Studying the causes of changes in forest and non-forest land using RS & GIS (Case study: conventional territory of Joojar village- Kermanshah - IRAN)

Sohrab Moradi[1] (Corresponding author), Eghbal Pahkideh[2]

[1.] Agriculture Sciences Faculty of Payame Noor University, Iran
[2.] Economics and Social Sciences Faculty of Payame Noor University, Iran

Abstract: The land use / cover is not fixed but changed in the effect of different operations. Identifying and recognizing these changes could help managers and planners to discover the factors involved in land use and coverage changes and to have a beneficent planning to control them. This study has been carried out with the purpose of investigating the capability of Landsat ETM+ & IRS-1D imagery for forest and non-forest extent mapping and determining forest and non-forest changes in Zagros forests from 1957 to 2010 and identifying the causes of these changes as well. A case study was accomplished at the conventional territory of Jojar village in Salas County from Kermanshah province, west of Iran. The land use map related to the forest and non forest lands in 1957 were provided via photo interpretation and classifying it in the environment of Arc GIS 10 software. After investigating the radiometric and geometric quality of satellite images, together with correcting them, the area of study was first divided into forest and non forest classes and then again into six classes of farms, forests, forest lands, gardens, ranges, and residential lands. Via employing the supervised classification and the maximum likelihood algorithm, the accuracy assessment of results obtained from the classification in comparison to the accurate ground map which was gathered using GPS from a systematic sampling network, showed the overall accuracy rate of 92.85%. The results obtained from investigating the land use changes of the area showed that in the course of studying the related area, 295.3 ha of forests and 223.9 ha of forest lands have been reduced and changed into farm lands & ranges and on the other hand range areas have got an increasing rate of 466.4 ha. The reasons are due to change of forest lands into farm lands, cutting the trees for fuel supplying, increase of the domesticated animals in the village, oak lopping for supplying herbs , etc.

[Sohrab Moradi, Eghbal Pahkideh. **Studying the causes of changes in forest and non-forest land using RS & GIS (Case study: conventional territory of Joojar village- Kermanshah - IRAN)**. *Life Sci J* 2013;10(3s):566-573] (ISSN: 1097-8135). http://www.lifesciencesite.com. 90

Keywords: Changes detection, IRS – 1D, Landsat ETM+, maximum likelihood algorithm, aerial photographs, satellite images.

1. Introduction

Natural resources preserve the life of human beings and other living organs, but this is attained through managing them. Identifying available resources, monitoring the change processes and availability of updated data and information are some of the key factors in planning, decision makings, and managements in any respect (1). Zagros site is the wide area in Zagros range of mountains that is extended from the southwest of the country, i.e. Piranshahr County, to the suburb of Firouz Abad County. Zagros forests which have been classified as semiarid forests would have a vital role in preserving the soil and moderating the weather and also balancing the economic and social conditions (3). Over use of Zagros forests during long times has made these valuable forests change into sensitive & weak ecosystems with considerable changes in the order of forests spices, the rate of density, together with decrease in volubility and quality. Accordingly, the rates and positions of these changes need to be provided based on numerical data by drawing accurate maps. So managers, experts and other enthusiast people to forest can find a reasonable solution for the related problem.

