Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 3, No. 7, p. 33-41, 2013
http://www.innspub.net

RESEARCH PAPER OPEN ACCESS

The use of geographical information system (GIS) for the assessment of ecological capability on forest land, in the Northern part of Iran

M. Davoudi[1], A. Eslami[2*], S. Sobh Zahedi[3], G.H. Habibi Bibalani[4]

[1]*Department of forestry, Science and Research Branch, Islamic Azad University,Guilan, Iran*

[2]*Department of Agriculture ,Islamic Azad University, Rasht Branch, Rasht, Iran*

[3]*Agricultural and Natural Resources Research Center of Guilan Province, Iran*

[4]*Department of Forestry, Shabestar Branch, Islamic Azad University,Shabestar, Iran*

Article published on July 26, 2013

Key words: Ecological capability, Boolean logic, GIS, land usage, Northern Iran.

Abstract

No doubt, the protection of soil and water resources requires a systematic approach and appropriate with ecological conditions of basins. In this context and in order to achieve sustainable management and development of a model to assess the suitable ecological capability, this study was carried out in the basin Masal, Gilan province and northern Iran. After the study and to identify factors effective for forestry land usage using geographic information system (GIS), ecological factors maps ranging from physical factors(including physiographic and topographic, elevation, slope, aspect, soil, rock, rain, temperature, etc.) and biological factors(including vegetation density, plant species value and etc.) was provided. The ecological capability of the study region was determined based on ecological model of forestry land usage based on land suitability (through Boolean logic). Then in each of the seven classes of above models, convenient features and condition in the area by code 1, and the rest by code 0 and eventually using the function And, watershed Assessment of forestry was conducted. The results indicate high capability (GIS) in evaluation model of ecological capability of land for forestry land usage that this was takes place by location of the damaged areas that have the ability to regenerate and development. Final results of investigation the region ecological capability for forestry land usage shows that out of seven classes of the Forestry in Iran, class 1 to 5 of forestry were present in the study area that between them the contribution of class 4 has more than others classes.

***Corresponding Author:** A. Eslami ✉ dr_eslami2006@yahoo.com

Introduction

To assess the environment capability can implement a desired effect in each region to land use preparation. To assigned different land use according to the potential of each region and determine the zoning, particularly to determine forest land levels that has a potential for increased forest area can raise the likelihood of forestry areas sustainability. One of the key strategies to achieve the objectives of forestry and minimization of environmental crises is forest use planning by taking the natural power for the desired user (Hossaini *et al,* 2003). Principles of proper planning and management of natural resources is focused on recognizing ecosystem talent. Awareness of the talents and potential of these resources can facilitated the preparation and implementation of practical initiatives to achieve economic-supportive and protection objectives (Naghash Zargaran, 2001; Mardookhpour, 2012). Land evaluation is a tool for strategic planning to use land (Rossiter,1996). Ecological capability evaluation, determination the land capability and land potential unit based on ecological characteristics such as soil, slope, altitude, aspect, geology and ...is to play a variety of forest management plans such as the manufacture of wood, water and soil conservation, protection of bio-diversity(Amiri, 2009). Multi-criteria evaluation method is a tool for simplification of complex decisions. It describes that in multi-criteria decision analysis, several criteria may be used instead of using an optimality measure (Asgharpour, 2006). In this way, at first a set of criteria appropriate to the purpose (s) decided by experts was determined and after weighting and prioritization in order to assess the capability and locating are used (Xue *et al*,2007). Out of the classification of data sets, physical - biological data was merged together and summarize and classify the information supplied to the bank sells maps and tables. Since the use of GIS in ecological capability evaluation there is no ecological limit to overlay different maps, so it can be involve further characteristic in assessment that will be increase the accuracy of the evaluation. Other factors that may improve the accuracy of assessing the ecological capability of GIS is accurately describe the characterization of new units produced in the multiple overlays (Darvishsefat, 2001; Kumar *et al*, 2013; Yousefpour *et al*, 2013).

