Sultan Qaboos University

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Land Use Change Analysis and Modeling Using Open Source (QGIS)

Case Study: Boasher Willayat

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Abstract:

Issues of land use/land cover changes and the direct or indirect relationships of these changes have drawn much attention in recent years. This research is an attempt to examine the use of QGIS Open source software integrated with GIS techniques to detect, evaluate, and analyze LULC change between 2000 and 2010, to project the future of LULC. MOLUSCE plugin was used for produced the map of area change between study period, and provide transition matrix the represented the replacement from one to others landuse. Finally to detect the future of LULC for 2025 by used Cellular Automata Simulation. As expected, the results showed an increase in urbanization (residential, public building and transport area) while decreasing in agriculture. In the term of projected LULC, the result also suggests a significant increase in residential and public building area. Meanwhile, predictions suggest the agriculture will be reduced by 1.49% in 2025. In conclusion this technique was to be a powerful tools for monitoring and modeling land use and change in land cover.

Keyword:

MOLUSCE , LULC, Simulation, urban growth, landuse, QGIS,

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Chapter One:

1.1 Introduction:

Urban growth has become a topic of major interest it has been studied widely in a number of scientific sectors. In this context the word expansion is defined in the Cambridge Dictionary as the process of creating building to cover area of land. In recent year, urbanization has increased rapidly in both urban and suburban area. Human activity and interaction with the earth's surface to obtain the necessaries of daily life have led natural land cover to become man-made land cove. These activities are considered the main factor in changing the use of land areas from arable to build-up and also to altering the natural environment both in urban and suburban area (Mallick et al., 2008).

One of the main reason for urban growth is increasing population numbers, population is recognized as a driving force behind environmental change and is uniquely simple to quantify along with the basic level of resources that is required per capita on survive(Meyer, 1992). Increasing population numbers in urban area require numerous means by which to obtain their needs including social services, housing, transport, sewages, and water supply, for example. Additional factors which can have an effect on urban growth include migration, industrial, commercial, agricultural, and technological factors (Mohammed and Ali, 2014). These requirements affect the urban area to be expanded. Rapid growth of an urban area is associated with the concentration of population in an area. Additionally, the extent of urbanization determines the pattern of change in land use and land cover (LULC).

In the last decade land use/ land cover has become a major issue at the global and regional level. International attention has focused on it because of concern over issues such as global warming and climate change. Land use is a more complicated term that can be defined in terms of disorders of human activities on the natural environment such as agriculture, transport, forestry and building construction. These activities alter land surface processes including biogeochemistry, hydrology and biodiversity processes. Social scientists and land managers define land use more broadly to include the social and economic purposes and contexts for and within which lands are managed (or left unmanaged) such as subsistence versus commercial agriculture, rented versus owned or private vs. public land (Turner, 2002). The knowledge of land use and land cover is important for many planning and management activities as it is considered as an essential element for modeling and understanding the earth's features.

Several techniques have been used to provide an estimation of (LULC). One of the interest techniques is MOLUSCE. MOLUSCE (Modules for Land Use Change Evaluation). MOLUSE is

designed to analyze, model and simulate land use/cover changes. The plug-in incorporates well-known algorithms, which can be used in land use/cover change analysis, urban analysis as well as forestry applications and projects.

MOLUSCE is well suitable to:

- Analyze land use and forest cover changes among special time periods;
- Model land use/cover transition potential or regions vulnerable to deforestation; and simulate future land use and forest cover modifications

In this study, the MOLUSCE was used to detect the change of land use between two period of time (2000 & 2010) , and measure it by many variables such as slope, aspect, roads, and wadies. This study is also included a prediction of (LULC) in the future , which is important to help urban planners in the process of decision making .

1.2 Aims and Objectives:

The main objective of this study is to examine land use and land cover (LULC) change between 2000 and 2010 and to estimate expected changes in the future. The specific Aim :

1- To detect change in LULC between 2000 and 2010 , and the impacts of urban growth on this change
2- To produce a thematic map of the study area and carry out post classification comparison in order to detect the size of change.
3- To Trains a model that predicts land use changes from past to present
4- To Predicts future land use changes the use of derived model, current state of land use and modern factors.
5- To use cellular Automata simulation model to project change in LULC.

