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Ecological Capability Evaluation with the Formulation approach of adapted Ecological models with the aim of Landuse Planning (Study Area:Bagh-e-Shadi protected area)

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ABSTRACT

The present study in addition to reviewing, completing and compilation of ecological models, has evaluated the ecological capability regarding to ecological and socio-economic needs in Bagh-e-Shadi, center of Iran. After that, land use planning was conducted by assessing capability of the environmental units. In this study, initially, ecological and socio-economic resources were identified and the database was created. In the next step, all ecological resources were classified and the stable and unstable ecological resources were integrated by GIS. Subsequently, ecological models adapted to local condition were prepared for land uses of conservation, intensive promenade, extensive promenade, agriculture, range management and forestry. In terms of potential capability in land uses of forestry, range management, agriculture, extensive promenade and conservation, respectively, classes 2 (forest protection), 2 (range with low capability), 4 (improper), 1 (extensive of type 1) and 2 (protection of degree 2), have the highest areas. Eventually, land use planning was done to determine the optimal land uses of environmental units.The results showed that the maximum optimal Land use was for forest. After that, the protection of grade 1 and 2 respectively had the maximum value.

Keywords: Ecological capability evaluation, Bagh-e-Shadi, Land use planning, GIS

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INTRODUCTION

Today, protecting and maintaining inhabits with high diversity, density and genetic reserves are more important to meet the needs of future generations and make a valuable resource for their life. Biodiversity is quantitatively and qualitatively in dangerous and because it can't be found in all places in the world, protecting and maintaining these valuable resources to reach the optimal diversity is essential especially for plant species. Different authors investigated various studies on ecological capability; Vosogh *et al* [11] evaluated the ecological capability using GIS by five maps of slope, aspect, land use, land cover, and hydrological features in arid and semi-arid areas in Iran. Moradzadeh [9] to develop forest area used the maps of environmental parameters using GIS. Haririfar [3] determined 765 sub ecosystems based on ecological capability in west of Iran. Karami *et al*. [5] prepared the map of land use using GIS for different uses in north of Iran. Since arid and semi-arid regions cover 80% of total areas in Iran, the importance of forest cover is necessary in these areas. According to the FAO, forest capitation of Iran is 0.2 ha which is one-quarter of universal capitation [10]. The present study was conducted to prepare ecological models and also evaluate environmental capability according to social and economic needs. Finally the land use planning and optimal land use were determined. Preparing the ecological models and considering the socio-economic factors are the innovations of the study.

MATERIAL AND METHODS
Site description
Bagh-e-Shadi, the protected area, is located in south of Yazd city with a 230 km distance, center of Iran (54° 05′ to 54° 14′ E, 29° 42′ to 29° 50′ N). This garden is unique in Yazd province due to its type, area and composition. Figure 1 shows the location of this natural resource reserve.
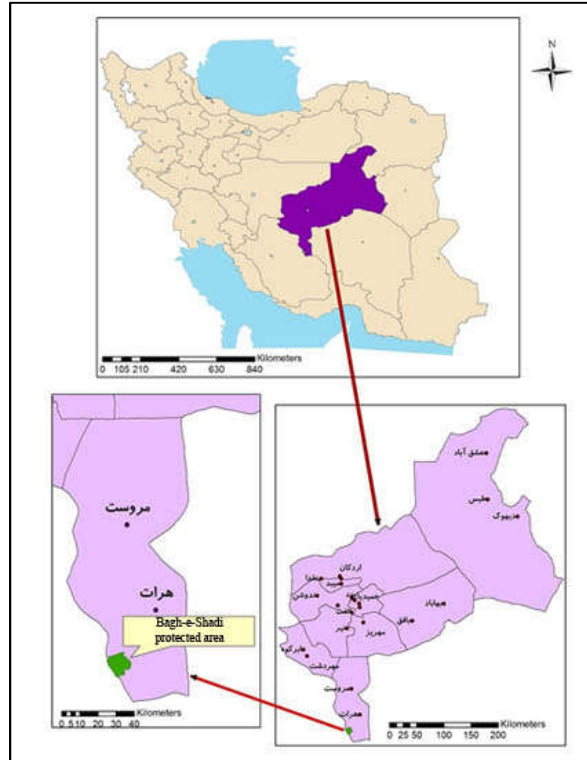

Figure 1: the location of Bagh-e- Shadi in Yazd province, center of Iran.