Remote Sensing (RS), as a science and technology of providing locative information, and Geographical Information System (GIS), for possessing analytic facilities, could play fundamental roles to identify and assess these changes. The numerical satellite images are another source of locative information with some privileges over other common sources (like maps), for example extensive coverage, less needs to do survey, less cost and being updated information. All these make it inevitable for the operator to use the satellite images for investigation & identification of land use changes. There have been carried out different researches in providing forest maps and investigating the changes in forest extension via different satellite images together with investigating their capability in Iran forests specially Hirkani & Arasbaran forests. Shataee (1996), during a research in plain forests of north for providing the forest map via satellite images, concluded that Landsat satellite images have got proper capability for providing the map of forest extension. Ranjbar (2002), in investigation and assessment of the destruction process of Arasbaran forests via Landsat satellite ETM+ & TM images, besides confirming high capability of these images in providing the map of forest changes, concluded that the destruction of the forests of the related region has gat a significant relationship with the parameters of distance from rural centers, altitude and geographical directions. Rafiean (2006) evaluated the capability of ETM+ data in providing forest map and also investigated the changes in parts of Iran north forest extension. He concluded that ETM+ data inherits enough capability for providing the map of forest extension, also about 8.2% of the initial volume of being investigated forests had been eliminated in this study. Najalou (2007), with the purpose of investigating the changes in the forest extension via the help of aerial photographs, topographic maps and IRA-IC & ETM+ in the form of a case study in Iran north forests, concluded that the satellite data have got proper capability for providing the map of forest extension in northern forests and thus can be employed in investigation of changes in these forests. Rezaee (2007), in a research with the purpose of investigating the process of changes in the forest extension via GIS in Arasbaran forests, concluded that satellite images have got a proper capability for showing different land use changes. He also recognized the inhabitance centers as the main effective factor in the process of changes. Amini (2008) studied the changes in Zagros forest extension via aerial photographs and satellite images in Armardeh forests and after selecting the best band series for classification of the area into forest and non forest classes in a period of 47 years, concluded that 4853 ha of the forest area has been reduced and 955 ha has been added to it. There have been carried out various studies over the investigation of forest changes via satellite images outdoors of Iran. Kanbhum (1998) in a research studied the process of forest changes in Thailand via Landsat satellite images and topographic maps and came to the conclusion that forest land use changes into other land uses has caused the forest destruction. Panikkar (1982) in a study of Indonesia land uses with the purpose of demonstrating forest changes via satellite data and topographic maps concluded that there has occurred 18.7% decline in forest coverage in a time period of 60 years. Yuan et al (2005), by studying the process of land use changes in city suburbs via ETM+ & TM, also assessing the accuracy of obtained maps via aerial photographs, concluded that investigating land use changes via Remote Sensing (RS) is conceivable. In Zagros forests, specially forests of Kermanshah province which are different from the ones in north of Iran and Arasbaran forests, yet there have not been carried out so much researches for investigating the capability of satellite images in identification and division of forest areas and also determination of the destruction rate and position of these forests. Based on the obtained results from the former researches in high capability of TM images for providing the forest map , were used ETM+ sensor images for having band width division rate of 15m. Based on what discussed above, the purpose of this paper is to study the changes of forest extension in conventional territory of Jojar village from Salas - e – Babajani County in a time period of 53 years (from 1957 to 2010) and also to provide the map of forest extension via satellite data. The results of this study can be helpful in using satellite images for providing the map of forest extension and also investigating its changes.

2. Materials and methods

Area of study: Jojar village is one of the villages of Dashte - e - Hor vill with longitude of 46° 12´, latitude of 34° 44´ and altitude of 136m which is located 5 KMs from Tazehabad south east. This village is unique among the villages of the related region for having farm lands, ranges, plenty of forest lands, a few gardens and other kinds of lands. Zemkan Permanent River is streaming from the west of the village. The inhabitance's occupations are, in respect of priority, ranching, farming, and gardening. The environment and the lands of the conventional territory of the village has undergone great changes during different eras from about 60 years ago up to now due to the various reasons like imbalance between domesticated animals in one hand and ranges & forests on the other hand, using the forest wood as a fuel source, imposed war and … . It is due to all these characteristics that this village was selected as the area of study. Figure 1 shows the position of the area of study.

Used data

In the present study, in order to attain the goals of the research, there used aerial photographs from 1957 prepared by Army Geographical Organization in scale of 1:50000, topographic maps of the region and surroundings in scale of 1:50000 bought from Army Geographical Organization, IRS-ID & ETM+ Land sat satellite images referred to 2010 for preparing forest map and the map of land use changes as well. The field measurements also were done via GPS. In different steps of this study, like inserting input data and other necessary information, correcting and processing data, analyzing and inspecting the accuracy of the results, also displaying and preparing the outputs together with printing, were used Arc GIS 10, PCI Geomatica, Arc view GIS and Excel software.

