Comparative Analysis of land use and urban growth modeling using geomatics technology (city of Najaf-Iraq)

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Abstract The assessment of changes in land use and land cover in the city of Najaf is important because of changes in government structures, wars, the economic blockade over the past decades, migration and increased population growth at the present time and the historical and religious importance it possesses, where this study aims to simulate the spatial temporal changes of the city of Najaf by applying the Land Change Modeler (LCM) model IDRISI program, For the time period (1986-2016). The results indicated a change in the use of land by increasing the area of residential use and services and the expansion of the city to the north and northwest, with a small increase in agricultural land at the expense of vacant land. The model also outlines future land uses for the year 2036, Knowing the direction of future growth helps decision-makers to amend and develop new plans to achieve sustainable urban development and protect historical sites.

1. Introduction
The problem of research in observing, discovering and analyzing the urban growth of the city of Najaf to preserve the historical value and historical heritage of the city, which requires specific administrative plans to discover, analyze and evaluate growth over time, and because of the lack of data and information available and the fact that survey techniques and traditional map numbers take a long time and cost, the study highlights The importance of remote sensing techniques in modeling urban growth forecasting and predicting future land use. It is possible to rely on the models that are included in the GIS programs and IDRISI Selva remote sensing techniques, as one of the standard methods to simplify reality is the use of models, as a land change modeler LCM for its ability to analyze spatially and temporally and calculate changes in land uses and forecasting is an innovative system Land planning and decision support.

2. Urban modelling
To achieve sustainable development of urban areas and to preserve the cultural and historical heritage of urban settlements being formed around areas with a high heritage, it is necessary to study the growth of those cities, Models are a simplification of reality, they are theoretical abstractions that represent systems. LULCC models are tools to support land change reasons, to understand system functions, and to support land use planning and it is policies, Models are classified according to use into three types:

1. Descriptive models: In other words, they are the models that attempt to describe and analyze the current state of a particular urban system, depending on the relationships between the main factors in the urban system.
2. Predictive models: They are models that attempt to describe the future status of a particular urban system and are either by simulating the behavior of that system or using dynamic analytical relationships to anticipate the future behavior of that system.

3. Prescriptive models: They are optimization paradigms, which attempt to determine the future status of an urban system based on “predetermined goals”.

3. Land Change Modeller (LCM)

Integrated software environment for ground cover analysis and forecasting, to solve the problem of accelerated land conversion and the very specific needs of biodiversity conservation. This application provides a powerful set of tools to analyze change and develop plans and scenarios that are applicable in the future.

To activate the model requires that the following paragraphs be fulfilled for the input maps used for analysis and forecasting:

1. Map key is identical in two input maps.
2. The categories in both maps are the same and in sequence.
3. The backgrounds on both maps are the same and have a zero value.
4. The spatial dimensions, including accuracy and coordinates, are the same.

4. Case study

The city of Najaf has emerged as one of the most famous Islamic civilized cities, and has gained its historical and religious significance through time from embracing the shrine of Imam Ali bin Abi Talib, it was center of "civilized radiation" Religious and cultural, for many centuries, despite its exposure during the past three decades.

The city has witnessed major changes in the spatial organization of urban land uses because of its religious function, which represents an "administrative", demographic "and service" weight for the cities of the governorate. The noticeable religious tourism movement, especially in recent years after the improvement of the security situation and the introduction of the international airport, affected the spatial relationships of land use in the city, which caused an increase in land prices and the spread of slums and inadequate housing. The proportions and areas of some uses changed at the expense of each other and also reflected on the functional change of land uses, where the change included two types, the first is planned, i.e. according to the master plan and detailed plans and the creation of new residential neighborhoods in response to urban growth, the second is unplanned changing.

5. Data and application

After pre-processing the satellite images and truncating the part shown in the above figures with an area of (80,463 hectares) that includes the center of Najaf Governorate and its adjacent areas, the study area is classified into six main categories of land use, as below:

1. Agricultural lands.
2. Industrial areas.
3. Religious areas.
4. Residential areas.
5. Rivers and water sources.
6. Empty areas.

Land uses maps are imported to the IDRISI Selva program in txt format, a 30-meter cell size has been determined when converting to a raster, depending on the spatial resolution of the landsat satellite images. Below are the land uses maps for the years chosen for the study after its opening and reclassification with the IDRISI Selva Program.
Figure 1. A satellite image of the city of Najaf (1996, 1986). Source: USGS

Figure 2. Land uses for the year 1986, researcher using the GIS program.

Figure 3. Land uses for the year 1996, researcher using the GIS program.
Figure 4. Predicting land use trend from 1996 to 2016, researcher using IDRISI Selva Program. Change percentages and change maps for the study period.

Figure 5. The change in land use for the years 1986-2016 for the city of Najaf, researcher using IDRISI Selva Program.

We observe, through Figure (6), that there has been a change in the use of land with its varieties (6-1), where it found approximately (10212 hectares) of vacant land (Class 4) has been transformed for other uses so the increase in the area of residential use and services was approximately (6000 hectares) And the area of religious use increased by about 788 hectares, including the increase in the area of the Valley of Peace cemetery. As well as adjacent vacant land.
Figure 6. The values of change in land use per unit hectare between 1986-2016 for the city of Najaf, IDRISI Selva Program.

Figure 7. The location of the transportation spaces from the vacant lands to the residential use for the years 1986-2016 for the city of Najaf.

