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Evaluation of Land Use Change in Lali City Applying Maximum Likelihood Algorithm

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Abstract

Urban land use maps, in addition to different classes of land use with spatial patterns, specify the type and intensity of land use; therefore, they can be used for current and future planning of urban land. In this study, land use changes in Lali city in 30 years (1987-2017) were investigated. To evaluate the land use changes in this time interval, several spectral images of Landsat satellites 5, 7, and 8 from the years 1987, 2001 and 2017 were utilized. After collecting data and the application of necessary pre-processing on them, also for the preparation of land use maps for the specified time intervals, data analysis was carried out by Maximum Likelihood Classification Algorithm. The findings obtained each year were monitored and controlled through field operations, and land use maps in 7 classes of agriculture, rangeland, forest, mountain, residential, river, and other areas were produced. Then, the changes in each land use were determined in the specified periods during 1987 to 2001, 2001 to 2017, and eventually 1987 to 2017. While the results obtained from the final changes illustrate that the overall level of vegetation compared to the beginning of the period has declined markedly which is an indication of deforestation in the region, urban areas, agriculture, and rangelands have maintained an ascending trend which can be due to increasing urban development and rural expansion, and the growing need of residents for housing, agriculture, and gardens.

Keywords*:* Lali City, Maximum Likelihood, Algorithm, Land Use.

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1. Introduction

Land use changes are one of the most fundamental topics on-trend around the world that has accelerated concurrently with the growth of urbanization (Mahdavi & Berenjkar, 2014). Physical development of cities is a dynamic and inevitable process during which the physical boundaries of the city undergo expansion in different directions, and then cause changes in the land coverage of the region (Amiri et al., 2007). Disclosure of these changes in remote sensing is carried out using air shots or satellite imageries from an area on different dates, and it describes changes along with land use features (Wang & Xu, 2010).

Remote sensing is a wonderful tool for mapping and monitoring the change areas over large regions (Longley 2002, Rogan and Chen, 2004; Lu et al., 2004), integrating with GIS, they provide an extremely useful and accurate information on changes in the earth's surface (Wu et al., 2006). Change detection is related to the monitoring, finding, and identifying changes of two registered satellite images from the same region obtained at two different times (Raja et al., 2013). The Landsat satellite images provide high accuracy for analyzing the spatiotemporal changes of land use and land cover that is accepted in the scientific community (Bakr et al., 2010).

Lali City witnessed intense land use and land cover changes mainly as a result of the increase in population, and economic growth. However, the Land use and land cover changes are not being monitored in a systematic method and estimation of the bigness of the changes is rarely being done; therefore, the science of the land use and land cover dynamics in the area is rare. In this research we attempt to map and quantify the land use and land cover changes in Lali City in 30 years (1987-2017), using remote sensing data. The research hypothesis is that over a 30 years, from 1987 to 2017, as a result of population growth, residential lands and agricultural areas have increased. The purpose of this article is to investigate land use changes in Lali city using GIS methods.

In the field of land use changes, many studies have been conducted. As an instance, in 2010 using Landsat satellite image, Matkan and his colleagues studied land use changes in Taleghan Dam in 20 years. The results indicated that dam construction has destructed the vegetation coverage of the region (Matkan et al., 2010). In 2011, monitoring TM and ETM images of Landsat satellite in 1989 and 2000, as well as the LISS image of the IRS satellite in 2007, Aliani studied the land use changes in the city of Talesh which showed that forest and agricultural lands have shrunk and urbanization has increased (Aliani et al., 2011). Also, by utilizing TM and MSS measuring images, Ramazani in 2011 examined the land use changes monitoring due to the construction of the dam in the watershed of the city of Esfarayen from 1972 to 2009 that illustrated the fact that due to the construction of the dam, many gardens and rangelands of the region have disappeared and it has changed land use (Ramazani et al., 2011).

Roosta also provided land use maps of Shiraz using ETM (2000), TM (1990), and IRS (2009) monitoring data. The results signified that the coverage level of gardens has decreased and the urban level of land use has increased (Roosta et al., 2012). Hadian in 2013, by investigating the effect of the construction of Hanna Dam on land use changes using Landsat satellite images showed that dam construction in the short term increases the hydroponic areas of land and after 15 years results in a severe reduction of these areas of land (Hadian et al., 2013). In a 2013 study, to prepare the Sabzevar city map, Akbari and his colleagues used the maximum Likelihood and artificial neural network of perceptron and classified land maps into four classes of residential areas, infertile land, vegetation, and roads (Akbari et al., 2013).

Omidvar and his colleagues in 2015 using TM images provided regional land use maps (Omidvar et al., 2015). Also, Rajabzadeh to examine land use changes utilized various Landsat satellite images and reviewed land use changes in 38 years (Rajabzadeh, 2016). Mousavi also studied the land use changes in the Abarkuh Desert in 38 years (1976-2014) using data from Landsat satellite images (Mousavi et al., 2016). Seyedeh Maedeh Shenani Howeizeh in 2016, to make a map of Abol Abbas watershed land use, employed different supervised classification models with maximum Likelihood algorithm

(Shanani Huveizeh & Zarei, 2016). In 2017, Sabzeqabae studied land use changes in the southern part of the city of Andimeshkh from 1985 to 2013, using MSS and TM images of Landsat 8 of 2013 showed that rangelands have diminished while residential areas, agricultural land, and water-covered lands have escalated (Sabzeghabae et al., 2017).

