



RESEARCH PAPER

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Investigation of forest area and density changes in Lorestan province using aerial photos interpretation and GIS in the past half century (A case study: Kakareza region, Lorestan province)

Arash Drikvand^{1*}, Mehri Khosravi², Amin Haidarpoure Monfared³, Amir Ahmadi⁴

¹*Department of Forestry Institute - Applications in Agriculture, Jehade Keshavarzi Lorestan Province, Lorestan, Iran*

²*Department of forestry, Yazd University, Yazd, Iran*

³*Department of Forestry Institute, Applications in Agriculture, Jehade Keshavarzi Lorestan Province, Lorestan, Iran*

⁴*Department of forestry, Islamic Azad University, Tehran, Iran*

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Abstract

This study located in the Oak trees coppice of kuckureza situated on 45th kilometers on the way to Aleshtar from northeast of Khorramabad at the middle area of zugross. In this study cognitional changes (area and accumulation) of these forests is studied via pictures taken from the air in (1:55000) and in 1376 (1:40000). For this purpose, geometric corrections are done as the movement correction issued from ups and downs on the pictures taken in the air is performed, then the forest frontier localities are fixed through sight inter pretation and thickness layers of canopy was appointed in a dotted network with the width of 2 millimeters. The frontier line of separated layers is drawn in Arcview software in the form of closed polygons and the area of these polygons are measured separately. Then any changes in area of these polygons in every stage of photographs are compared through software and the layer changes of the thickness of canopy are provided. The study didn't show a noticeable change during last four decades. It shows a decrease on its area from 2593 hectares in 1334 to 2577 hectares in 1376. And in fact it has decreased 16 hectares during last forty-two years. And 16 percent of canopy in 1334 was high over 50 percent. While it lessened to 12 percent in 1376. which seems to be issued from felling off trees and firing in the past. And also the forest canopy of 47 percent of these forests was (5-25) percent in 1334 and it increased to 48 percent. In 1376 and 3 percent of increasing was the result of effective controlling and forestry plans. And in -semi- thick (25-50) percent no considerable change is found.

* **Corresponding Author:** Arash Drikvand ✉ Arashdrikvandi@yahoo.com

Introduction

Forest resources are important and vital resources of every country and sequence of these resources in different climatic and human courses has been much important for prospective planning. West oak forests on Zagros Mountains have been very important in terms of area, environmental problems and water and soil resources conservation. The forest has lost its productivity due to economic and social factors and lack of integrated management and this trend has thrown the regions forests into jeopardy. The role of Zagros forests is obvious for everyone since, 40% of Iran surface water is flowing in Zagros area it is the water supply of several rivers in Iran, and the residents living in the area is possible by water supply from the mentioned watershed (Ghazanfari *et al.*, 2004; Pourreza *et al.*, 2008).

Middle Zagros has forests with high biodiversity, so, climate diversity, soil vegetative cover, physiographic conditions and latitude and longitude difference have caused specific ecosystem conditions and this diversity. Lorestan province is a mountainous region and 60% of its area has a slope higher than 12% and whole the region has been located in Karkhe and Dez basin and has various forests. Total area of the province forests is 885000 ha. Considering that, this region has an important role in long-term social, economic and environmental goals of the country and on the other hand, with regard to current conventional utilization of the forests and population growth, the forests area and density have been changed so, having knowledge about destruction rate, increasing or decreasing of the forests area and density seem to be necessary for long-term planning which become possible in this study (Pourreza *et al.*, 2008).

Manteghi and Sammak, (2000) investigated the possibility of announcing of updated statistics of northern forests area using aerial photos of year 1994. They also assessed the resulted changes compared with statistics of previous years.

Tavakoli (1996) and Delafkaran (2002) studied the trend of qualitative and quantitative changes of northern Zagros forests. In this study, description of different land types in terms of quantitative (determining the percentage of each land type) also description of forest lands type in terms of qualitative (determining the percentage of different forest degrees in terms of density) using aerial photos of the years 1955, 1968 and 1990 over the time. Pirbavaqar (2005) investigated the forest area variations related to topographic factors and regions built by human using forest digital maps in state 2D which had been extracted from aerial photos of the years 1967 and 1994. Rafieian (2003) studied the variations of northern forests area between years 1994-2001 using sensor images ETM+. He ultimately achieved a map with acceptable overall accuracy. Dunber (2004) worked on regional forest cover variations of Kanzas, America during 1941 to 2002. Five stages black and white aerial photos related to 1941 to 1991 and one color infrared aerial photograph related to year 2002 were used to carry out this work.