In this study, environmental assessment (ecological and socioeconomic) of forest with a comprehensive view of all environmental factors within a forested watershed basin is considered as planning unit and management of land. In this regard, while the study of effective ecological factors (physical and biological), the homogeneous environmental units (sites) was identified in the forest and determined and the land use type of each unit will be determined by complete focus on forest ecosystems sustainability based on the particular environment characteristics. Hence, determining the capability and quality of the studied area on forestry and to identify areas prone to forest and increase its level (which is defined in this study as forest zone) with forest operations, forest sustainability can be ensured.

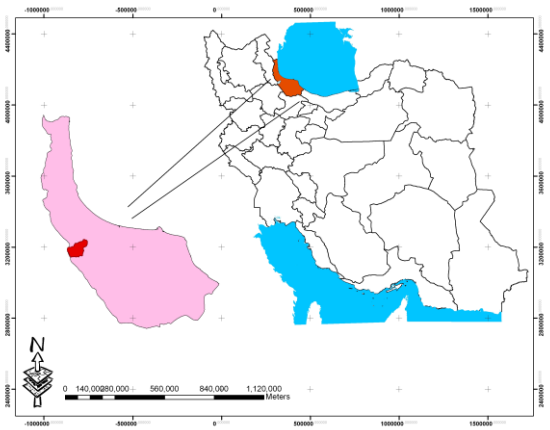

Fig. 1. Site of study.

Materials and methods

Site of study

The study area is located in North Iran and in the western part of Alborz Mountains, Guilan province in the area of Masal city (Fig. 1). Masal catchment basin covers an area of 17,986 hectares of forest is considered as the West forest of the Sefidrud River. Minimum and a maximum altitude from the sea level are 81 and 3057 m, respectively. In terms of geographical location has been located along the width of the East 26' 46 º to 11' 51 º and North

altitude 54' 34 º to 27' 38 º. In terms of zone division, the aforementioned study area is located in Zone 39.

Methods

In this study, after the study and to identify factors effective for forestry land usage using geographic information system (GIS), ecological factors maps ranging from physical factors(including physiographic and topographic, elevation, slope, aspect, soil, rock, rain, temperature, etc.) and biological factors(including vegetation density, plant species value and etc.) was provided. Conceptual model of the research process show that in Fig. 2.

