Research Journal of Recent Sciences ISSN 2277-2502
Vol. **3(2),** 74-80, February **(2014)** *Res.J.Recent Sci.*

An Investigation on the Trend of Changes in Land use/Plant Coverage Case Study in Arangeh-watershed in Alborz Province of Iran

S. Tavafi[1], H.Arzani[2], H.M. Mohammadi[3], M.Jafari[2] and S.Babaie[4]
[1]epartment of Range management, Science and Research Branch, Islamic Azad University, Tehran, IRAN
[2]Department of Natural Resources, Tehran University, IRAN
[3]Department of Agriculture, Tehrann University, IRAN
[4]Department of Forestry, Science and Research Branch, Islamic Azad University, Tehran, IRAN

Available online at: www.isca.in, www.isca.me
Received 9th July 2013, revised 28th August 2013, accepted 1st October 2013

Abstract

Physica appearance of earth surface countinusely changes due to human activities as well as natural phenomena and consequences appear in both local and global scales. The issue is so important that trend of changes in area of rangelands has been considered as an high value index in the evaluation of rangeland sustainability. Sufficient knowledge on the subject, is necessary for implementation of a perfect management on land as a major source in agriculture sector. Current research carried out to investigate the trend of changes in land use. To study the land use in 1996, were used the map provided based on lands at satellite TM 1996 by Forest, range and watershed organization of IRAN. To provide land use map for the year 2011,image from satellite IRS (LISS-III sensor) were used. In this area, land use categories were separated as rangelands with different percentage of coverage, appearance of stone masses, orchards, cropped lands and residential areas. Result showed that most area is related to rangelands marked as R3 (with coverage of 5-25%). Residential areas, despite of minimum area under usage, had the maximum of increasing changes (around triple). Trends of changes in land use categories in 15-year period was determined in significance and non-significance trial using spss.16 software. Such results showed that among the factors investigated, increasing changes in residential areas is significant (p‹0.01).

Keywords: Land use, changes, IRS, residential areas, arangeh.

Introduction

Land use has been increasingly changed from land as a natural resource to a substrate for agricultural activities and building residential areas in recent decades in IRAN. This, necessitates proper knowledge on the issue in order to help any fundamental planning. Now days, with more migrations from villages to cities, many villages are going to be out of population or converted to leasure places for city dewellers. The consequence will be more and more changing of natural resources and arable areas to buildings and villas. Rangelands, as a renewable source, cover some 54% of total Iran′s surface. So, due to it′s large extension, and vital role playing in human life, any change in rangelands will result in many harmful environmental effects. Therefore, knowledge on the issue and its trend is highly important as a key factor in rangeland management. Man brings destruction to natural resource, and rangelands in particular by entering domestic animals were than capacity to rangelands or by changing agricultured lands to residential areas, depending to his need from time to time.

Qualitative and quantitative damages to rangelands of IRANO-TOURAN were assessed[1]. In this research it was concluded that during a period of 40 years (from 1956 to 1996) around 9.1% of rangelands in mentioned area has been converted to other uses. In a research on effective factors on the destruction of rangelands of Kermanshah province, it was concluded that the main element in such destruction on ranglands is land use changes as excessive animal feeding[2]. They showed that in the lands located adjacent to villages, the main factor of land use change is construction activities and animal feeding is the second important factor, while in nomadic territories, the animal feeding is main damaging cause on rangelands. Regarding the mentioned parameters, it seems that more accurate managerial plans are required to protect rangelands, and total environment in a larger view, not only from excessive animal feeding, but also land use cases.

Because of it′s high importance, having knowledge on land use patterns and their changes during time which inbcludes different land uses, is a main prerequisite for any optimal land use programming[3]. Due to lack of surface maps of land uses, the utilization of satellite images has been proposed in recent years. Moreover, as conventional approaches to investigate land use changes and coverage are generally expensive and time consuming, there has been attention to satellite images with regard to merites such as extended and unified field of vision, applying different parts of electromagnetic energy expectra to record phenomena characteristic, frequent coverage and posibility of using hard wares and soft wares[4]. Satellite remote sensing data is not only cost effective, reliable and timely but also meets the essential requirements of data in the

Geographical Information System (GIS) domain, which are current, sufficiently accurate, comprehensive and available to a uniform standard[5]. Many studies have been carried out so far regarding the determination of land use and land coverage. In most cost effective studies, application of remote sensing techniques and geographical data system and experts have emphasised on satellite data like land sat, spot, and IRS in provision related maps[6].