The aim of this study is Investigation on the forest area and density changes in Lorestan province (middle Zagros forest) using aerial photos interpretation and GIS in the past half century.

Materials and methods

Study area

Kakareza forests have been located in 45 km far from eastern north of Khoramabad city and between longitudes 48° 15" and 48° 20" and latitudes 33° 40" and 33° 44". The maximum elevation from sea level is 2800 m and its minimum is 1400 m. Therefore, an area about 3000 ha in the west part of the region was restricted by GPS. The study area has been located on Chekriz slope. Forest cover of the region includes *Quercus brantia* var.persic, *Crataegus aronia*, *Acer cinerascens*, *Pyrus syriaca*, *Pistacia atlantica*, *Cerasus microcarpa*, *Cotoneaster* sp., *Amygdalus* sp., etc. Dominant type of the region is *Quercus brantia* var.persic (multi-purpose forestry plan of Kakareza, 2004).

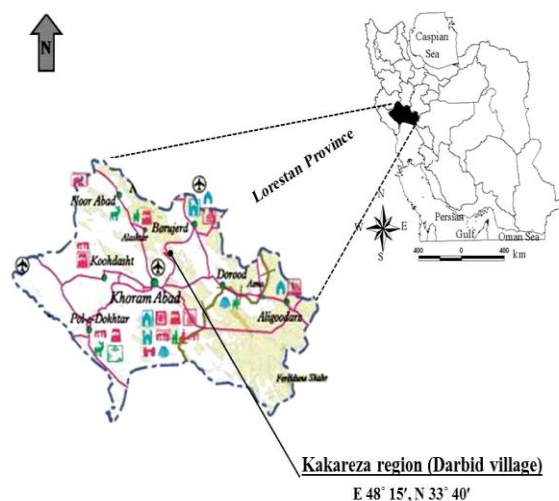


Fig. 1. location study area in the Kakareza region, Lorestan province.

Used data:

- Paper maps with scale of 1:50000 and digital maps as 2D and 3D with scale of 1:25000 which have been produced from mapping organization of Iran.
- Aerial photos of the region of year 1955 with scale of 1:55000, Aerial photos of the region of year 1968 with scale of 1:20000 and Aerial photos of the region of year 1997 with scale 1:40000. The photos of year 1955 were produced from Armed Forces Geographical Organization and the rest of photos were produced from mapping organization of Iran.
- Ground statistics were collected by systematic-random method with network dimensions of 500*1000 and square plots of 100*100 and 60 plots were taken from the whole the region.
- Information about herbaceous ground cover, soil and land of the region (texture, tone, color and grain size) which were obtained field sampling and experimental analysis.

Forest map derivation from aerial photographs

Firstly, positive film scan was produced from aerial photos of year 1997 to do required geometric corrections. Then, corrected image of the region was extracted from PCI9.1 software by entering some information including camera type, focal distance, Image marginal points, flying height, ground control points (GCP), elevation digital model, etc. Since aerial photos of the years 1955 and 1968 did

not have all the required information to do geometric corrections by mentioned method, so, these photos were corrected by approximate correction method using a referenced photo (aerial photo of year 1997). In this method, relationships between the points of referenced photo (X, Y) and non-referenced (X', Y') were determined using two polynomial functions then, corrections of the photo are carried out by adapting the considered image and base image. Now, the considered image coordinates are found using spatial coordinates of the nearest pixel in geo-referenced image (Hajarian, 2005). Then, obtained area and density between two series of aerial photos of the years 1955 and 1997 were compared.