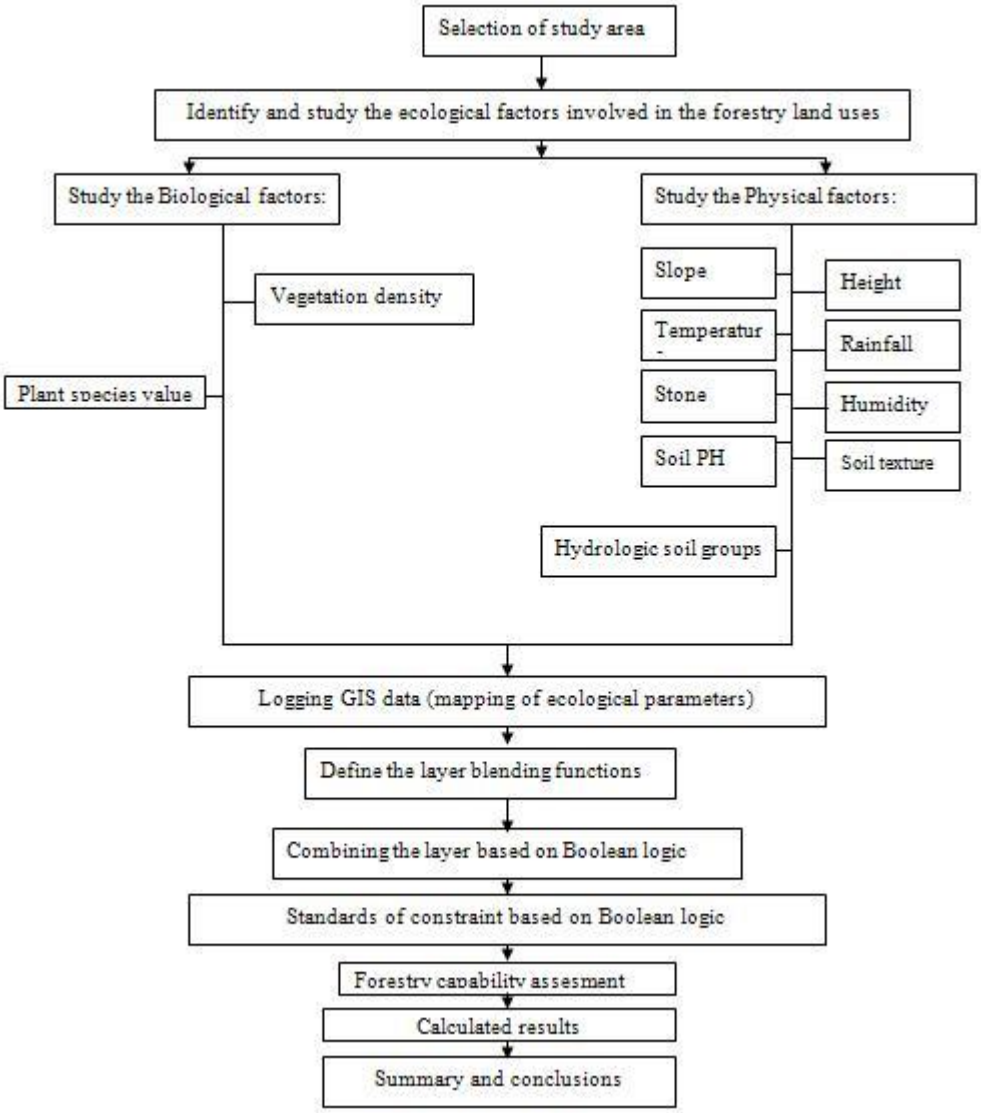

Fig. 2. The process of evaluating the ecological capability using Boolean logic.

Data collecting and identify ecological resources

With regard to this issue that the assessment of land uses ecological capability is necessary, ecological resources as the land identity card that is resources map is provided. So, data and related information layers was prepared and entered into GIS. In this organizing and spatial and descriptive data management appropriate with operation was analyzed that includes the preparation of maps:

- Topographical maps, geological maps, maps of soil (soil texture, soil PH and soil hydrologic groups), map of climate including climate classification, precipitation, and isothermal, type map and density of vegetation

Data analysis and integration maps

Since the analyzing and summarizing is the process of mapping or showing the distribution of ecological resources in a watershed that is called unit or base, in the study watershed, at first, environmental units as land use units to evaluate the forestry ecological capability in GIS environment has been determined as follows:

1. Digital elevation Model (DEM), preparation methods and its applications

The basis of most studies, research and planning related to land is awareness of the appearance situation and characteristics of the land surface, such as elevation, slope, aspect, and the like. Achieving these properties is usually in the form of physiotherapy study. Digital elevation model (DEM) to simply be called a digital map that contains all elevation of its coverage area points. Therefore, using topography lines and elevation points, DEM map was produced. Then using it, slope, aspect and elevation map were obtained. In figure 3 DEM, raster of whole basin is shown where in the figure 4 were isolated based on the DEM range forest boundary. Because in this study only forestry land use has been considered, the forest area has been isolated from other land uses that DEM of forest raster has been indicated in figure (5). This work was performed for all maps of biological and physical factors.

2. Using Boolean logic to land suitability analysis

In this study, Boolean logic was used in GIS-based land suitability analysis. One of the most common methods of resource evaluation is Multi-factor evaluation method in systems analysis (Makhdoom,2002&2004). In other words, for each criterion in connection with forestry land use, this logic was divided only into two groups of appropriateness and inappropriateness. By this description, for conditions available in each class value 1 and for other areas where is not in this class be given a zero value (Fig. 3-13).

Results

The table 1 according to the ecological specification and importance value of climax species and sub-climax as well as other plant species and their participation in the area that has own special ecological characteristics, of course, by the practical aim of this study from the experts point of view are used in completing and reform the table. In this way that from first to 7th class, due to the favorable areas for the proper growth of each plant communities were classified. In this research, a PH layer was considered as the neutral level.