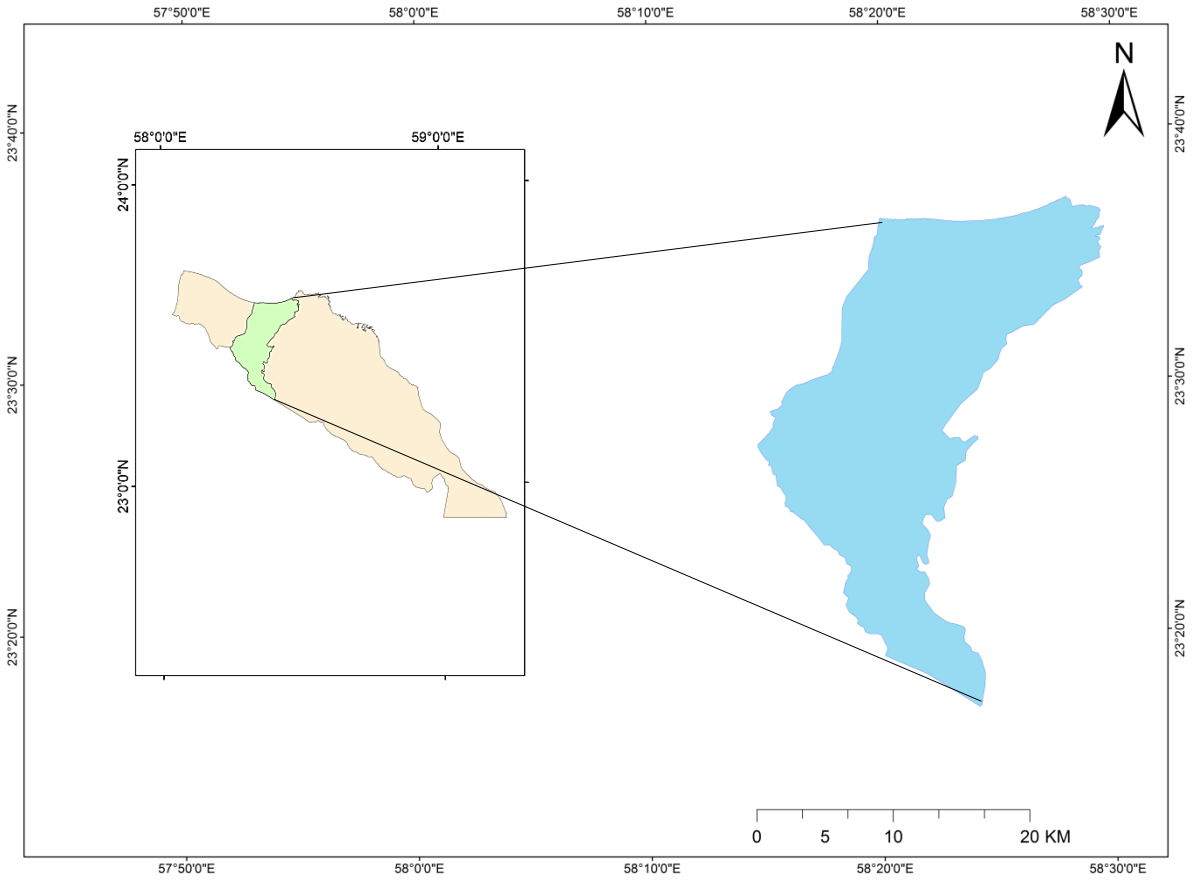
1.3 Research Question:

1- What are the main changes which have taken place in LULC classes during the 10 years period under consideration?
2- Which factors can explain the changes and strong is their explanatory power?
3- What changes are expected in future and where
4-

1.4 Study area:

is one of the wilayats of Muscat, in northeastern Oman. The province borders wilayat Muttrah in the east and Muscat International Airport in the west, it overlooks the Sea of Oman from the north. It contains several archaeological sites. According to the 2010 National Census, the population of wilayat Bawshar was 192,235 spread over its 43 villages and towns. The most noteworthy of these are Al Khuwair, Sultan Qaboos City, Al Ghubra, Al Adheeba, Ghala, Al Sarooj, Bowsher Al Qadima, Al Ansab Sanab, Al Hamam, Al Awabi, Al Misfah.

