International Journal of Agriculture: Research and Review. Vol., 2 (S), 959-968, 2012
Available online at http://www.ecisi.com
ISSN 2228-7973 ©2012 ECISI Journals

EVALUATION OF DEVELOPMENT POTENTIAL AND PLANNING LAND MANAGEMENT OF CHEHEL CHAY WATERSHED IN GOLESTAN, IRAN

ESMAEIL SHEIDAI KARKAJ[1*], JAVAD MOTAMEDI[2], AHMAD ALIJANPOUR[2], MORTEZA MOFIDI[1]

1- Department of Range and Watershed Management, Gorgan University of Agricultural Sciences and Natural Resources, Iran.
2- Department of Natural Resources, Urmia University, Iran.

Corresponding Author Email: esmaeil_sheidayi@yahoo.com

ABSTRACT: Improper use of land resources and destruction of whole ecosystems come from the lack of attention to its capability and not doing land planning and absence of most appropriate land uses in the area. Land use planning is the process of determining the best use of the land according to its ecological and socio-economic characteristics. Therefore, in the present study, in order to land use planning of the Chehel Chay watershed in north of Iran, firstly the ecological thematic maps of the area were overlaid based on the Makhdum systematic analyses model on GIS environment. Then using Makhdum model, land surface capability was evaluated for seven land uses including forestry, agriculture-rangeland, aquiculture, conservation, concentrative and extensive tourism, urban and village development. Finally, by considering the ecological capabilities and potential socio-economic problems of the area and natural selection of land use by nature, planning and prioritize of land uses for whole area was conducted. Based on results, all of seven land uses were recommended which at the end 21%, 9.7%, 8.9%, 49.11%, 0.09%, 11.17 and 0.01% of the total watershed area were allocated to abovementioned seven land uses respectively. Conservation had highest surface by 49.11%. Also, Results of accordance index of the maps with current land use map showed that amount of spatial accordance rate of forestry and agriculture-rangeland in both current and recommended land use maps were calculated which was 20.1 and 16.1 percent respectively, and spatial accordance degree of prepared capability map of other land uses were zero because of non existence of these land uses type in the watershed. Because most of the study area was recognized to be suitable for conservation, measures should be implemented to prevent forest degradation and clear cutting. We can introduce alternative land uses to preserve forests and insure socio-economic life of native people of the watershed at the same time; therefore according to the study results aquaculture and recreation land uses are prescript as two new alternatives.

Key words: Chehel Chay watershed, Ecological capability, GIS, land use planning, spatial accordance index.

INTRODUCTION

Problems and increasingly deterioration of natural resources comes from intensive and improper use of these areas. Land degradation and the loss of land productivity are two of the foremost environmental problems of our time (Taghvaye Salimi *et al.,* 2008). In addition, lack of attention to capacity and potential of land and water resources caused imbalances in natural and anthropogenic ecosystems (Ward *et al.,* 1998). Moreover, land use changes are altering human and natural systems globally and regionally (Turner and Meyer, 1994; Solecki, 2001).

Land use planning allows to principled utilization from natural resources for achieving sustainable development and inhibition of distraction of resources. On this basis, land use planning firstly tries to find most appropriate place for various land uses and then arranging these sites according to their ecological relations and socio-economic aspects (Makhdum, 2008).

Optimal utilization of land sources requires the evaluation of its developmental capacity;

therefore in order to achieve sustainable development and improve the environment it must be based on the allowable exploitation (Najib Zadeh *et al.*, 2008). Land use planning means to locate suitable areas for the development of applications based on its ecological characteristics.

These days, it is possible to combine various ecological and socio-economic data through the utilization of GIS, which results in using less time and expense (Saroensong *et al.*, 2006). However, the use of geographic information system (GIS) due to its ability to analyze systemic problems in the way information may help in selecting the appropriate locations for various land uses in the areas of natural resources (Malek Ghasemi, 2003).

