Evaluation of the impacts of spatial-temporal urban land policies and law on the optimal urban expansion using CA-Markov, Mahabad

Iraj Ghaderi Motlagh[1], Zahra Pishgahifard[2*], Majid Vali Shariyat Panahi[3]

1. PhD Candidate in Geography and Urban Planning, Department of Geoghraphy, Islamic Azad University, Science and Research Branch, Tehran, Iran
2. Professor, Department of Political Geography, University of Tehran, Iran
3. Associate Professor, Department of Geography, Islamic Azad University, Science and Research Branch, Tehran, Iran

Received: 9 July 2016 Accepted: 7 November 2016

Extended Abstract

Introduction

Urbanization processes are now pervasive, because more than half the worldpopulation is living in cities. This proportion will increase to over 72% by 2050. Most of this urban growth will occur in less developed countries. States are controling over urban land covers and land-use changes, zoning, building regulations, taxation, eminent domain, finance, and conservation rules. However, centralized governmental policies and control in most less developed countries always create ineffective land delivery system and distortions in normal land market behavior. Land policy is a directional and macro political behavior appearing as the attitude, norms and guidelines of the behavior makers. In recent years, the "LUCC" community[1] has produced a large set of operational models that can be used to predict or explore possible land use change trajectories. The models can not only support the exploration of future land use changes under different scenario conditions, Scenario analysis with land use models can also support land use planning and policy. So far, all these models were divided into three classes: empirical and statistical models such as Markov chains and regression models, dynamic models such as Cellular Automata (CA), and Agent-based models and system dynamic model, and integrated model. On the basis of rapid growth of Mahabad in the near future, a systematic approach and accurate planning is the key and plays a vital role in being successful. Given the geological region of Mahabad in the area, the aim of this study is to analyse the changes in the years 1985 to 2015 as well as to predict and simulate the rate of growth of the city by 2021.

Methodology

In this study, applied research is performed through a descriptive/educational method. The research also has used satellite imaging (multitemporal sensors of Land Sat TM, and ETM based on the years 1985, 1993, 2003 and OLI82015) to determine and evaluate land changes in the two classes of built areas and not built areas in the city of Mahabad. In order to manufacture the maps, we have used Autocad2015, IDRISI Selva, Envi 4.8, and ArcGIS 10.2.2. For production of land cover maps, we have employed the maximum probability method by

* Corresponding Author: Sorour1334@yahoo.com; Tel: +98 9128485976

1. Land Use/Cover Change (LUCC)

supervised classification. This method is considered to be the most accurate method of classification amongst many researchers. Finally, the files of maps of land areas are converted from raster format into GIS vector formats in two classes of built and not built areas.

Results and Discussion

It is essential to ensure accuracy and to validate the appropriate practical simulation. Maps of land cover classification in this study were evaluated for 2015 by an overall kappa coefficient of 90% higher than the 85% from calculations based on error matrix. This indicates that there is a good agreement between the classification and land cover types on the ground. Thus, land cover maps for a 30-year period in four whole coverage plans in the years 1985, 1993, 2003 and 2015 were studied with the two classes (built land and not built). Model forecast maps show that the process of centralization in land classes is continued during the study. Based on field observations and survey maps prepared by consulting engineers to design housing site selection with a 20 year old plan in the city of Mahabad in 2025, the simulator predictions and plans of the city in the areas of study are approved. According to satellite images and the maps created from sharing the role of the National Land Survey and housing estate, it seems important for organization of public lands to focus on the urban fringe of the city. The following reasons are a support of this idea. A: An overview is focused on satellite images of urban areas will influence a widespread mandatory horizontal expansion. Because of the conditions and regulations, the transfer of municipal lands, the annexation of the lands to expand the city is believed to be appropriate. Referring to the cases of transfer of the Roads and Urban Development Department of Mahabad, assignment in the immediate area in previous years show the intervals assigned to the land a few years to the time required to build. This requires the necessary time for the perennial works in the area to take place. Therefore, verified simulation model reveals that it is a very close estimation to real life situations and conditions. The percentage of acceptance of our study is delayed to the time after the action has taken place and is faced with the relevant facts.

Conclusion

Research studies indicate that the extent of Mahabad expansion in the geological region in terms of space and time via interpretation of the resulting satellite images show 514 hectares increase in land by 1985. This figure in 2015 increased to an average of 1237 hectares based on actual and projected maps with the help of satellite techniques. Consequently, with the help of the Markov mode, this figure increased to 1657 hectares by 2021. Additionally, the amounts of land belonging to the National Land Survey and housing estate increases from 28 hectares in 1985 to 397 hectares by 2021, according to the estimations. Construction of make-up and organization of physical space phenomena due to socio-economic development of networks and the establishment of settlements as a result of natural processes and social and economic factors will enable vast advancements across the city of Mahabad. In analysis of the physical or spatial construction, a particular emphasis on treatment and physical system components is a fundamental requirement.