It is situated at 23°33'54.61"N latitude and 58°25'12.79"E longitude



Map1: Study Area of Boasher Willayat

1.5 Previous studies:

1- Hongjie Xie ,(Land Use Land Cover Change Analysis of Maverick County Texas along the US Mexico Border), University of Texas at San Antonio.2008

This study was discussed conducted of Land Use Land Cover analysis (LULC) for Maverick County Determination of land cover change was sought for demographic correlation. The dataset used in this study was downloaded from the USGS Land Cover Institute website. As study expected, the results showed an increase in urbanization while decreasing in agriculture. The USGS classification model includes an "Urban" class, so this class was compared against all other 11 classes. The result of that for the 1992 – 2001 change product suggested that 6 % of Maverick County was "Urban" with the remaining 94 % of land use was fell into the other categorizes. And the study emphasis that the use of satellite imagery has become a strong tool for analyzing and interpreting earth systems and the anthropogenic influences that continue to pressure the planets limited resources.

2- Selçuk Reis, (Analyzing Land Use/Land Cover Changes Using Remote Sensing and GIS in Rize, North-East Turkey), Aksaray University, Faculty of Engineering, Department .2008

In this study, LULC changes are investigated by using of Remote Sensing and Geographic Information Systems (GIS) in Rize, North-East Turkey. In this study he researcher applied three techniques, Firstly supervised classification technique by using maximum likelihood method is applied to Landsat images acquired in 1976 and 2000. The second part focused on land use land cover changes by using change detection comparison (pixel by pixel). In third part of the study, the land cover changes are analyzed according to the topographic structure (slope and altitude) by using GIS functions.the results of this study indicate that severe land cover changes have occurred in agricultural (36.2%) urban (117%), pasture (-72.8%) and forestry (-12.8%) areas has been experienced in the region between 1976 and 2000. It was seen that the LULC changes were mostly occurred in coastal areas and in areas having low slope values.

3- Yikalo Hayelom Araya , URBAN LAND USE CHANGE ANALYSIS AND MODELING: A CASE STUDY OF SETÚBAL AND SESIMBRA, PORTUGAL, University of Münster.2009

In this study urban land use change analysis and modeling of the Concelhos of Setúbal and Sesimbra, Portugal is implemented using multispectral satellite images acquired in the years 2000 and 2006 The LULC maps are first obtained using an object-oriented image classification approach with the Nearest Neighbor algorithm in Defines. Classification is assessed using the overall accuracy and Kappa measure of agreement. Urban sprawl has also been measured using Shannon Entropy approach to describe the dispersion of land development or sprawl. Results indicated that the study area has undergone a tremendous change in urban growth and pattern during the study period. A Cellular Automata Markov (CA_Markov) modeling approach has also been applied to predict urban land use change between 1990 and 2010 . the land use maps of 2006 are simulated to compare the result of the "prediction" with the actual land use map in that year so that further prediction can be carried out for the year 2010.

4- Aspeq Karsidi, Spatial analysis of land use/ land cover change dynamic using remotes sensing and geographic information system : A case study in downstream and surrounding of the Ci Tarum watershed. The University of Adelaide. May,2004.

The study in concerned with land use/ land cover change detection , identification analysis and prediction using remote sensing and GIS techniques in downstream of the Citarum watershed and its surrounding in Java, Indonesia. supervised classification likelihood classification and NDVI transformed image are used to classify and identify with land use/ land cover categories. A post classification comparison approach was used to detect with land use/ land cover change and A Cellular Automata Markov (CA_Markov) used to predict possible future with land use/ land cover pattern in the study area. There is an indication that with land use/ land cover was converted from intensive agriculture land such as a rich filed to settlement, rather than from less intensive uses such as dry/open land.