The aim of current study was to apply Makhdum systemic procedure for preparation the environmental units map and obtaining data which are essential for outline drawing for land preparation and restoration of natural resources and recommend the optimal use based on the two important statements including the ecological capacity of each units and sustainable development requirement of the entire Chehel Chay watershed in Golestan province of Iran. In other word, the ultimate goal of this study is conducting the second phase of land use planning which includes selection and offer the best and most proper land use plan for each planning unit, based on two propositions listed for this area.

In land use planning procedure an accordance index is calculated for distinguishing spatial turbulence in system as a resistance sign of watershed. In other word, accordance index show the spatial similarity of land uses between current land use map and recommended land use map for special point in the watershed. This index ranges between 0-100. Obviously, the high rate of accordance index, between two maps of current land use and recommended land use in case of same land use explains more consistent of ecosystem in viewpoint of ecological, economic and social aspects.

Among the investigations related to land planning and determination of the ecological capacity of natural resources lands using GIS and RS, environmental evaluation (ecological, economic and social) of Kazem Rood watershed by Babaei (2002), land planning of Arasbaran protected area (Sarhang Zadeh and Makhdum, 2002), land use planning using GIS and RS (Faraj Zadeh and Karami, 2004), land planning of land use management of south-east coast of Caspian sea (Ownegh *et al.*, 2006), determination of ecological capacity of Markazi province in Iran for agriculture and rangeland management (Mir Davoudi *et al.*, 2008), study the land suitability in Srilanka using GIS for agriculture (Perrera and Silanadradjan, 1991), regional land planning of land use in Netherland (Estoufghel and Antel, 1999), role of different land use evaluation procedures in India (Jonsen *et al.*, 2000), Land use planning for land management using the geographic information system (GIS) in the Loumir watershed of Guilan province in northern Iran by Taghvaye Salimi *et al.*, (2008) could be mentioned.

Chehel Chay watershed is located in Minu Dasht town, Golestan province, Iran. The study area is located at 55° 23' to 55° 38' E and 36° 59' to 37° 13' N. The maximum and minimum altitude is 2750 m and 190 m, respectively and the watershed area is 25683 ha. Total length of stream flow is 675.5 Km. Based on land use map (Fig. 1) from the total area of the region, 9750 ha (37%) is dedicated to agricultural and range lands, 15930 ha (62%) forest lands and remained is dedicated to residential areas.

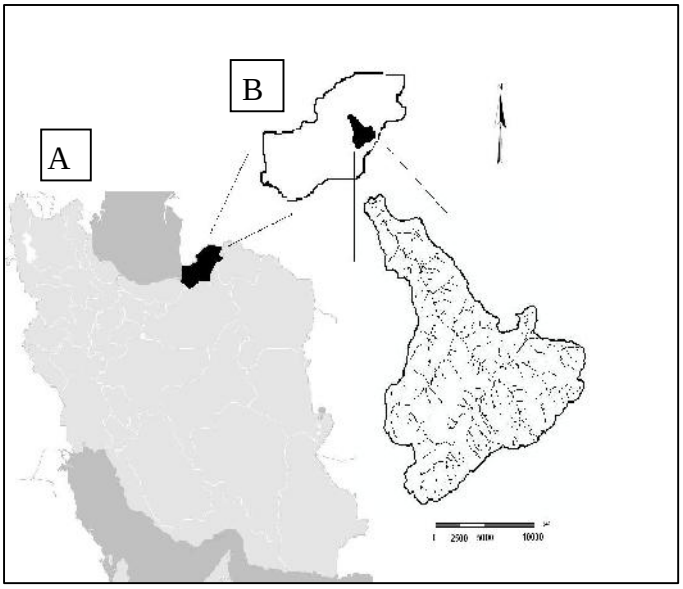

Figure 1. Geographical location of Chehel Chay watershed, Minu Dasht In *A*: Iran and *B*: Golestan province

MATERIALS AND METHODS

In the present study, determination of land suitability to seven different land uses including forestry, agriculture-rangeland, aquiculture, extensive and concentrative tourism, urban and village development and environment conservation was conducted with applying Makhdum ecological model. Finally, second stage of land planning was conducted which based on it, among present options, the best option as a recommended land use for each land units was selected based on land use priority using qualitative-comparative procedure (Makhdum, 2008).