Some research have used remote sensing techniques and geographical data system to produce land use map for Long cavi island Malaysia, using TM images with high level of precision[7].

Some others, produced land use, maps for level on the banks of Arizona river via linear Imaging Self-Scanning Sensor(Liss-III)[8]. Different phenomena in land coverage classification Keshtkar[8] were separated by using data from Liss-III and IRS through contrast improvement, providing color pseudo-images and principle component analysis (PCI)in Ghurkhude area of khorasan province in Iran[9]. It was concluded that data taken from liss-III are capable of separating rangelands from other land uses in Sorkhabad watershed of Mazandaran proviunce in north Iran, as he differentiated ranglands with low density, middle density and high density algorithms with morethan 90% of acuracy using RVI and NDVI indexes[10]. In a study done by using Tematic Mapper (TM) and Advanced very High Resolution Rediometer (AVHRR) data in north east US, it was concluded that, land use changes and coverage is due to city development, as well as Microclimate and Hydrological changes[11]. In this study, which was carried out using supervised classification, 4 types of land use were distinguished: i. Urban and residential areas ii. Forest lands iii. Agricultural lands iv. Marine areas. Provided maps indicated that urban areas have been developed while, agricultural lands are reduced. Changes in land use from 1888 to 1990 in an area of Milan (Italy) were studied using topographic maps, aerial images and digitized TM data[12]. They concluded that during a century, residential areas have increased from 2.6% to 32% while in contrast, rangelands have reduced and converted to residential areas.

Material and Methods

Study area: The research was done in Arangeh watershed, located in north of Iran and down the Amirkabir dam in Alborz province, between the 51˚ 2′ to 51˚13′ east and35˚54′ to 35˚57′ north (figure-1) with 10190 ha area. Amirkabir dam is one of the most important dams in IRAN which supplies the main part of drinking water of Tehran the capital. The maximum hight from sea level of study area is 3660m which is located in east and the minimum hight is 1660 m, located in exit point of the watershed. Different types of land use in area includes rangeland, with dominant plant type *Oryzopsis holciforme–Astagalus gosypinus*, orchards, limited irrigated agriculture, residential teritoris and leasure places.

Landuse map of 1996: In order to study land use in 1996, the map of land use provided by Forest, Range and watershed organization on the basis of satellite images of lands at sensor TM, 1996 was used, and according to basic topographic map (1:25000) and Digital Elevation Model (DEM), the TM image was geometrically corrected up to ortho (3D) level. This was carried out for assessment of the validity of land use map provided by Forest, Range and watershed organization. Later, map was compared with corrected images, in away that index, fixed and stable phenomena on the map (such as waterways,…) were compared to images. For this purpose, point control on the geo referenced digitized map of waterways transferred to corresponding points on TM image. This was repeated to the extent that the control points on the waterways map were exactly overlaied the image at the same points. These rectification were carried out in Orthorectification method using Geomathica 9.1 software.

