The study of spatial distribution of Forest Changes in the northern forests of Iran

M. P. Bavaghar mahtab_bavaghar@yahoo.com
A. A. Darvishsefat adarvish@chamran.ut.ac.ir
M. Namiranian namirani@nrf.ut.ac.ir

RS & GIS laboratory, Faculty of Natural Resources, University of Tehran, Karaj, Iran

Phone: +98 261 2223044
Fax +98 261 2227765

Keywords: Spatial distribution, forest changes, elevation, slope, aspect

Abstract:

The possibility of analyzing environmental data using a GIS approach is a very useful assistance in forest management. A case study was performed in some parts of the northern forests of Iran with an area equal to 1033 km^2. These forests have individual economical and environmental characteristics, so it is necessary to protect them, seriously. To provide a comprehensive protection planning in these forests, it is essential to study spatial distribution of forest changes related to environmental parameters. Five environmental parameters were concerned including slope, aspect, elevation above sea level and distance from roads and residential areas.

The aim of this study was to provide a description of spatial distribution of forest changes related to the above environmental parameters. To meet this aim, environmental factors have been derived from different data sources. Based on aerial photos dating 1967 and 1994, digital topographic – thematic maps in these two years have been prepared. According to these maps, the forest area in the north of Iran was decreased about 141572 hectares (7.1%) in this period. In this research, as a part of a comprehensive project, forest maps including an area of 78806 hectares were extracted from 1: 25000 digital maps in 4 watershed basins separately at the first and the end of the period. These maps later converted from vector to raster format. By comparing these two maps, forest decrease map was obtained. A precise digital elevation model (DEM) having a spatial resolution of 30 meters was produced. Based on the digital elevation model, different parameters including elevation, slope and aspect classes were achieved. The roads and residential areas were also extracted from digital maps and then related classes representing the distance from these features were concluded. Each of these classified maps was multiplied by forest decrease map to determine the role of them in reducing the area of the forest. By comparing forest decrease map and the resulted maps, the rate of forest decrease in these classes and their interactions in each watershed basin was investigated separately. It is concluded that by increasing the elevation above sea level, slope and distance from roads and residential areas; forest decrease rate reduces continuously. In contrast, forest decrease rate was almost the same in different geographical aspects. The results of this study will provide suitable information about forest protection planning for managers.

Introduction

The broad leaved forests of the north of Iran related to the third geological period having particular genetic diversity are the most important renewable natural resources in Iran. These forests with a rich biodiversity are said *hyrcanian forests*. More than 80 tree species and 50 shrub species exist in these forests with an area of 1.9 million hectares.

Therefore, these forests have unique economical and environmental characteristics, so it is necessary to protect them, seriously Decreasing of forests area in the north of Iran is one of the important problems in recent years. According to the information represented by Forest and

Ranges Organization (FRO) of Iran and also by comparing the maps of forests of the years 1967 and 1994, the forest area in the north of Iran was decreased about 141572 hectares (7.1% of the total area) in this period.

Comprehensive protection planning in these forests needs to be aware of the main factors causing deforestation and decreasing forests area Since there are valuable data (digital topographic-thematic maps for the years 1967 and 1994) about these forests, it is necessary to analyze them quantitatively. This will provide important information about forest changes and spatial distribution of these changes related to different environmental factors. The possibility of analyzing environmental data using a GIS approach is a very useful assistance in forest management.

Puzzola and Folving studied the forests spatial distribution in Mt Etna in relationship with some environmental characteristics, such as topographic, geological and climatic parameters. In this study GIS techniques were used for the analysis. Cropper *et al.* (1999) investigated the factors, which affect the location of deforestation in northern Thailand. The authors presented a model to predict where deforestation is likely to occur and examined the effects of two government policies – road building and establishment of protected areas – on this likelihood.

The aim of our study in Iran was to provide a description of spatial distribution of forest changes related to environmental parameters including slope, aspect, elevation above sea level and distance from roads and residential areas in 4 watershed basins.