Methods
Studying the land evaluation is a multi-dimension process which indicates the ecological capability and socio-economic needs. Besides, evaluating the capability is estimation of possible use of the land for agriculture, rangeland, forest, tourism, conservation, aquaculture etc. [7]. For this purpose, Makhdoom's method [7] was applies for assessing the Bagh-e- Shadi which is classified in five groups:
1. Identifying the ecological supplies and collecting the socio-economic data.
2. Analyzing the data and overlaying the maps to prepare the maps of environmental homogenous units.
3. Assessing the environmental homogenous units which are comparing with local ecological models. These models have been designed based on features of local area.
4. Evaluating the environmental capability based on socio-economic needs.
5. The final decision for the type of land use in homogenous units and socio-economic needs of local people, and finally the map of optimal uses were prepared.
 These steps are depended on each other and based on system analysis. In system analysis, the basic resources are analyzed, then the data will be classified and finally the maps of units will be prepared by overlaying the stable and unstable environmental resources. Overlaying the maps of classified data make homogenous units which each one has biophysical and socio-economic features to make evaluation map of ecological capability for different goals. Although each unit may have potential for various uses, selecting the type of a uses depends on the ecological limitations and socio-economic needs. Hence, the priority of uses and selection of optimal uses were conducted based on deductive method, vulnerable analysis and local people's needs. Finally, the map of optimal uses for Bagh-e-Shadi area was prepared by integrating the optimal uses of all homogenous units.
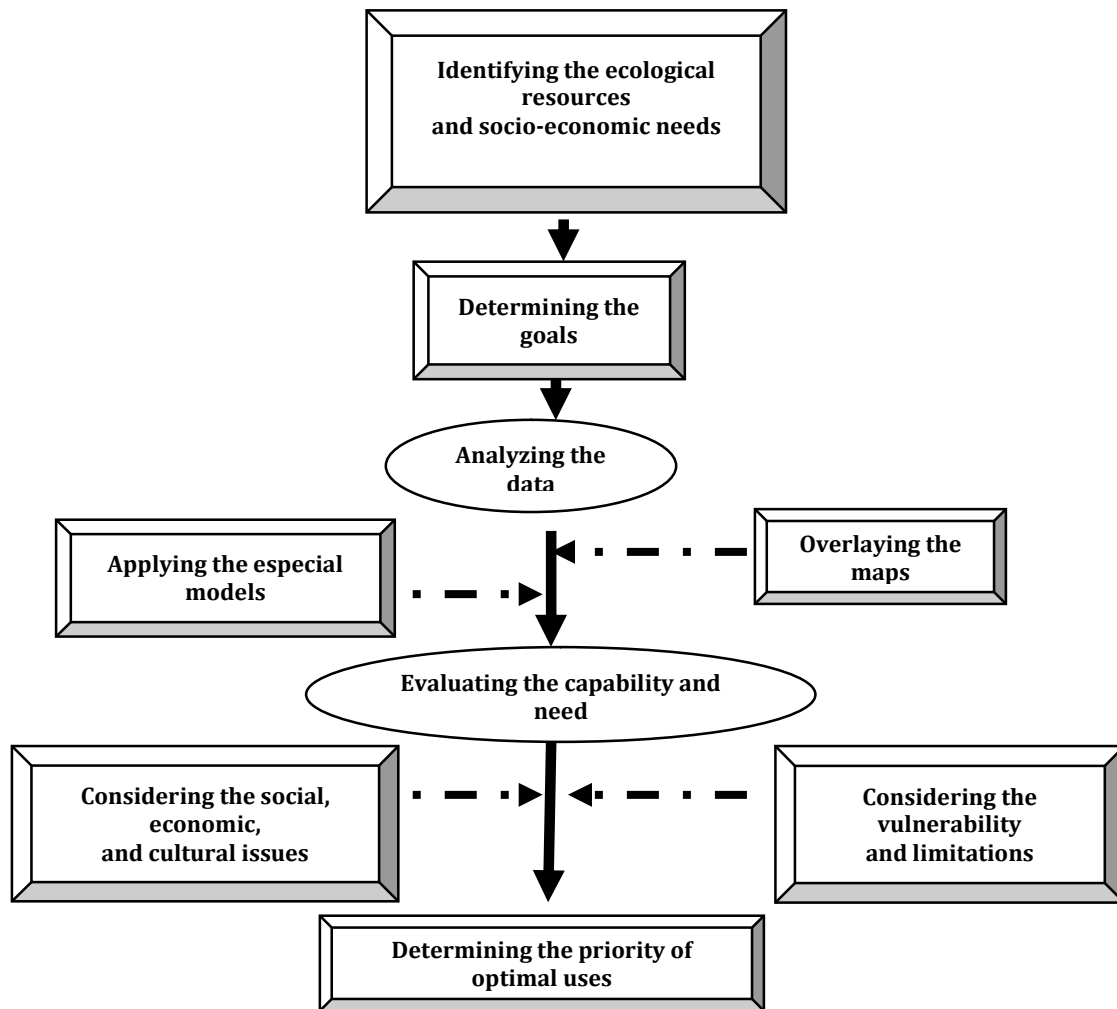
Figure2: The hierarchy of the steps used in the present study