Outside of Iran, Thapa and his colleagues, using satellite image and remote sensing techniques in 2006 investigated different land use changes in Catomanti, Nepal (Thapa & Murayama, 2006). Devon, in Greater Dhaka, Bangladesh, evaluated land use changes from 1975 to 2003 using satellite image. His findings showed that significant expansion in suburban areas has significantly diminished water level, agricultural land, vegetation, and lagoons (Dewan & Yamaguchib, 2009). Abad and his colleagues in 2011 conducted the supervised classification over Western Nile Delta on four images of Landsat 1984, 1999, 2005, and 2009, and showed that a major change has altered the infertile land into the agricultural land (Abd et al., 2011). Using data from Landsat 7 and the maximum likelihood classification algorithm in 2016, Cherto studied land use changes in Mcono in a time interval from 2000 to 2016 and then classified the land use into seven main classes of LULC (Cheruto et al., 2016).

Also, Alam et al., 2020 examined the land use and land cover changes in the Kashmir valley between the periods from 1992–2001–2015 using the Landsat satellites and maximum likelihood. Results showed that three land use change patterns were observed: 1) increase of the area under marshy, plantation, built-up, shrubs, and barren; (2) decrease in water and agriculture; (3) decrease in forest and pasture classes in (1992–2001) and increase at them in (2001–2015) (Alam et al., 2020).

2. Methodology

2.1. Study Area

In this research, Lali city is considered as the study area. Lali city covers a total area of around 1418 kilometers. It is located in the north of Khuzestan province and is 175 kilometers far from Ahvaz. From the east and northeast, it abuts with the city of Andika, from the south and southwest with the city of Masjed Soleyman, from the north and northwest with Sardasht, Dezful, and from the West with the city of Gotvand, Figure (1).

Figure 1. The location of the study area

2.2. Method

In this study, the research model is fieldwork and descriptive-analytic. First, the required data were collected and then analyzed. Data analysis was carried out by applying the maximum likelihood classification algorithm to prepare the land use map. The findings were prepared through field control operations and land use map in 7 classes of agriculture, rangeland, forest, mountain, residential, river, and other areas. To investigate land use changes in Lali from 1987 to 2017, Landsat satellite multi-spectrum imageries were used. The corresponding data included Landsat images with 165 rows and 38 passes, including TM Landsat 5 sensory images taken on July 14, 1987, ETM+ Landsat 7 sensory images taken on July 28, 2001, OLI Landsat 8 sensory images taken on July 16, 2017. This research includes different steps that will be illustrated later in the following sections.

The study process is shown in Figure 2.

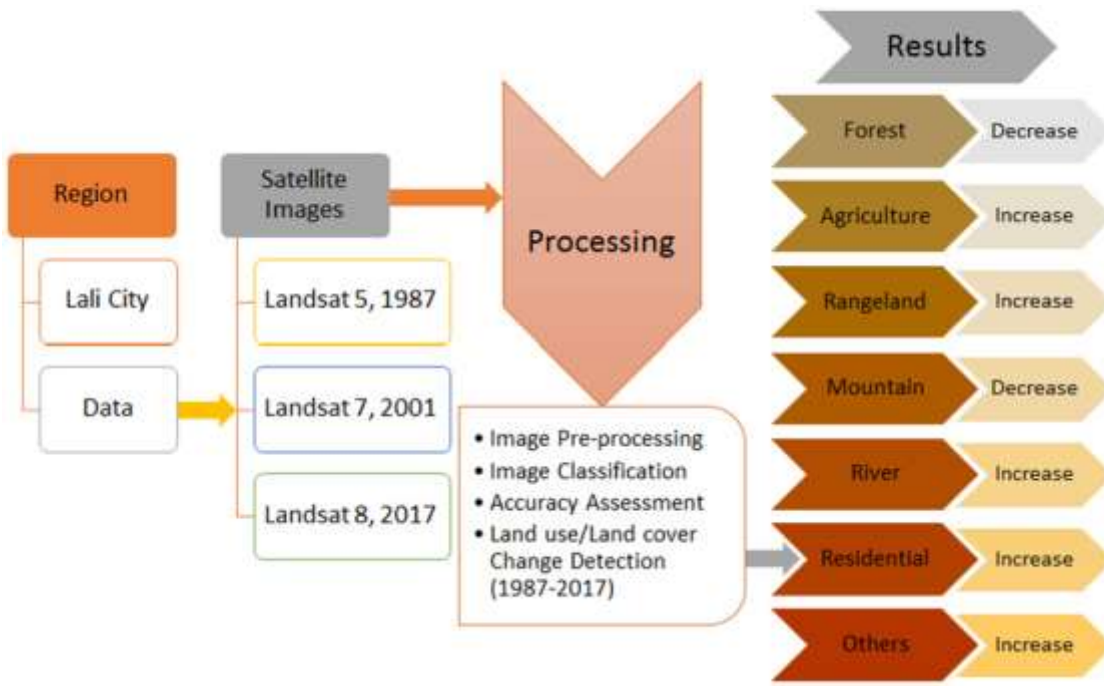

Figure 2. Study process of the study area

2.3. Image Pre-Processing

The raw and basic data of all sensors have different errors. Although primary correction is applied to satellite images after receiving from the satellite at ground stations, they still contain errors such as displacement due to ups and downs, while lacking coordinates (Makhdoom et al., 2011); therefore, the identification and detection of possible errors in satellite data are significant (Alavi Panah, 2006). Preprocessing of satellite images includes the examination of data quality, radiometric correction, geometric correction, and atmospheric correction (Alavi Panah, 2003; Mabasheri, 2010). In this research, to resolve defects and errors of raw images received from sensors, atmospheric correction and calibration were employed. In this research, Quick Atmospheric Correction (QUAC) model was applied to the band of satellite images due to the wavelength of each band (Bernstein et al., 2012) and the final result was used as an input image for classification.

