4th Intercontinental Geoinformation Days

igd.mersin.edu.tr

Applying object-oriented processing techniques for investigating land use/land cover changes and predicting future changes (Case study: Miandoab, Iran)

Abolfazl Ghanbari *[1], **Khalil Valizadeh Kamran** [1], **Arezoo Rahimi** [1]

[1]*University of Tabriz, Department RS & GIS, Tabriz, Iran*

Keywords
Land cover
Changes Predict
Object-oriented Processing
Camera calibration
Markov Chain Model
Miandoab

Abstract

Assessing the dynamic changes in land use/land cover in the management and sustainability of natural ecosystems is important. This study aims to investigate the ability of object-oriented processing of satellite images for land cover detection and prediction of future changes using CA Markov model in the township of Miandoab. For this purpose, land cover maps were obtained for the years 1984, 1994, 2004, 2014, and 2018 using the threshold setting method in eCognition 9.1 software and Landsat satellite images of TM, + ETM and OLI. The CA-Markov model was used to predict future changes for 2032. The accuracy of the forecast model was obtained by matching the predicted map of 2018 with its real value. This value represents the validity of modeling results. The results showed that during the period of 34 years (1984-2018), gardens and human-made lands have been improved significantly, so the area of the gardens grew45km between 1984-2018 and human-made lands increased from 6.21 km2 in 1984 to 27.55 km2 in 2018. In recent years, compared to previous years, the water bodies have diminished, and if the management and resources planning are not altered in the region, this trend of change will have irreparable consequences soon.

1. Introduction

Land use/cover can be considered as a combined concept in terms of physical, social, cultural, economic and information of any country. In fact, land use maps include how to use the land for various human needs (Fezizadeh et al., 2021). Rapid urbanization leads to rapid land use/cover change that can cause a severe deterioration of living environment in urban areas (Sun et al., 2016). One of the effects of urban growth is destroying the environment around the city and changing the agricultural lands to urban usage. Land-use changes are a dynamic and complex process that interconnects natural and human systems (Koomen, et al, 2007). Monitoring land use and land cover changes (LULCC) is an important part of ecological planning in areas with rapid changes. The rapid development of industry, local phenomena such as internal security problems and hard living conditions in rural areas can directly affect LULCC (Satir and Erdogan, 2016). LULCC influences forests by deforesting for agricultural use or other uses are elements that contribute to global environmental change. Therefore, knowing the process of these changes in the past, present and future are essential for decision-making of sustainable development (Nguye, 2018). Land use refers directly to human activities on the earth, while land cover identifies the natural properties of the earth (Ozdogan, 2016; Singh and Singh, 2011). LULCC is the result of human activities that affect both terrestrial surface and atmospherical region (Pielke et al., 2011). LULCC is a significant factor in global changes and has a notable impact on ecosystem processes, biological cycles, and biodiversity (Basommi et al., 2016; Verburg et al., 2004). In recent years, depending on the type of land use and the growing population of the world and economic growth, identification of effective LULCC has become a global concern (Jia et al., 2015). Factors and influential forces in the formation and expansion and land use change can be considered as a result of natural, social, economic and other conditions and characteristics. (Moazeni, 2015). Human activities are reshaping the terrestrial environment (Seto et al., 2011). With the development of remote sensing technology, abundant spatial data is available now. Satellite data is the fastest and affordable method available for researchers to produce a land-use

* **Corresponding Author**

*(a_ghanbari@tabrizu.ac.ir) ORCID ID 0000-0001-6225-0433
(valizadeh@tabrizu.ac.ir) ORCID ID 0000-0003-4648-842X
(arezoo.rahimi.9121@gmail.com) ORCID ID 0000-0002-4442-9453

