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Investigation and Prediction of Land Use Change in Shahrekord City Using Land Change Model and GIS

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Abstract

Predicting and modeling land use changes is important to be aware of the quantity and quality of possible future changes. One of the methods used by planners to control the trend of land use change is modeling. Among the methods used for land use change are CA-MARCOV, CLUES, DINAMICA EGO, GEOMOD and LCM. This study was conducted to investigate land use changes in Shahrekord city in the period of 1990, 2000 and 2020. In order to analyze the changes in the region, images of Landsat 5TM satellite for 1990 and 2000 and Landsat 8 OLI, 2020 were used. The model used in this research is the Land Change Modeler. First, in the vegetation index area, they were classified into several classes without cover, low cover, medium cover, high cover and very high cover. Also, according to the location and topography of the area, they were considered for the classification of urban uses, agriculture, water area, wasteland and roads. Comparison of the 2020 forecast map with the 2020 land use classification map showed that the forecasts were acceptable for urban use.

Urban use was done with great accuracy for the city of Hafshejan and for the cities of Taqanak, Farokhshahr and Surshjan was also very accurate. Also in the discussion of roads was high accuracy. In the discussion of vegetation and agriculture, there was no forecast of water reduction (reduction of reserves) and it was found that in the forecast map, vegetation, especially in the east, has increased much. The 2030 forecast indicates further development of urban land use and vegetation and agriculture.

Keywords: Satellite Images, Classification, Land Use, Shahrekord, NDVI, LCM

1. Introduction

Population growth and the tendency to urbanization as well as improper human use of available resources cause changes in land use (Heidari and Saleh, 2021). Human history shows the devastating effects of increasing population growth and, consequently, unprecedented urban growth, industrialization, expansion of agricultural land, and land use change. Land use change, in turn, leads

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to soil degradation and increased erosion. (Goran, 2019). Land use change and land cover is a widespread process that in many cases negatively affects natural resources such as soil, water and vegetation. Land use and land cover change is probably one of the most important factors affecting human well-being around the world. On a global scale, land use and change of cover lead to a reduction or change in biodiversity, as well as a reduction in ecosystem services and their benefits to society. The formation and expansion of unfavorable and incompatible land uses will lead to a large part of the environmental consequences in an area, and this means the importance and position of land use in the development of areas in sustainable development. At present, unprincipled land use change is one of the most important problems in all parts of Iran (Sokhangoe, 2017). The importance of vegetation as a dynamic and effective factor on living conditions requires that always qualitative and quantitative information be provided and related changes be determined in short periods of time. Land use change and land cover is a dynamic and complex process that results from the intersection of natural and human systems and has direct effects on water, soil and air. Occurrence of this phenomenon will have economic, social and environmental consequences on a local, regional and global scale (Keshavarz et al., 2018).

In this research, land use and vegetation changes during 1990, 2005 and 2020 in Shahrekord are investigated using images and information related to Landsat satellite and using LCM model method. Also, a forecast for 2035 will be reviewed and analyzed.

2. Literature Review

Akbarian et al. (2013) examined the evaluation of land use change trends using RS and GIS data in the urban area of Ardabil. And the results showed that from 1990 to 2010, residential land increased from 26.4 to 51.4 square kilometers, and with the increase of residential land and infrastructure, the use of agriculture and pastures decreased. Also, according to the results, it was found that most of the changes were made in the outskirts of Ardabil.

Omidvar et al. (2015) investigated the detection of land use change and vegetation in Yasuj city using remote sensing. The results showed that the highest area in 1986 was related to barren land use with 14.2 square kilometers, followed by residential land use with 3.26 square meters and green space with 2.15 square kilometers. In 2010, the highest area was related to residential use with 10.27 square kilometers, then barren land use with 8.68 square kilometers, and at the end, vegetation with 0.66 square kilometers had the lowest area. The highest rate of change in the study period was related to residential use with 157% (increase of 7 square kilometers) and the decreasing trend of waste land use area (5.52 square kilometers) and green space (1.49 square kilometers).

Mousavi, Ranjbar, and Hasili, (2016), Monitoring and Tracing of Land Use Changes in Abarkooh Basin Using satellite images (2014-1976) in their research, seven types of land use including urban, agricultural, barren, rocky, rangeland, clay plain and desert were identified in the classification. Finally, the results showed that the levels of rangelands (5.65%), rocky areas (2.52%), barren (3.63%) and agriculture (1.04%) had an upward trend. Urban land area (4.33%), clay plain (6.89%) and desert (6.03%) had a declining trend. Most of the land use changes were destructive and spatially and corresponded to the area around human aggregation centers such as Abarkooh and Mehrdasht.

Khnamani et al. (2019) studied the evaluation of land use change and land cover change using remote sensing technique and object-oriented classification algorithm in Dasht-e Bartesh Dehloran region in Ilam province. The results of the trend of land use change showed that the average rangeland use with the decrease of more than 21 thousand hectares, had the most changes. In the next rank was agricultural lands, which showed an increase of more than 15,000 hectares (doubled), due to the increase in population and the existence of sufficient water resources in this area. Poor rangeland land use also shows an increasing trend of about 1.5 times, indicating the destruction of medium rangelands. Saline lands also show an increasing trend at first, but then show a decreasing trend due to becoming agricultural lands. The total accuracy of 90 and the kappa coefficient of 95-90 show the very high accuracy of this method in determining land use.