2.4. Image Classification

To classify using the supervised model first, the number of classes was divided into seven separate land use based on the objective of the research, including agriculture, rangeland, forest, mountain, residential, river, and other areas (including rangeland and infertile land).

Then, the maximum likelihood model (most similar) was used for classification, because this model is the most well-known and the most widely used for classification (Mather, 1999). Also, to improve the quality of classification and the integration of dispersed pixels in the class concerned, the post-classification model with dimensions of 3 × 3 was used (Firoozi Nejad, 2013). Eventually, after reviewing the accuracy of the classification, the land use maps of the years 1987, 2001, and 2017 were drawn.

a. Selecting Educational Samples

To conduct a classification using the maximum likelihood algorithm, the necessary samples should be selected first. In fact, the educational samples should be representative of the class they demonstrate; therefore, the educational points should be to the extent that the characteristics of the samples can be pointed out accurately and completely (Mather & Tso, 2009). Hence, for choosing land use in this study, the samples were selected regarding ground control points prepared by ground measurement and also using Google Earth software.

b. Separability of Classes

For the separation of educational samples, after specifying the samples, the Jeffries-Matusita distance index was used. This index is obtained from the following relation (Equation 1) and its range is between 0-2 (Lu et al., 2004).

$$JM\ (i,j) = 2(1 - e - a(i,j)) \tag{1}$$

In this relation JM (I, J) is equal to the Jeffries-Matusita distance between Class I and J. Also, in this model, zero means non-separability, 0-1 determines very weak separability,1.9 means weak separability, 1.9 to 2 signifies good separability, and 2 indicates complete separability between the classes.

c. Classification of Images with the Maximum Likelihood Algorithm

After selecting educational samples for agricultural, rangeland, forest, mountain, residential, river, and other areas, the maximum Likelihood algorithm was used to perform image classification; then images from the years2017, 2001, and 1987 were classified.

d. Accuracy Assessment

In this study, evaluation was carried out after the production of land use maps through the application of a supervised model using ground control points that were randomly selected from field visits and air photographs as a referenced data for any land use. To determine the accuracy of classification, photography of ground control points was done using GPS and from 200 land control points. This was used as reference data with classified images and concerning error matrix preparation. Then, the accuracy of the classification for classified images was evaluated using the results of the matrix table and the Kappa index.

2.5. Land Use Land Cover Detection

Based on the objectives of this research, land use maps of the studied area should be accurately based on satellite image analysis. Therefore, among the models of analyzing images, it should be selected a model that results in accurate land use maps so that they can provide past changes and also forecast changes in the future with much accuracy.

a. Detection of Changes using Land Use Multiplication Matrix (LMM)

Land use Multiplication Matrix (LMM) was used to detect changes in the time intervals considered. In this model, the following relation (Equation 2) is used (Jalili, 2013; Shojaian, 2014).

$$LMM = CT1 \times 10 + CT2 \quad (2)$$

In this Equation, the LMM stands for Land use Multiplication Matrix. CT1 is the classified image of the first period, and CT2 is the classified image of the second period.

3. Results and Discussion

3.1. Examining the Separability of Classes

After selecting appropriate educational samples, the separability of bands was investigated using the Jeffries-Matusita criterion in the classification of 7 classes. Table (1) shows the results of the separability of classes in different years.

Table 1. Separability of classes based on the jeffries– matusita criterion in the years1987, 2001, and 2017

Year	Separability (min)	Separability (max)	Separability (mean)
1987	1.24	1.99	1.61
2001	1.42	1.99	1.70
2017	0.89	1.99	1.44

3.2. Preparing of Land Use Maps using the Maximum Likelihood Algorithm

After the classification, using the maximum likelihood algorithm, land use maps were created from satellite images during 1987, 2001, 2017 (Figure. 3).