5- Addis Getnet Yesserie, SPATIO-TEMPORAL LAND USE/LAND COVER CHANGES ANALYSIS AND MONITORING IN THE VALENCIA MUNICIPALITY, SPAIN, March, 2009

The objectives of this research were to map and determine the nature, extent and rate of changes and to analyze the spatio-temporal land use/land cover change patterns and fragmentation that has occurred in Valencia Municipality. Images were acquired from Landsat MISS, Landsat TM and ETM. The techniques used in this

study were supervised method parallelepiped-maximum likelihood and change detection. The result of this study Built up areas increased from 3415ha (24%) to 4699ha (34%) while agricultural areas decreased from 6560ha (48%) to 5493ha (40%) from 1976-2001. The rate of change was as high as 1.8 % for built up surface while agricultural lands were converted at 1% per year.

6- Marwa WA Halmy, Land use/land cover change detection and prediction in the north-western coastal desert of Egypt using Markov-CA, Alexandria University. September 2015

This study was described land use/land cover (LULC) changes in part of the northwestern desert of Egypt and used the Markov-CA integrated approach to predict future changes. They mapped the LULC distribution of the desert landscape for 1988, 1999, and 2011. Markov-CA was used to predict land use change in 2011 and project changes in 2023 by extrapolating current trends. The projected LULC for 2023 revealed more urbanization of the landscape with potential expansion in the croplands westward and northward, an increase in quarries, and growth in residential centers.

7- (Wanhui Yu et al, Analyzing and modeling land use land cover change (LUCC) in the Daqing City, China. University of Wisconsin-Milwaukee,2011.

This study ensures that during the past decades, land use land cover change (LUCC) has taken place around most Chinese cities at unprecedented rates. During this process, many rural lands, such as forests and wetlands, have transformed to human settlements. this paper analyzed the long-term (from 1977 to 2007) land use land cover change, and modeled the change using a system dynamic model. Through analyzing the trend of land use land cover change, three groups of driving forces, including land use management, population growth, and economic and social policies, have be identified to model LUCC in the Daqing City.

8- Sreenivasulu Ganugapenta & Jayaraju Nadimikeri, Land use and Landover analysis using RemoteSensing and GIS: A case study in and around Rajampet, Kadapa, Yogi Vemana University.2011

The study aims to find out the land use/land cover features of in and around Rajampet of Kadapa District, Andhra Pradesh, India. The total area of the region is

316.88 sq.km. The study has made use of high resolution IRS LISS III satellite imagery for identifying the land use/land cover classes. ArcGIS and Erdas were used to predict the future of land use/ land cover. The land use and land cover analysis in and around Rajampeta area has been attempted based on thematic mapping of the area consisting of built-up land, agriculture land, water bodies, forest and waste land using the satellite image.

Other related previous study:

1- Chris W. Baynard, Remote Sensing Applications: Beyond Land-Use and Land-Cover Change, Department of Economics and Geography, University of North Florida.2013.

2- Charles Chisanga, Free Open Source Software (FOSS) Geographic Resource Analysis Support System (GRASS GIS 6.4) for Mapping Land use, land cover dynamics, Luswishi Farm Block, Lufwanyama District, November 2015

Chapter 2:Methodology:

2.1 Data and Material Used:

The main data used in this present study were two land use of Boasher willayat which created by the GIS staff, also I used many spatial variables as the table showed:

Layer	Type of layer
Landuse of Boshar 2000&2010	Vector
Boashar_Road	Vector
DEM	Raster
Slope	Raster
Aspect	Vector
Builtup_Boshar	Vector
Wadis	Vector