Bayati et al. (2018) studied and predicted land use changes using LCM and GIS (Case study: Alvand city - Qazvin province) showed the results. In their research, they divided the vegetation of the region into 5 classes: no cover, low cover, medium cover, high cover and very high cover. In terms of use, they were classified into 5 classes: residential (urban) lands, agricultural lands, water, barren lands and roads. Finally, using the Markov and CA-Markov chain model, they determined the forecast map of land use and vegetation changes for 2017 and 2034. The results showed that the development of urban (residential) land use in Alvand city went to the south and some areas in the east.

Salamatnia et al. (2020) studied the power and evaluation of spatial-temporal changes in Yasuj city in the direction of urban development. And the results obtained from their research showed that according to the trend of land use changes in the residential or urban part of Yasuj city, there were extensive changes that these changes were from the surrounding uses including forests, pastures, agriculture and water bodies. The forest that is located around the city of Yasuj and inside the city produces many ecosystem services for this area, which with the increase and development of the city, these services have decreased in terms of quantity and quality, so it should be considered. Also, the results obtained from this research can be used as a model for selecting suitable locations for urban development with respect to environmental considerations. Studies based on spatial data, especially in the context of human settlements (due to their variable nature), can be the basis for careful planning.

Heidari and Saleh (2021) studied the growth and development modeling of Isfahan using remote sensing data in the LCM model. The final results of their research showed that the modeling of user conversion potential in all sub-models showed a high accuracy of 95%. The calculation of the prediction model was also obtained using the kappa coefficient equal to 0.9. The results of the study of changes and land use forecast indicate the development of urban areas of Isfahan. These changes show that other land use classes are declining and according to the results of the LCM model in the whole period, urban land has increased from 21,293 hectares in 1997 to 23,607 hectares in 2017. It is predicted that this upward trend will continue in the future. According to the Markov chain model, Isfahan urban lands will reach about 24023 hectares by 2027.

Rezaei et al. (2021) studied, classified and evaluated satisfied land use changes using Landsat satellite images. Case study: Qazvin plain aquifer. Analysis of changes showed that the area of rangeland lands had a decreasing trend during the studied years and other land uses had an increasing trend. So that the area of lands with irrigated agricultural use, residential and industrial areas, rainfed and abandoned lands and saline and barren lands increased by 14.24%, 38.8%, 25.37% and 8.37% respectively, but lands with rangeland use increased by 16.21%.

Valizadeh Kamran et al. (2021) studied the modeling of forest land use changes using LCM in Fendeqloo forest area. And the results of their research showed that during the period 2010 to 2019, the area of forests decreased from 3204 hectares to 3070 hectares and agricultural lands from 8515 to 9030 hectares in 2019. Rangelands and water levels also decreased during the period. Also, built-up land increased from 3.1% of the total area to 4%. Spatial variables, slope, direction, digital model of height, distance from forest, road, village and waterway were used for modeling. Prediction of user changes for 2019 and 2025 was modeled with the Markov chain analysis model. Evaluation of the predicted 2019 map with kappa accuracy of 0.87 shows the efficiency of the LCM model in the study area. Finally, a forecast was made for the future, which showed that, if the current trend of change continues, the forecast for 2025 will decrease as the area of constructed land increases and agricultural land decreases; also, the density of forests will be reduced.

Abdu 2019 studied the assessment of classification accuracy and the trend of land cover-use changes as key components of satellite imagery. The results show that the PCA technique has been widely used to study land cover changes and land use in many "developed" countries. But it still needs to be done in developing and underdeveloped countries where land cover and land use change are poorly mapped, and planning knowledge for such changes is crucial.

Fahad et al. 2021 studied land use-temporal land use assessment and cover during the rapid urban expansion of Lahore, Pakistan from 2000 to 2020. They used Landsat images in their research and considered the four floors of the area built, agricultural land, barren land and water. The results showed that the areas built on agricultural lands were expanded. So that the built area had a significant growth from 22.99% to 47.17% of the total study area in 2000 to 2020, respectively. Leta et al. (2021) studied the modelling and dynamic prediction of land use change based on the Land Change Modelling(LCM) in the Nasheh watershed, the upper Nile basin, Ethiopia. The research findings showed the expected rapid change in LULC in the coming years. The conversion of forest areas, rangelands and grasslands to other uses, especially agricultural land, is a major change for LULC in the future. Measures must be taken to achieve rational use of agricultural land, and forest conversion must be well managed. Raihan et al. (2021) investigated the combined effects of climate change and land use on long-term flow in the Upper Halda Basin, Bangladesh. The LCM predicted a reduction in grasslands along with arable land at the expense of artificial areas. In combination, climate change and land use were predicted to increase annual flow in the future, and climate change is likely to be a greater driver of river flow change than land use change.

Oliveira et al. (2022), Land use forecast for 2030 and its effects on water access in a Brazilian sub-basin: Using the LCM and SWAT models, the results showed that the LULC forecast for 2030 showed an increase in forests and pastures to the detriment of agricultural areas.

3. Material and Method

3.1. Study Area

Shahrekord city is one of the cities of Chaharmahal and Bakhtiari province which is located in the northeast of the province. In terms of geographical location, the city is located 48 degrees and 22 minutes to 50 degrees and 49 minutes in the east and 32 degrees and 20 minutes to 33 degrees and 31 minutes in latitude in the north. The center of this city is Shahrekord.