2.2.1. Identifying the ecological and socio-economic resources
Identifying the ecological and socio-economic resources was done by data bank for evaluating the capability and preparing a collection of descriptive maps and data.
2.2.2. Analyzing and summarizing the data
It contains two sub sections including data analysis and data summary
2.2.3. Analyzing data
In this step, the data are divided into simple classes based on analytical method. Hence, strong analyses cause to analyze the data easily and make more appropriate findings for next steps.
2.2.4. Summarizing and synthesizing
The data obtained from previous step, are integrated again, so that the new data are usable for evaluation process and determine as an index of basic data. All data should be classified into ecological classes by multi-criteria analysis[7] to determine the appropriate uses.
Stable ecological resources are including slope, elevation, aspect, soil type, vegetation which create the ecological units. These layers are integrated in GIS and also coding the units are done in the GIS. Unstable ecological parameters are included climate, water supplies, soil erosion, and wild inhabits and also socio-economic characteristics such as land use.
2.2.5. Review, completion and development of ecological models
The models of land uses which applied for conservative area, are ecological models of Iran and were selected based on conservative purposes and socio-economic characteristics. Identifying zones and their natural vulnerability is the main part of capability in conservative regions. Each model is particular for a given area with special ecological and socio-economic situations which simplify the decision. Here,

ecological models regarding to various uses such as protection, intensive promenade, extensive promenade, agriculture, rangeland and forestry.
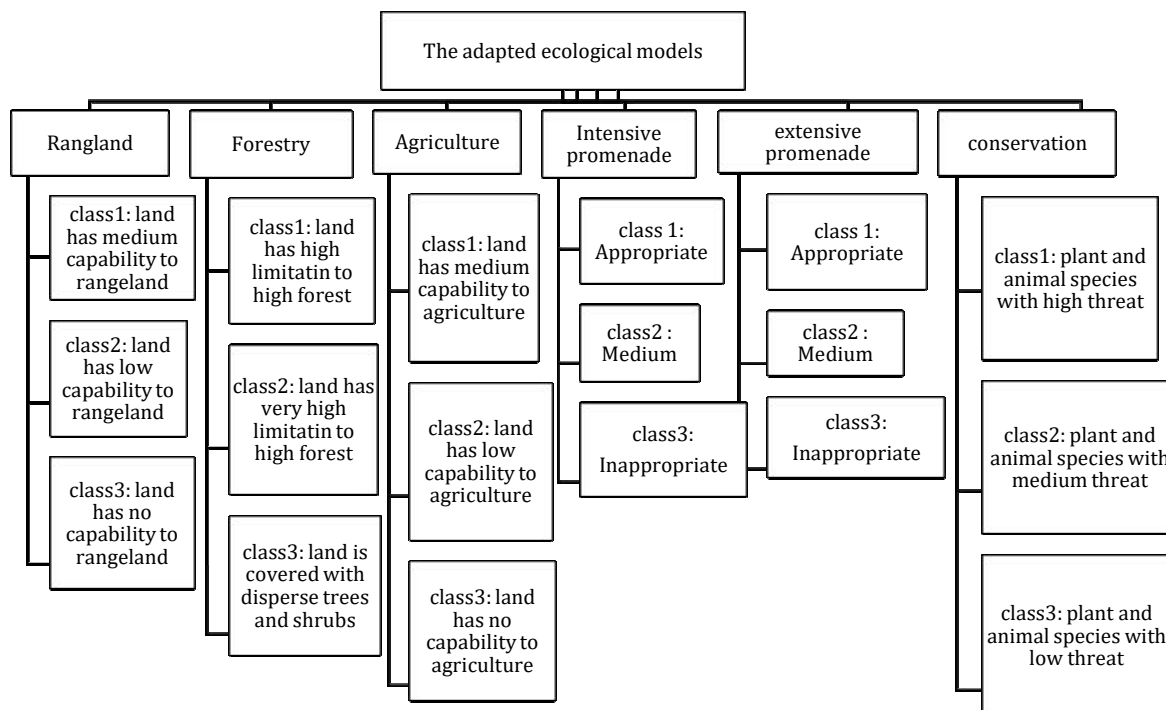

Figure3: The adapted models for Bagh-e- Shadi

2.2.6. Evaluating the environmental capability regarding to socio-economic needs

The inappropriate uses should be omitted to make the minimum conflict in the area. Because vulnerability is influenced by type and rate of uses, considering this issue is more effective in modeling for land capability. There are a large number of socio-economic factors which affect the vulnerability of natural lands. Since human communities have impact on natural ecosystems, the type of lands and land uses are dependent on human activities [6].