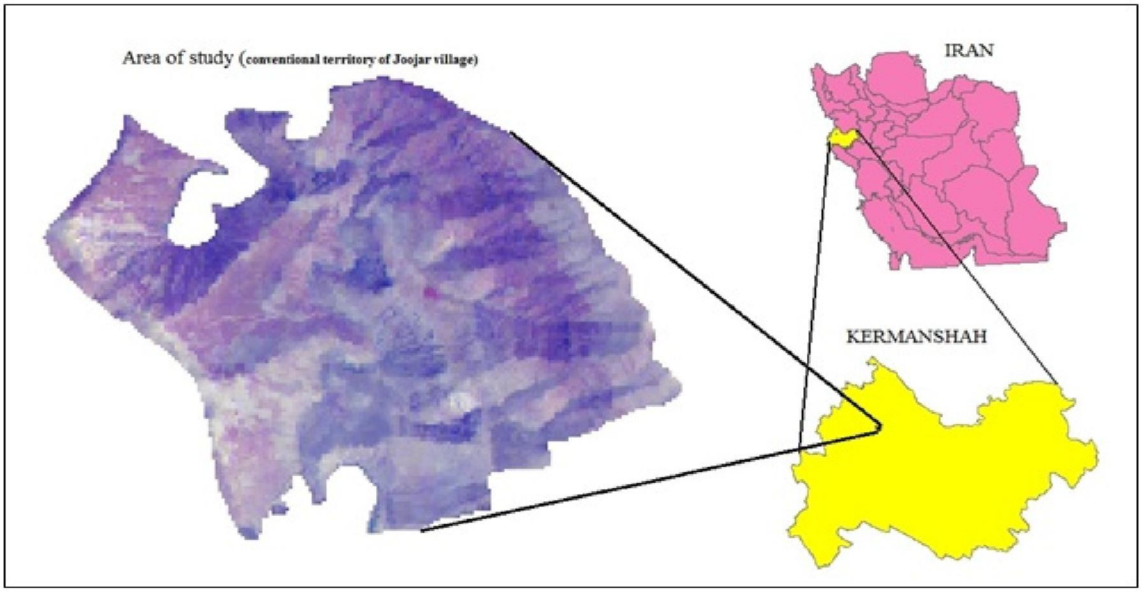


Figure 1: position of the area of study in IRAN

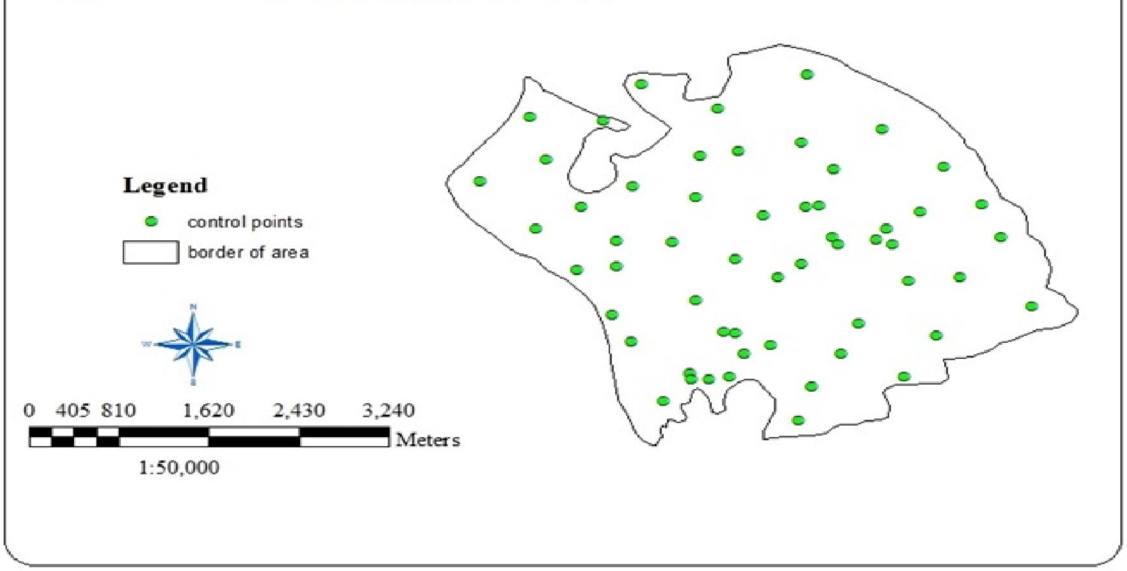
Drawing out land use map from aerial photographs: In this paper, the act of interpretation was done based on their physical natures over the terrains and phenomena in aerial photographs. The quality control of aerial photographs was done via stereoscope, and then it was scanned and measured in quality via zooming on monitor screen and preparing uncontrolled mosaic. Afterwards, it was justified inward and outward and corrected in the sense of errors with division rate of 1m via PCI Geomatica software in orthoengine sector by using land control points from 1:50000 topographic map and also obtained land points via GIS. Every interpreter should always mingle his/her own knowledge with objective perception and topographic data in recognizing natural terrains and related conditions and also should be able to interpret aerial photographs based on significant factors (8). By emphasis on this issue and using different factors of interpretation like shape, ton, size, color, pattern, shadow, context, topographic terrains and …, measures were taken to interpret aerial photographs.