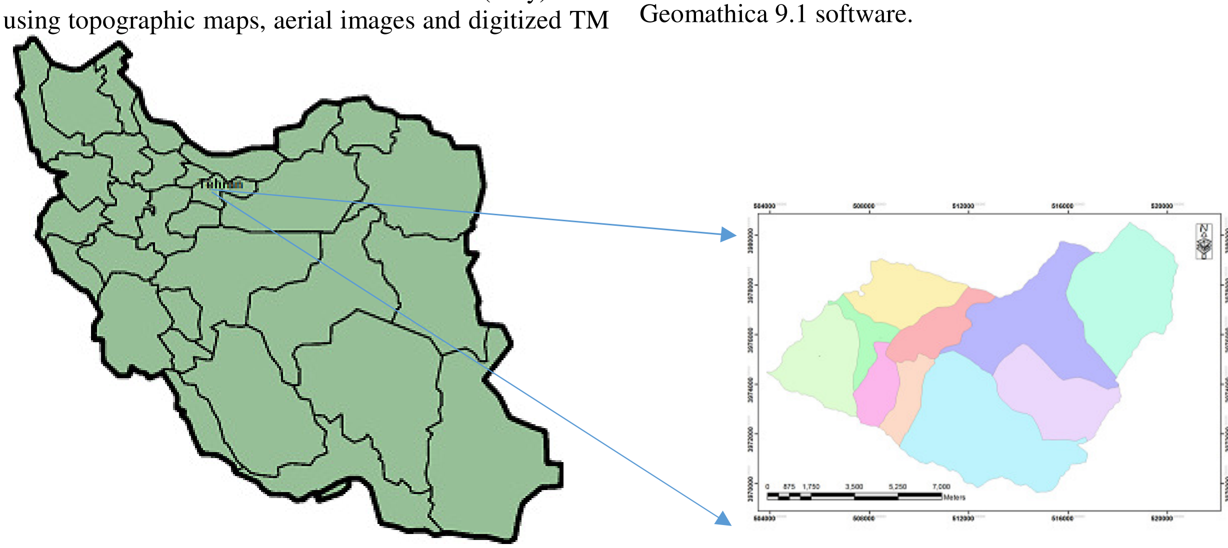


Figure-1
Location map of Arangeh watershed Alborz province, IRAN

Land use map of 2011: Image pre-processing: To provide land use map of 2011, we used cloud-free Indian Remote Sensing Satellite (IRS) image which is related to Liss-III sensor, June 2011. This sensor has four spectra; Green (0.52-0.59µm), Red (0.62-0.68µm) and moderate infrared (1.55-1.7µm) with differentiation capability of 23.5 m. The image was projected in Universal Transverse Mercator (UTM) zone 39, WGS84. using at least 15 well-distributed ground control points and nearest neighbor resampling. The root mean square errors (RMS) were less than o.5 pixel. As the studied area was mountains, latitude correction was carried out using Digital Elevation Model (DEM) map and orthorectification geometric correspondence in Geomathica 9.1 software.

Image classification: Image classification was done on the basis of land cover and land use classification system developed by Anderson[13]. The unsupervised image classification method was carried out before visiting the field. We tried to improve our awareness of land use class through using land use map 1996 and topographic maps (1:25000) and inquiring local people. For each land use class, training areas and inside those areas, training points were recorded by GPS. In order to select training areas we should note that spreading the samples on different phenomenon of the image should be appropriate so that none of the degress or spectral values are eliminated, and the size of the samples are also appropriate in a way that the number of pixels in every sample would be at least ten times the number of used bands in classification[14]. At least 20 samples were selected in different classes of land use (120 points) and half of these points were meant to evaluate the accuracy of classification were not included in the first process. In order to make the images emergent and extract data from the images, different techniques of image processing such as, contrast improvement, making pseudo color images, principle components analysis (PCA) on the major bands were used. Then by introducing sixty recorded training points to the software the supervised classification technique with maximum likelihood algorithm as one of the most accurate methods of classifying basic pixels was applied. This was done using Geomathica 9.1 software.

Making index: Making indexes help to distinguish the plant cover. Bands 2 and 3 in the spectrum of red and near infrared were used as follows. NDVI = (LISS 3 – LISS 2) / (LISS 3 + LISS 2), RVI = (LISS 3 / LISS 2). ENVI 4 software was used to make indexes. Vegetation index shows the status of plant cover on the land surface in vast regions. Numerical value of the Normalized Difference Vegetation Index (NDVI) varies between 1 and -1. Positive numerical values related to concentrated plant cover and numerical value of zero and amounts close to that are attributed to the regions without plant cover.

The results of various researches suggest the ability of bands 2 and 3 in distinguishing the plant cover, because the plant cover has a high rate of reflection in the spectrum of near infra red[15-17].

Accuracy of classification and change detection: To examine the accuracy of the classification, the error matrix was used to assess classification accuracy[18] and for that purpose the land recorded points which were not included in the classification process as a control point were used. Total accuracy, accuracy of user, accuracy of producer and kappa statistics were obtained from the error matrix table. Then by using ARCGIS 9.3, vector maps of 1996 and 2011 were compared and the results were provided in the tables and graph. The obtained results were analyzed statistically using SPSS 16 software, and significance or insignificance of land use changes over 15 years were examined.

Results and Discussion

After preparation of error matrix , statistical characteristics, accuracy of producer, accuracy of user, commission error which reflects the number pixels located mistakenly in unrelated classes and ommision which reflects the complexity of spectra reflection in the area and those pixels not identified and located in their own real class, was extracted for each class as represented in table1. The total accuracy was 86.3% and kapa index was 84%.As we can see in table 1. In Arangeh watershed, 6 classes of land use can be ditinguished with regard to different levels of plant cover in rangelands: i. Orchards and irrigated arables, ii. Rockiness area, iii. High density rangelands with plant cover of more than 50% (R1), iv. Middle density rangelands with plant cover of 25% to50% (R2) v. Low density rangelands with plant cover of 5% to 25% (R3), vi. Residential areas.