Principally, this procedure is the method for natural resources evaluation and determines seven above-mentioned land uses and ranked them. Evaluation and determination of land capability for each of land uses was conducted by comparing the biotic and abiotic parameters in each point and prebuilt models for each land use. Then, qualitative prioritize by using six existed defaults among the options, recommends best land uses for land units on which units planned alongside each other so socio-economic problems, land uses spatial order, naturally selected land use by ecosystem and other problems affective in land uses order would be considered (Makhdum, 2008).

Totally preparing of land form units is first step in land use planning procedure. For this purpose, initially, slope maps, slope direction and elevation classes were extracted from a topographic map (1:50000) by Arc GIS 9.2 software and then by overlaying these maps, land form unites map was prepared. In the present study, 378 polygons of land form units were obtained. For mapping the environmental units, ecological entities of watershed should be involved. So, the first step is entering soil type map on land form unit's map. This is resulted in first base environmental map. At the next step, vegetation type map combined with first base environmental units' map and second base environmental units' map was obtained. At the final step, vegetation density map combined with first base environmental units' map and about 2000 polygon were obtained, which is the final environmental units map and is the basis for evaluation of the land ecological capacity and recommending the land use. These steps are shown schematically in figure 2.

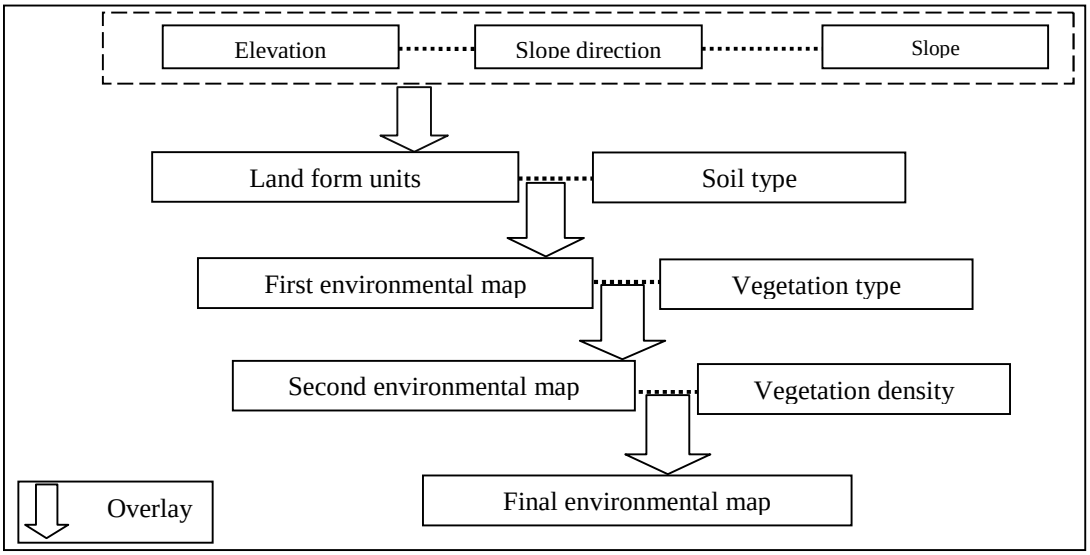

Figure 2: Schematic process of overlaying basic maps and creating Final environmental map

In order to evaluate the capability of each final environmental unit to various land uses, seven Makhdum models were applied. By determining the capacity of each unit to various land uses, prioritize and recommending the most appropriate land use for the region was conducted. Recommending the best land use was conducted using qualitative-comparative procedure and considering the six defaults and current land use type (Fig 3) in each of defined units. Qualitative procedure was selected due to limitations in accessing the detailed information.

In order to identify sustainability of the region, the spatial accordance rate in each of land uses at current status and recommended land use map was calculated. This fraction was the ratio of surface area of studied land use in current situation to surface area of same land use on recommended map. Whatever that ratio is closer to 100 shows a better suitability for its current land use and its principality consistent with criteria for land use planning model and the closer to zero indicates that the exploitation of the region are not suitable and could resulted in ecosystem degradation in the region due to lack of suitability.