Based on food and agricultural organization (F.A.O) recent definition of for forest, land forest, range and other kinds of lands, the aerial photographs of the region were interpreted and various land uses were partitioned.

For this purpose, a new polygon theme was created in Arc GIS then was drawn polygon around the areas recognized as forest and saved in a shape map as a separate file. Primarily, various land uses on the map were divided into two general subcategories: forest & non forest and hence were prepared the related map. In the following step, the non forest land use was splited into smaller units, i.e. farm lands, range, garden, residential region, etc.

Drawing out land use map from satellite images: Before applying satellite data their qualities need to be ensured in the sense of no disorders and radiometric & geometric errors as well and if there is any, they should be corrected soon. In this study, in geometric corresponding of satellite data via land control points, three steps, namely identification control points and reading their coordinates, determining the equations and eliminating improper points and geometric corresponding via generalizing the equation and repeating sampling were accomplished. Primarily, the Digital Terrain Model of the area was attained from the area surveying topographic curve drawn out from 1:50000 paper maps with division rate of 5 m. Afterwards the land control points were drawn out via using paper and topographic numerical map, color image and land points obtained in forest cruising via GPS. The process of geometric correction of images was accomplished applying PCI software. On the whole, 60 land control points were drawn out from geometric correspondence. In this process, we carried out geometric correction of the images from different bands with spatial resolution of 5m and RMSE less than 1 pixel via polynomial method also using land control points applying a quadratic equation and the method of resample the nearest neighbor. For investigation of geometric condition of the data, were used vector layers of roads water channels drawn out of 1:50000 paper map and some control points obtained while forest cruising. Matching these layers with satellite data showed the correct geometric correspondence between data and the map.

figure 2 - location of control points in the area of study



Drawing out useful information and classifying the images: In this study, for drawing out useful information concerning the research goals was applied combining classification. In this classification, after geometric correction and reconstructing the image, the first step is determining categories of classification. For this purpose, according to the decided goals in this research, the area of study were classified into seven subcategories of forests, forest lands, gardens, ranges, residential regions and bare lands (with no plant coverage). In this classification, concerning the number of land uses, were selected some didactic samples in each land use. The didactic samples were determined in harmonic distribution in the related region. Plant coverage & soil condition were inspected superficially, considering the kind of land use. The coordinates of didactic samples were attained via GPS. These samples were indicated on the image and their land uses were inserted into the software. In the processing of the satellite images for classification, there used different algorithms among which maximum likelihood method, with higher accuracy than other methods, has been used in this study. In this method the likelihood law is applied for image classification and the likelihood of belonging a pixel to a specific class is assessed. If belonging to this class be in higher likelihood than other classes, the related pixel will be classified in it.