2.2.7. The vulnerability

Vulnerability is a multi-dimension process which is occurred in animal and plant ecosystems. It means when the ecosystem is faced dangers, the needs of the plant or animal can't be supported by the relative ecosystem and they must migrate to undesired areas. So the venerable parts of ecosystem will received the maximum dangers and these changes may be irreversible [6].

2.2.7.1. Vulnerability due to natural environment, socio-economic parameter indoor and outdoor of case study

Different factors affect the vulnerability of Bagh-e- Shadi which the main parameters are presented in the following monograph.
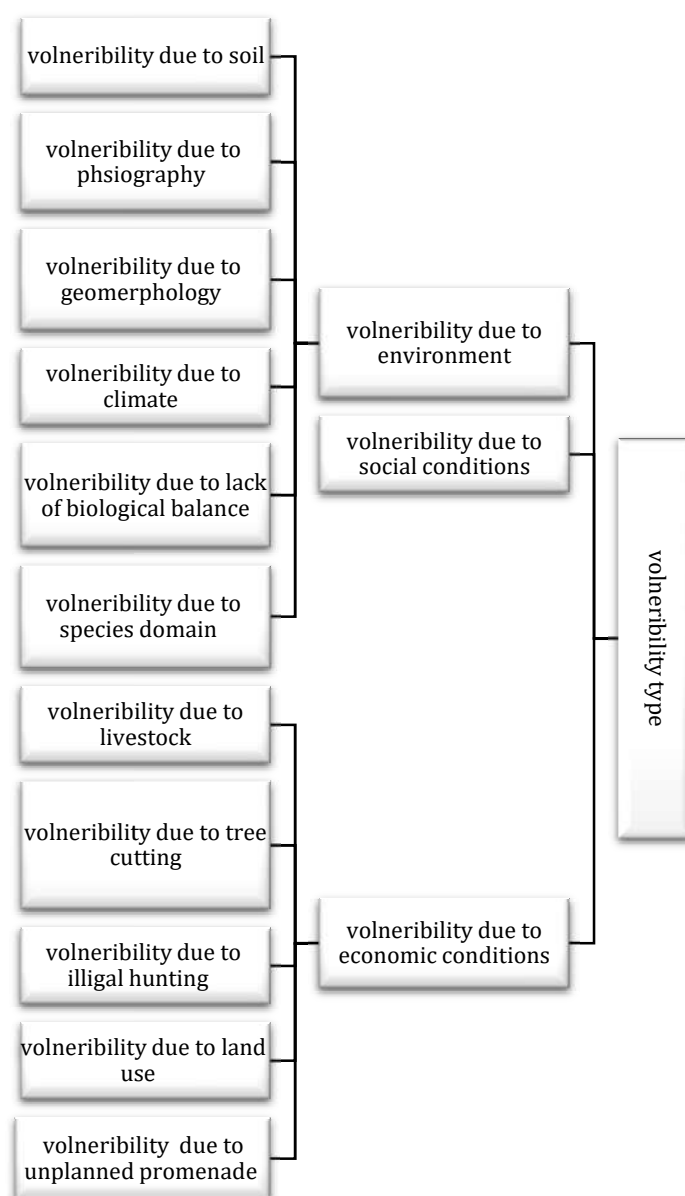
Figure 4: The types of vulnerability due to environment, social and economic factors indoor and outdoor of Bagh-e-Shadi.

2.2.8. Evaluating the environmental units

Evaluating capability is the middle step of land use planning [2]. It is expected that capability evaluation provides basic information for land use planning to determine the most appropriate use and management of land; because the most principle and basic aim of land use planning is use of land ecologically, economically and socially to reach the most suitable land use [7].

After analyzing the basic data, the appropriate output will be obtained for management. It is occurred by assessing the ecological homogenous units for special uses of production (utilization), natural limitations (erosion, diversity reduction etc.) and management needs [4]. Subsequently, after overlaying the ecological resources and making the homogenous environmental units, their characteristics will be recorded. By applying these features and comparing with their models, the ecological capability will be determined.

RESULTS

3.1. Preparing the maps of environmental units

The importance of ecological capability is strongly eminent, so that if a land has no capability for a use, not only it can't improve the environmental situation, but also accelerate the degradation [1]. For this purpose, to determine the ecological capability of environmental units, the stable and unstable resources

of environmental units with particular models were studied in GIS. After that, the outputs were prepared as maps and table (table 1-10). The maps 5 to 9 have strong capability for forestry, rangeland, agriculture, extensive promenade and conservation. The area has no capability for intensive promenade due to the imitations.