Data was classified and zero and one mapping in steps 2-2 in this stage were combined using the AND function. Map of classes and the results of the integration of ecological and environmental factors are as follows (Fig. 14-19).

The table 2 and Fig. 14-19, show that the highest suitable floor area is seen in the fourth floor that this is due to the better overlap of the contributing factors. Note that is seen in the integration of maps is that it can be expressed that slope and permeability is an important factor and in some cases is a limiting factor to select a suitable location for the forest land use. If all suitable areas selected in the region is consider 100%, class 4 by 63/54% has allocated the most total selected suitable area and class 1 has allocated the least rate of selected suitable area. With regard to the area percentage to the total area of forest area can also be expressed that the total forest area was 18949/876 ha. In general, the selection of suitable areas covered 9/15% of the area.

Results in the form of located maps show Forestry land use from first class (F1) to five Class (F5):

Due to the located regions in the map on the first class (F1) observed that suitable regions are located in the north and Northeast of the region which is located in the slop of 0 to 25%. The vegetation in the selected region is Beech – Hornbeam and its canopy is dense and its climate is a very wet-over cold.

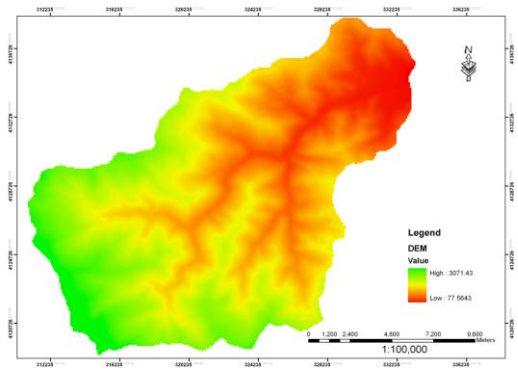

Fig. 3. DEM raster map of total study area.

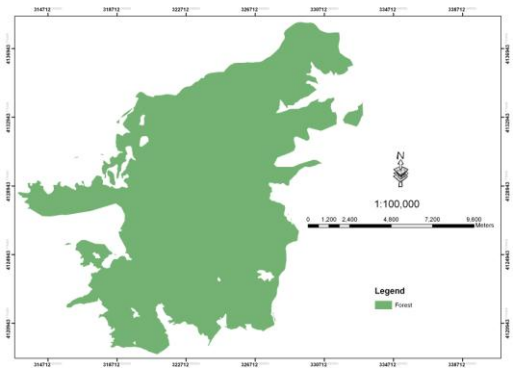

Fig. 4. Map of ecological factors (biological and physical) in the region.

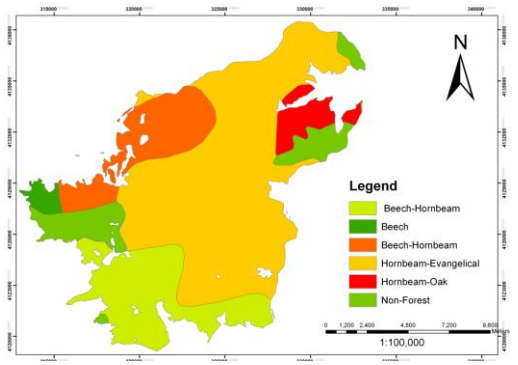

Fig. 5. Typing map of the studied forest.

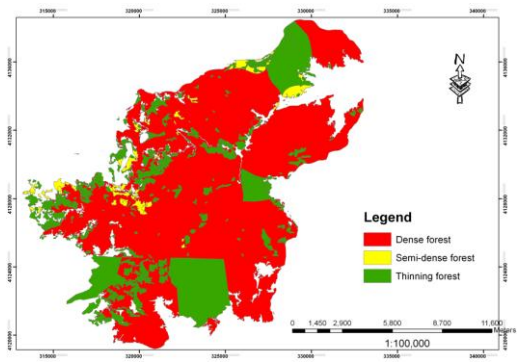

Fig. 6. Map of canopy percent of the studied forest.