Methodology

1. Study area

The study area is situated in eastern Gilan province in southwestern of Caspian sea (Fig. 1). The research was performed in 4 watershed basins while 113 watershed basins cover the *hyrcanian forests* totally. These 4 watershed basins cover approximately 1033 km^2. Elevation ranges from 0 to 2900 meters above sea level and slope varies from 0 to 320%. This region has a temperate climate and rainfall is distributed throughout the year. The study area is flat at the north and rugged mountains cover southern parts. The most important forest species are *Fagus orientalis, Carpinus betulus, Quercus castaneifolia, Zelkova carpinifolia, Acer velutinum, Gleditschia caspica, Alnus subcordata, Alnus glutinosa, Diospyros lotus, Parrotia persica, Ulmus glabra, Taxus baccata, Populus caspica.*

2. Data

The data used in this study were

- Digital 1:25000 thematic-topographic maps dating 1982 which prepared based on 1:20000 aerial photos dating 1967, according to the FRO order and National Cartographic Center (NCC) supervision. These maps were produced by traditional cartography at first and then converted to digital maps. They have 63 different data layers including: residential areas, roads, rail ways, forests, ranges, gardens, contour lines, etc
- Digital thematic-topographic maps dating 2001 which prepared based on 1:20000 aerial photos dating 1994, according to the FRO order and NCC supervision. These maps including 276 sheets, have 63 different data layers the same as pervious maps.
- Roads and residential areas maps which were extracted from 1:25000 digital maps dating 2001.
- Forest area maps, which were extracted from 1:25000 digital maps at the start and the end of the period
- Watershed basins boundary maps.

Fig. 1. Location of the study area

3. Extracting forest maps from 1:25000 digital maps

Forest layers were extracted in Microstation software and then values of 0 and 1 were labeled to non-forest and forest areas respectively in Arcview software. This process was done for all of the map sheets covering each watershed basin for both 1967 (Fig. 2(a)) and 1994 (Fig. 2(b)) years. By comparing forest maps related to the start and the end of the period (1967 and 1994), forest decrease and increase maps were obtained separately in these 4 watershed basins (Fig. 2(c)). These maps having a resolution of 30 meters were imported to the Idrisi software. Among four watershed basins, one of them (watershed basin number 26) is illustrated in figure2.

4. Preparing digital elevation model (DEM)

After extracting contour lines from the 3D digital maps, a precise digital elevation model having a spatial resolution of 30 meters was created for each watershed basin separately

5. Preparing elevation, slope and aspect maps

Slope and aspect maps were achieved using digital elevation model. Elevation classes map considering 100 meters classes was obtained through the classification of digital elevation model. Slope classes map was achieved by classifying the slope map into 6 classes including 0-20%, 20-40%, 40-70%, 70-100%, 100-150% and >150%. Aspect map was also classified into four main geographical aspects.

6. Preparing distance class maps, considering the distance from roads and residential areas

Distance from roads and residential areas were the two other important data layers. Roads and residential areas layers were extracted from digital maps dating 2001 in the Microstation software and later these maps were converted from vector to raster format. Distance from roads and residential areas maps were prepared for each watershed basin separately. These maps were then classified considering 200 meters classes. All of the mentioned maps as geographical data layers stored in raster-based Idrisi software. The resolution of all of the maps was 30m* 30m.

Each of these classified maps was multiplied by forest decrease map to determine the role of them in reducing the area of the forest in each watershed basin.