Table 1: Environmental units for forestry capability

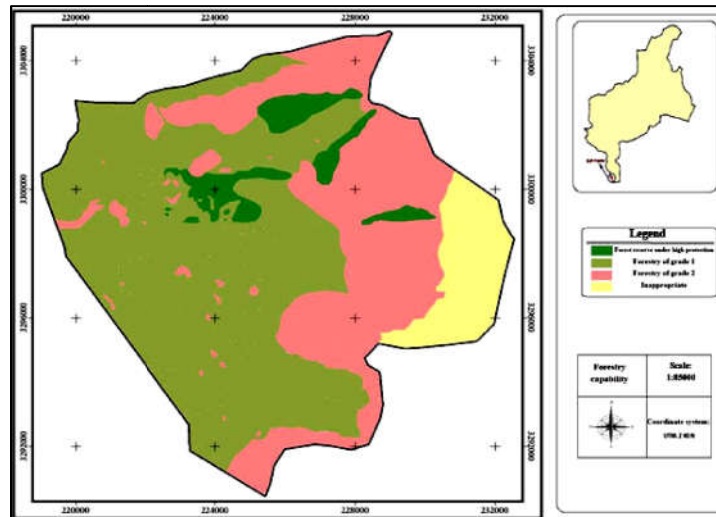| Relative area (%)	Area (ha)	Land use	class
5.3	617	Forest reserve under high protection	1
54.3	6332	forestry of grade 1 (under protection)	2
32	3737	Forestry of grade 2	3
8.4	979	Inappropriate	4

Figure 5: The map of areas for forestry capability

Table 2: Environmental units for rangeland capability

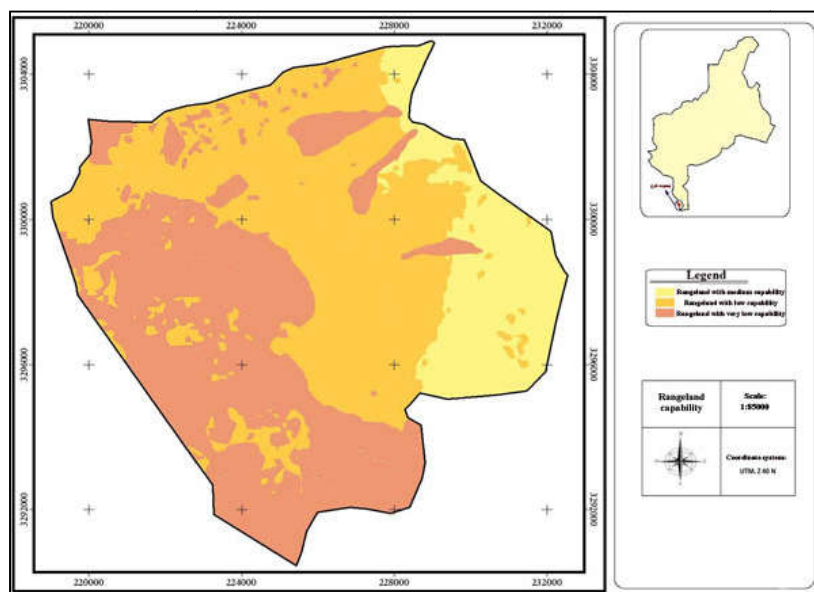| Relative area (%)	Area (ha)	Land use	class
15.7	1832	Rangeland with medium capability	1
62.6	4966	Rangeland with Low capability	2
41.7	4867	Rangeland with very low capability	3