Area calculation

Forest lands were determined on aerial photos with scale of 1:40000 and 1:55000 by visual interpretation. Then, the lands were divided to separated polygons, and area calculation was carried out in Arcview software for each determined units separately. Therefore, the area of each polygon which has different densities (F_1, F_2 , and F_3) was calculated during the two periods. Also, determination of area variations during the period easily becomes possible through this method.

Determination of canopy density

Optical method was used to determine canopy density. For this purpose, dotted network was created on considered areas in which forest masses was closed. Considering that, high accuracy is needed in density determination, also with regard to small forest masses in these regions; dimensions of dotted network were considered 2mm by 2mm. For this purpose, the network was designed in PCI software and was placed on considered regions. The existent points on the polygon were counted after creating and transferring the dotted network to the photo. Also the points located on forest masses were counted. In this stage, if more than half of a point was on the border, so the point was counted as well as the points which were as middle on the region and outside the region. After counting all the points, forest mass density was determined considering proportion and fit between

existing points in the forest mass and polygons points.

Determination of area and canopy density variations

After determining the forest polygons and each polygon area (in Arcview software), all polygons areas were summed separately in each region and period to obtain a value as the region area in considered year. This trend was conducted for each series of the photos as well as determination of area in each considered year.

Results

- *Investigating the area of density classes in Kakareza region using aerial photos of year 1955 (scale of 1:55000)*

According to the conducted study in the region using aerial photos with scale of 1:55000, it was found that the study area is 3012.5 ha and total area of the forest lands was estimated about 2593ha in 1955. Density class F3 (density of 5-25%) includes the maximum area and density class F1 (density higher than 50%) has the minimum area of the region which can be seen in table 1, figure 2 and 3.

Table 1. Area of density classes in Kakareza region in 1955 (scale of 1:55000).

Area (ha)	Density classes
427	F1 (density higher than 50%)
1027	F2 (density of 25-50%)
1139	F3 (density of 5-25%)
2593	Total

Study of density percentage of the density classes in Kakareza region using aerial photos of year 1955 (scale of 1:55000)

According to conducted studies it was found that, F3 (density of 5-25%) has the maximum relative frequency percentage in 1955 and F1 (density higher than 50%) has the minimum value (Table 2 and Graph 2).

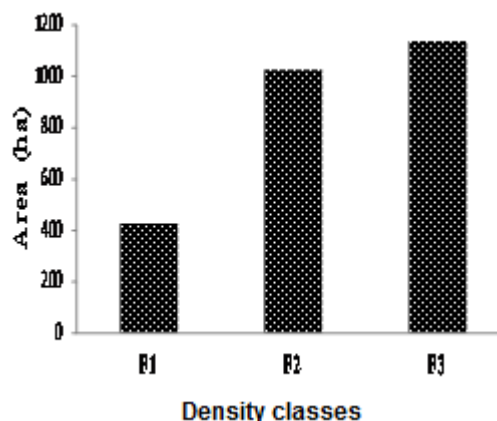


Fig.

Fig. 2. Area of density classes in Kakareza region in 1955.

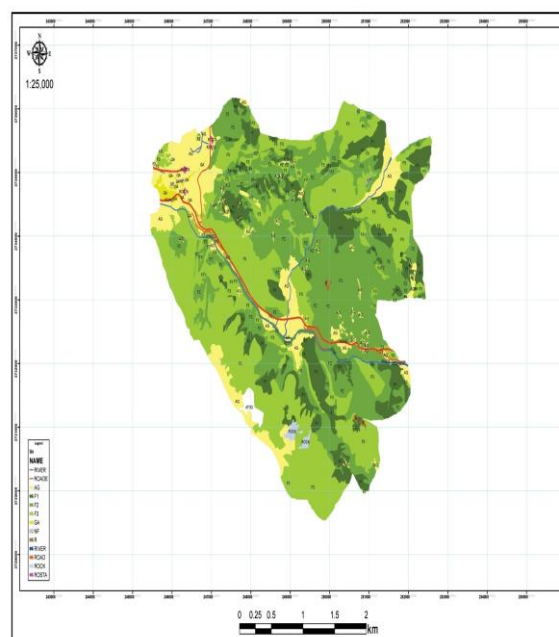


Fig. 3. Study area coverage using aerial photos of year 1955.