RESULTS

In this study, a systematic method known as the Makhdum Model (Makhdum, 2008) was used for the analysis of maps in relation to the ecological and socio-economic resources of the Chehel Chay watershed. The different kinds of maps were used in this research to determine the ecological resources of the area under study were Digital Elevation Model (DEM), slope and aspect, soil texture, soil depth, soil texture, vegetation type and density.

Results obtained from the model in the stage of determining the capability of watershed to various land uses (Figures 4-8) showed that greatest suitability in the watershed among the all land uses was related to protection land use which included nearly entire the basin area and the lowest was for intensive recreation land use. Detailed results were presented in Table 1.

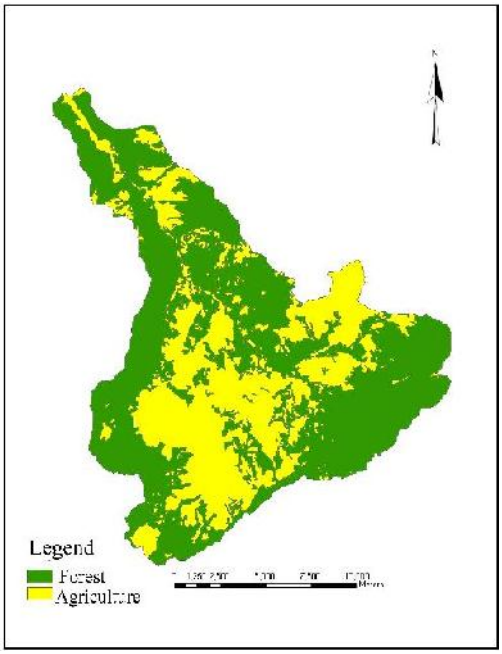

Figure 3. Current land use map of the watershed

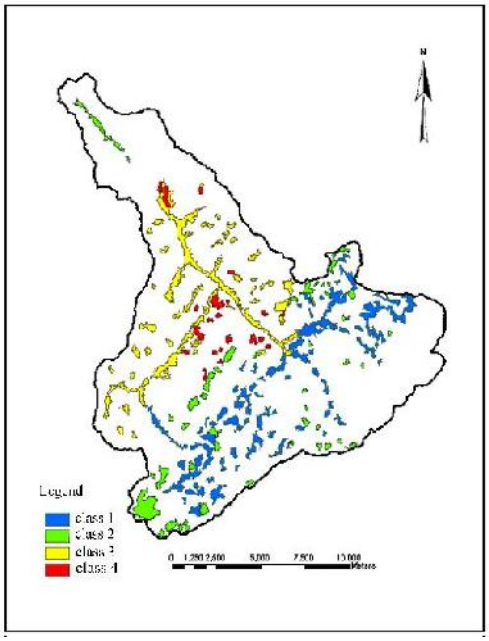

Figure 4. Land maps suitable for agriculture-rangeland

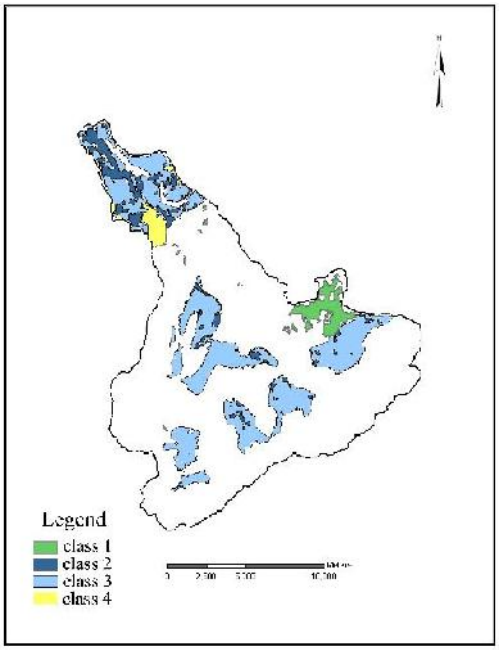

Figure 5. Land maps suitable for forestry

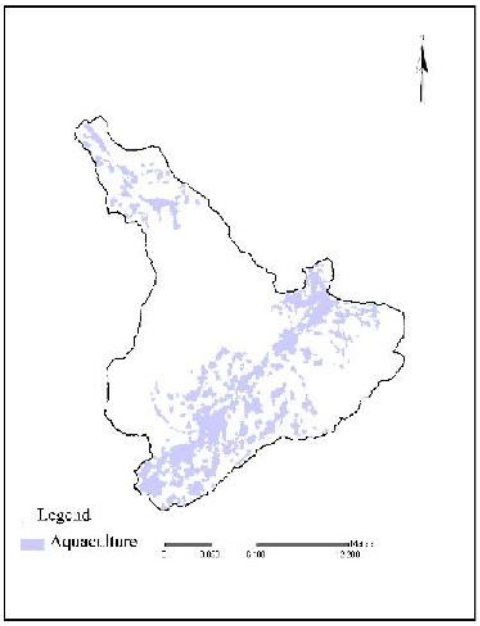

Figure 6. Land maps suitable for aquiculture

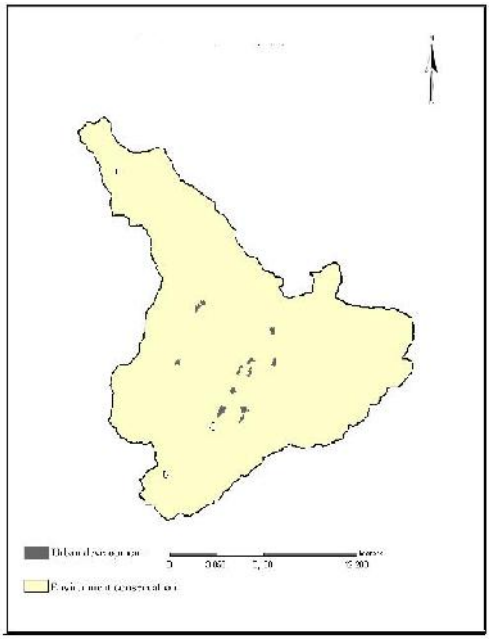

Figure 7. Land maps suitable for conservation, urban and village development

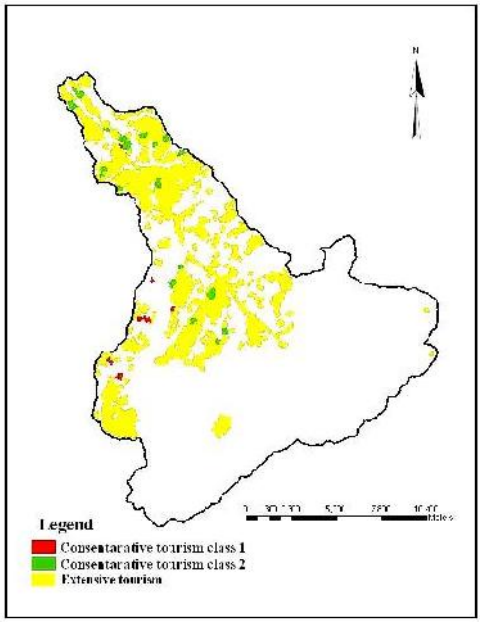

Figure 8. Land maps suitable for tourism

Table 1. Lands surface area suitable for various land uses

Land use type	Surface area (ha)	Land percent
Forestry	7709	30
Agriculture- rangeland	3371	13.1
Aquiculture	5128	19.9
Consentarative tourism	43	0.2
Extensive tourism	5159.4	20.1
Residental areas	150	0.6

All of seven land uses were subjected to capability evaluation. Only forestry and agriculture-rangeland have been established in the region and other land uses were not common. Finally the seven produced maps and current land use map were operated using Arc GIS and the appropriate utilization of each section was determined and prioritized in second step. Results of the second step of land planning (Fig. 9) which indicates best land use offer for land units showed that considering to current status of the region, land use variety is limited to forestry and agriculture-rangeland land uses, results of the model recommended all of seven land uses in different levels which could cause maximum and also optimum exploitation of sources. Among them, environment conservation by 12613 ha has the highest area. Many of the prepared spectra were seen fit for two or three appropriate uses by the systematic model to first determine and subsequently select the best utilization for the area considering the socio-economic status of the area. The results of the evaluation of the area based on maps obtained indicated land suitability and allocation as follows: 21 percent for forestry, 9.7 percent for agriculture-rangeland, 8.9 percent for aquiculture, 49.11 percent for environment conservation, 0.09 percent for concentrative tourism, 11.17 percent for extensive tourism, 0.01 percent for urban and village areas. Detailed Results for land uses planning of Chehel Chay watershed were presented in Table 2.