Figure 6: The map of areas for rangeland capability

Table 3: Environmental units for agriculture capability

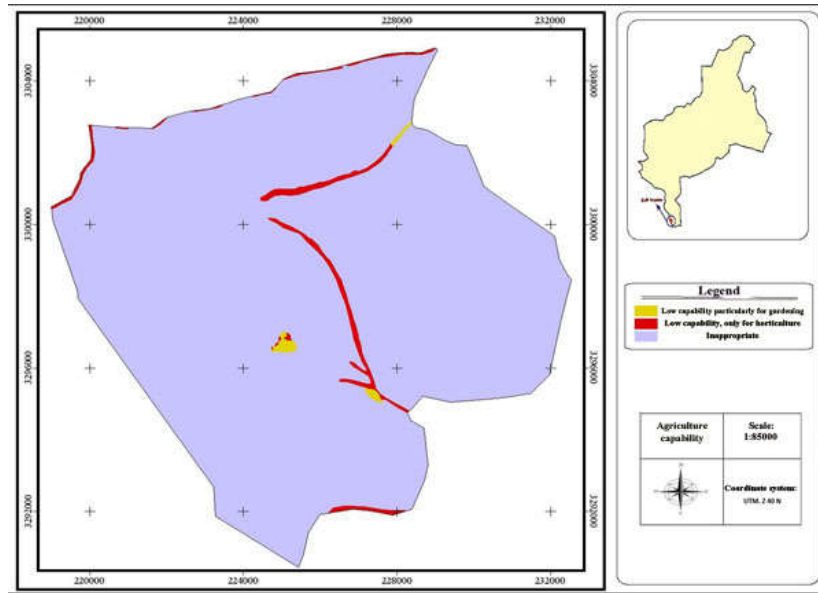| Relative area (%)	Area (ha)	Land use	class
-	-	Lack of capability due to poor water and soil supplies	1
0.3	37	Low capability particularly for gardening	2
1.9	219	Low capability, only for horticulture	3
97.8	11409	Inappropriate due to all parameters	4

Figure 7: The map of areas for agriculture capability

Table 3: Environmental units for extensive promenade capability

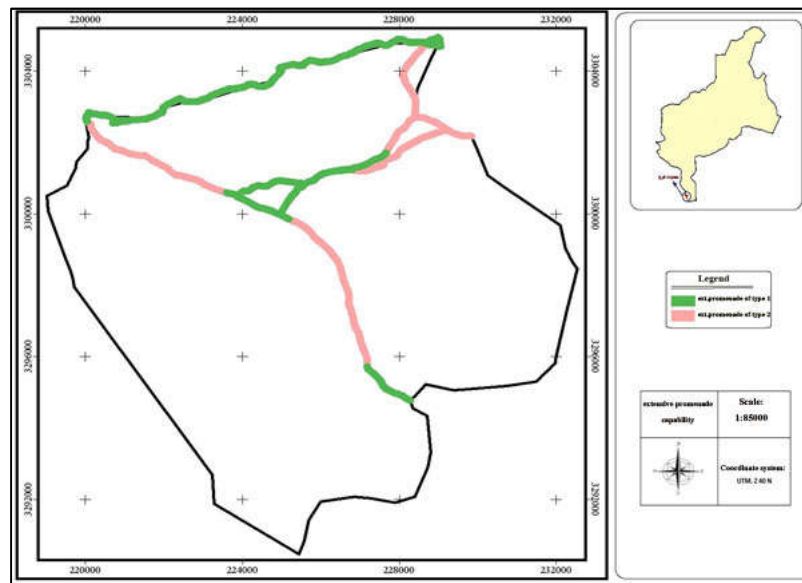| Relative area (%)	Area (ha)	Land use	class
2.8	327	extensive promenade of type 1	1
2.3	270	extensive promenade of type 2	2
-	597	Total (indoor zones)	3

Figure 8: The map of areas for extensive promenade capability

Table 5: Environmental units for conservation capability

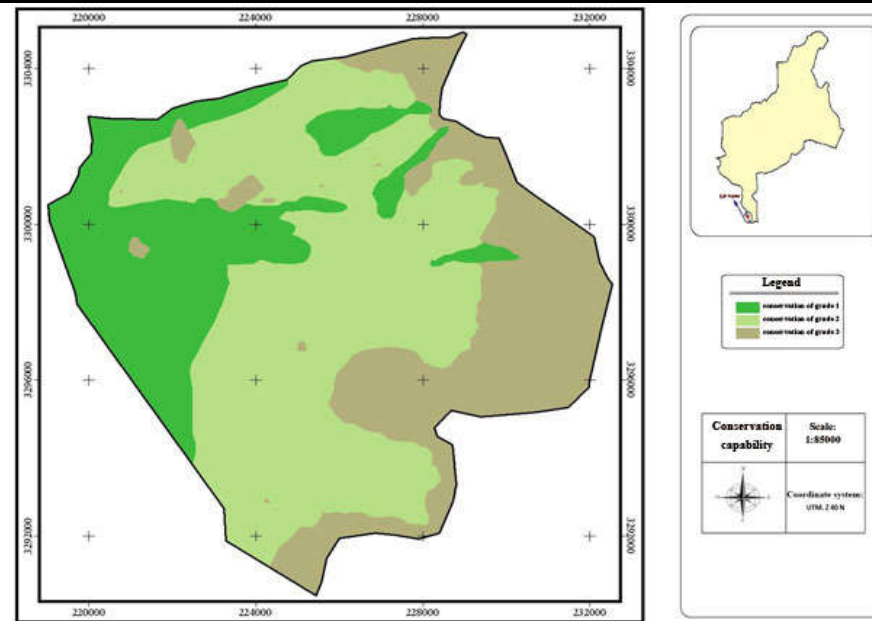| Relative area (%)	Area (ha)	Land use	class
23.3	2719	conservation of grade 1	1
49.6	5784	conservation of grade 2	2
27.1	3162	conservation of grade 3	3