Table 2. Relative frequency percentage of density classes in Kakareza region in 1955 (scale of 1:55000)

relative frequency %	Density classes
16	F1 (density higher than 50%)
39	F2 (density of 25-50%)
45	F3 (density of 5-25%)

Investigating the area of density classes in Kakareza using aerial photos of year 1997 (scale of 1:55000)

According to the conducted study in the region using aerial photos with scale of 1:40000, it was found that the study area is 3012.5 ha and total area of the forest

lands was estimated about 2577 in 1997. Density class F3 (density of 5-25%) includes the maximum area and density class F1 (density higher than 50%) has the minimum area of the region which can be seen in Table 3 and Fig. 4.

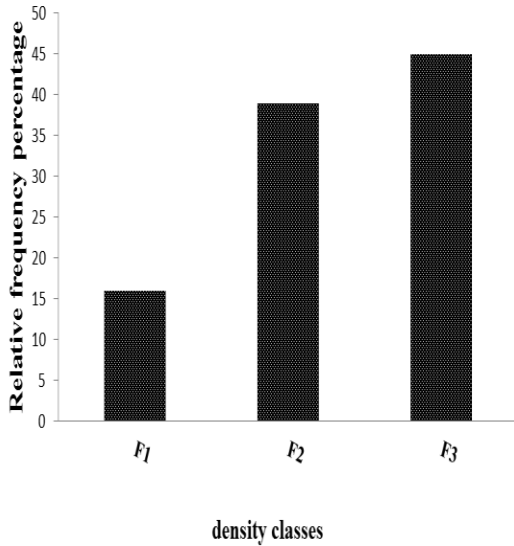


Fig. 4. Relative frequency percentage of density classes in Kakareza region in 1955.

Table 3. Area of density classes in Kakareza region in 1997 (scale of 1:40000)

Area (ha)	Density classes
314	F1 (density higher than 50%)
1043	F2 (density of 25-50%)
1220	F3 (density of 5-25%)
2577	Total

Study of density percentage of the density classes in Kakareza region using aerial photos of year 1997 (scale of 1:40000)

According to conducted studies it was found that, F3 (density less than 25%) has the maximum relative frequency percentage in 1997 and F1 (density higher than 50%) has the minimum value (Table 4 and Figure 7).

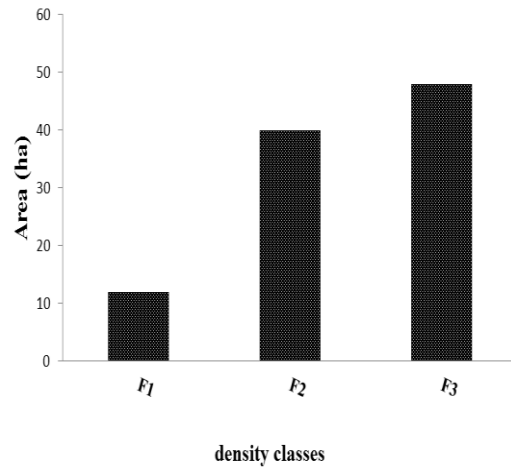


Fig. 5. Area of density classes in Kakareza region in 1997 (scale of 1:40000).

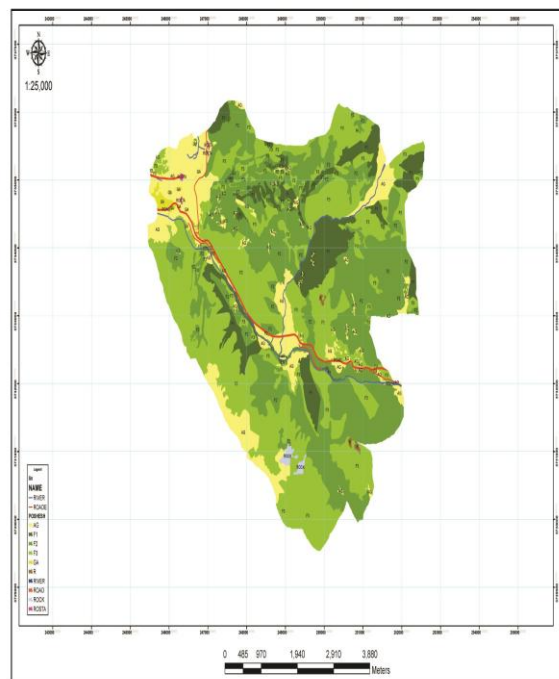


Fig. 6. Study area coverage using aerial photos of year 1997.