Main features include the following physical or spatial parameters in Mahabad:

- Open City is under the influence of natural factors. Expansion of the city has occurred in north-south axis and in the middle part of the east-west axis.
- River of Mahabad flowing is along the east-west axis with a strong edge strongly separating the northern part and southern part.
- One of the main limitations is the relative height of the city compared with the sea level for physical development.
- In addition to the expansion of urban constructions, the use of correct (position and with appropriate slope) methods towards the high lands and maximum neighborhood distances to the main body of the city is plausible.

Markov model analysis of urban development planning helps us provide a quick and reliable direction as well as provide an accepted principle and guideline for future projects. The model

also provides clear decision for space systems and estimates growth with a high level of accuracy and reliability. Following this approach of management and mentality, in combination with such an evolutional ideas, would be paramount and extremely beneficial for the future.

Keywords: land cover, Mahabad, Markov model, urban growth.

References

1. Abdi, N.; Zanganeh Shahraki, S.; Marsousi, N.; Rostami, Sh. (2016). Evaluation and Prediction of the Optimal Path for Urban Development of Sanandaj Using CA Markov**,** Geography and Urban Planning Research, No. 4. pp. 431-446.
2. Akbari, E.; Shekaribadi, A. (2014). Processing and extracting information from satellite data by using Envi Software**,** Satellite Press, Tehran
3. Arsanjani, J.J.; Helbich, M.; Kainz, W.; Darvishi Boloorani, A. (2013). Integration of logistic regression, Markov chain and cellular automata models to simulate urban expansion**,** International Journal of Applied Earth Observation and Geoinformation, Vol. 21, pp. 265-275.
4. Asheri, E. (2015). Study on Urban Land Use Change Impacts on Rural Settlement Strategy using Automated Cell Model (Case Study City of Urmia)**,** Geographical Planning of Space Quarterly Journal, No. 18, pp. 151-167.
5. Department of Housing and Urban Development of West Azerbaijan Province (2011). Comprehensive Plan of the City of mahabad, Existing Studies, the five Report.
6. Divsalar, A.; Mohammadzade, H. (2011). Checking the role of development projects and Urban Construction On urban land market Case Study: City Mahmoud Abad**,** First National Conference of Utopia Iran, Islamic Azad University, Amol Branch, Mazandaran.
7. Eslah, M.; Almodarresi, S.A.; Mofidifar, M.; Malekzade Bafeghi, Sh. (2014). Checking Efficiency of Markov Chain Model to Estimate Changes in Land Use and Land Cover using Satellite Images LANDSAT**,** First National Conference on Application of advanced spatial analysis models (remote sensing and GIS) in land use planning, Islamic Azad university, Yazd Branch, Kerman.
8. Espada, J.R.; Apan, A.; McDougall, K. (2014). Spatial modelling of natural disaster risk reduction policies with Markov decision processes**,** Applied Geography, Vol. 53, pp. 284-298.
9. Faramarzi, M.; Fathizad, H.; Pakbaz, N.; Golmohamadi, B. (2013). Application of Different Methods of Decision Tree Algorithmfor Mapping Rangeland Using Satellite Imagery (Case Study: Doviraj Catchment in Ilam Province)**,** Journal of Rangeland Science, Vol. 3, No. 4. pp. 321-330.
10. Gong, W.; Yuan, L.; Fan, W.; Stott, P. (2015). Analysis and simulation of land use spatial pattern in Harbin prefecture based on trajectories and cellular automata-Markov modelling**,** International Journal of Applied Earth Observation and Geoinformation, Vol. 34, pp. 207-216.
11. Guan, D.; Li, H.; Inohae, T.; Su, W.; Nagaie, T.; Hokao, K. (2011). Modeling urban land use change by the integration of cellular automaton and Markov model**,** Ecological Modelling, Vol. 222, pp. 3761-3772.
12. Halmy, M.W.A,; Gessler, P.E.; Hicke, J.A.; Salem, B.B. (2015). Land use/land cover change detection and prediction in the north-western coastal desert of Egypt using Markov-CA**,** Applied Geography, Vol. 63, pp. 101-112.
13. Han, J.; Zhang, Y. (2014). Land policy and land engineering**,** Land Use Policy. Vol. 40, pp. 64-68.
14. Jiang, P.; Liu, X. (2016). Hidden Markov model for municipal waste generation forecasting under uncertainties**,** European Journal of Operational Research, Vol. 250, No. 2, pp. 639-651.