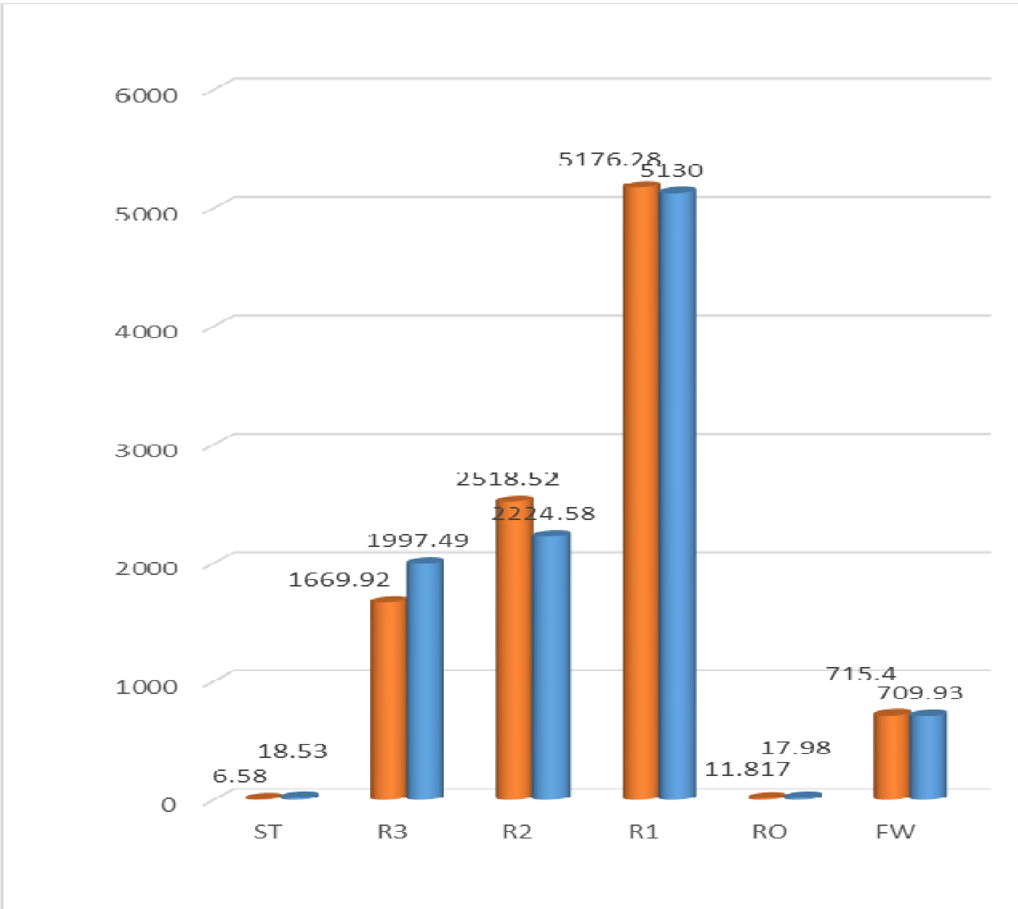
With reference to table 2, we can see that the largest area in land use classes is related to R1 and R2 types with 72.8% and smallest area is related to residential areas with 0.18%. The total percentage of changes from 1996 to 2011 is 7%. The highest level of changes is that of increasing in residential areas as well as R3 rangelands, while the lowest level of changes is related to decreasing trend in orchards and arable lands. Figure 2 shows the area of each land use classes on hectar in 1996 and 2011. Figures 3 and 4 show land use map in two different years.

Table-1
Different amount of producer and user accuracy in separate classes of land use

Commission	Ommission	Accuracy of producer	Accuracy of user	Class of land use
2.15	3.67	96.23	97.85	Irrigated arables
7.55	4.08	95.92	92.45	R1
9.80	8.25	91.75	90.20	R2
11.55	15.35	84.65	88.45	R3
13.39	26.63	74.37	86.61	Residential areas
17.70	9.74	90.26	82.30	Rockiness areas

Table-2
Percentage of land use classes and the percentage of changes in the period of 1996-2011

Change of area(percentage)	Change of area(ha)	Area percentage2011)(	Area percentage (1996)	Land use classes
-0.05	5.47	7.03	7.08	Irrigated arables
-.45	46.19	5.08	51.25	R1
-2.91	2.94	22.02	24.93	R2
+3.25	327.57	19.78	16.53	R3
+0.12	11.9	0.18	0.06	Residential areas
+0.06	6.163	0.17	0.11	Rockiness areas
7	691.293	100	100	Total



R1: Rangeland with high density, R2: Rangeland with moderate density, R3: Rangeland with low density, RO: Rockiness area, FW:Irrigated arrable, ST:Residential area.