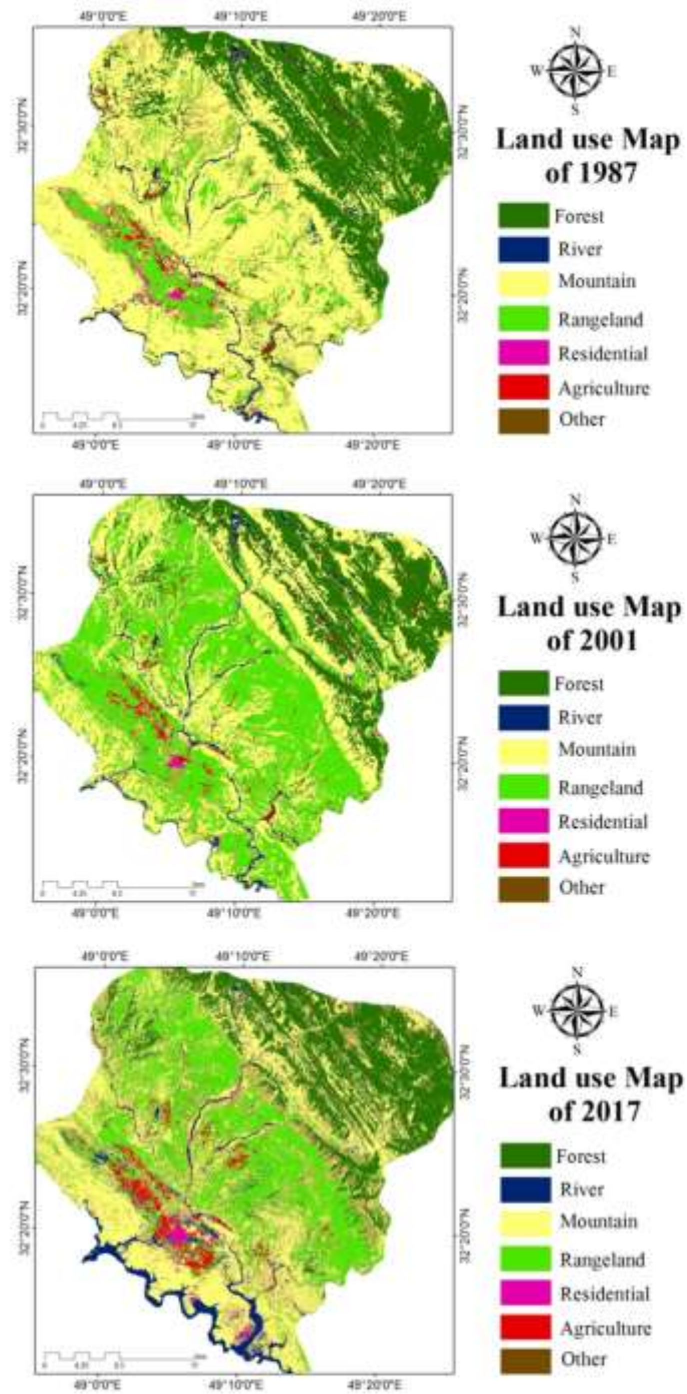

Figure 3. Land use maps of the study area during 1987, 2001, and 2017

3.3. Accuracy Assessment for the Classified Images

After classification of images and preparing land use maps using TM, ETM, OLI data, the Kappa coefficient was used to evaluate the accuracy of the classification maps. The findings are illustrated in Table (2). The results show the proper accuracy of land use maps and correspondence with ground data.

Table 2. Evaluation of the accuracy of land use maps of 1987, 2001, and 2017 based on general accuracy and Kappa coefficient

	Land use map of 2017	**Land use map of 2001**	**Land use map of 1987**
General accuracy	88.42	94.11	94.66
Kappa coefficient	0.85	0.92	0.93

3.4. Land Use Area During 1987, 2001 and 2017

The area of land use available in the maps obtained from different years is presented in Table (3). According to the data, the largest area is occupied by mountain and so is the lowest level by residential areas.

Table 3. Land use area during 1987,2001, and 2017

Land use type	**Land use area in 1987 (ha)**	**Land use area in 2001 (ha)**	**Land use area in 2017 (ha)**
Forest	44957.77	26481.80	31902.15
Agriculture	2493.62	2972.94	2990.70
Rangeland	16094.18	51026.10	35694.90
Mountain	66495.59	52269.28	48624.55
River	4341.37	4157.56	6371.65
Residential	1246.25	127.53	1431.15
Others	3333.75	2926.30	12947/04

3.5. Land Use Land Cover Change Detection using LMM Model

In this section, the maps of the three years of 1987, 2001, and 2017 were investigated, and using the LMM model in the GIS environment, maps of land use changes were prepared in the aforementioned periods.

a. Land Use Land Cover Change Detection Map during 1987-2001

Land use change map of the study area was prepared between 1987 to 2001 using the LMM model, Figure 4. Also, the changes in land use types during this period are calculated and shown in Table (4).