15. Kamusoko, C.; Aniya, M.; Adi, B.; Manjoro, M. (2009). Rural sustainability under threat in Zimbabwe – Simulation of future land use/cover changes in the Bindura district based on the Markov-cellular automata model**,** Applied Geography, Vol. 29, No. 3, pp. 435-447.

16. Kaviani, A.; Farhoodi, R.; Rajabi, A. (2016). Analysis of Urban Growth Pattern in Tehran City by Landscape Ecology Approach, Geography and Urban Planning Research, No. 4. pp. 407-429.

17. Kityuttachai, K.; Tripathi, N.K.; Tipdecho, T.; Shrestha, R. (2013). CA-Markov Analysis of Constrained Coastal Urban Growth Modeling: Hua Hin Seaside City, Thailand**,** No. 5, pp. 1480-1500.

18. Lalepour, M.; Srour, H. (2012). Review the rules and Urban land policies after the Islamic Revolution**,** Fourth Conference planning and urban management, 21 May, Mashhad, Iran

19. Meshkini, A.; Nourmohammadi, M. (2013). Analysis of urban land management challenges for developing countries**,** Fifth International Conference on Urban Planning and Management**.**

20. Ministry of Roads and Urban Development (2012). Project of land needed location housing programs in Mahabad, General Directorate of Roads and Urban Development in Western Azerbaijan province Poyanaqsh Consulting Engineers.

21. Mirabadi, M. (2016). Spatial analysis and explanation of social inequalities in urban areas of Mahabad, Ph.D thesis in geographic and urban planing, Islamic Azad University, Science and Research Branch.

22. Morsi, E.A.M. (2003). The role of the state in managing urban land supply and prices in Egypt**,** Habitat International, Vol. 27, No. 3, pp. 429-458.

23. Pilevar, A.A.; Afrakhte, H.; Karimipour, Y.; Soleimani, M.;Ghahroodi, M. (2011). Checking the Lmpact of Political Decisions on Land and Housing Instability and Structural Changes Resulting from the Political Approach: Bojnoord, Geography and Development Iranian Journal, No. 23. pp. 141-162.

24. Pourmohammadi, M.R.; Taghipour, A. (2012). Resumption of Urban Brownfields, Journal of Geography and Planning, No. 42, pp. 65-88.

25. Puertas, O.L.; Henríquez, C.; Javier Meza, F. (2014). Assessing spatial dynamics of urban growth using an integrated landuse model. Application in Santiago Metropolitan Area, 2010-2045**,** Land Use Policy, pp. 415-425.

26. Sadatshojaei, R. (2009). Examine the Relationship between the Price of Land and the Use of Urban Land in Tehran, Three Neighborhoods of Jamal Abad, Yusef Abad and Yakhchi Abad, Journal of Housing Economics, No. 46, pp. 85-104.

27. Sang, L.; Zhang, C.; Yang, J.; Zhu, D.; Yun, W. (2011). Simulation of land use spatial pattern of towns and villages based on CA–Markov model, Mathematical and Computer Modelling, Vol. 54, No. 3-4, pp. 938-943.

28. Saraiey, M.H. (2009). Investigate the causes of land remain abandoned entrusted with residential land use in the city of Yazd, Urban- Regional Studies and Research, No. 3. pp. 43-70.

29. Shafizade. M.H.; Helbich, M. (2013). Spatio temporal urbanization processes in the megacity of Mumbai, India: A Markov chains-cellular automata urban growth model**,** Applied Geography, Vol. 40. pp. 140-149.

30. Wanga, S.Q.; Zheng, X.Q.; Zang, X.B. (2012). Accuracy assessments of land use change simulation based on Markov-cellular automata model**,** Procedia Environmental Sciences, Vol. 13, pp. 1238-1245.

31. Yang, X.; Zheng, X.Q.; Chen, R. (2014). A land use change model: Integrating landscape pattern indexes andMarkov-CA**,** Ecological Modelling, Vol. 283, pp.. 1-7.

32. Zaregaziri, A.; Sheikh, V.; Sadadin, A.; Salmanmahini, A. (2012). Simulation of spatial – time of changes in forest area in the Watershed Chehelchai in Golestan province by using automated cell integrated model and Markov chain, Iranian Journal of Rangelands and Forests Plant Breeding and Genetic Research, No. 2, pp. 273-285.

33. Zhou, D.; Lin, Z.; Liu, L. (2012). Regional land salinization assessment and simulation through cellular automaton-Markov modeling and spatial pattern analysis**,** Science of The Total Environment, Vol. 439, pp. 260-274.