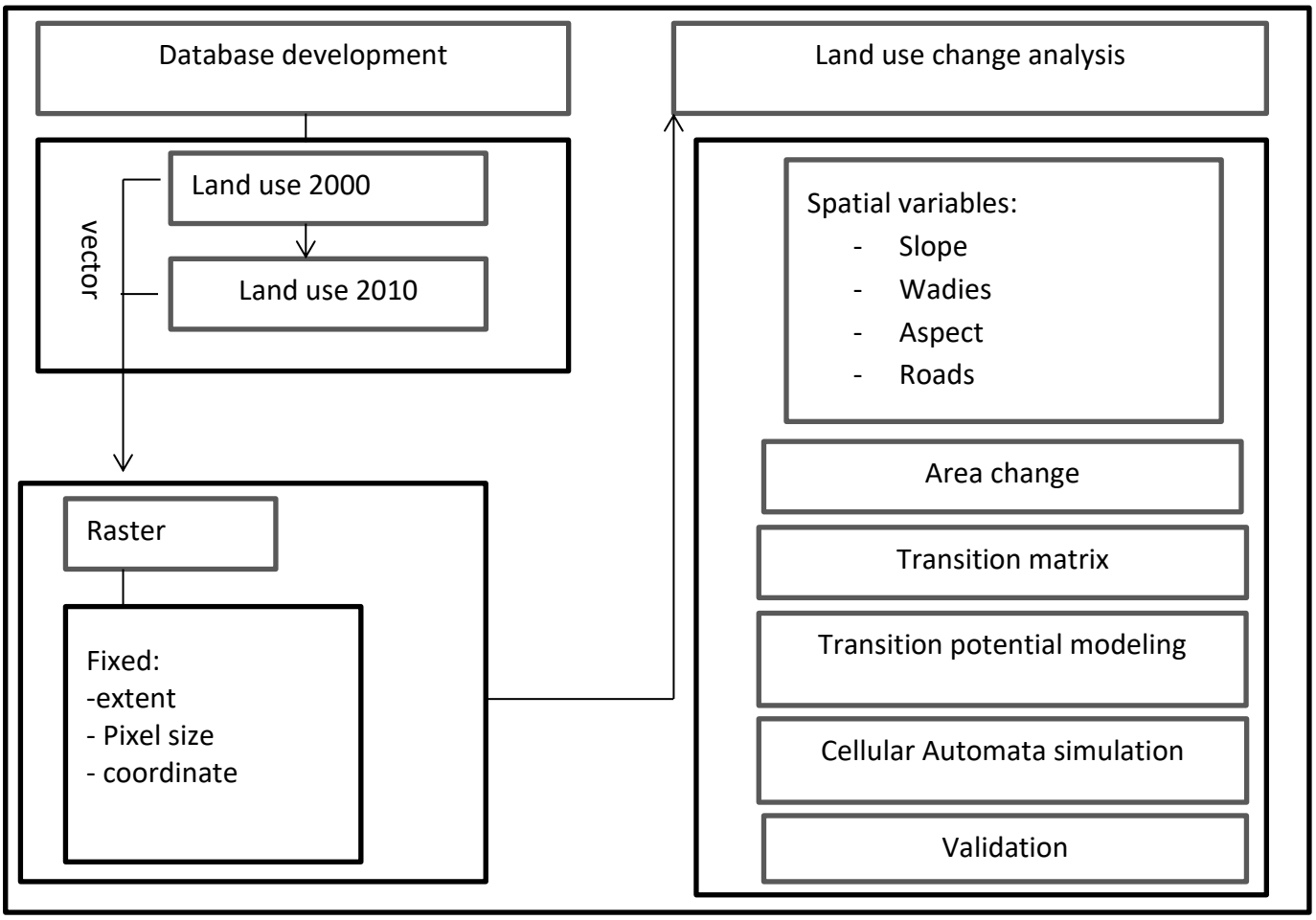
2.2 Method used in this study:

Two land uses of study area were created by GIS Staff and classified using ArcMap and I used a group of spatial variable such as slope , aspect, wadies, and road were they must maintained first in ArcMap to be the same pixel size, coordinate and fixed scale. Then entire these data to MOLUSCE Plugin that used to obtain land cover change map and to establish the trend of change for the study area between 2000 and 2010.
The plugin measure the percent of area change in a given year and provide transition matrix shows the proportions of pixels changing from one land use/cover to another and the plugin carried out the area change map which present the change in the land from 2000 to 2010 in the all 8 classes. MOLUSCE uses Artificial Neural Network (ANN), Multi Criteria Evaluation (MCE), Weights of Evidence (WOE) and Logistic Regression (LR) methods to model land use/cover transition potential. In this study were used two methods which were (ANN) and (LR). A cellular-Automata Simulation was used in the plugin to project the change in LULC. And to predict future change based on the classified image from 2000 and 2010. This model was based on previous change and not on any anthropogenic or natural processes.