This city has an area of 3004 square kilometers, including 3 districts, 10 cities and 8 villages. Shahrekord, the capital of the province with an altitude of 2100 above sea level, is the highest center of the province in Iran and for this reason is known as the roof of Iran. In terms of relative position, this city leads to Isfahan province from the north, east and southeast, to Koohrang city from the west, and to Farsan and Ardel from the south and southeast (Karimi Dehkori et al., 2019)

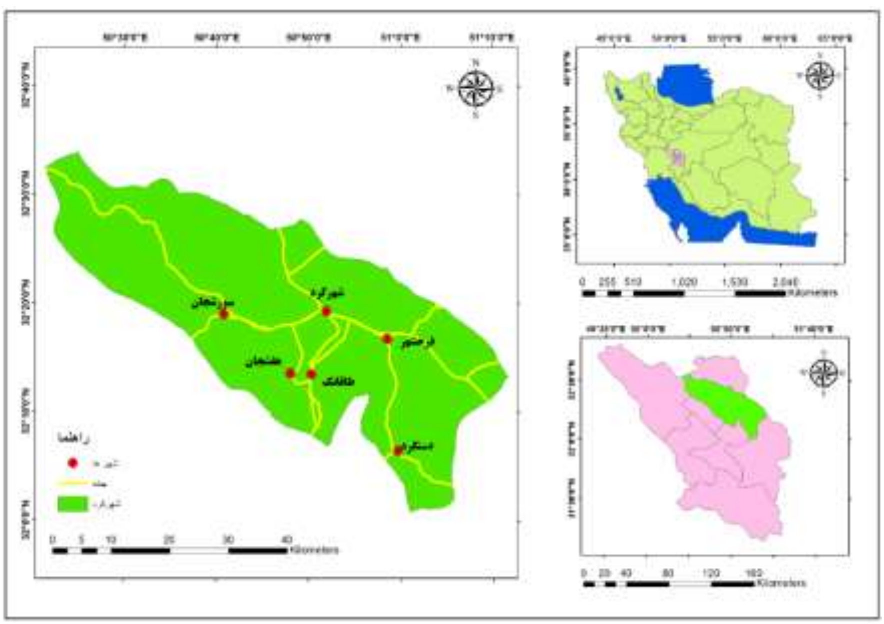


Figure 1. Map of the geographical location of the study area

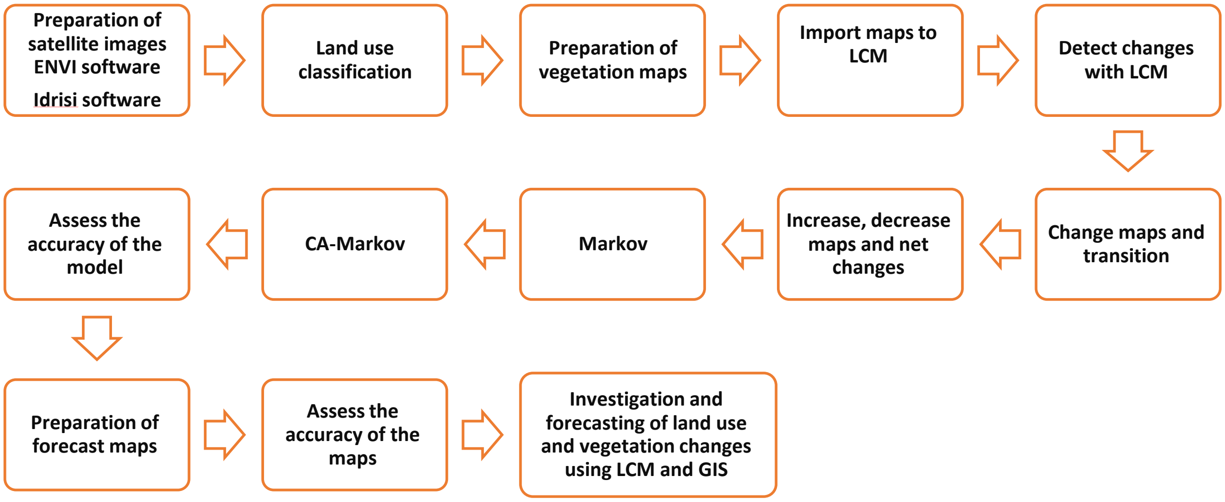


Figure 2. Workflow diagram

In this study, Landsat 5, and 8 satellite images of TM and OLI sensors in the periods of 1990, 2000, and 2020 have been used. Table 1 shows the information of the images used.

Table 1. Specifications of the images used in the research

Solar Date	Gregorian date	Crossing	Row	Sensors
1369/04/24	1990/07/15	164	38	TM
1379/05/05	2000/07/26	164	38	TM
1399/04/27	2020/07/17	164	38	OLI

Normalized Difference Vegetation Index (NDVI): is a numerical index that is calculated and used using visible bands and near-infrared bands for remote sensing analysis. The advantages of this index are the reduction of the topographic effect and the elimination of the zero denominator. The value of this index lacks a unit. In interpreting the values of this index, zero indicates the absence of vegetation, negative values of uncovered surfaces and values greater than zero indicate the presence of vegetation, so that the higher the value, the higher the density of the cover. (Keshavarz, 2018). This plant index, which is one of the most famous and simplest plant indices used, is defined in terms of two red and infrared bands as follows (Fatemi, 2017).

$$\mathrm{NDVI} = \frac{\mathrm{NIR} - \mathrm{R}}{\mathrm{NIR} + \mathrm{R}} \qquad (1)$$

This index has normal values in the range between 1- and +1, which makes it easy to check and display the values. Different NDVI values represent different coverages. Water, snow and ice have NDVI negative and soils have values less than 0.05 and clouds usually have values around zero (Fatemi, 2017).

Classification of satellite images is one of the most important methods for extracting practical information. By knowing the ratio of user changes over time, future changes can be predicted and appropriate actions taken.