Table 4. Relative frequency percentage of density classes in Kakareza region in 1997 (scale of 1:40000)

Relative frequency percentage	Density classes
12	density higher than) F1 (50%)
40	F2 (density of 25-50%)
48	F3 (density of 5-25%)

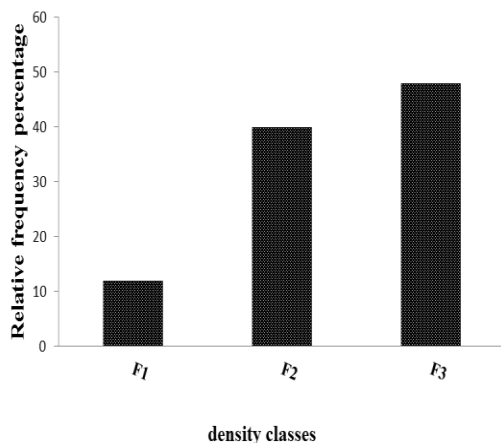


Fig. 7. Relative frequency percentage of density classes in Kakareza region in 1997.

Discussion and conclusion

For investigating the canopy variations in aerial photos of different periods that the photos needs fitting to determine change location, geo-referencing the photos is not possible for all the photos due to lack of required geometric information (Hajarian, 2005). Therefore, approximate correction method using a base image by selecting or creating a geo-referenced image is recommended for such investigations. An advantage of this method is fully consistent images. Combining the capabilities and facilities of various image editor and classifier software along with using visual interpretation techniques would have the best result to classify the considered phenomenon in aerial photos properly, and relying on a specific approach or software will decrease classifications results quality due to their limits (Sadeghi, 2005).

In this study considering intact diapositive of year 1955, the photos of this year were used but, the photos of year 1968 were eliminated due to low quality. In a similar study (Hajarian, 2005) also, aerial photos of year 1955 were eliminated because of low quality and aerial photos of the years 1967 and 1994 were investigated.

Combined interpretation (visual-visual) method was distinguished as proper method to determine land border and forest types. Rafieian (2003) and Sadeghi (2005) introduced combined and visual

interpretation method to separate forest borders and types.

As Sachas (1998) explained, if it is possible to separate vegetative cover type in aerial photos, this data is a suitable source to investigate variations in land scape level. This case was approved in this study. Results of the years 1955 and 1997 show that, there was no area change during last four years. Total forest area has been decreased from 2593 ha in 1955 to 2577 ha in 1997. In fact, the forest mass has had 16 ha reduction within 42 years. Also 16% of investigated forests had high density (higher than 50%) in 1955 while, this value has been 12% in 1997. The destruction is because of cutting and forest fires in the last periods. In 1955, 45% of these forests had a density by 5-25% which increased to 48% due to more control and covering the region by forestry plans. There is no sensible change in semi-dense class (25-50%). Finally these assessments show that, there is no sensible area variation in the region (Kakareza) oak forests but, the forests density has had some changes so that, 113 ha of density class F1 (density more than 50%) has been decreased during the study period (1955-1997) and has become other classes (F2, F3). Also 81 ha of density class F3 (density of 5-25%) has been increased during the study period but, there was no sensible change in density class F2 (density of 5-50%) during the study period.

Suggestions

- Geometric correction of displacement due to topography should be done in order to investigate aerial photos and to derive their information.
- Accuracy of manual and digital data derivation from aerial photos should be compared by conducting an investigation.
- Most critical factors in reducing the forest area should be found by conducting an investigation and then should be used in development of macro-management strategies.
- To implement periodic monitoring plans in order to produce accurate and updated data of the region forests status.

- In order to indicate forest cover variations in these regions, combination of derived data from aerial photos and derivable data from satellite images should be used.

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