Figure 9: The map of areas for conservation capability

3.2. Determining the optimal uses (land use planning)

The capability of land for various uses was determined in previous section. Here, the most appropriate land is determined for optimal use in particular unit. The priority of uses was determined based environmental, social and economic parameters by quantitatively deductive method in GIS to prepare the final map based on land use planning in comparison to optimal models.

Table 6 indicates the conformity between optimal uses and current uses and also figure 11 shows the optimal uses of Bagh-e-Shadi.

Table 6: The conformity between optimal uses and current uses of Bagh-e-Shadi

|	The use area (ha)							
Optimal uses	**Burned forest**	**Forest**	**Remote lands**	**Former mining area**	**Gardens and rangelands around village**	**Rangeland**	**The range of village**	**Total**
Conservation of grade 1		2056						2056
Conservation of grade 2		5568						5568
Promenade grade 1 of		172						172
Promenade grade 2 of		222						222
Protected forest reserve		608						6088
Medium rangeland		910				979		1887
Horticulture and agriculture					27		8	35
Afforestation	118		3	4				125
Poor rangeland		410						410
Very poor rangeland		582						582
Total	118	10526	3	4	27	979	8	11665
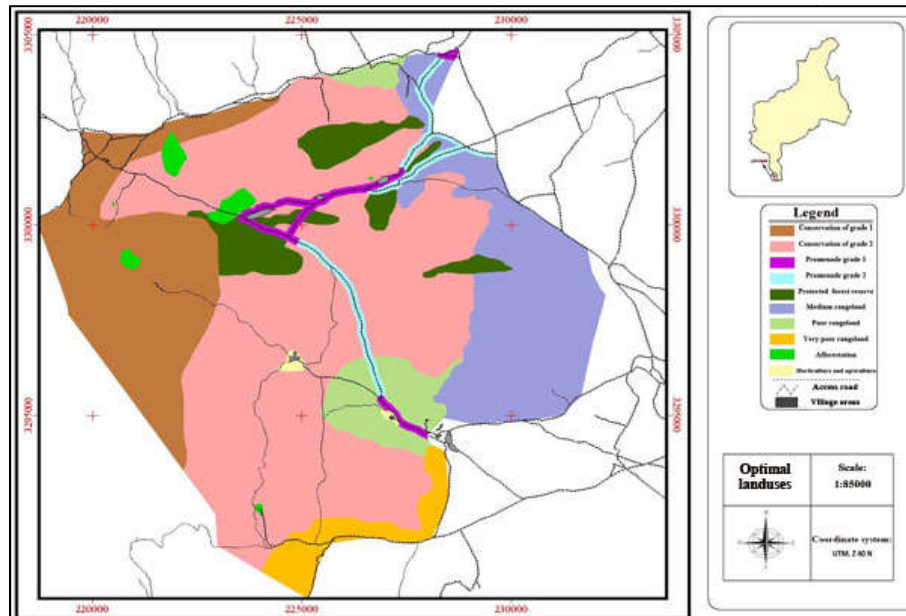
Figure 10: The map of optimal landuses (land use planning) for Bagh-e-Shadi

DISCUSSION

Results show the maximum area is for optimal use of forest. Forest have eminent impacts on maintaining biodiversity. Baghe-e-Shadi due to its semi-arid climate and its vulnerability, causes the forest were considered as two optimal uses of conservation grade 1 and 2.

