 1993): No or very slight erosion = class1, slight= calss2, moderate=class3 and severe=class4

**: Sanchez *et al*., 1982

Since by considering the sustainable development, the main aim of the project is reaching a sustainable tourism and since achieving this aim is not possible without preserving the environment and natural resources, the following rules were defined for determining the type of land uses:

Rule 1: The units with class 1 of conservation (C1) have the highest priority, but they can involve multiple land utilization type (MLUT) with the uses that do not have degradations of the land, such as foresting, pasturing, extensive recreation (Ex.R) such as walking on the skirts, rock-climbing and mountain biking.

Rule 2: The units with class 2 of conservation (C2) have the second priority. These units are usually limited due to high slopes. Thus, even if they have potentials for foresting, it is not proposed due to hard work, unless in special conditions. With uses that do not involve

destruction of the land such as pasturing and extensive recreation including walking on skirts and rock-climbing, these units (C2) can involve multiple land utilization type (MLUT).
Rule 3: The units with class 1 of foresting (F1) have the highest priority after C1 and C2. F1 units can involve multiple land utilization type (MLUT) by uses such as pasturing and extensive tourism and sometimes intensive tourism (such as camping, and recreational bicycle riding).
Rule 4: The priorities of class 2 of foresting (F2) are next to class 1 of foresting. Also, F2 units can involve multiple land utilization type (MLUT) by other uses such as pasturing and different types of tourism.
Rule 5: In case being together with C3 which has native vegetations, for the units with class 3 in foresting (F3), the priority is given to C3 for maintaining the native vegetation and natural views. Otherwise, considering the mentioned regulations, the priority will be given to loadings (L).
Rule 6: In case no suitable native vegetation exists in the stream vicinity, the intensive tourism is prior to extensive tourism in the units with class 3 or lower.
Rule 7: According to the studies for vegetation coverage, sloped and rocky regions have better native vegetation. Thus, range and conservation are prior in such units.
Briefly, land use priorities are sorted as following:
C1>C2>F1>F2>C3≥F3≥L and Ex.R can be as a MLUT.

3. Results and Discussion

The study area contains three physiographic units, including hills, piedmont plains and upper terraces (plateaus). Fig. 2 and Table 3 show land component and their developed soil on each unit. Based on the field works and lab analyses, all the Entisols and some of the Inceptisols are located in the upper (hills) part of the study area, whereas all Inceptisols are located in the lower (piedmont plain and plateaus) part of the region. Soil depth also changes from very shallow (sometimes rock outcrop or without soil) in the summit of hills to very deep in the piedmont plains.

