Evaluation and Simulation of Land Use Change Using Object-oriented Classification and Markov Chain Model, Case Study: Birjand City

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1. Introduction

The global expansion of urbanization has created a motive for turning green and natural spaces into urban or human environments. On the one hand, increasing demand for land and housing, and on the other hand, limitation of land within cities, are pushing residents to find alternative housing in the surrounding areas. This process leads to increasing conversion and change of land cover and land use in the periphery of cities. Land use change is a process by which human activities transform the natural landscape and usually refers to the functional role of land for economic activities.

This change of use can take place in the agricultural lands and orchards, or the ranges and forests and the slopes of mountains and hills. Therefore, one of the environmental hazards and ecological crises that the world faces is the phenomenon of land use change. Given the importance of the land use change process, it is necessary to estimate the rate and extent of land use or land cover changes in the region and the main drivers of these changes. Geographic Information Systems (GIS) and remote sensing techniques provide effective tools in studying and monitoring land use change / land cover in space and time. In general, the classification of satellite data refers to the separation of similar spectral sets and their classification. In other words, it expresses the classification of pixels constituting images, assigning or introducing each pixel to a class or a particular phenomenon. Object-oriented method is one of the methods of classifying images. In object-oriented classification, in addition to spectral features, geometric features of phenomena are also considered. In this way, object-oriented classification is a process that links land cover classes to visual objects. After the classification process, each image object is assigned to one (or none) of the class.

In this research, it has been tried to analyze the land use change of Birjand city using two models of object-oriented classification and Markov chain model and to predict its trend for 2025.

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2. Study Area

Birjand is a city in eastern Iran and the center of Birjand city and the capital of South Khorasan province. The city is located at 59 degrees and 13 minutes of longitude and 32 degrees and 53 minutes of latitude and at an altitude of 1470 meters above sea level.
According to Population and Housing Censuses of Iran in 2016, the population of this city was about 203,000 people and it is a city with relatively high and physical and population growth in the east of the country.

3. Materials and Methods

In this research, the land use changes in Birjand city were evaluated and simulated using satellite imagery images from 2000 to 2017 and predicted their changes by 2025. For this purpose, the object-oriented classification method has been used to classify the images. In this classification, for segment generation, the scale parameter is 10, the color parameter is 0.8, and the compression is 0.1 and shape is considered 0.4. In order to increase the resolution of classification classes for each class, further classes were created that merged with the main classes at the end. The final result is the segmentation of 4 general classes including vacant land, rangelands, built-up area, orchards and agriculture lands. After the classification of images, the CA-Markov model was used to predict of land use changes in the Birjand city.

4. Results and Discussion

According to satellite images, in 2010 compared to 2000, the built-up areas have been stretched discontinuously to the north and northeast direction of Birjand city, as well as to the west and to some extent to the east, which indicates that the physical growth of the city follows the pattern of sprawl in this period.
The results of the classification of images in this study show that the area of built—up lands and the orchards and agricultural lands increased during the period between 2000, 2010 and 2017, and this increase is more significant between 2010 and 2017. The pattern of change has been such that the share of vacant lands and rangeland has been reduced. During the 17-year period, 0.48% of the area of rangelands and 0.38% of vacant land have been reduced annually. In contrast, the largest increase is related to built-up area, so that 6.12% has been added to this land use annually. Orchards and agricultural lands have also increased in area with a growth rate of 2.61% per year.
According to the Markov chain model, the changes in the area of land uses in 2025 compared to 2017 will be similar to 2000-2017, so that orchards and agricultural lands (1.09), built-up areas (1.17), vacant lands (0.98), rangelands (0.97) will be.

5. Conclusion

In the present study, using satellite images during the period from 2000 to 2017, changes in land use of orchards and agricultural land, built-up areas and rangelands were investigated. In order to evaluate these changes, the object-oriented classification method in Ecogonation software was used and to predict and simulate the future, Markov chain method was used. Using the Markov chain model, the pattern of land use

change for 2025 was predicted and modeled. The model consists of three steps: 1. calculating the conversion probabilities by using Markov chain analysis. 2. Calculating suitability of land use/land cover maps based on the multi-criteria evaluation. 3. The allocation of the land cover based on the CA's spatial operator. Based on the changes made in previous years, this model examines the probability of future changes and the spatial allocation of these changes. According to the Markov chain model, during the years 2000 to 2017, the area of the built-up lands, agriculture and orchards increased and the area of vacant lands and range decreased. If the same trend continues, between 2017 and 2025, the area of the built-up area will increase by 17.13%, orchards and agricultural lands by 9.8%, and in contrast, the area of vacant lands will decrease by 1.81% and the area of rangelands will decrease by 2.32%.

In general, this pattern of land use change indicates an increase in human intervention and the dominance of human landscapes (settlements, orchards and agricultural lands) over the natural environment (especially rangelands). The next point that can be understood from the comparison of the maps is the development and sprawl growth of the settlements, which causes a part of rangeland and even agriculture and orchards to be changed to use for construction. In general, this abnormal trend of land use change should be controlled with a systemic approach to the study area, taking into account urban-rural, environmental and socio-economic dimensions in planning. This means that the change of use of good agricultural lands, orchards and rangelands must be controlled. This means that the change of use of good agricultural lands, orchards and rangelands must be controlled. One of the most important measures that can be considered is to follow the pattern of compact and urban infill growth with a focus on the use of urban brownfields and eroded texture.

Keywords: Land Use Change, Object-Oriented Classification, Markov Chain, Birjand

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