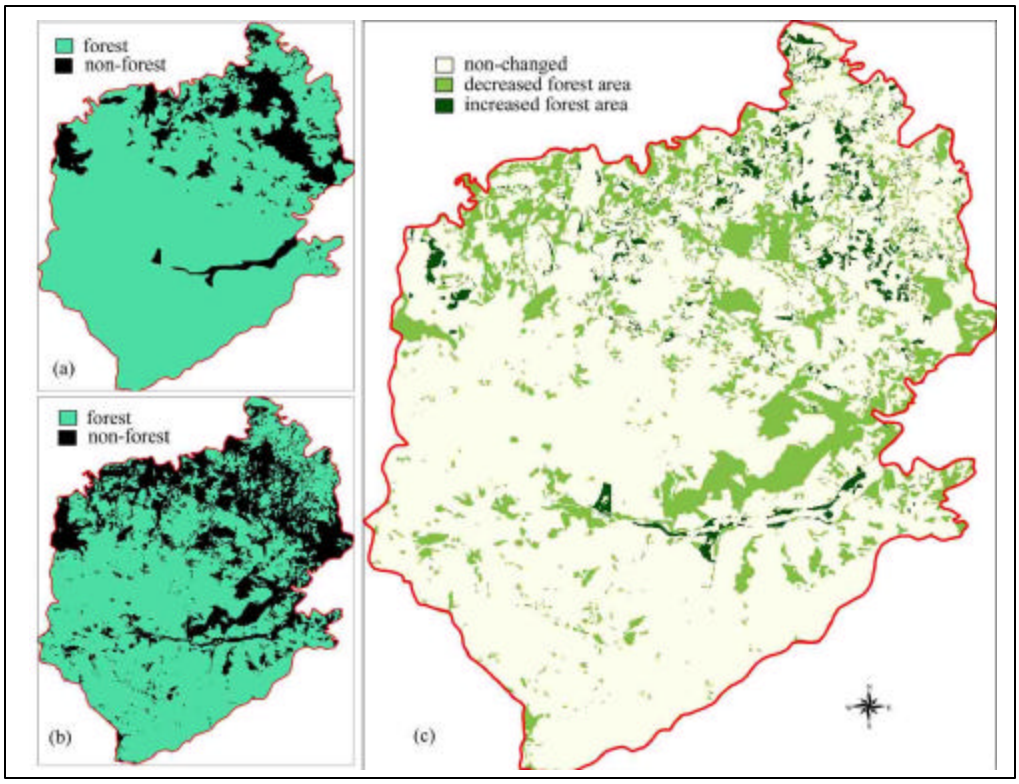

Fig. 2. The forest map dated 1967 (a), the forest map dated 1994 (b) and The forest change map in this period (c).

Results

According to this study, the forest area was decreased about 4228 ha (20% of the primary area) in watershed bas in number 26, 1528 ha (10% of the primary area) in watershed basin number 27, 2823 ha (10% of the primary area) in watershed basin number 28 and 1017 ha (6% of the primary area) in watershed basin number 29. It is concluded that by increasing the elevation above sea level, forest

decrease rate reduces but there are some irregularities in this process (Fig. 3(c)). It was observed that there was a diverse relationship between deforestation rate and slope percent (Fig. 3(a)). We also found that by increasing the distance from roads and residential areas, forest decrease rate reduces

continuously (Fig. 3(d, e)). In contrast, forest decrease rate was almost the same in different geographical aspects (Fig. 3(b)).