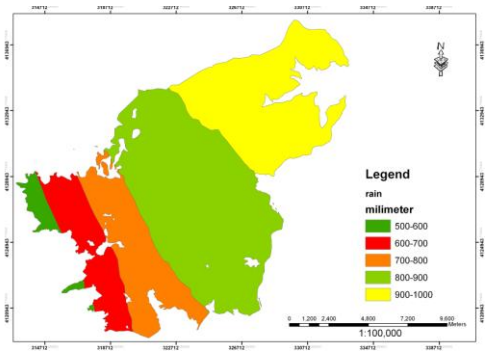

Fig.7. rain forest maps of the study area.

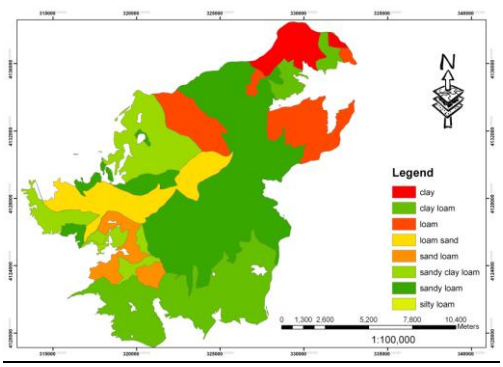

Fig. 8. Soil texture map of the study area within the forest.

Selected areas of the second class (F2) suggests that the selected areas are in the Northeast and in low gradient 0 to 25% and the vegetation in the selected region is Beech – Hornbeam and its canopy is dense and semi-dense and its climate is a very wet-over cold. It explained that selected areas of the second class cover the entire first class area and its area due to factors under the second class is more than the first class. From the selected areas of the first and second class can be concluded that best places of this classes in slope point of view is dedicated to less steep slope.

Selected areas of the third class (F3) suggests that the selected areas are in the North and Northeast and Southeast and in low gradient 0 to 25% and slightly higher to 35% and its vegetation is Beech – Hornbeam and its canopy is semi-dense and it favored from over cold climate.

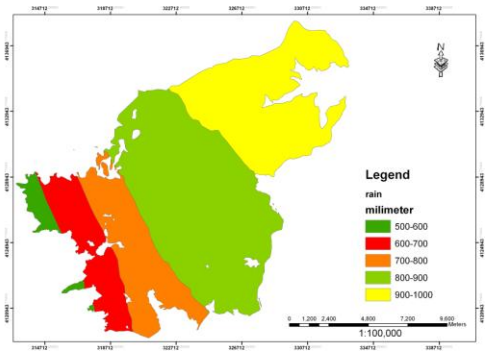

Fig.7. rain forest maps of the study area.

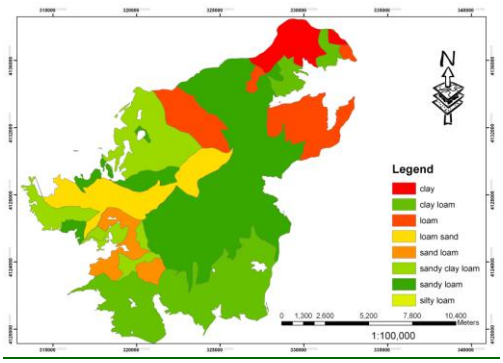

Fig. 8. Soil texture map of the study area within the forest.

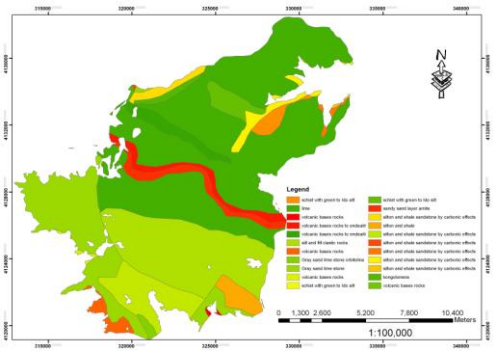

Fig. 9. Bed rock map of the study area.