Determining the accuracy of classified images: Information and topical maps obtained from satellite data, do not always posses equal accuracy and accordingly, they should be inspected in this respect. The best way for determining the accuracy of obtained maps from satellite data classification via numerical method is comparing them pixel to pixel with (perfect or sampled) land realities. After studying the map and forest cruising, were taken 10 samples randomly from each land use. These samples, then, were corresponded to the map of classification via forest cruising. Ultimately Error Table 1 resulted. The numbers in Table 1 can be explained in this way: among 10 samples classified as forest, 9 samples are in accordance with land reality, namely, they have been classified truly and one remaining sample is actually forest land that has been wrongly classified as forest. Among 10 samples classified as forest land, 9 were true but one was classified wrongly that was actually range. In contrast, in site 1, i.e. in forest lands, classification has been wrong and these samples have not been devoted to forest lands but to forests. In fact it has been forest land which was not classified truly. Other classifications can also be explained in this way. Using Error Table 1, there can be drawn out various criteria for explaining the accuracy of classifications qualitatively among which Overall Accuracy is one that is obtained via the following formula.

$$\text{Overall Accuracy} = \frac{\text{the sum of samples in class } x \text{ classified truely}}{\text{the sum of samples being classified in class } x}$$

With calculating the overall Accuracy of each class and ultimately their average, Grand Overall Accuracy equal to 92.85% was obtained which shows the high accuracy of classification. The low rate of classification, on the other hand, was due to samples located in the borders of the classes.

Table 1: error matrix resulted from comparison of classified map with ground truth samples

	classes	**Ground truth**							
		forest	land forest	agriculture	horticulture	range	residential	bare land	**Sum (ha)**
classification	forest	9	1						**10**
	land forest		9			1			**10**
	agriculture			8		2			**10**
	horticulture				10				**10**
	range			1		9			**10**
	residential						10		**10**
	bare land							10	**10**
	Sum (ha)	**9**	**10**	**9**	**10**	**12**	**10**	**10**	**70**

Results

Investigating the areas of different land uses:

Based on provided land use maps (Figures 3 & 4), the areas of different land uses in different eras have been presented in Table 2.

Table 2: areas of different land uses in the time period between 1957 to 2010

Land use	**Area of land use in 1957 (ha)**	**Area of land use in 2010 (ha)**
agriculture	0	32.403104
bare land	28.930817	48.606767
forest	1029.4422	734.10118
horticulture	1.0744022	1.8254062
land forest	351.47363	127.57088
range	39.499322	505.95104
residential	4.2643404	4.2262989
sum (ha)	1454.6847	1454.6847