Figure-2
The area (ha) of each land use classes in two different years

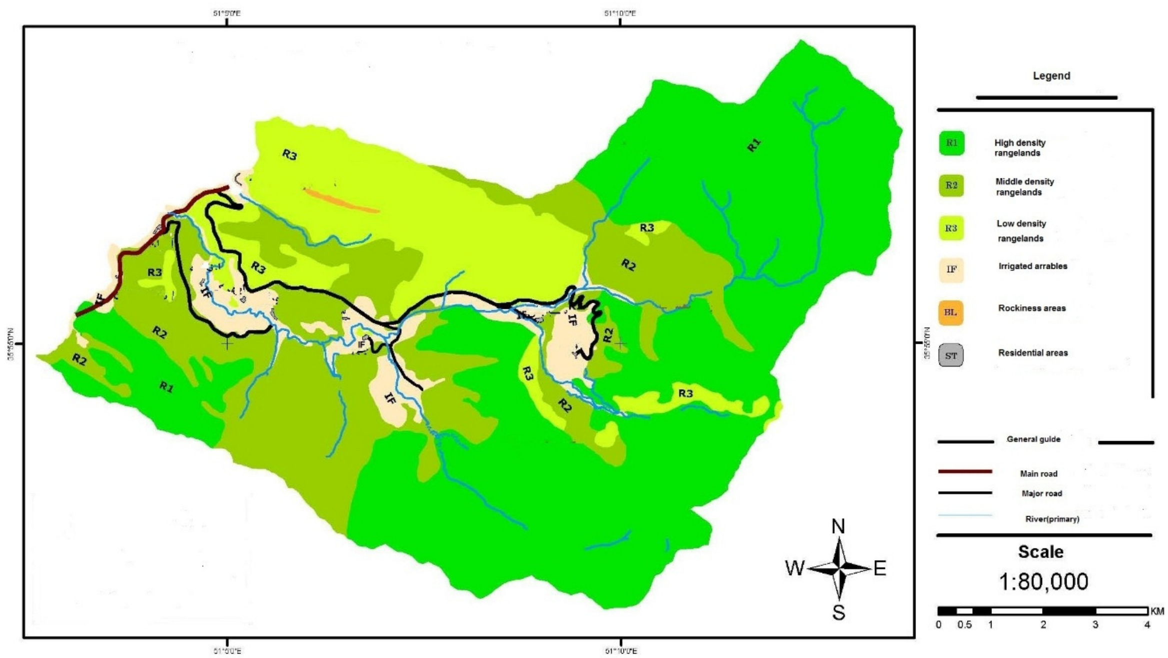


Figure-3
Land use map of 1996

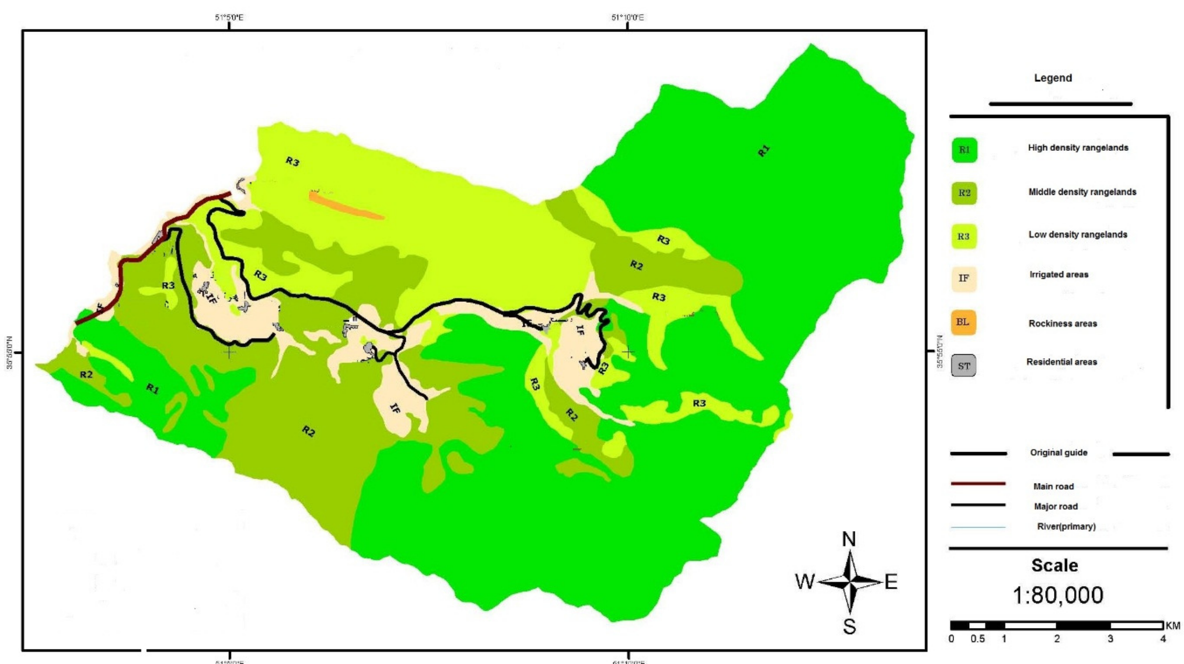


Figure-4
Land use map of 1390

Significance test for changes: To investigate the significance or non-significance of land use change from 1996 to 2011,Tstudent analysis was applied on different land use classes of the studied area in 10 allotments according to table 3. The results showed that only the changes in residential lands with the assurance of 99% were significant ($p<0.01$).

Table-3
Results of T student test for significance of changes

Studied factors	year	N	Mean	Standard deviation	Standard error	P-value	Significant
R1	1996	10	57.625	678.064	214.423	0.185	ns
	2011	10	513.o28	672.206	212.570		
R2	1996	10	251.84	150.731	47.665	0.202	ns
	2011	10	222.454	137.77	43.567		
R3	1996	10	166.989	216.957	68.608	0.150	ns
	2011	10	199.739	250.811	79.313		
Rockiness area	1996	10	1.181	3.734	1.181	0.343	ns
	2011	10	1.798	5.685	1.798		
Irrigated arable	1996	10	64.518	44.432	14.05	0.380	ns
	2011	10	70.99	48.983	15.48		
Residential	1996	10	0.655	0.468	0.148	0.003	**
	2011	10	1.841	1.348	0.426		

Conclusion

According to findings of previous researchers current study also demonstrates that satellite image such as those from IRS, LISSIII in accompany with training sample with proper distribution and acceptable accuracy are capable of extracting land use maps. In this work, different classes of land use were determined with 86.3% of accuracy which is an acceptable result for classses separation. Nasiri[19] states that accuracy required for land use classes classification should be more than 85%. It was revealed via T student test that changes in residential areas was significant at level 0.01 in a 15-years period. These areas have been developed by 11.9 ha that means equal reduction in other classes. More clearly, during this period, 6.5 ha of R1 and R2 rangelands and 5.4 ha of orchards and