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Research Paper

Land Use Changes and Urban Development Simulation Using Neural Network and Markov Chain Cellular Automata

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Abstract

Nowadays, most land use changes occur in urban areas, due to the growing population in cities and villages and the desire to live in urban areas. Urban rapid development in recent decades has led to large changes in the cities around and has had many environmental impacts. In this research, we evaluated land use changes and urban development simulation using satellite imagery and with neural network model and Markov chain auto-cells in Rasht city. For this purpose, Landsat satellite imageries were used from 2000, 2008 and 2017. After preprocessing the image and selecting the best band combination, the images were classified using the neural network method. Then the classified images were entered into the land changes model and predicted modeling output maps using the CA-MARCOVE method for 2027. The results obtained between 2000 and 2017 indicate that the area changes in urban lands, rice fields and forests were 9041.88, 7841.33 and 55.78 hectares, respectively, which were positive in Rasht city and negative in rice fields and forest and the projection map for 2027 with the CA-MARCOVE method also indicated a significant increase in urban use of 14105.04 hectares in the coming years. The results of this study indicate that the current trend of land use changes will lead to adverse environmental impacts and, consequently, irreversible socio-economic damage. Therefore, it is essential for the region planning and management unit to adopt a comprehensive approach to conduct future environmental problems and to curb the horizontal development of settlements in the area.

Key words: *Land Use, Satellite image, Neural network model, Markov chain auto-cells, Rasht city.*

Extended Abstract

Introduction:

The importance of land use as a key component in natural resource management, environmental change and a dynamic and affecting biological condition requires accurate quantitative and qualitative information to be provided and varied in the short term. (Triantakonstantis & Stathakis, 2015: 194; Akbari and Rezaei, 1397: 94). In the meantime, remote sensing data provide valuable multi-temporal data on the processes and patterns of land cover change and land use, and help to develop an understanding of the impact of human activities on natural resources. (Esfahanzadeh, 2016: 34). Urban development is a global phenomenon and one of the most important phenomena that has a great impact on both nature and human environment due to its many ecological and socio-economic aspects. The city of Rasht, like other urban areas, has undergone numerous changes in

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agricultural and horticultural uses and residential uses over many years. In this study, satellite imagery is used to evaluate land use changes and simulate urban development in the period 2000 to 2017, so that the results of the research can be of great help in micro planning. And provided the experts with a great deal to prevent environmental degradation.

Methodology:

In this study, using satellite imagery of land use changes and simulation of growth and development of Rasht city using neural network model and Markov chain automated cells. Landsat 2000, 2008 and 2017 images were used for this purpose. After image preprocessing and selecting the best band composition, the images were classified by neural network method. Selected classes include 7 classes, forest, man-made areas, paddy fields, sand, sea, ponds and vacant lots. The digital layers used to classify and apply Markov auto cells include: GPS capture points for image classification and accuracy assessment, proximity to main roads, river avoidance, distance from surrounding villages, slope And height. Then, the classified images were entered into the land change modeler and the model outputs were predicted by CA-MARCOVE for 2027.

Results and discussion:

The results show that out of the total area of man-made area increased, 3612 hectares were converted to paddy fields and 1 hectare to water use, 2138 hectares were made to man-made areas, 1646 hectares to the sea and 24 hectares to the Bayer area. In the present study, Markov chains and automated cell fusion methods were used to predict land use changes in Rasht. To do this using IDRISI software, three series of land use maps were prepared for the years 2000 to 2017. Finally, based on the factors involved in urban land use changes in the study area, the inputs of the automated cell model were selected as Table (1). The prediction is a function of the model inputs.

Table 1: Input variables in the automated cell simulation model

Row	*Variables affecting land use*
1	*near the main ways*
2	*distance from the river*
3	*elevation*
4	*slopes*
5	*distance from surrounding villages*

Source: Authors' Studies, 2018

Then, by calculating the Kramer coefficient in the model, one can obtain an estimate of the correlation of each variable with the existing land uses and hence its ability to predict land use changes. By repeating 10,000 times of trial and error in the multilayer neural network, calibration and conversion potential maps were generated in the images from 2000 to 2008 and 2008 to 2017. Following the acceptable accuracy of the model for prediction, using the CA-Markov model, the 2027 User Prediction Map was prepared for the study area shown in Figure (1).