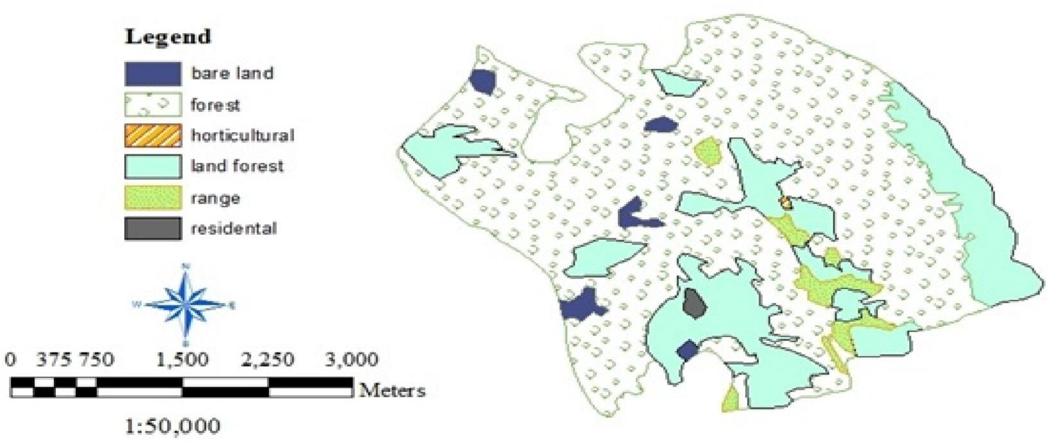
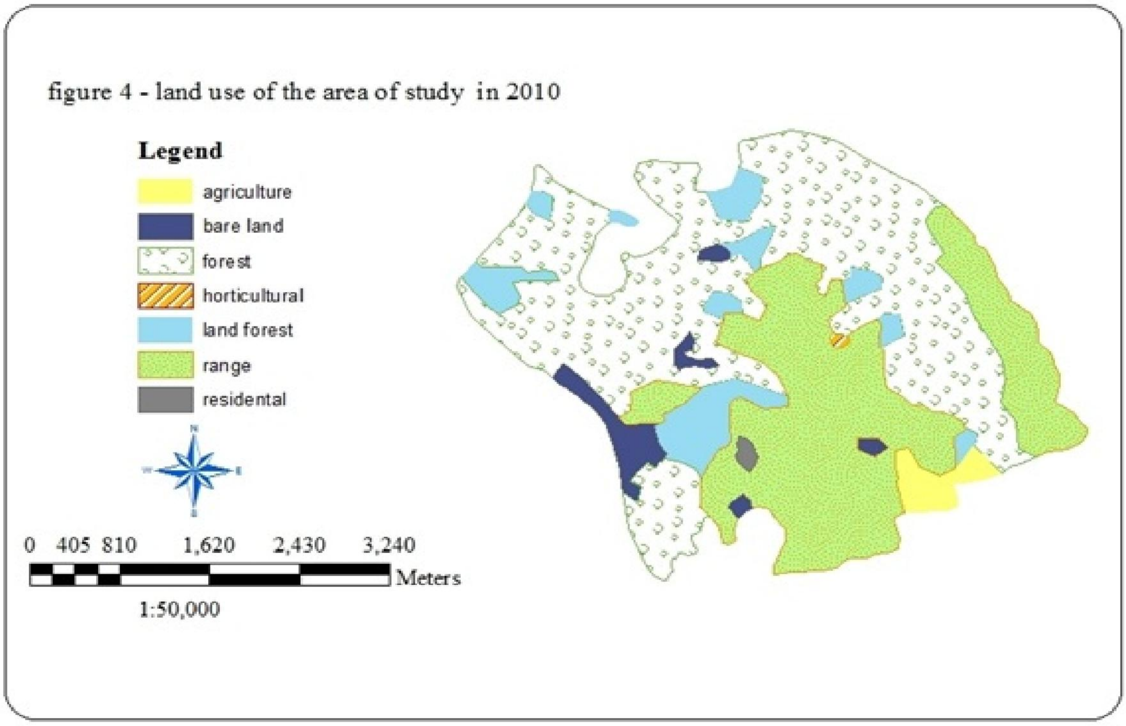


figure 3 - land use of the area of study in 1957



3. Discussion and Conclusion

Based on Figures 3 & 4 and also Table 2, the main land use changes in the related area of study are as follows:

1. Range lands have been developed to 466.451718 Hs. Forests & forest lands have been declined to 295.34102 & 223.90275 Hs respectively. The reasons are as follows:
   a) Changing forests into farm lands: As the majority of oak trees of the region have been located in high and mountaineer parts, low-slop areas and prone to it being available. So by passing the forest and identifying suitable regions the people have scalped all trees & shrubs and changed them into farm lands during the recent years. Unfortunately as these pieces are small in area, scalping is continued in some scattered points in the local borders of the forests around the village. So in the same time while the number of family members increases, they keep on these kinds of destruction to supply their different initial needs.
   b) Cutting trees to supply fuel: During the imposed war, supplying fuel from trees, due to the shortage of fossil fuels, has got an increasing and incredible flow. Unfortunately, not only the people of the village, but also the residents of the approximate cities have influenced these destructions so that selling woods had become a kind of occupation for some people who abused ongoing condition of that time. Besides, supplying fuel from wood by the people of the village and other profiteer people, providing the coal from the forest woods had made the forests of the conventional territory of the village a kind of ruin both in quantity and quality.
   c) Increase of the domesticated animals in the village: In parallel with flow of population increase, there occurred an increase in number of domesticated animals with purpose of supplying diary, wool, selling them and also job making. In the conventional territory of this village, as besides forest understory vegetation, there is limitation in range for ranching, ineluctably, after melting snow on the earth, there begins traffic of domesticated animals and therefore nonstop grazing in the forest continues to the next snow season. This process leads to the appearance of plenty of Micro Terrace in the forest soil and consequently to the unfruitfulness and reduction of soil fertility, biological imbalance in delicious vegetables, increasing and growing of non delicious vegetables and ultimately destruction of forests and changing them into unsuitable ranges which in turn change into bare lands with no plant coverage in case of continuation of this process.

d) Lopping oak trees to supply forage: The people of this village have supplied some parts of their needed forage from lopping the oak trees from the old times and it still continues. In this process due to no substitution for forage, shortage of farm lands, the region being mountaineer and also experience of centuries living in cumbrous regions have forced the people to promote their agricultural & ranching needs by exploiting the nature as possible as they can.

e) Traditional use of oak trees as building materials and agricultural tools: Except for some specific cases which to some extent have changed the homespun of the village, still using straight oak trees as ceiling timbres is a common task. On the other hand, as the roofs are covered with mud, so tree foliages are used as secondary building materials over the ceiling timbers. Every year, the people of the village, with forest cruising, find this kind of trees, which in fact are the best ones, cut and then store them by their house to use them when necessary. The branches and browses of these trees are used not only as fuel resources but also for making the house fences (*Parzhen*) and temporary cottages (*Kaper*). On the other hand as in old times the life of these people has been dependant on nature, accordingly they have used tree trunks to make agricultural tools like ploughs, roof roller and used tree knots especially from maple & pear trees to make different kinds of handicrafts. So, forests and forest lands have undergone great changes.

2. Farm lands have developed 32.403104Hs. Most of these regions have been already ranges with rather flat areas which have been plowed via ploughs in traditional ways in very old times. But these lands have been deserted for generations and hence have changed into ranges. With the progress of technology and farming machineries also with farming getting easier, the people of the village, again, turned to cultivation in these regions. So the inspections over land use changes in the era under study shows that at the beginning of this period there has been no farm land in the area of study but now farm lands have developed to the rate of 32.403104Hs.
3. Range lands have developed 426.45172Ha. As the reasons of declining forests and forest lands are changing forests to farm lands, cutting trees to supply fuel, no imbalance between number of domesticated animals and ranges, lopping the trees to provide forage, traditional use of oak trees as building materials and agricultural tools, this declination ultimately leads to change of forests first into forest lands and finally to ranges. As at the onset of the era under study most parts of the area have been covered with forest and forest lands but later on have been destructed both in quality and quantity, hence, more development of the ranges is not so farfetched and in case of the continuation of this process the rate of ranges will be declined in out coming years as well.
4. Increase of garden lands with rate of 0.751004Hs due to trespassing of the owner of the only garden in the area of study to forest lands.
5. There occurs no change in residential lands during the ear under study. The reason is migration of youth and young couples to cities and ultimately no increase in the number of families. Besides, due to the low price of lands around the village, there is no much tendency from the village residents to seize these lands.
6. The bare lands with no plant coverage have increased 19.67595 Hs during the era under study. The reason is due to cutting trees and exploiting forests and ranges extremely, unbalanced and extreme entrance of domesticated animals into ranges and consequently increases of micro terrace and beating the soil, no fruitfulness in forest and range species. Ultimately all these factors cause the destruction of ranges and changing them into bare lands with no plant coverage.