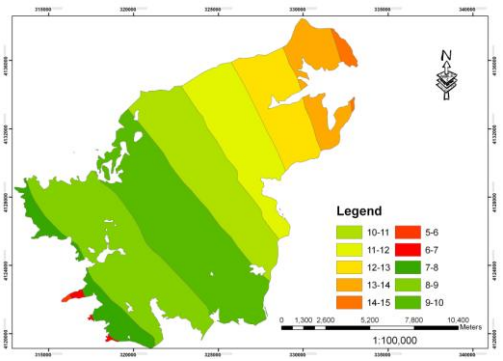

Fig. 10. Temperature map of the study area within the forest.

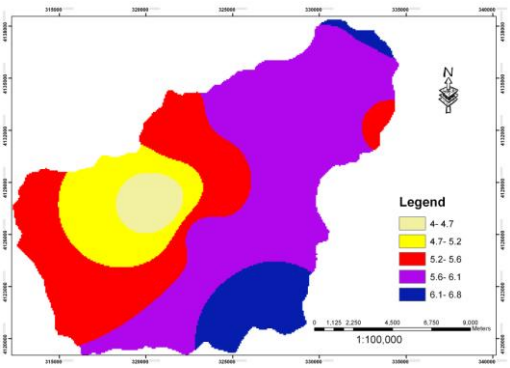

Fig. 11. PH map of the study area.

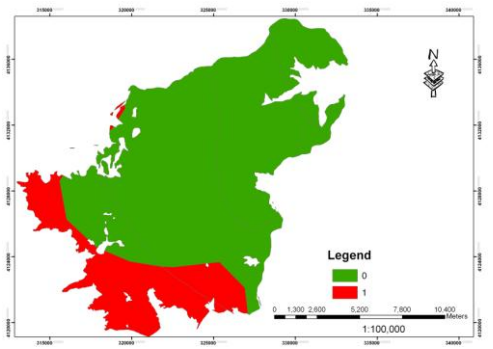

Fig. 12. Boolean map of forest climate in the forestry class 1.

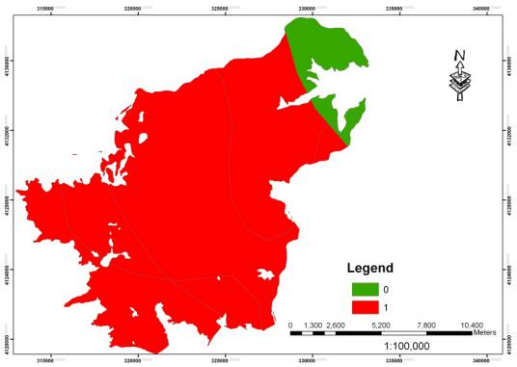

Fig. 13. Boolean climate map in the forestry class 4.

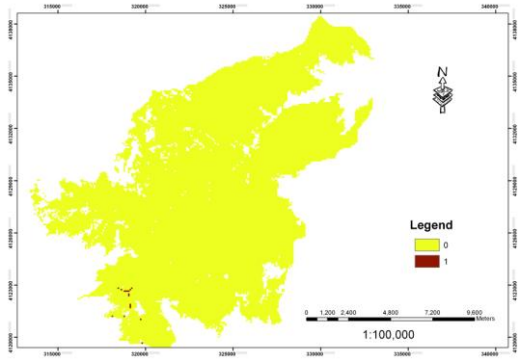

Fig. 14. Map class 1 of forestry.

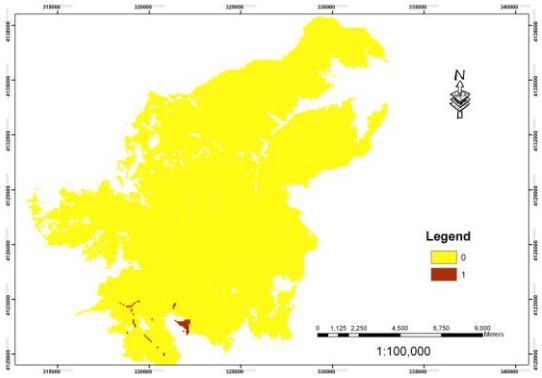

Fig. 15. Map class 2 of forestry.