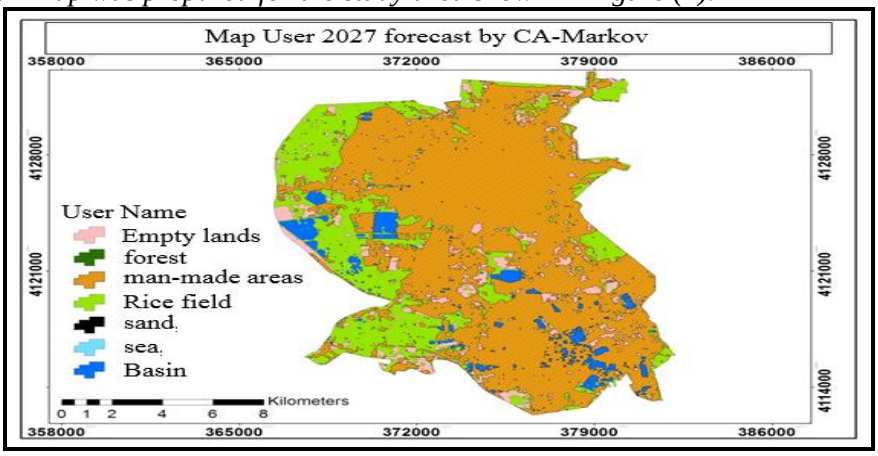

Figure 1: Land use forecasting map of Rasht city using CA-Markov for 2027, Source: Research Findings, 2018.

Table 2. Land use area of 2027 using CA-Markov

User class	*2027 forecast area (ha)*
Jungle	*0/13*
Sands	*0/9639*
Water	*974/26*
rice field	*4797/82*
Man-made areas	*14105/04*
Wasteland	*1599/03*
Sea	*6/39*

As can be seen from Table 2, the area of most land uses, except for man-made areas and the sea, declined as forest land use from 1031/95, sandy land from 15/42, water from 22/333, paddy fields from 88/12/85 and wasteland from / 66. 3629 hectares decreased in 2000 to 0.13, 0.96, 97.26, 47.72 and 15.03 ha in 2027, respectively. In contrast, the land use area of the man-made areas increased sharply to 14105.04 hectares, while sea use increased by 6.39 hectares.

Conclusion:

The use of Landsat satellite imagery is useful in terms of availability, duplicate coverage and lower cost of source data, as well as determining the extent of land cover changes and land use prediction using the models used in Research can be a good alternative to costly methods of discovering change in the shortest time possible. Other objectives of this study were to use satellite imagery and LCM tools to detect changes occurring in the region during the study years 2000–2008 and 2008–2017. Therefore, multi-layer neural network method was used to detect the changes. Examination of changes from 2000 to 2008 showed an increase in urban class area, with the city area increasing from 6793.91 hectares in 2000 to 8940.41 hectares in 2008. The highest increase in urban area was observed from 2008 to 2017 after image classification. During the study periods, paddy, forest and wilderness land use has been steadily declining, and vegetation use has had a protective role as urban land use. In this study, the prediction of physical growth in the city of Rasht in the coming years (2027) was investigated. This is how the 2017 forecast map was first derived using the CA-MARKOV model. Comparison of the results of the prediction map with that of the image classification showed high accuracy. The 2027 forecast map also shows a significant increase in urban land use by 14105.04 hectares in the coming years. Considering the results, it is possible to study changes in vegetation cover and to prevent its unnecessary changes and transformations. Because vegetation plays an important role in reducing environmental issues in urban areas. In contrast, the disappearance of vegetation causes severe environmental crises in relation to the rapid growth of urbanization and the formation of the thermal island of the city. As a result, vegetation is considered as an indicator of environmental sustainability in urban communities. Therefore, proper vegetation management is considered as an integral part of any sustainable urban development. Since degradation of vegetation and rising surface temperature can have adverse effects on the environment, identifying environmental sensitivities (crises) caused by this factor is essential as it can play an important role in urban development management.