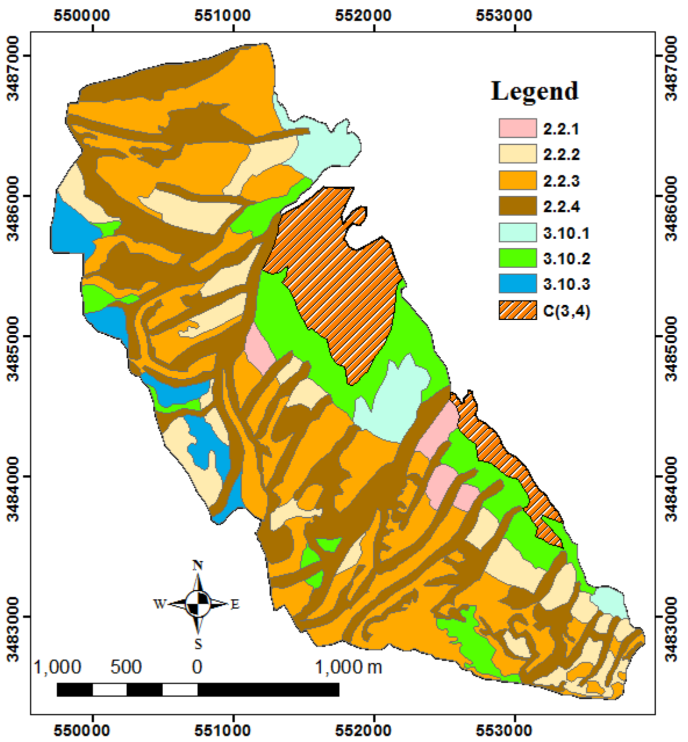

Fig. 2. Land unit maps of the study area

The landscape of the study area presents a wide range of slopes. As Fig. 3 shows slope changes from 0 to more than 50 % as well, resulting more than 65 % of the land has the slope of over 15 %. It indicates that the study area has no loading potentials in accordance with many ecologic models; therefore, this region has practically no capability to establish a tourism area. Rashidi *et al*. (2010) and Akbarfazeli *et al*. (2014) described the slope over 15% are not suitable for tourist activities especially for child and old men. Thus, a lot of their study areas evaluated as unsuitable. As it was earlier stated, in case of no limitations for the slope stability and/or conservation and if the improvement activity is economically justifiable, the slope factor can be changed for that region based on the types of applications (land uses) and the economic costs. For example, according to the employed model, maximum slope for class 1 is 12 % for light loads, but this rate reduces to 5 % for heavy loads, since heavy loads require deeper excavations and foundations. It is worth noting that these improvements can also be useful for increasing of tourist activities.

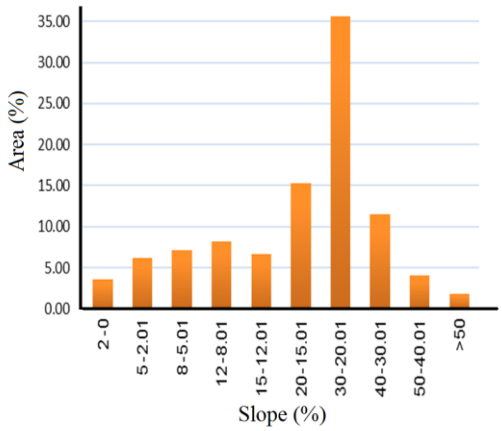

Fig. 3. Classification of the slope in the study area

Table 3. Land component (physiographic) properties in the study area

Land type	Land unit	Land component	Description	Main limitation
2	2.2	2.2.1	Moderately deep to deep (in foot slope) soils, medium to heavy soil textures with gravels and carbonates accumulation (Typic Calcixerepts & Calcic Haploxerepts)	High slope
		2.2.2	Shallow to very shallow soils, heavy soil texture with gravels and carbonates accumulation (Typic Calcixerepts & Lithic Haploxerepts)	High slope
		2.2.3	Very shallow to shallow soils, medium to heavy soil textures with gravels and rock outcrop (Lithic Xerorthents)	High slope and rock outcrop
		2.2.4	Without or very shallow soils, medium (mainly silt) and heavy soil texture with gravel and rock outcrop (lithic xerorthents)	Erosion, high slope and rock outcrop
3	3.1	3.10.1	Deep to moderately deep soils, medium soil texture with gravels and carbonates and sometimes clay accumulations, gently sloping on alluvial fans (Typic Calcixerepts & Calcic Haploxerepts)	Erosion and few relief
		3.10.2	Deep to moderately deep soils, medium soil texture with gravels and carbonates accumulation on highly eroded alluvial fans (Typic Calcixerepts & Calcic Haploxerepts)	Erosion and moderate relief
		3.10.3	Moderately deep to shallow soils, heavy soil texture with few amounts of gravels and carbonates accumulation on old alluvial fans (Typic Calcixerepts)	Erosion and few relief
4	4.4	4.4.1	Deep to very deep soils, medium soil texture and few amounts of gravels and carbonates accumulation, sometimes clay, gently sloping (Typic Calcixerepts & Calcic Haploxerepts)	Erosion and few relief
Complex	4.4,3.10	4.4.1,3.10.1	Deep to very deep soils, medium soil texture and few amounts of gravels and carbonates accumulation, sometimes clay, gently sloping (Typic Calcixerepts & Calcic Haploxerepts)	Erosion and few relief

Table 4 shows land capabilities for different scenarios were presented for some map units. There are three defined scenarios for decision making.