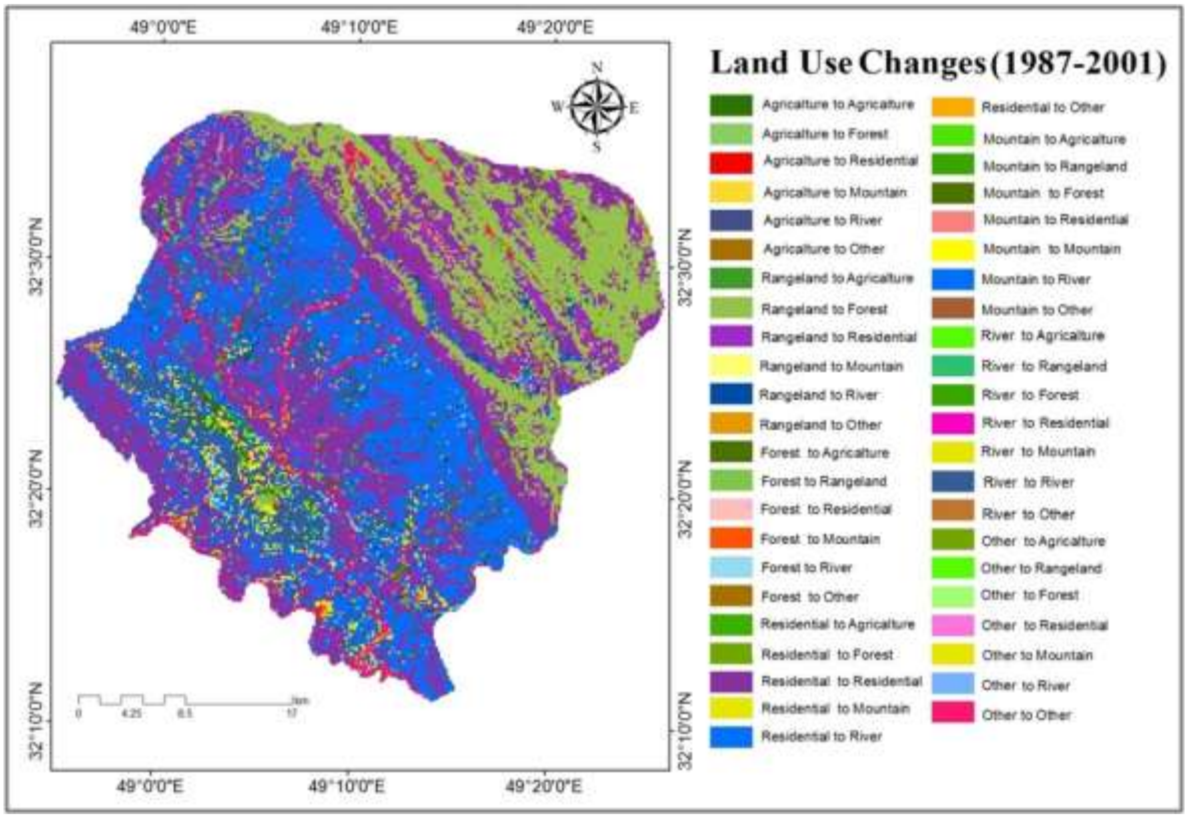

Figure 4. Land use change map during 1987-2001

Table4. Changes of land use types during 1987 to 2001

No.	Land use type	Area(ha)	Change %	No.	Land use type	Area(ha)	Change %
1	Agriculture to Agriculture	807.70	0.57	23	Residential to Others	1052.04	0.75
2	Agriculture to Forest	41.30	0.02	24	Mountain to Agriculture	143.66	0.10
3	Agriculture to Residential	261.38	0.18	25	Mountain to Rangeland	10.60	0.007
4	Agriculture to Mountain	236.85	0.16	26	Mountain to Forest	14.14	0/01
5	Agriculture to River	477.62	0.34	27	Mountain to Residential	437.14	0.31
6	Agriculture to Others	201.82	0.14	28	Mountain to Mountain	306.28	0.21
7	Rangeland to Agriculture	829.08	0.59	29	Mountain to River	4250.32	3.03
8	Rangeland to Forest	25290.64	18.07	30	Mountain to Others	45.83	0/03

9	Rangeland to Residential	9740.35	6.96	31	River to Agriculture	472.44	0.33
10	Rangeland to Mountain	53.02	0.037	32	River to Rangeland	3.53	0.002
11	Rangeland to River	2155.53	1.54	33	River to Forest	150.73	0.10
12	Rangeland to Others	75.22	0.05	34	River to Residential	1112.57	0.79
13	Forest to Agriculture	3.53	0.0025	35	River to Mountain	428.77	0.30
14	Forest to Rangeland	105.68	0.07	36	River to River	11120.86	7.94
15	Forest to Residential	50.48	0.03	37	River to Others	101.12	0.07
16	Forest to Mountain	109.58	0.07	38	Others to Agriculture	53.02	0.03
17	Forest to River	943.46	0.67	39	Others to Rangeland	3.53	0.0025
18	Forest to Others	78.76	0.05	40	Others to Forest	3.53	0.0025
19	Residential to Agriculture	478.81	0.34	41	Others to Residential	260.35	0.18
20	Residential to Forest	1503.11	1.07	42	Others to Mountain	17.67	0.01
21	Residential to Mountain	1916.63	1.36	43	Others to River	491.72	0.35
22	Residential to River	31413.74	22.44	44	Others to Others	2578.80	1.84

According to Table 4, in the period 1987-2001, different uses have changed. So that, the most changes occurred at the rate of 31413.74 hectares and were related to the conversion of residential use to the river. Also, the least changes were related to the conversion of river use to rangeland, and its amount is set at 3.53 hectares. The net rate of change of each user is also shown in Table 5.

Table 5. Areas of land use changes during 1987–2001

Land use type	Land use area in 1987 (ha)	land use area in 2001 (ha)	Change of land use area (ha)	Changes trend
Forest	44957.77	26482.80	-18474.97	Decrease
Agriculture	2493.62	2972.94	479.32	Increase
Rangeland	16094.18	41026.10	24931.93	Increase
Mountain	66495.59	52269.28	-14226.31	Decrease
River	4341.37	4157.56	-183.80	Decrease
Residential	1246.25	127.53	29.05	Increase
Others	3333.75	2926.30	-407.45	Decrease

b. Land Use Land Cover Change Detection Map During 2001-2017

Figure (5) illustrates the map of land use changes during 2001-2017. The changes in land use types are calculated and have been demonstrated in Table (6).