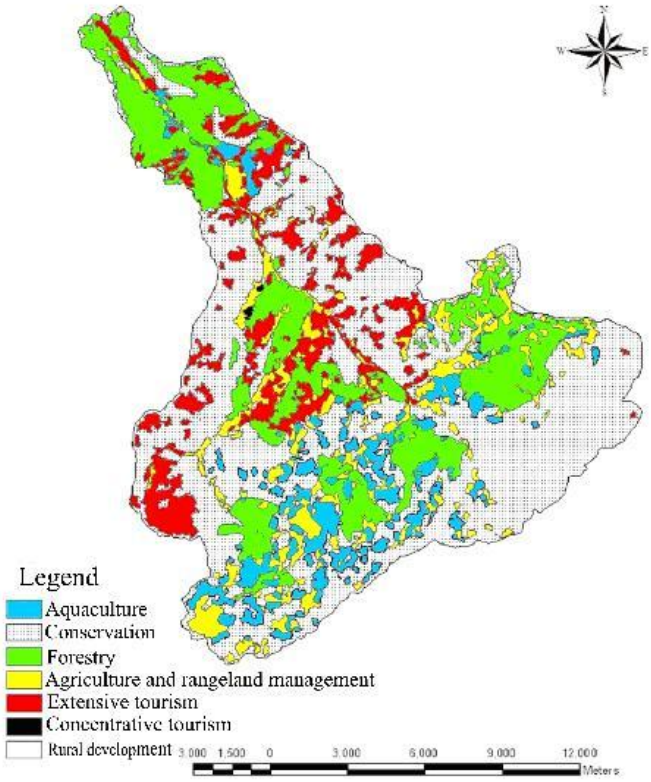

Figure 9. Recommended land use maps based on land planning results

Table 2. Surface area of each of land uses in recommended map

Land use type	Surface area (ha)	Land percent
Forestry	5395	21
Agriculture- rangeland	2496	9.7
Aquiculture	2282	8.9
Environment conservation	12613.35	49.11
Consentrative tourism	23	0.09
Extensive tourism	2870	11.17
Urban and village areas	0.9	0.01

Results of comparing the spatial accordance rate of each land use at current status (Fig 2) and recommended status (Fig 8) showed that forestry and agriculture-rangeland land uses have spatial consistency by 20.1 and 16.1 percent, respectively. With respect to the nature of mentioned index, whatever this number is closer to 100, represent the more spatial following of specific current land use from planning recommended map. Therefore, this finding show that forestry has more spatial consistency in both current land use and future recommended maps. Spatial accordance degree of prepared capability map of other land uses were zero because of non existence of these land uses types in the watershed.

DISCUSSION

Since for achieving sustainable development, three sustainability indexes including ecological, social and economic, should be considered, thus utilization from land according

to its ecological capability and with respect to social and economic conditions is essential. Thus table 1 shows suitable lands for each land uses indicating that protection land use has the greatest suitability among the all of land uses which nearly included whole of watershed surface. This is the sign of existed resources importance in the area and their sensitivity to degradation (Ziran, 1999).

Through examining the prepared land planning maps, we determine that we cannot only use environmental units for just a single purpose; the potential exists for multiple uses. However, in any one unit, no more than a single type of utilization can, ultimately, be implemented (Makhdum, 2008). Hence, under special circumstances and only through considering the socio-economic conditions of the area and its residents' way of life as well as their tendency and desire to use the land for specific utilization, must the best use for each unit be determined and prioritized. To this end, it is best to consider the following points in prioritizing our findings.

As not separated in Makhdum model, agriculture-rangeland land use evaluated as shared land use and 2496 ha (9.7%) of the area for first four classes identified as suitable land use.