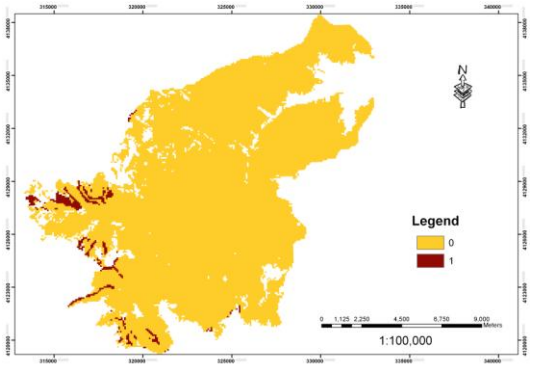

Fig. 16. Map class 3 of forestry.

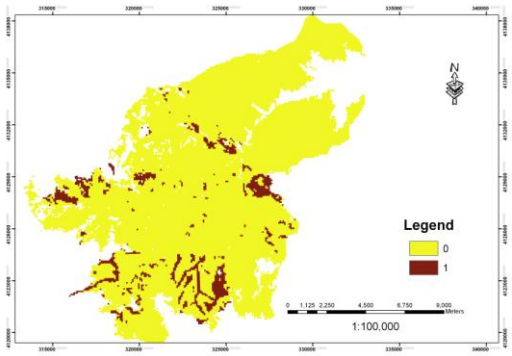

Fig. 17. Map class 4 of forestry.

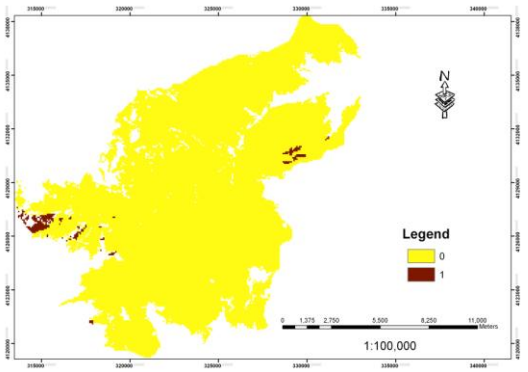

Fig. 18. Map class 5 of forestry

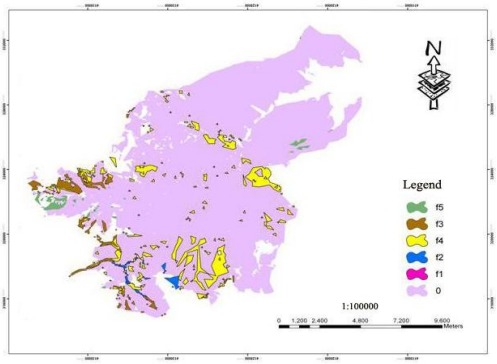

Fig. 19 . Map of total classes, after the integration

Selected areas of the fourth class (F4) that is allocated the largest selected area as can be shown in the map" (Fig. 17) is located in the North and North-East and South and West and South-Western and will be covered all the selected areas in the previous class. The slope of selected area is 0 to 55%. Selected vegetation types are beech- hornbeam, hornbeam-Evangelical and slightly oak-hornbeam that is allocated a large area of the region. Selected areas canopy slightly is as dense and a lot of it is as semi-dense and its climate is very wet-over cold and wet-over cold and wet- moderate. The floor area is increased due to the overlap factor of the slope factor, and the canopy is dense. The class area is increased due to the overlap of factor, specially the slope, canopy and density factors.

Selected areas of the fifth class (F5) is located in the North and North-East and its slop is 0 to 65% and its selected regions is non-forest that its canopy is semi-dense to sparse and its climate is very wet-over cold and wet- over cold and wet- moderate. There is no relationship between the selected areas of 5th class and the other classes, that is, it cannot distinguish an interface between them.

Discussion

In this study, ecological capability evaluation of the forest with a comprehensive view of all ecological factors in forest watershed of Masal in the northern Iran has been considered as a unit of planning and land management. In this regard, physical and biological factors were performed in the forest. Then, using geographic information system and using Boolean logic method (AND and OR) ecological capability evaluation was conducted in the study area. Then locating maps for Forestry land use from the first class (F1) to Class V (F5) was classified as a separate map.