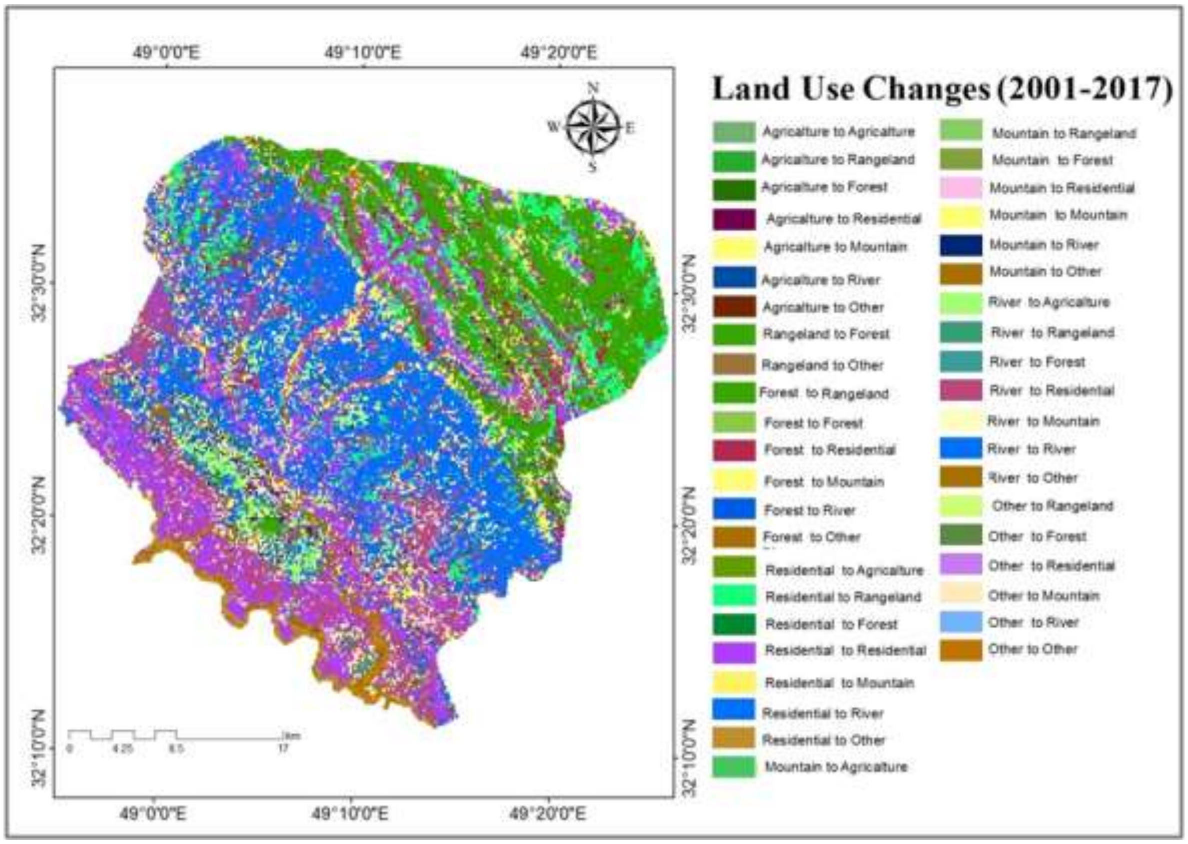

Figure 5. Land use change map during 2001-2017

Table 6. Changes of land use types during 2001- 2017

No.	Land use type	Area (ha)	Change %	No.	Land use type	Area (ha)	Change %
1	Agriculture to Agriculture	333.36	0.23	22	Mountain to Agriculture	222.43	0.15
2	Agriculture to Rangeland	341.5	0.24	23	Mountain to Rangeland	3.53	0.002
3	Agriculture to Forest	108.31	0.07	24	Mountain to Forest	243.77	0.17
4	Agriculture to Residential	632.38	0.45	25	Mountain to Residential	1303.03	0.93
5	Agriculture to Mountain	871.05	0.62	26	Mountain to Mountain	658.81	0.47
6	Agriculture to River	488.71	0.34	27	Mountain to River	383.49	0.27
7	Agriculture to Others	70.7	0.05	28	Mountain to Others	283.85	0.20
8	Rangeland to Forest	122.67	0.087	29	River to Agriculture	2459.97	0.017
9	Rangeland to Others	3.53	0.002	30	River to Rangeland	661.67	0.47
10	Forest to Rangeland	20479.59	14.64	31	River to Forest	948.26	0.67

11	Forest to Forest	7.07	0.005	32	River to Residential	15609.03	11.16
12	Forest to Residential	4019.10	2.87	33	River to Mountain	5717.84	4.08
13	Forest to Mountain	1636.03	1.16	34	River to River	23671.52	16.92
14	Forest to River	509.75	0.36	35	River to Others	2023.93	1.44
15	Forest to Others	14.14	0.01	36	Others to Rangeland	87.1	0.06
16	Residential to Agriculture	104.93	0.07	37	Others to Forest	116.65	0.08
17	Residential to Rangeland	9933.87	7.10	38	Others to Residential	986.44	0.7
18	Residential to Forest	187.23	0.13	39	Others to Mountain	643.67	0.46
19	Residential to Mountain	7694.02	5.5	40	Others to River	99.97	0.07
20	Residential to River	8548.19	6.11	41	Others to Others	2266.1	1.62
21	Residential to Others	1630.9	1.16				

The data obtained in the period 2001-2017 showed that the most changes related to the conversion of forest use to rangeland at the rate of 20479.59 hectares and the lowest changes related to the conversion of rangeland to other areas and mountains to rangeland and rangeland to others at the rate of 3.53 hectares. Also, the amount of net changes of each land use is shown in Table 7.