With respect to maoutainous and generally steepy areas of the region, only 0.09 percent of lands (23 ha) was suitable for consentrative tourism land use, but since mountainous and forest areas is appropriate for extensive tourism, thus extensive tourism land use has much more surface with 2870 ha in 11.17% (Makekadyrova, 2008).

Regarding to availability of considerable surface water resources in the area, it is expected that high areas have the potential to aquiculture (Crespi and Lovatelli, 2011), but steepy lands and sometimes inappropriate soil and geological formation, potential of this land use was lowered. Based on results of the model, 2282 ha (8.9%) was suitable for this land use.

In units situated close to villages in an area and since multiple uses are possible, the priority is with the use presently in place. In units with soil erosion vulnerability that presently enjoy fairly stable surface vegetation covering, the priority is with the status quo since slightest miscalculation and/or mistake could result in irreversible damage to the area. In units where there are no socioeconomic limitations, the priority is with the one demonstrating the highest potential (Espejel *et al.*, 1999).

After determination of capability of various land uses and determining their priority, results of prioritize (Table 2) showed that applied planning model suggested different land uses which caused increasing diversity of revenue sources for watershed residents and could resulted in continous sustainable development for this area. Therfore capability of this watershed to all 7 land use in better class presented the better environmental condition of Chehel Chay watershed (Ownegh and Mirkarimi, 2003).

Applied planning method has suggested the highest surface area for protection land use and degradations of soil and vegetation cover that observed in the area could confirm this. This land use followed by forestry in terms of surface area and it seems that due to completely proper ecological conditions, natural selection of ecosystem for forestry provided more easily.

Given the forest lands and mountainous regions have large surface area of the region, consequently tourism land use could be has significant development in the region. Indeed relatively cold climate and steep region restricted extensive tourism and thus this land use has surface area less than 0.1 percent but 11.17 percent of the area identified as suitable site for wide recreation. Existing sufficient water sources and fertile soils made the region appropriate for agriculture but steep mountainous lands inhibited the much development of this land use in recommended map by land use planning process and only 9.7% was considered to this land use.

The results of accordance index show that the accordance of the current land use is not in any way based on its ecological potential and in this way, achieving sustainable development for the region is not possible and will follow the destruction and decline of the region's resources. Also through examining the prepared land planning maps, we determine that we cannot only use environmental units for just a single purpose; the potential exists for multiple uses. However, in any one unit, no more than a single type of utilization can, ultimately, be implemented (Makhdum, 2008). The priority of land use in some of the units is determined based on political needs, and the possibility for changing it does not exist (Pierce *et al.*, 2005). In some units where one use has no advantage over another and from the priority point of view are close, multiple uses may be proposed (Makhdum, 2008). Determination of the appropriate land use for the purpose of best utilization of the land in the country and preventing further destruction of resources due to population increase can and will be an

effective step in devising strategies for stable expansion (Prato, 2007).

Since planning model used in this study predicted lower surface area to residential land use compared to current population, therefore it is suggested that other models by considering other decision-making parameters is used for accurate location and proportional with existed population for residential land use in the region. The precision of GIS output is considerably higher than that of manual methods and claims have been made that from the time point of view computerized methods take about one third of the time needed for manual methods employed when organizing a land use planning project Through employing GIS and combining the various raster layers of the area, which in reality represent its ecological resources, one can obtain a map for appropriate land utilization of the area. However, determination of priorities for appropriate land use from obtained maps cannot be adequately precise without considering the socio-economic condition of the area or the tendency of area residents to utilize the land for certain specific uses.

REFERENCES

Babaei Kafaki S (2001) Socio-economic and ecological and environmental evaluation of forests of Kazem Rood watershed (basin no. 36 of north forests). PhD thesis of forestry. Islamic Azad University, research and science branch, Tehran. In Persian.

Crespi V, Lovatelli A (2011) Aquaculture in desert and arid lands: development constraints and opportunities. FAO Technical Workshop. 6–9 July 2010, Hermosillo, Mexico. FAO Fisheries and Aquaculture Proceedings No. 20. Rome, FAO. 2011. 202 pp.