It must be acknowledged that there is a large common between the selected regions from the first to fourth class. That is, from the first to fourth class, in addition to the previous class area, the new area is added. But on the 5th class, due to different studied factors with the prior classes, selected areas has no common point with previous classes. Therefore, the results of the implementation of Boolean logic indicate the presence of classes 1 to 5 and absence of classes 6 and 7 of forestry land use in the study area. Amiri Studies (2009) was also indicating the fact that the information on classification factors in forests area of 2000 and 3000 in the northern Iran was affected and according to the conditions, the studied site had been calibrated. The result of the ecological evaluation model for forestry land use by Boolean method in that region indicating the forestry classes 3, 4 and 5. But classes 1, 2, 6 and 7 have not been seen in this region. And different results have been calibrated compared to the present study. Hence, based on the studied logic, the evaluation should suffer relative change. Therefore, it is necessary that the models are calibrated for use in each region. This is indicating that in Boolean methods due to the limited range of choice and criteria values in the process of evaluation, there is not great flexibility assessment since the classes are selected based on definite criteria. But this method due to the simplicity of operation and ease of use is concerned but the other advantage of this method is that it does not take any risk. Namely, forestry classes selected by this method certainly have the best conditions that are defined for the choice. As the layers and elements shown in the results was observed, despite the limitations of a single layer cause to being zero of the map and its lacking suitability for forest land use. Finally it can be acknowledged that to the stability and survival of northern forest ecosystems of Iran and the possibility of taking advantage of all the benefits by human societies and playing the most possible important role of environmental resources is necessary. The first step in the socio-economic and ecological characteristics of habitats identified as being accurate and complete and type of land use of each site can be done based on habitat characteristics and capability. This act while reduces damage to habitat provides possible commercial utilization of specific habitats by conditions and framework that are already determined.

References

Asgharpour MJ. 2006. Multi criteria decision making tehran: tehran university press.

Amiri MJ. 2009. Forest road design based onecological capability of Watershed Basin Series 6 Anjil Bon and compared withthe present situation. M.Sc thesis of Forestry, Teacher training University. Page 85.

Darvishsefat AA. 2001. Assessment and Environmental Planning by GIS Tehran University Printing Press, 304 pages.

Hosseini SM, Amiri MJ, Rafatnia N, 2003. forest and mountain Road projects planning on the Basis of land evaluation. Forest Science **3**, 23–29.

Kumar D, Singh P, lal M, Kherawat B, kumar B, Kumar R. 2013. Monitoring and Modeling of Baghin River Basin part of Uttar Pradesh Using Remote Sensing and GIS Techniques. International Journal Of Forest, Soil And Erosion *(IJFSE)* **3**, 64–67.

Makhdoum M. 2004. EnvironmentalAssessment andPlanningwithGIS, Tehran University publication. P 340.

Makhdoum M. 2002.Foundation forlanduse planning, Tehran, Tehran University publication. P 289.

Mardookhpour A. 2012. Utilizing the KINFIL model for investigation of deforestation on the runoff-peak (case study: Sepidroud catchment). International Journal Of Forest, Soil And Erosion (IJFSE) **2,** 18–23.

NaghashZargaran M. 2001. To study leaves, LAIand their relationship, somecharacteristics of thesoil andmass andthepermanent study of Mid-forestsoftheCaspianSea, M.a thesis of Gorgan University, p 67.

Rossiter VG. 1996. A theorical framework for land evaluation Geoderama **72,** 165-190

Xue YJ , HU YM, Liu SG, Yang JF, chen GC, bao ST. 2007. Improving land resource evaluation using fuzzy neural network ensemables. 369–384.

Yousefpour M, Naghdi R, Moradmand Jalali A. 2013. The investigation of the usability of GIS facilities for planning forest roads network in Iranian Caspian forest. International Journal Of Forest, Soil And Erosion (IJFSE) **3**, 26–31.