Table 7. Area of land use changes during 2001-2017

Land use type	Land use area in 2001 (ha)	land use area in 2017 (ha)	Change of land use area (ha)	Changes trend
Forest	30784.25	31902.15	1117.91	Increase
Agriculture	2327.85	2990.79	662.94	Increase
Rangeland	53898.05	35694/90	-18203.14	Decrease
Mountain	47663.07	48624.55	961.49	Increase
River	3148.26	6371.65	3223.39	Increase
Residential	452.25	1431.15	978.90	Increase
Others	2688.80	12947.04	10258.24	Increase

c. Land Use Land Cover Change Detection Map During 1987-2017

In Figure (6), land use changes of study area are elucidated during 1987-2017. In Table (8), the changes in land use types have been pointed out.

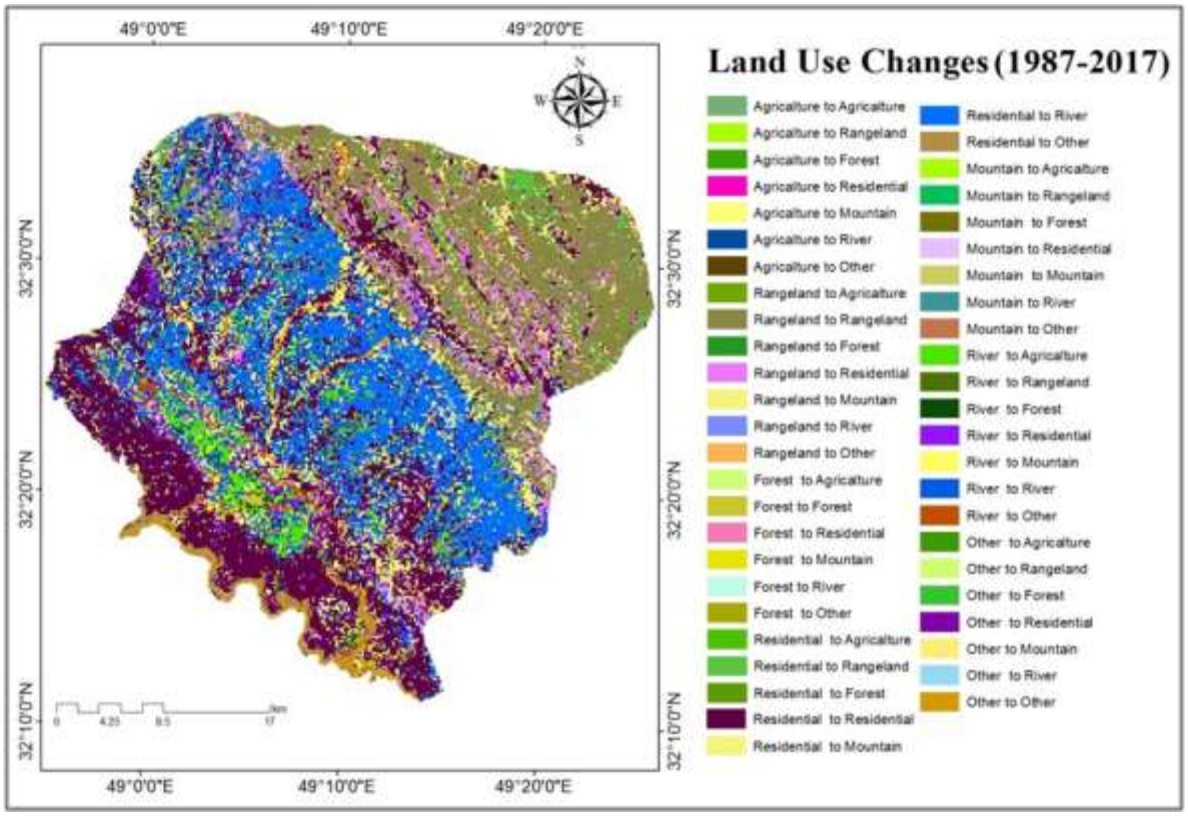

Figure 6. Land use change map during 1987-2017

Table 8. Changes of land use types during 1987- 2017

No.	Land use type	Area (ha)	Change %	No.	Land use type	Area (ha)	Change %
1	Agriculture to Agriculture	208.69	0.14	24	Residential to River	22267.19	15.91
2	Agriculture to Rangeland	147.2	0.1	25	Residential to Others	2356.83	1.68
3	Agriculture to Forest	84.84	0.06	26	Mountain to Agriculture	185.03	0.13
4	Agriculture to Residential	463.96	0.33	27	Mountain to Rangeland	35.35	0.025
5	Agriculture to Mountain	691.76	0.49	28	Mountain to Forest	136.59	0.09
6	Agriculture to River	286.34	0.2	29	Mountain to Residential	799.05	0.57
7	Agriculture to Others	163.03	0.116	30	Mountain to	815.08	0.58