Figure 8. The location of the transportation spaces from the vacant lands to the religious use for the years 1986-2016 for the city of Najaf.
We notice from Figure (8) that the increase in religious use is the expansion of the Wadi Al Salam cemetery to the northwestern direction of the city, due to the circumstances in which the country went through wars, conflicts and changes in government structures during the study period.

Cities are dominated by human intervention, patterns of change can be complex, and therefore difficult to understand, this part of the model provides the ability to set trends to suit the change pattern in the ground. In other words, it is a way to generalize about the pattern of change. The numerical values whenever you approach a value of 1 indicate a high possibility of transmission in that region. From the above figures, we note that the optimal direction for the extension of the complaint use lies to the north of the city, while the best extension of religious use (the tomb of the Peace Valley) is to the northwest and the agricultural use is concentrated in East and northeast of the city. Benefit from the analysis of land use change over a period of time and knowing the direction of the change pattern in predicting the future shape of land use in the city within the model by means of transition potentials, in this part of the model more than one subform is created that represents the transition capabilities for each type of Land uses in entry maps.
Through transition sub model structure, this part of the model is activated to create the sub-model structure by defining the layer of variables and their type. The variables can be either static or dynamic components. Constant variables express aspects of the fundamental suitability of the transition in question, and do not change over time. Dynamic variables are time-dependent engines such as proximity to the city center or roads and are recalculated over time during the prediction.

Moving to Run Transition Sub-Model, the actual modeling of the transition sub-models is performed. This panel runs the navigation subform specified in the subform to be evaluated. There are three systematic methods for modeling:

1. Multi-Layer Perceptron (MLP).
2. Similarity-Weighted Instance –based Machine Learning (Sim Weight).
3. Logistic Regression.

This study was done using the first method MLP multi-layer algorithm for its ability to operate multiple transitions up to 9 transitions for each sub-model. Whereas SimWeight and Logistic Regression can run only one transmission per subform.
After completing the activation of the sub-models and setting the transition probability file is an array that records the possibility of changing each land use category to every other category, a change prediction has been applied. This panel allows you to determine the amount of change that will occur to some extent in the future using the process of predicting the Markov chain or model User defined. Markov Chain. The amount of change using the previous and subsequent land use maps with the specified date. It determines exactly the amount of land area that is expected to move from a later date to the prediction date based on projecting the possibilities of moving to the future and creating a transfer probability file. Below is the transition probability matrix of 2036.

The rows represent land uses in the previous land cover map. The columns represent uses in the subsequent map. That is, the ratio of the probability of land moving from industrial to residential use is 0.036, and from industrial to religious use is 0.0068, and from vacant land to residential use is 0.1137, We
note through the matrix that the largest increase will be in residential use and services, followed by agricultural use.

![Projected Land Cover]

**Figure 13.** Landuse for 2036.

6. Validation of the Model
Validating the form is an important step. In this study, forecasting of the projected land use map for 2016 was used compared to the actual land use map 2016. In general, there are two methods that are most used in validating models: visual and statistical procedures, using the visual approach gives a cross tabulation between the 1996 land use map, the projected 2016 map and the actual 2016 map used to assess the accuracy of the map model. The result of this process is a map that contains three main categories, namely:

1. The areas in green that indicate that the change model is expected and has already changed.
2. The red areas that indicate the model are predicted to be stable and changed.
3. The areas in yellow which indicate the model predicted change and did not change.
Figure 14. Validation of 2016 map model.

We note from the evaluation map that the areas in green constitute the majority of the region and are the regions that the model predicted by change and actually changed, after assessing the predictive power of the model, it can be adopted to predict the land use map for 2036 with the assumption that there are similar driving forces based on changes between the land use maps of 1986 and 2016.

7. Conclusion

1. The model has three consecutive processes: change analysis, potential transition modeling, prediction change.
2. Markov chain is used to predict future scenarios of land use or the possibility of using another prediction model in line with the researcher's vision.
3. The research proved the ability of the land change modeler LCM model on the spatial and temporal analysis of land use change for two previous time periods (1986-2016) for the city of Najaf by defining the areas.
4. The changes were represented by an increase in the area of the category of residential lands and services with, as well as religious use, and a decrease of vacant lands to the north and northwest.
5. It also demonstrated its ability to predict the future uses of the city and show them with illustrative maps and determine the direction of growth with maps showing the optimal direction for changing the land use category to another category.
6. The model includes a set of mathematical models that are relied upon in modeling potential transition to Earth uses and are multi-layer neural network (MLP), logistic regression, or SimWeight.

References

[1] Yasmine M, Pedro C, Joel S and Mário C 2015 Land Cover Mapping Analysis and Urban Growth Modelling Using Remote Sensing Techniques in Greater Cairo Region—Egypt), ISPRS International Journal of Geo-Information.
[2] Batty M 2009 urban modeling, university collage London.
[3] Raouf Muhammad Ali Al-Ansari Najaf Al-Ashraf is an ancient Islamic city with a study of its most prominent urban landmarks, architect and researcher in Islamic architecture - London, published article.

[4] Naseer Abdul-Razzaq Hajj Al-Basri 2018 The importance of digital modeling in understanding the functional change of urban land uses), University of Kufa / College of Urban Planning / Department of Regional Planning, published research, Najaf Governorate.

[5] USGS (http://glovis.usgs.gov)

[6] IDRISI SELVA 17.0 HELP SYSTEM.