Predicting and modeling future changes is also important for use in long-term planning and preventing some unbalanced changes in the environment (Keshavarz et al., 2018). In this research, using remote sensing techniques and images received from Landsat 5 and 8 satellites, the trend of changes and prediction of vegetation changes based on NDVI index in Shahrekord basin was evaluated using land change modeling. The NDVI Vegetation Index is one of the most widely used vegetation indices, and its useful performance has been reported in many studies by various researchers. The numerical value of this index fluctuates between the numbers -1 to 1, and it has been proven that the closer it gets to 1, the more vegetation increases. In this study, the images were divided into five classes without vegetation, low vegetation, medium vegetation, high vegetation and very high vegetation. The results obtained from this section will be shown in the form of various maps for the years 1990, 2000 and 2020.

Recognizing the existing uses in the region: One of the important and key points in preparing land use maps from satellite images is to achieve a clear definition of the existing uses in the region. Obviously, the standard and uniformity of these maps in terms of guidance, scale, color, signs, etc. are also very important points in preparing these maps (Sokhango, 2017).

According to the knowledge of the region, also review the status of existing land uses in the region and Using experts' opinions, field studies and knowledge of the capabilities of images used in agricultural lands, urban areas, barren, water areas and roads, as well as vegetation in the study area were considered for classification. After classification according to the existing uses and also using the normalized difference vegetation index (NDVI), all the required maps will be prepared and the results obtained from the maps will be displayed.

Assessing the accuracy of the classification results: In this step, the accuracy of the classified images of all three periods was evaluated using the classification accuracy. Classification accuracy was calculated for classified images using the Kappa index. In general, the accuracy of classification is evaluated in order to estimate the accuracy and level of reliability of the results and also to compare different classification methods with each other.

Kappa coefficient: Kappa coefficient is used to calculate the classification accuracy in the supervised classification. The kappa value calculates the classification accuracy relative to the case where an image is classified completely randomly. The kappa coefficient is between zero and one. A value of zero for kappa means that the classification is done without any criteria and is completely random. In this case, the classification results are not interpretable and should not be analysed. Values above zero indicate a level of accuracy, and if kappa equals one, it means a completely correct classification based on the samples taken.

Implementation of land change modeler: In order to monitor the land use changes of Shahrekord in the specified time periods, i.e. 2000-1990, 2020-2000 and 2020-1990, as well as forecasting the changes and the factors affecting them for 2030 based on the land use maps of the specified years.

Detecting changes using LCM: The LCM program is actually a tool for land management and planning as well as decision support tools. This model is widely used in prioritizing environmental planning and protection efforts. Land change modeler allows the user to quickly analyze land use changes and also predict future land use change scenarios in different situations and model the effects of species and biodiversity. In this section, maps related to changes in the years 1990-1990, 2020-2000 and 2020-1990 have been identified, as well as the forecast map of changes for 2020 and 2030.

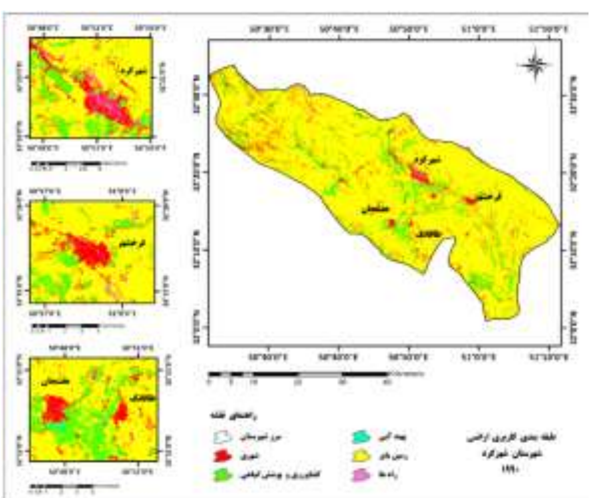
Predicting land use change: To predict change, a set of tools is provided that controls the process of predicting dynamic land cover changes. After determining the end date for forecasting, the amount of change in each transfer can be determined by Markov chain analysis or by determining the transfer probability matrix. Use the Markov chain and generate a continuous transfer probability matrix from the stchoice module to obtain a probability image or evaluate the probabilities of situations where any ground cover can exist in any pixel position. The use of automated cell model (CA-MARKOV) to predict the vegetation status of the region in the coming years and the next step is the validation of the model and map. Finally, after performing all the mentioned steps, a vegetation change map is prepared and the accuracy of the maps is evaluated. Finally, the amount of future land use change through Markov chain analysis and using land use maps of the first and last period, was calculated as a matrix of change probability and it was used as a basis for planning the future time period. This matrix shows the probability of transferring each of the uses to a user. Finally, using this matrix, it shows the land use map of the next year.

4. Discussion and Results

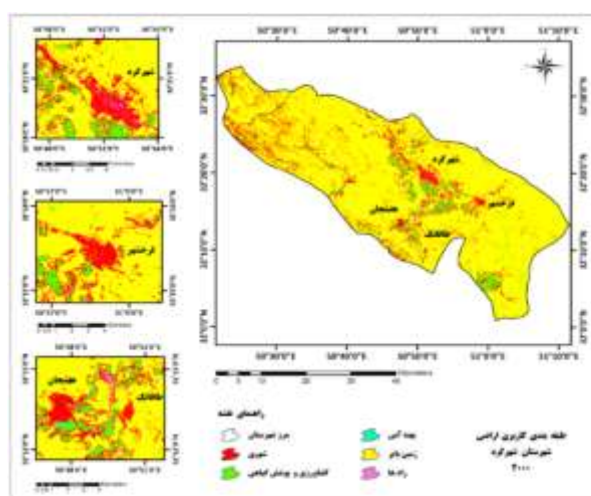
Land use is the use of land in the current situation and shows the types of land use according to its use. Determining the use of important lands and the changes made on these uses is one of the important issues that should be addressed and the extent of these changes in different time periods should be considered. In this research, this issue, ie user changes created in Shahrekord, was examined. The theoretical foundations and background of research on this subject, as well as important materials and methods that can be used to do so, which are described in detail in previous chapters. Therefore, in this chapter, only the maps obtained from the processes performed on the land uses and vegetation will be shown, and all the maps will be shown below. Finally, after determining the amount of changes in the forecast map for 2020 and 2030, production and validation were performed. At the end of this chapter, after all the created maps have been placed, a general summary and discussion of similar research is given.