Cite this study

Ghanbari, A., Kamran, K. V., & Rahimi, A. (2022). Applying object-oriented processing techniques for investigating land use/land cover changes and predicting future changes (Case study: Miandoab, Iran). 4th Intercontinental Geoinformation Days (IGD), 258-261, Tabriz, Iran

map (Pal & Mather, 2005). In recent years, satellite image analysis has been proposed as a tool for identifying and extracting LULCC (Szuster et al., 2011). Remote sensing and GIS data are extensively used to identify and analyze the LULCC (Hua, 2017). Remote sensing data can effectively record the location of land cover and it is a marvelous source of data for extracting, analyzing and simulating LULCC (Pradhan et al., 2008; Singh et al., 2018). Different methods have been proposed for extracting land cover information from satellite images. Object-based processing of satellite images (OBIA), has overcome the weakness of the pixel-based approach which refuse to use side information in the process of satellite image classification (Blaschke, 2010). Object-based techniques use more data including geometric information related to the shape of features and their placement, various side information (digital elevation models, various mathematical indicators) for the classification of phenomena and side effects compared to the traditional methods of classification. The satellite image classification using object-based techniques has been widely used so far (Blaschke, 2014): also, many approaches have been used in the framework of OBIA techniques to classify satellite imagery (Benz et al., 2004; Tiede et al., 2010 and Strasser & Lang, 2015). Regarding the LULCC, most of the desirable agricultural lands are located around cities, therefore, uncontrolled urban expansion with low population density destroys agricultural lands. Environmental, economic and social effects caused reduction of agricultural activity. The city of Miandoab, with the population of 134,000 in 2016, has experienced widespread growth over the past few decades. In addition, because the city is located in an alluvial plain and between two permanent rivers, it is surrounded by high-quality agricultural lands and numerous villages; therefore, it is essential to pay attention to the development of the city and its effects on the surrounding areas as the transition areas of the city and the village. Recent advances in tools and remote sensing techniques have enabled researchers to make effective modelling for future land cover changes. In this context, many models have been created to simulate the dynamics of landscape change. One of these models is the combined cellular automata model and Markov chain analysis. Markov chain analysis states that the future status of a system can be modeled solely based on immediate past status. The cellular automata model is used to allocate a spatial dimension to modeling dimension. Therefore, in this research, for modeling the land-use change of the city and its surrounding areas, the CA-Markov model has been used. The simulation method is divided into two sections: prediction of quantitative changes by Markov.

2. Method

In this study, two types of data including satellite imagery and GPS data, which were obtained from field operations, were used. Satellite images used include Landsat satellite imagery between 1984-2018 with a period of 10 years and rows and path of 168-34 for the months of July and August. It should be noted that the images related to TM Landsat 5, ETM Landsat 7 and OLI Sensors relates to Landsat 8, and due to the presence of information gap in most of the Landsat 7 images, it is tried to use Landsat 5 images as far as possible. According to the purpose of the study, first, the images were pre-processed in the ENVI 5.1 software environment; then, the GIS images and layers included topographic data obtained from the DEM 30, normalized difference vegetation index (NDVI) and other information layers, were entered into the eCognation developer software for database classification and the application of different algorithms. These processes include algorithms (Brightness, NDVI, SI, GLCM ...) to identify existing applications and select the most appropriate indicator for the study area. In the post-processing stage, the land-use change trend has been evaluated and the results have been analyzed. It should be noted that in this study to evaluate the accuracy of classification in different years, in addition to land harvest points, Google Earth images were also used.

3. Results

In the preprocessing stage, all Landsat satellite bands were stacked and cut in ENVI software. After performing various studies and testing the scales, coefficient of shape and compression of scale 10 with, 0.2 and 0.5 for Landsat 5 and 7, and the scale 170 with 0.3 and 0.5 for Landsat 8 images were selected as the appropriate scale for extraction of the complications in the image. In this research, various functions and capabilities of OBIA (Object-Based Image Analysis) techniques are used to extract land cover with high accuracy; these functions include texture information (GLCM), average of image bands, normalized difference vegetation index (NDVI), normalized difference water index (NDWI), and brightness index. To implement object-based processing, suitable criteria and algorithms were selected for extraction of each land use/land cover based on ground control points, and then the spatial thresholds, as well as thresholds based on the calculated indexes, were applied to extract the desired applications. This processing method was applied to all images in virtually identical conditions.