According to the obtained results, it is found out that during the ear under study, the decline in forest areas have been considerable. Concerning the statistic data obtained in the course of this study, decline in the forest area has been 28.7% it is worth mentioning that the area of farm lands and ranges develop linearly in the region under study and in case of continuation, the ranges in turn will face a terrible condition in the future years. It is hoped that with government planning and people contributions the flow of forest and forest land destructions will be prohibited as much as possible.

Recommendations

1. It is recommended that the changes in forest area be investigated in two sequential eras (before and after victory of Islamic Republic of Iran) and the causes of destruction be investigated in each era respectively.
2. It is recommended that the changes in forest area be investigated in accordance to factors like height, slope, and direction independently or in a combination of these factors, with mutual

effect on each other, via Remote Sensing (RS) data.

References

1. Ahmadi Sani, Naser, 2005. The investigation of the capability of ASTER sensor images for providing the map of Zagros forests densities (Case study: forests of Mariwan county), Thesis of MA in forestry, faculty of Natural Resources, Tehran University.
2. Amini, Mohammad Rashid et al, 2008. The investigation of changes in Zagros forest extension via using aerial photographs and satellite images (Case study: forests of Armardeh of Baneh). Journal of agricultural science and natural resources 15th volume, 2nd No.
3. Sagheb Talebi, Khosro, Takatom Sajedi, Farshad Yazdyan, 2005. An overview on Iran forests, Press of the institute of forests and ranges researches.
4. Ramin nya, K, providing the forest map and classifying it via using satellite data in numerical method in forest of Kheyrood Kenar – Nowshahr, Thesis of MA in forestry, faculty of Natural Resources, Tehran University.
5. Rezaee Banafsheh, Majid et al (2007); Investigating and evaluating the process of forest area changes via Remote Sensing (RS) and GIS (Case study: Arasbaran forests 1987-2005). Journal of geographical researches –No. 62, 159 – 143 p.
6. Rafi'yan, Omid, Ali Asghar Davish Sefat and Manouchehr Namiryan, 2006. Indicating the changes in northern forest extension from 1991 to 2001 via ETM+ sensor images (Case study in Babol forests), journal of science and techniques of agriculture and natural resources), 10th year, 3rd,B No. 286-277 p.
7. Ranjbar, Abolfazl et al (2002); investigation of the changes in forest areas via GIS and Remote Sensing (RS, Research plan of technical faculty, Khaje Nasiradin Tousi University.
8. Zobayri – M, Dalki – A, 2008. The principles of interpreting aerial photographs, Tehran University Press, 6th edition.
9. Shataee Jouybari, Sha'ban, 1996. Providing the forest map via using satellite images in numerical method. Thesis of MA in forestry, faculty of Natural Resources, Tehran University.
10. Najarlo, Sahar et al, 1386. Assessment of the capability of multi spectrum and blended images of Landsat satellite 7 and IRS-ID in providing the map of forest extension, Journal of agricultural sciences and natural resources, 14th volume, No5th.
11. Kellenberger, T, W.1996. Comparison of potential of IRS-IC, SPOT and Landsat- TM multispectral and panchromatic data for forest area classification in Northeastern Switzerland. Department of Geography, University of Zurich, Germany.
12. Kanbhum, R.T. 1998. Study on forest change detection in eastern forest by remote sensing technique. National Research council of Thailand. Remote Sensing of Environment (90), pp: 154-161
13. Panikkar S.V. (1982); Forest change detection. http://www.gisdevelopment.net/ application/environment/conservation/frcm0005 pf.htm
14. Smailpour Podeh. S, Oladi. J, Pormajidian M.R. and miryaghoobzadeh M. (2009); Forest Change Detection in the North of Iran using TM/ETM+ Imagery. Asian Journal of Applied Sciences, Year: 2009, Volume: 2, Page No.: 464-474
15. Yuan, F.K.E., Sawaya, B.C., Loeffelholz, Bauer, M.E. 2005. Land covers classification and change analysis of the Twin Cities (Minnesota) Metropolitan Area by multi temporal Landsat remote sensing. Remote Sensing of Environment (95), pp: 317-328.

2/2/2013