Table 2. Land use classification of 1990

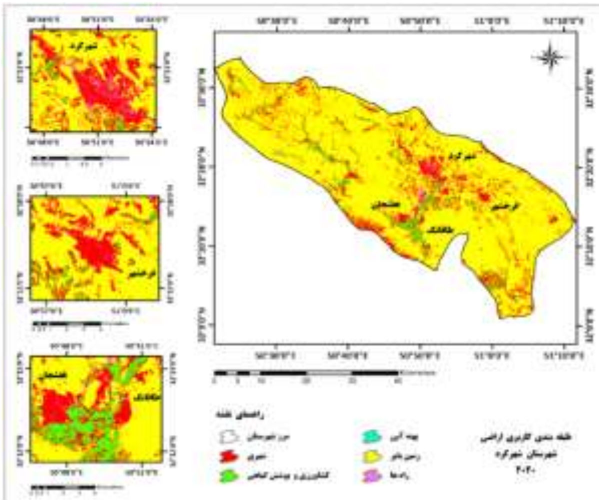
Amount (meters)			Percentage of user class			User class
Year 2020	Year 2000	Year 1990	Year2020	Year2000	Year1990	
933172500	433377900	184425300	20.436 %	8.917 %	3.795%	Urban
239753700	251767800	467345700	4.933 %	5.180 %	9.616 %	Vegetation and agriculture
1181600	16623900	71793900	0.243	0.432 %	1.477 %	Water zone
356655960	4057067700	4093004700	73.386	83.479 %	84.218 %	Wasteland
48690000	101150100	43417800	1.002 5	2.081 %	0.893 %	ways



A. Land use classification map of 1990



B. Land use classification map of 2000



C. Land use classification map of 2020

Figure 3. Land use classification maps

4.1. Accuracy Assessment

The validation of user maps was done using the classification method. The most similarity was done using the kappa coefficient, which can be seen in Table 3.

Table 3. Validation of land use maps

Year	Total accuracy	Kappa
1990	98.6435 %	0.9617
2000	96.9510 %	0.9376
2020	99.5815 %	0.9929

4.2. Land Use Area

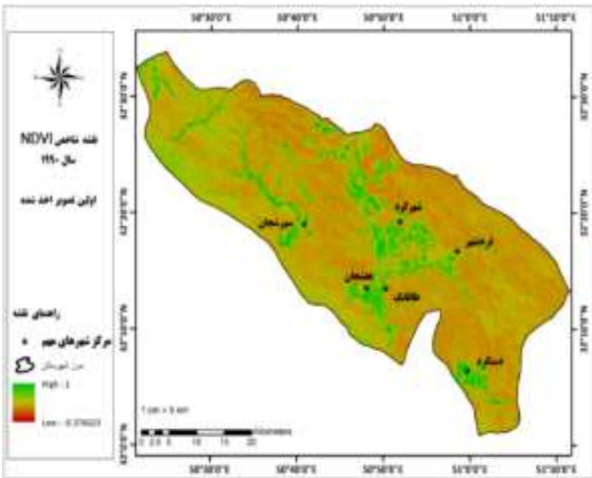
The segregated land uses (urban, vegetation and agriculture, Water zone, barren lands and roads) can be seen in Table 4.

Table 4. Land use area

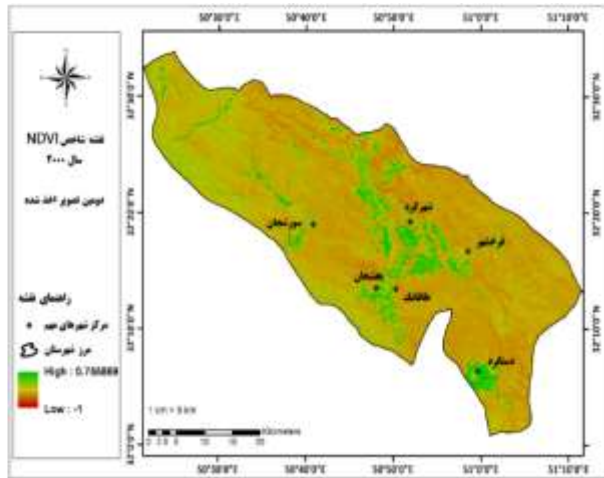
User class	Year		
	1990	2000	2020
Urban	184425300	433377900	933172500
Vegetation and agriculture	467345700	251767800	239753700
Water zone	71793900	16623900	1181600
Wastelands	4093004700	4057067700	3566559600
Roads	43417800		

4.3. Vegetation Changes

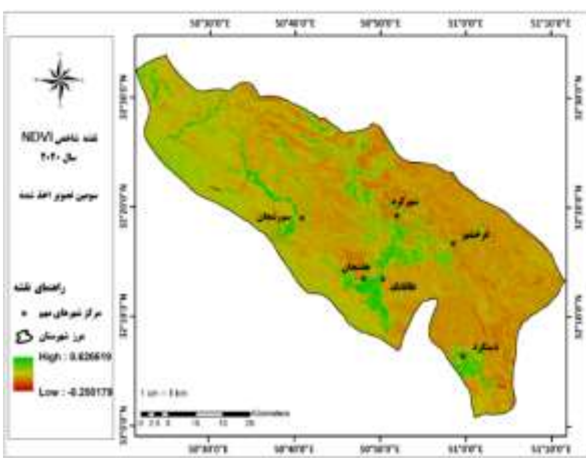
Figure 4 shows the amount of vegetation obtained using the NDVI index when taking images in 1990, 2000 and 2020.