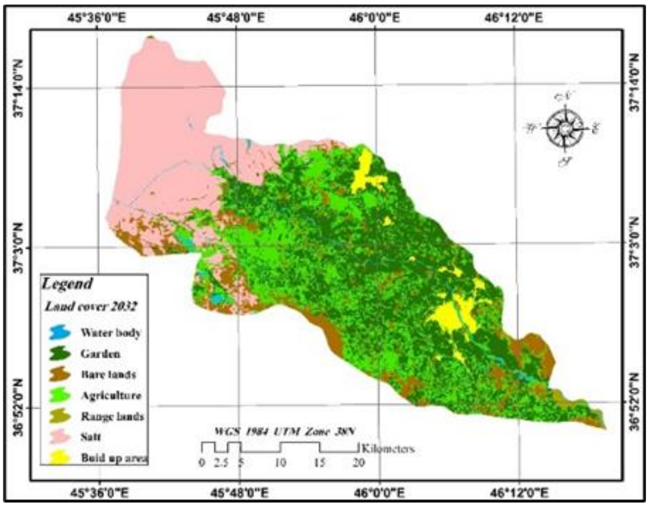

Figure 1. Predicting Future Land Cover Change with CA – Markov Model- 2032

4. Discussion and Conclusion

In this research, the land cover map in was created using object-based processing of satellite images for 34 years (1984-2018) with a general accuracy of 0.89 and Kappa coefficient of 0.8770 in seven classes (water, garden, pasture, agriculture, bare lands, salt, and building area). The analysis of the results showed that at the beginning and in the period of 1994 due to increased rainfall in the study area, farming and water have increased; then, due to the reduced rainfall in the area and the beginning of the drought, the agricultural land area and water have decreased. In the following years, since 2004, with the beginning of irrigation networks, the exploitation of the agricultural land and garden area has increased. Nevertheless, in the same years, due to the reduction of rainfall and mismanagement of water resources, the water bodies of the region have been reduced, and due to the salinity of Urmia Lake, with decreasing the water level and drying of the lake, Salt field of the region is expanding. Following the research process, the map of future changes of 2032 was obtained using the Cellular automate Markov chain model in the Terrset software. To evaluate the accuracy of the prediction model map, first, using the images of 1994 and 2004, the map of change was predicted for 2018, and then the predicted model of land cover changes was compared with real land cover values in 2018. The consistency of the predicted values with the real values of 2018 represents the high accuracy of the prediction model. Accordingly, future changes in land cover are expected in the next 13 years (2032). Evaluation of the prediction model for 2032 indicates significant growth in the constructed areas and salt marshes. Increasing salt marshes can have devastating effects on the environment, agriculture, and gardens. We also see these effects in the study area. As a result, the area of agricultural lands and gardens has decreased in the last period of the total study period. Because of an increase in population, pressure on natural resources and the growth of agricultural and garden lands, man-made lands are also increasing in the study area. On the other hand, agricultural and pasture usage show negative growth. Significant growth of saline lands in the coming years in the region will change the landscape of the land and will bring irreparable damage to the environment. Considering the changes in land use / cover in the eastern part of the study area, it can be said that this part of the study area in the current conditions, due to past degradation and conversions, is disruptive and indicates the development of degradation. Since one of the consequences of the destruction and transformation of land over a period of time is increased desertification and destruction of biodiversity, it can be concluded that due to the drying of Urmia Lake, probably, the destruction of natural vegetation, increased size of barren lands by decreasing vegetation and decreasing preservation capacity, have increased dust and reduced soil fertility in the region. Therefore, modifying management and conservation plans for the ecosystem of the region is essential.

References

Basommi, L. P., Guan, Q. F., Cheng, D. D., & Singh, S. K. (2016). Dynamics of land use change in a mining area: a case study of Nadowli District, Ghana. Journal of mountain science, 13(4), 633-642.

Benz, U. C., Hofmann, P., Willhauck, G., Lingenfelder, I., & Heynen, M. (2004). Multi-resolution, object- oriented fuzzy analysis of remote sensing data for GIS-ready information. ISPRS Journal of photogrammetry and remote sensing, 58(3-4), 239-258.

Blaschke, T. (2010). Object based image analysis for remote sensing. ISPRS journal of photogrammetry and remote sensing, 65(1), 2-16.