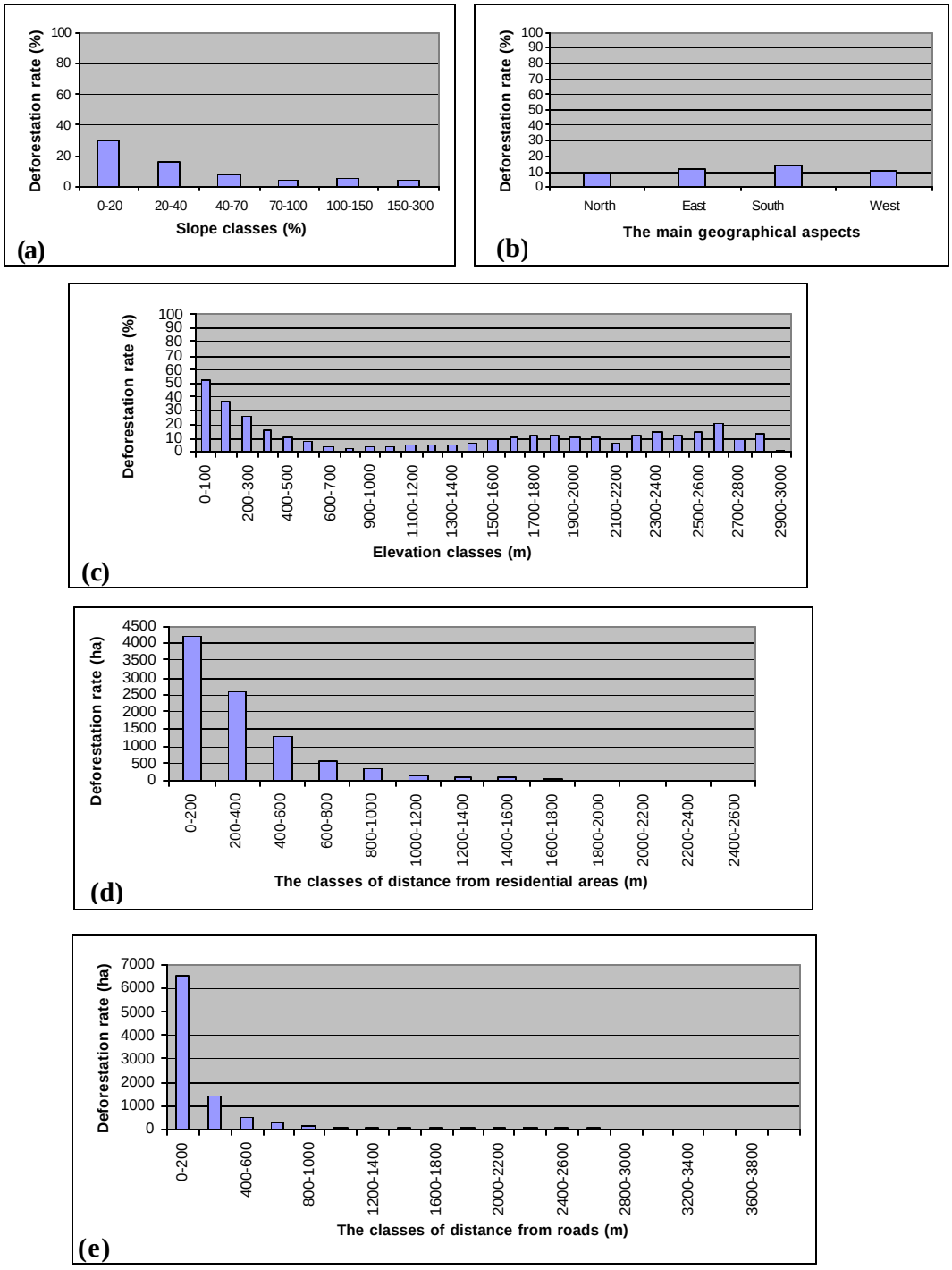

Fig. 3. These five charts show the relationship between the deforestation rate versus the slope (a), aspect (b), elevation (c), distance from residential areas (d) and distance from roads (e)

Conclusion

According to socio-economical conditions in Iran and the expansion of agricultural lands into the forests in low elevations, deforestation has increased in recent years. In this study the most quantity of deforestation also observed in low elevation forests. Of course, the rate of deforestation in high elevation forests is greater than the middle elevation ones because of the presence of mountain pastures and livestock. In this manner, the most deforestation was occurred in the areas with lower slopes because of being easy of access for human and livestock. An exception was observed in watershed basin number 29 in which deforestation rate in the last class (slope percent more than 150%) was more than the former class. A small part of this class was covered by forest and this area was deforested accidentally. Therefore a high rate of deforestation was observed in this class.

By increasing the distance from residential areas and villages, deforestation rate was reduced. So it is resulted that the most deforestation was due to anthropogenic factors. Inside the forests, deforestation rate was reduced as the distance from settlements was increased. In Iran although it is affirmed to increase the amount of roads in forests, because of their role in preventing wood smuggle and facilitating forest utilization, but it is observed that the most deforestation was done in the areas near the roads. In these areas because of easy of access, forest exploiting is overdone. It is said that in southern aspects because of existing suitable conditions such as being warmer, the presence of light demander species and rich under growth, the possibility of presence of livestock is more than the other aspects. It means that in this geographical aspect, deforestation rate must be the most, but in this research it was concluded that deforestation was the same in all of the geographical aspects. Such investigations will assist managers to recognize susceptible areas, which in the possibility of deforestation and degradation is more than the other areas. Suitable strategies can be considered consequently to control degradation and to perform sustainable management in these areas.

References

1- Cropper, M., Griffiths, C., Mani, M., 1999. Roads, population pressures and deforestation in Thailand, 1967- 1989. Land Econ. 75, 58-73.

2- http: //www.projects/gigis/workshops/7ecgis/papers/puzzolo/virginia_EU_GIS.htm

3- Manteghi, A., Sammak, M., 2001. Information about the area of forests in the north of Iran using aerial photos dated 1994 and detecting of changes implementing previous data, the proceeding of sustainable development in northern forests of Iran conference, (1): 49-54