A. NDVI Index in 1990



B. NDVI Index in 2000



C. NDVI Index in 2020

Figure 4. NDVI Index in 1990, 2000 and 2020

Results related to the detection of vegetation changes in the first period

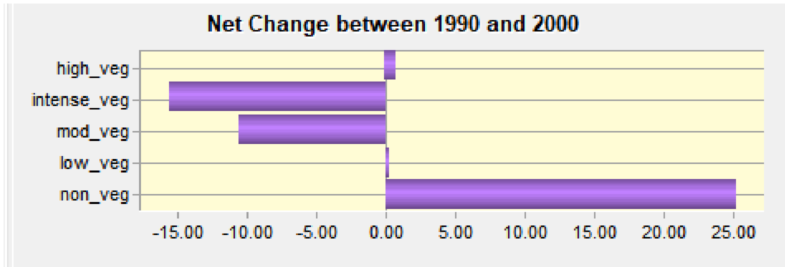


Figure 5. The extent and manner of change of vegetation classes 1990-2000

In Figure 5, which shows the extent and manner of change of vegetation classes, we see a sharp decrease in vegetation.

Results related to the detection of vegetation changes in the second period.

During this period, we saw a decrease in the number of uncovered classes and an increase in the number of low vegetation classes and to some extent a moderate vegetation class.

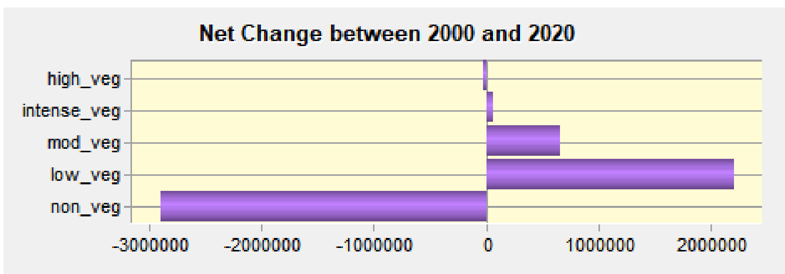


Figure 6. The extent and manner of change of vegetation classes 2000-2020

Show changes to user classes with LCM first period (1990-2000)

To better display the results of user class changes, an exchange map has been created between two different user classes, which can be seen in Figure 7.

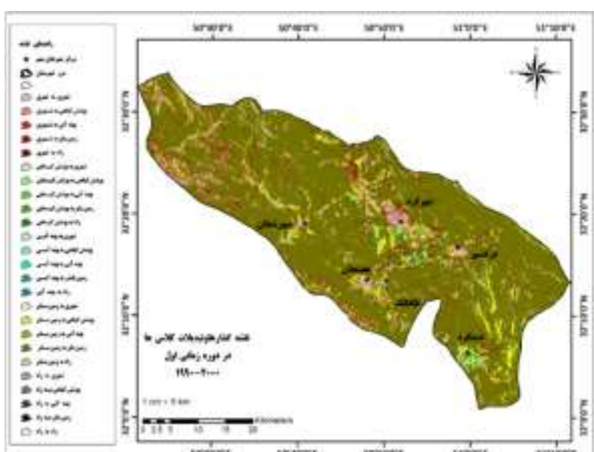
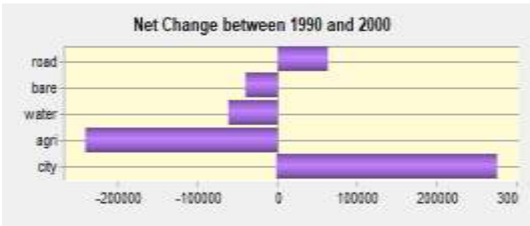


Figure 7. Maps and class transformations in the first period of 1990-2000

Diagrams of these changes resulting from the use of LCM can also be seen in Figures 8 and 9. Gain and loss and Net change maps that show the decrease and increase of in each user class.



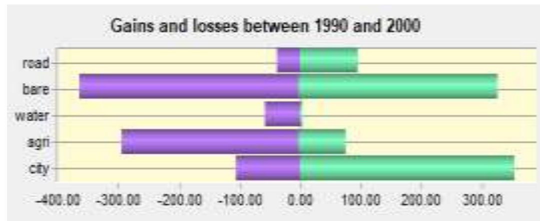


Figure 9. The rate of net changes of each user in the first period of 1990-2000

Figure 8. The rate of change of each user in the first period of 1990-2000

Show changes of user classes with LCM second period (2000-2020)