arables have been changed to residential areas. Since in the studied area, considering the location of the area ,its closeness to metropolises like Tehran, losing the position of villages as producers and an increase in the land price in recercent years, some rangelands and agricultural areas have been changed into residential ones, tht results in many unreversable damage to environment. In a research titled “study of land use changes in desertification in suburb areas of Ardakan” it was concluded that the main factor causing destruction in the area is an uncontrolled transformation of other land use types into residential places[20]. Two more researchers too in their study in Jordan in a research with the purpose of finding reasons of land destruction came to the same conclusion[21]. In an article titled "Trends in setting and developing of second homes (Villas) in northern parts of Tehran", spending thier leisure and an increase in air pollution in downtown were considered as the main reasons for the development of villas in northern areas of Tehran[22].

As it was mentioned, in the studied area during 15 years, residential areas have tripled. Accordingly, it is necessary that responsible authorities and planning managers to pay more attention to the issue. The main factor that can be effective prevention of this trend is continous monitoring on land changes. To achieve this goal, remote sensing technique and using satellite images can be effectively utilized. It is recommended that legal limitations should be executed strictly to prevent current trend of changing of natural resources and rangelands to villas and residential places. Besides, there is a possibility for finding a suitable area for building villas in order to prevent damage to other places. And finally, proper knowledge should be given to people regarding the environmental consequences of changes in land uses and developing residentials in rangelands.

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