• Scenario 1: all land improvement activities are done and costs and time are not limited (the ecological capability of the land).
• Scenario 2: some essential activities of land improvement are done, due to limitation of costs and time (the best suggested land use).
• Scenario 3: just some activities of land improvement are done which need for land conservation (the best land use based on the current situation).

As the rules of determining priorities for land uses show, conservation or preservation of land resources is in the highest priority. Accordingly, the areas such as main streams are among the essentially preserved regions, and any activities that cause the degradation and changing of these regions are forbidden. However, the uses such as extensive recreation or foresting (in case of suitable soil) that are not in contradiction with the preserved regions can simultaneously be utilized. For example, ecological capability symbol of C1F1E2 shows the land unit with class 1 of preservation (C1), class 1 of foresting (F1) and class 2 of extensive tourism (E2). Based on the rules of determining priorities for land uses this map unit should be allocated to conservation areas, but it has also very good capability for foresting (F1) and foresting can also has a positive effect on conservation, so if there is no limitation of costs, foresting can be a usage, too. Therefore, conservation and foresting can be a multiple land utilization type for scenario 1. Furthermore, this map unit has a class 2 for extensive recreation, thus using a wise management with some expenses (not as much as for foresting costs) it can involve a multiple land utilization type of conservation and extensive recreation (such as mountain biking) for scenario 2. Finally, at the current situation and without considerable expenses, since current land use is range land, this map unit can involve a multiple land utilization type of conservation, extensive recreation and range (such as mountain walking and climbing) for scenario 3, although, the capability class for range is class 4 (R4 is not shown in ecological capability symbol).

Table 4. ECE for different scenarios in some of the map units

Remarks and/or limitation	Scenario3	Scenario2	Scenario1	ecological capability symbol	Working unit No.	Unit code
Slope/rocky/climbing on the slopes/ conservation	CRE	CE	CF	C2F2E3	532	1
Local sever soil erosion/slope/main stream / conservation	CRE	BCFE	BCF	C1F1E2	432	2
Secondary stream/ conservation	CE	CRE	F	C3F1E2M3	322	3
Potentials for future developments especially intensive tourism / suitable soil	CE	FI	LF	F1E2L3	331	4
Slope / potentials for future developments / suitable soil	CE	FI	MF	F1E2R3M3	322	5
Potential for development and pasture landscaping	LR	LR	MF	F2R2M3	412	9
Potential for development and landscaping / neighboring for mountain biking	LR	BLR	BMF	F2E2R3M3	423	10
potentials for future development especially intensive tourism	LI	LI	LF	F2E2L3	433	11
Secondary stream/ conservation / rocky area/ rocky and pasture landscaping	CE	BFC	BF	C3F2R3	512	13
Potentials for future development and green areas	CRE	MFg	MF	F1R2M3	411	17
Potentials for future development and green areas / adjacency for mountain biking	CRE	BMFg	BHFg	F1R2H3	311	18
Pasture coverage / rocky and pasture landscaping	LRr	LRFr	Fr	F2E3H5	532	23

Symbols: B=mountain biking, C=conservation, E=extensive tourism, F=foresting, G=garden, g=green area, H=heavy loading, I=intensive tourism, L=light loading, M=moderate loading, R=pasturing (range), r=rocky, X=critical region, 1 to 5 (in ecological capability symbol) = very suitable classes to weak classes.

Fig. 4 shows the land use system map for different applications or uses to develop a tourism region. Table 5 shows the percentage and area of the best capability for each land uses in the study area. As it can be seen, the region has suitability or capability for different uses required for establishing a tourism area. In other words, the study area has suitability for creating a tourism area, since for instance, if the region does not have potentials for loading such as building, it will practically has no possibilities for establishing a tourism area; why there is no tourism area without settlements. According to the results, despite merely using the soil map in this model, but different other ecologic models are also properly used.