					Mountain		
8	Rangeland to Agriculture	157.84	0.112	31	Mountain to River	3137.89	2.24
9	Rangeland to Forest	35.35	0.025	32	Mountain to Others	186.08	0.13
10	Rangeland to Residential	6818.41	4.87	33	River to Agriculture	2065.76	1.47
11	Rangeland to Mountain	4198.1	3.001	34	River to Rangeland	30.54	0.021
12	Rangeland to River	1466.33	1.04	35	River to Forest	705.22	0.5
13	Rangeland to Others	187.08	0.13	36	River to Residential	2335.40	1.66
14	Forest to Agriculture	7.07	0.005	37	River to Mountain	1389.37	0.99
15	Forest to Forest	182.13	0.13	38	River to River	5873.9	4.19
16	Forest to Residential	334.56	0.23	39	River to Others	913.25	0.65
17	Forest to Mountain	242.80	0.17	40	Others to Agriculture	14.14	0.01
18	Forest to River	166.14	0.11	41	Others to Rangeland	64.62	0.04
19	Forest to Others	395.64	0.28	42	Others to Forest	94.17	0.06
20	Residential to Agriculture	509.02	0.36	43	Others to Residential	604.33	0.43
21	Residential to Rangeland	6033.01	4.31	44	Others to Mountain	369.63	0.26
22	Residential to Forest	467.62	0.33	45	Others to River	239.83	0.17
23	Residential to Mountain	9335.54	6.67	46	Others to Others	2068.7	1.47

The results of land use changes in the period 1987-2017 showed that the highest change was related to the conversion of residential to the river at the rate of 22267.19 hectares and the lowest change was related to the conversion of forest to agriculture at the rate of 7.07 hectares. Also, the changes in land use types are illustrated in Table (9).

Table 9. Area of land use changes during 1987-2017

Land use type	Land use area in 1987 (ha)	land use area in 2017 (ha)	Change of Land use area (ha)	Changes trend
Forest	44957.77	31902.15	-13055.62	Decrease
Agriculture	2493.62	2990.79	497.17	Increase
Rangeland	16094.18	35694/90	19600.73	Increase
Mountain	66495.59	48624.55	-17871.04	Decrease
River	4341.37	6371.65	2030.29	Increase
Residential	1246.25	1431.15	184.90	Increase
Others	3333.75	12947.04	9613.28	Increase

In this study, it was found that tree cover and forests have significantly decreased compared to the beginning of the period, and these uses have become urban and agricultural uses, which indicates deforestation and urban development. The results are similar to the studies of Alam et al., 2020, Aliani (2011), Omidvar et al. 2015, Mottakan (2010), and Abd (2011) on the reduction of tree cover and green spaces.

The results also showed that urban and agricultural areas have increased which is similar to the results of Sabzeghabae (2017), Shenani Hoveyzeh and Zarei (2016), and Rajabzadeh (2016). The reason can be the increase in the population of villages and cities and the need of residents for housing and the increase of agricultural lands and gardens. This conclusion is consistent with the results of Motkan et al. (2010). In their research, they examined land use change and concluded that with the increase of agricultural lands and gardens as well as the decrease of barren lands, the residential area has increased. Population growth and subsequent increase in demand for food products, water supply for agriculture and ease of access to it, as well as mechanization of agriculture have led to the growth and development of agriculture and change of use of other lands to this use, which is one of the reasons for increasing agricultural lands in this period.

Therefore, the reason for the increase in agricultural lands can be attributed to the conversion of other uses to this use, as well as the increase in population for income and tourism. The results of the present study in this field are consistent with the results of Hadian et al., 2013. While these results are different from the results of Thapa et al., 2006 and Devan (2009) and in their studies, agricultural lands have been reduced.

The results also showed that despite the decrease in rangeland use during the period 2001-2017, rangelands have doubled during the 30 years. This increase in rangeland use and conversion of tree cover to rangeland indicates deforestation and reduction of tree cover in the region, which is similar to the results of Mousavi (2016) and contrary to Sabzeghabae (2017) research on the reduction of rangelands.

Also, during the 30 years, the amount of water areas and rivers has increased. The increase of water areas and especially the area of the river and the construction of water ponds are in accordance with Sabzeghabae study in 2017. Finally, the research hypothesis on the increase of residential areas and agricultural lands during 30 years, from 1987 to 2017 was accepted.

4. Conclusion

In sum, the present study conducts a classification based on the maximum likelihood model of the years1987, 2009, and 2017. The results of the study elucidate that the overall level of vegetation and forests have declined noticeably compared to the beginning of the period which is an indication of deforestation and urban development. Also, urban and agricultural areas have expanded, which can be due to increasing urban development and human activities that have caused changes of other land use to residential use. The reason for that can be an increase in the population of villages and cities and the growing need of residents for housing and accommodation, agricultural areas, and gardens. Even more so, the increase in agricultural land can be another reason for land use changes of other uses to agricultural land use, as well as the growth in population as a result of income and tourism. The increase in rangelands can be a sign of deforestation and transformation of forests and vegetation to rangelands and rangeland during the past 30 years. Despite the decline in rangelands in the middle interval from 2001-2017, and in total during the past 30-year period, rangelands have faced the highest degree of changes and have experienced a growth rate by double.

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