Blaschke, T., Hay, G. J., Kelly, M., Lang, S., Hofmann, P., Addink, E., ... & Tiede, D. (2014). Geographic object-based image analysis–towards a new paradigm. ISPRS journal of photogrammetry and remote sensing, 87, 180-191.

Fezizadeh, B., & Taheri, A. (2021). The Application Of Object-Based Image Analysis Approach For Land Use/Cover Change Modeling Of Urban Growth Within The City Of Maragheh. Journal environmental based territorial planning (AMAYESH) winter 2021, Volume 13, Number 51; Page(s) 1 To 22.

Hua, A. K. (2017). Land use land cover changes in detection of water quality: a study based on remote sensing and multivariate statistics. Journal of environmental and public health, 2017.

Jia, K., Liang, S. L., Liu, J. Y., Li, Q. Z., Wei, X. Q., Yuan, W. P., & Yao, Y. J. (2015). Forest Cover Changes in the Three-North Shelter Forest Region of China during 1990 to 2005. Journal of Environmental Informatics, 26(2).

Koomen, E., & Stillwell, J. (2007). Modelling land-use change. In Modelling land-use change (pp. 1-22). Springer, Dordrecht.

Moazeni, M., Aghayi, V., Badali, A., Pari, H. 2015. Study of land use changes in Parsabad Moghan city using satellite imagery, 1st International Congress of Earth, Clean Space and Energy, Ardebil, University of Mohaghegh Ardabili, https://www.civilica.com/Paper-ATTITTDE01-ATTITTDE01_379.html.

Nguyen, T. T. H., & Ngo, T. T. P. (2018). Land use/land cover change prediction in Dak Nong Province based on remote sensing and Markov Chain Model and Cellular Automata. Journal of Vietnamese Environment, 9(3), 132-140.

Özdoğan, M. (2016). Image classification methods in land cover and land use. In Remote Sensing Handbook-Three Volume Set (pp. 265-280). CRC Press.

Pal, M., & Mather, P. M. (2005). Support vector machines for classification in remote sensing. International Journal of Remote Sensing, 26(5), 1007-1011.

Pielke Sr, R. A., Pitman, A., Niyogi, D., Mahmood, R., McAlpine, C., Hossain, F., ... & Reichstein, M. (2011). Land use/land cover changes and climate: modeling analysis and observational evidence. Wiley Interdisciplinary Reviews: Climate Change, 2(6), 828-850.

Pradhan, B., Lee, S., Mansor, S., Buchroithner, M., Jamaluddin, N., & Khujaimah, Z. (2008). Utilization of optical remote sensing data and geographic information system tools for regional landslide hazard analysis by using binomial logistic regression model. Journal of Applied Remote Sensing, 2(1), 023542.

Satir, O., & Erdogan, M. A. (2016). Monitoring the land use/cover changes and habitat quality using Landsat dataset and landscape metrics under the immigration effect in subalpine eastern Turkey. Environmental Earth Sciences, 75(15), 1118.

Seto, K. C., Fragkias, M., Güneralp, B., & Reilly, M. K. (2011). A meta-analysis of global urban land expansion. PloS one, 6(8), e23777.

Singh, P., & Singh, S. (2011). Landuse Pattern Analysis Using Remote Sensing: A Case Study of Mau District, India". Archives of Applied Science Research, 3(5), 10-16.

Strasser, T., & Lang, S. (2015). Object-based class modelling for multi-scale riparian forest habitat mapping. International Journal of Applied Earth Observation and Geoinformation, 37, 29-37.

Sun, A., Chen, T., Niu, R. Q., & Trinder, J. C. (2016). Land use/cover change and the urbanization process in the Wuhan area from 1991 to 2013 based on MESMA. Environmental Earth Sciences, 75(17), 1214.

Szuster, B. W., Chen, Q., & Borger, M. (2011). A comparison of classification techniques to support land cover and land use analysis in tropical coastal zones. Applied Geography, 31(2), 525-532.

Tiede, D., Lang, S., Albrecht, F., & Hölbling, D. (2010). Object-based class modeling for cadastre-constrained delineation of geo-objects. Photogrammetric Engineering & Remote Sensing, 76(2), 193-202.