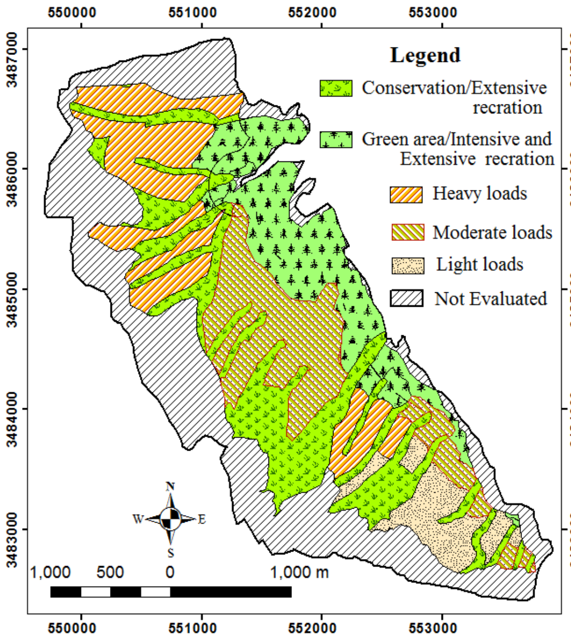

Fig. 4. The land use system map for different applications to develop a tourism region in Ghara-Ghach area

Table 5. The percentage and area of the best capability for each land use of the study area

Ecological model (land use)	Area	
	hectare	percentage
Conservation/ Extensive recreation	179.6	28.7
Green area/ Extensive recreation	137.4	22.0
Heavy loads	129.7	20.7
Moderate loads	127.3	20.3
Light loads and intensive recreation	51.9	8.3
Total	625.9	100

Based on the results (data not shown here because of their high volume), the most important limiting factors in the region include soil depth, slope and coarse fragments of soil. In a same area (Shahid Abbaspour Dam) Firuzi *et al*. (2013) also reported the same results for recreations. These factors almost have correlations with each other, such that by increasing the slope, the soil depth is reduced and the percentage of coarse fragments such as gravels, cobbles and boulders increases. It is worth noting that coarse fragments are important both because of reducing the potentials to store water and nutritional materials in agriculture and problems that may make in agricultural operations, and also due to engineering uses, especially in compaction subjects. The mentioned factors are directly effective in green area uses such as green recreation areas (landscapes or parks) and foresting. Thus, improvement or modifying them is not economical in large areas. These factors are also among the most important ones for different types of loadings. However, since the loadings are not usually done in large area (e.g. building units), spending costs in this respect are economically justifiable. Hence, the considered limitations can be improved by backfilling and leveling activities or terracing.

In the final ECE, the conservation applications or ecologic conservation model have the most area (28.7 %) and intensive recreation and light loading have the least area for this purpose (8.3 %). It is to note that the locations that for example have class 3 for heavy loading, they will have class 3 or lower classes (class 2 or 1) for moderate or light loads. Thus, if only land suitability or ECE classes (without priority and importance of applications) is considered, light loading applications will definitely have more portions as compared to moderate or heavy loads. However, according to land use priorities, (that somehow includes economic values), it is not logical to allocated light loads, where there have capability and potential of heavy or moderate loading applications.

4. Conclusion

To develop a tourism region some requirements are essential, such as recreations, landscapes and green area, residential area (buildings), etc, there are discriminations between tourism regions and recreation areas. On the other hand, ecological capacity in the small area needs own criteria which are different form usual models developed for the large area. This study shows that for environmental planning in small and limited areas (especially when large scale maps are exist), single-factor evaluation of soil can make proper strategy to map suitable land use in conformity to the actual potential of the land. In this regard, using a soil map which is accurately created with management views or purposes, it can be emphasized that the hypothesis “soil can only evaluate agriculture potential” (Makhdoum, 1999; Adhami Mojarrad, 1989) is incorrect for the study area and probably for the same areas. However, it should be noted that the current research is done based on a very detailed soil map (1:1000 scale), and it should be experimented and tested for conventional soil survey, performed in 1:25000 to 1:50000 scales. The results also indicated large scale soil map can be used in ECE and/or LE as an exclusive input layer to evaluate the environment potentials or suitability based on a single-factor evaluation model. The employed model and method can be a standard approach in the same areas in which general models are unsuitable and inapplicable. This also can be effective in reducing the cost and time for land use planning instead of usual multi-factor evaluation. However, local conditions and characteristics, and possibility of improvement or un-improvement of them, are very important factors which influence choosing a model and on its efficiency.

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