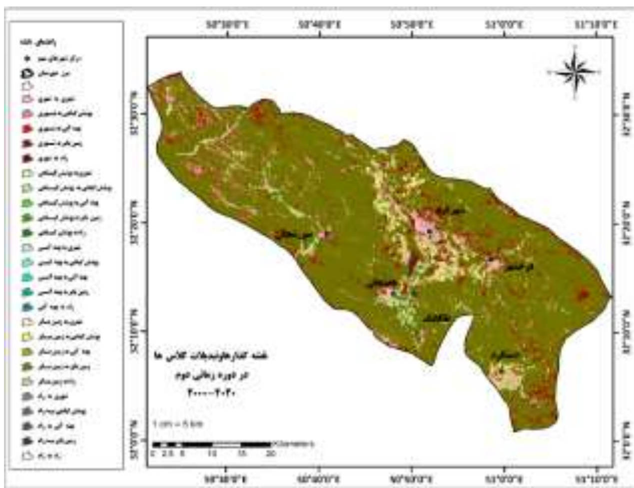
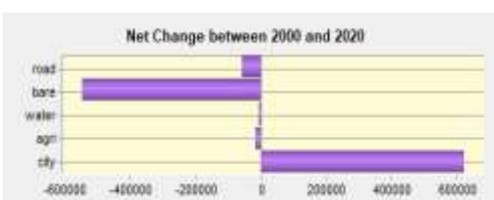


Figure 10. Maps and class transformations in the first period of 2020-2000



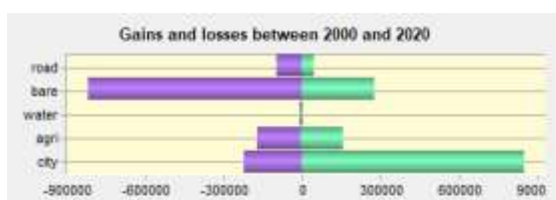


Figure 12. The rate of net changes of each user in the first period of 2000-2020

Figure 11. The rate of change of each user in the first period of 2000-2020

4.4. CA-Markov Module

The forecasts for 2020 and 2030 are shown in Figures 13 and 14.

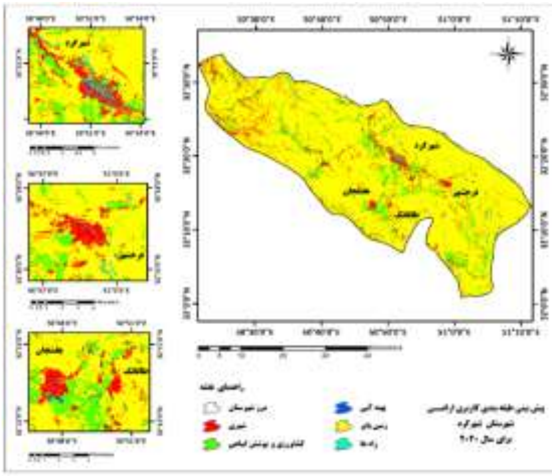


Figure 13. 2020 forecast map

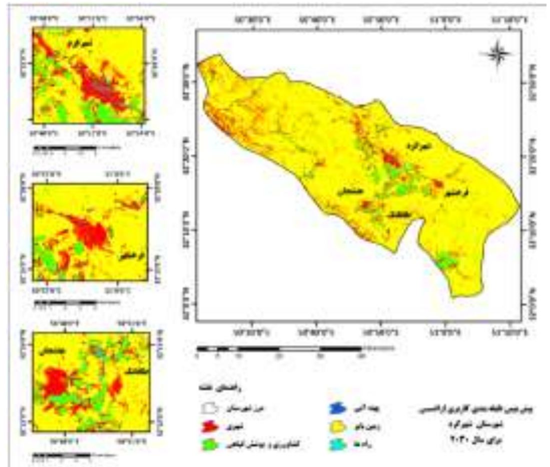


Figure 14. 2030 forecast map

Validate module (validation)

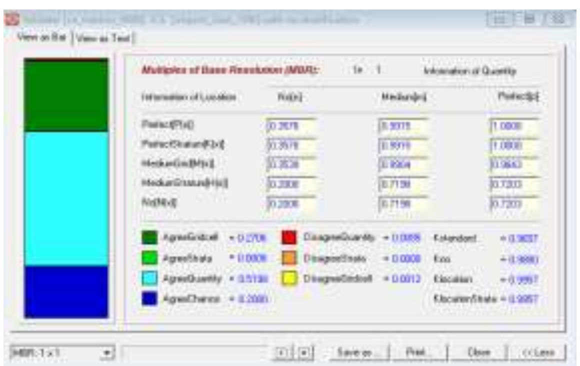


Figure 15. Validation of the first period

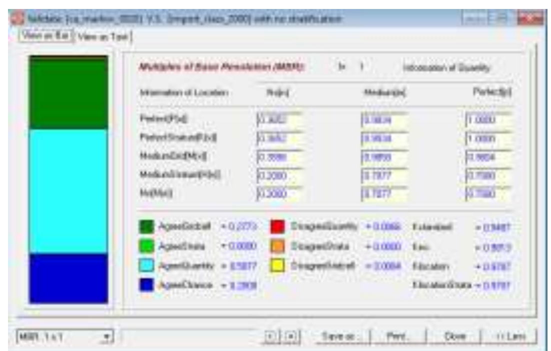


Figure 16. Validation of the second period

5. Discussion

One of the main preconditions for optimal land use is knowledge of land use pattern and its changes over time. Principled exploitation of natural resources requires patterns and models of the region in order to observe the guidelines of ecological models and sustainable exploitation.

In this study, works done by Akbarian et al. (2013), Omidvar et al. (2015), Mousavi, Ranjbar, and Hasili, (2016), Khonamani et al. (2017), Bayati Ashkaftaki et al. (2018), Salamatnia et al. (2019), Heidari and Saleh (2021), Rezaei et al. (2021), Valizadeh Kamran et al. (2021) in Iran. And works by Abdu 2019, Fahad et al. 2021, Leta et al. (2021), Raihan et al. (2021), Oliveira (2022) outside Iran on the subject of land use change. In all these researches, remote sensing methods and GIS techniques were used to achieve the best results.