Espejel I, Fischer DW, Hinojosa A, GarcõÂa C, Leyva C (1999) Land-use planning for the Guadalupe Valley, Baja California, Mexico. Landscape and Urban Planning. 45: 219-232.

Faraj Zadeh M, Karami T (2004) Land use planning using RS and GIS. Journal of geographical researches. 47: 81-94. In Persian.

Hamze B (1997) Ecological capability evaluation of Siahkuh watershed (Yazd) for recreation land use. M.Sc thesis of Islamic Azad University, research and science branch, Tehran. In Persian.

Jansen Hans GP, Bas AM, Bouman BJ, Schipper R, Hengsdijk H, Nieuwenhuyse A (2000) On Tools For Land Use Analysis (paper for the mini-symposium "Integrating approaches for natural resource management and policy analyses, "XXIV International conference of Agricultural Economists, Berlin, August 13 & 19.

Makekadyrova AS (2008) Procedural Aspects of Estimating the Land Potential for Tourist Recreation Zone Creation. Studies on Russian Economic Development, Vol. 19, No. 2, pp. 209–211.

Makhdum M (2008) Foundation for land planning. 8th edition. Tehran University Press. p. 289. In Persian.

Malek Ghasemi A (2003) Development of forest and green space at around of Tehran based on land planning principles and using GIS. MSc thesis of Islamic Azad University, research and science branch, Tehran. In Persian.

Najib Zadeh MR, Sepehri A, Heshmati GhA, Rasooli AK (2008) Evaluation of ecological capabilities for rangeland using GIS and ERAMS (case study: Yeke Chenare Marave Tappe watershed). Quarterly research-science Journal of Range and Desert of Iran. 15 (2): 200-214. In Persian.

Ownegh M, Ghanghermeh A, Abedi,G (2006) Land use management plan for southeastern coasts of the Caspian Sea: (introducing a numerical model for ecological potential assessment and land use planning). J. Agric. Sci. Natur. Resour., 13(5): 139-151. In Persian.

Ownegh M, Mirkarimi SH (2003) A model for assessing land use copatibility in Golestan Province: introducing a new phase for the second stage of land use planning. J. Agric. Sci. Natur. Resour., vo 2, 10(3). 5-15. in Persian.

Perera A, Thillanadarajan V (1991) GIS for land use planning, Asia Pacific Remote Sensing, Vol, no.2.

Prato T (2007) Evaluating land use plans under uncertainty. Land Use Policy. 24: 165-174.

Saroinsong F, Harashina K, Arifin H, Gandasasmita K, Sakamoto K (2006) Practical application of a land resources information system for agricultural landscape planning. Landscape and Urban Planning. pp. 15-30.

Solecki WD (2001) The role of global-to local linkages in land use/land cover changes

in South Florida. Ecological Economics. 37, 339-356.

Squires VR, Grinson LT, Thomas D (1990) The use of remote sensing and environmental resources measurements to determine the present and potential Grassland production in semi-arid areas. Proceeding of the international symposium on grassland vegetation. Science press, Beijing China. pp 7-20.

Stookvogel JJ, Antle, JM (1999) Regional Land Use Analysis: The development of aperational tools (paper presented at the conference on system Analysis for Agricultural development, Lima, P: 11-17.

Taghvaye Salimi E, Soleimani1 K, Habibnejad Roshan1 M, Sabetraftar K (2008) Land use planning for land management using the geographic information system (GIS) in the Loumir watershed of Guilan province in northern Iran. Caspian J. Env. Sci. Vol. 6 No.2 pp. 141-149.

Turner BL, Meyer WB (1994) Global land use and land-cover change: an overview. In: Meyer, W.B., Turner, B.L. (Eds.), Changes in Land Use and Land Cover: A Global Perspective. Cambridge University Press, England, pp. 3-10.

Ward D, Ngairorue BT, Kathena J, Samuels R, Ofran Y (1998) Land degradation is not a necessary outcome of communal pastoralism in arid Namibia. Journal of Arid Environments. 40, 357–371.

Ziran Z (1999) Natural resources planning, management, and sustainable use in China. Resources Policy 25: 211–220