Rangelands are the second use which covers the maximum area after forests and its highest amount is for medium rangelands. After forest and rangeland, burned forest is the third use which is prioritized for afforestation. Other uses have little portion in priority of optimal uses.
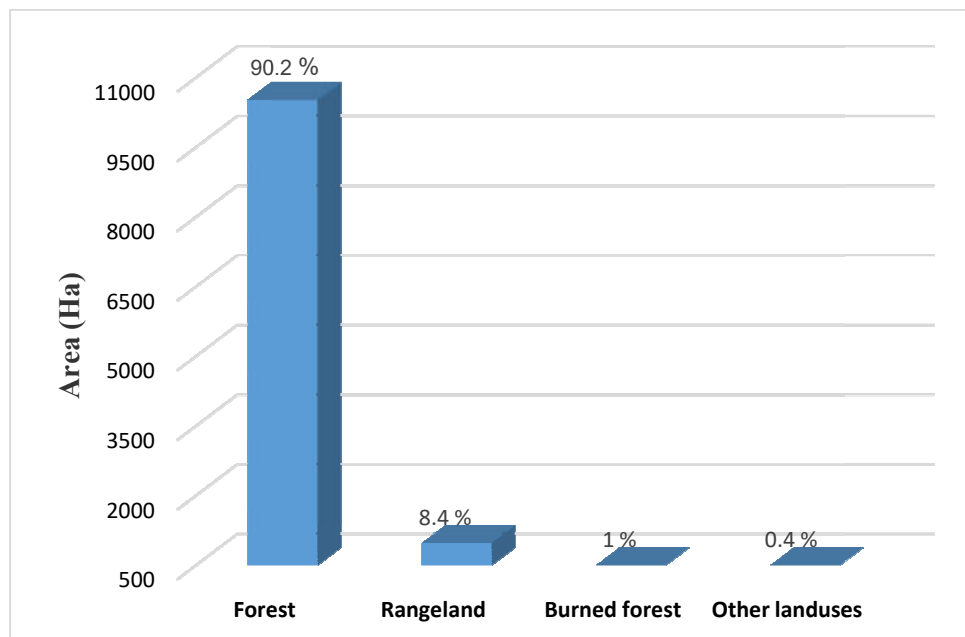

Figure11: The area of different Land uses for optimal Land uses

According to the graphs, it is concluded that forest has the maximum of optimal uses. Besides, the highest area of optimal use is belonged to conservation grade2, subsequently conservation grade 1 and medium rangeland.

The present study is distinguished from other studies on land use planning, because it has used the SAW. The present study has been used various factors for reaching the most appropriate use of lands. It covers the methods and process used by previous others and has presented the optimal use by desired analysis

of environmental units. The study has applied the economic, social and ecological factors, while other researches only used one or two of them [9, 11, 5, 3].
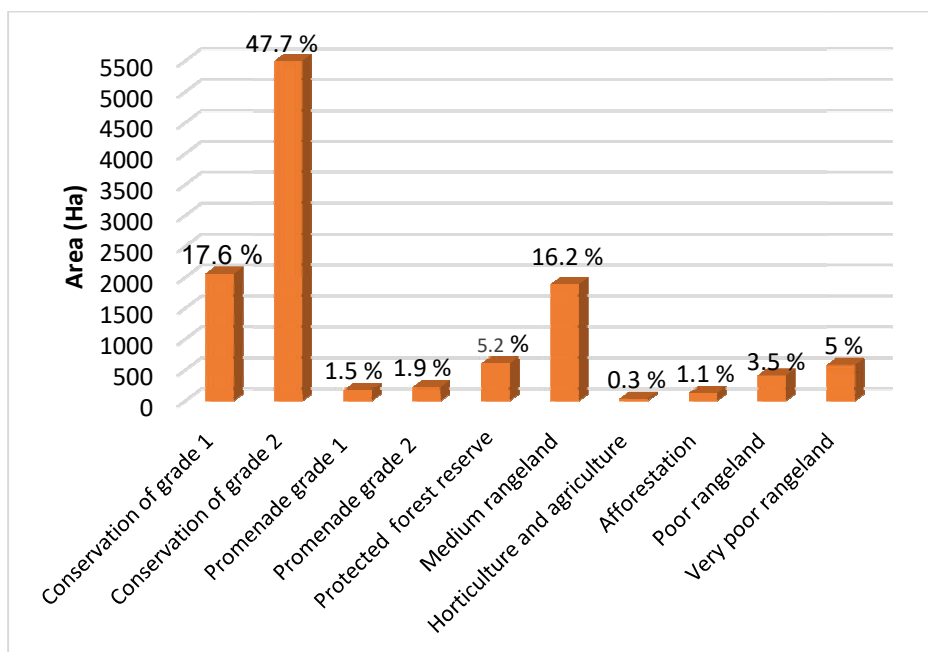

Figure 12: The area of optimal uses.

The similar point of the study with previous ones is considering the socio-economic needs, while some points distinguished the present study including: using the qualitatively deductive approach to weighting the uses, identifying stable and unstable ecological resources in GIS and determine the adaptive ecological models be on socio-economic needs of Bagh-e-shadi.
Three main suggestions are recommended for next studies:
- ✓ Zoning the present case study according to priority of optimal uses
- ✓ Preparing the comprehensive data bank of environmental, social, and economic factors
- ✓ Locating the most appropriate area for afforestation and reforestation.

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