In these studies, the LCM model is used and the results obtained from internal and external cases indicate that satellite images and LCM land use change model are suitable to obtain the land use changes and also to predict future changes. Therefore, according to all the presented cases and similar researches, it can be concluded that all these researches are in the same direction and the results show that it is appropriate for this method to study the land use in different levels and years.

6. Conclusion

Due to the increasing degradation at the level of natural ecosystems, determining the extent and location of land use changes and predicting its future trend can provide valuable information to managers. Predicting land use change is necessary to achieve models with good performance, so before using these models, their ability must be accepted by experts. Because studies related to the use of these models in predicting change not only in Iran but also in the world are in the early stages. In the present study, in addition to detecting changes, changes in land use of the city using the LCM model and with the approach of artificial neural network have been predicted and the capability of this model in the study area is evaluated. In this study, evaluation and prediction of land use changes were performed using LCM model. The results of the research show an acceptable ability for the model to predict land use changes in the city. The results of the study showed that the area of barren lands and vegetation and water areas in the whole study period has been greatly reduced. Therefore, it is necessary to take preventive measures to protect vegetation and water resources so that we do not end up witnessing the problems resulting from the destruction of the two. In this study, it was found that the variables of distance from rivers (water zones), distance from road and distance from urban land uses have a great effect on increasing the accuracy of LCM. But other causes such as digital modulus of altitude, slope, etc. should also be used in this type of research. As shown in Figure 6, we have the highest vegetation density in the agricultural lands around the important cities of this city.

Proximity to residential and commercial centers as well as communication routes, the difficulty of managing distant farms and gardens have caused such a phenomenon. Also, the high density of vegetation around the city of Shahrekord is due to the fertile plain of Shahrekord, which has a high area and a high amount of usable water. But as you can see the vegetation density maps of the second and third years, you will notice a decrease in vegetation density, especially around the city of Shahrekord, and also the accumulation of vegetation density around other cities to a smaller area. In recent years, the groundwater level of Shahrekord plain has decreased significantly, which has led to the cultivation of a large area of the plain. However, a suitable density of vegetation can be seen around the city of Hafshejan, which is due to the existence of earthen dams in the area and the collection and use of fresh water stored in the earthen dam of Cheshmeh Zaneh. But finally, we see a decrease in the density of vegetation in Shahrekord. To prepare the land use map of Shahrekord city with satellite images, urban classes, vegetation and agriculture, water areas, barren lands and roads were considered for three time periods. According to Table 3, the overall accuracy for 1990, 2000 and 2020 was 98.6435%, 96.9510% and 99.5817%, respectively, which was a very high accuracy. The largest area of classifications has been the share of barren land use, which has decreased during the two study periods. This class has been converted to other classes as shown in Figures 10, 11, 13 and 14. Especially in the second period of the study, we saw its change to an urban user class. In recent years, the neighborhoods of Mirabad and Manzaria (for Mehr housing and national housing) in the north of Shahrekord have been created, developed and expanded, which has attracted at least 40,000 people over the past two decades. The increase in urban land use in Shahrekord has been due to migration from other cities. The overall kappa resulting from the evaluation of the accuracy of the maps produced in 1990, 2000 and 2020 with the method of maximum similarity or maximum probability was obtained 0.9617, 0.9376 and 0.9929, respectively, which shows the high accuracy of the maps produced. These values were higher than the results of Bayati Ashkaftaki et al. (2018) as well as Khnamani et al. (2019). The study of land use area in Table 4-5 shows that in all three dates of classification, the barren land class had the highest percentage, but during these years has had a downward trend. The urban user class in 2020 was about 5 times the same as the user class in 1990, which represents a significant increase in these 30 years. Meanwhile, half of the vegetation user class has been reduced. The percentage of vegetation in 1990 is about twice that of the same class in 2020. Studies show that since 1998, programs have been implemented to control the reduction of vegetation, which has been able to reduce the rate of disappearance of vegetation in the city. Unfortunately, the level of running water and its reserves has seriously decreased significantly. This amount in 2020 is about 16% of the reserves and water use classes in 1990. The user class of communication roads and roads has not increased significantly and they are following an almost constant trend. In this study, after preparing land use maps, changes were detected for the period 1990-2000 and 2000-2000. In the first study period according to Figure 11, the highest decrease was in the vegetation and agricultural land use class and the highest increase was in the urban land use class.

In the second period, according to the figure, the highest decrease was in the wasteland use class and the highest increase was in the urban land use class. Regarding Shahrekord city, in the first period, most of the changes in the vegetation and agriculture sector to the city class were due to land use change permits by the relevant departments.

And in the second period (changes in the surrounding wastelands) due to the non-issuance of these permits to convert agricultural uses to urban and at the same time settlements in the surrounding barren lands. Land use change predictions for 2020 (for comparison) were made in Figure 15 and 2030 in Figure 16. Comparison of the 2020 forecast map with the 2020 user classification map shows that the forecasts are acceptable for urban use. Urban use for the city of Hafshejan has been done with great care. Accuracy is also high for the cities of Taqanak, Farokhshahr and Surshjan. The discussion of roads is very accurate. In the discussion of vegetation and agriculture, there is no forecast of water reduction (reduction of reserves) and we see that in the forecast map, vegetation, especially in the east, is much higher. The 2030 forecast indicates further development of urban land use and vegetation and agriculture.

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