2.3 Software used:

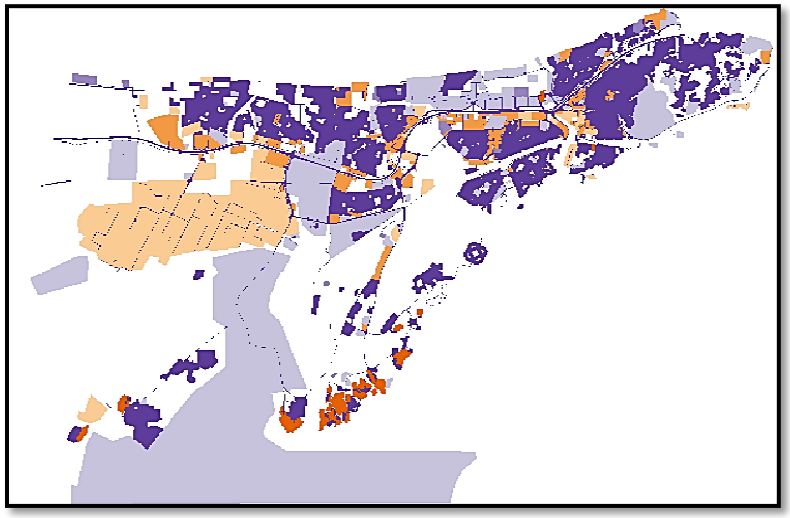
In this study, ArcMap version 10.3.1 and QGIS version 2.14.11. Were used to prepare the data, to analyse image and to map results. Microsoft Excel was used to produce tables, graphs and charts.

2.4 Flow chart:

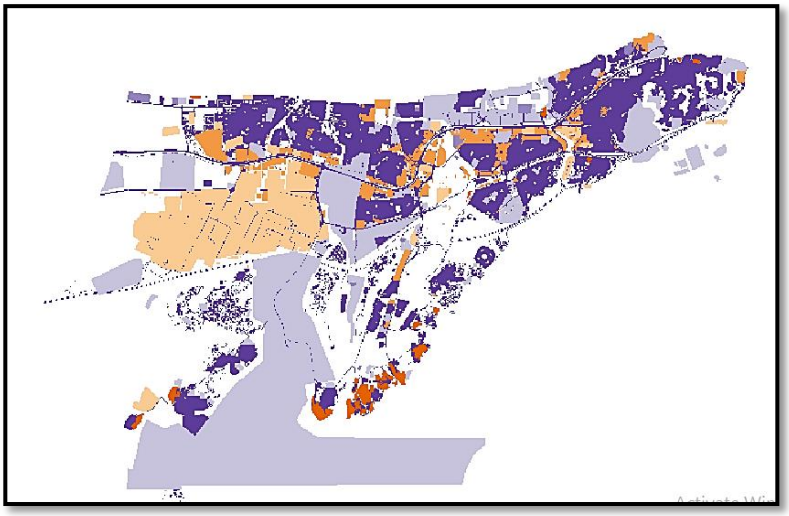


2.5 Data preparing:

The land uses were used in the study both them vector data and were classified into 8 categories which were agriculture, commercial, industry, lake, recreation, residential, and transport . On other hand most of spatial variables were used in vector format, where the MOLUSCE deals with raster data. First thing to convert all vector data to raster data to be able to deal with plugin. Other terms to deal with plugin is to set the same coordinate system for all layers which are (WGS_1984_UTM_Zone_40N). Applied resample process for all layers to determine the same pixel size, in this study I was set pixel size as (30 M). finally to set a fixed extent for all layers. By all these processes the data were able to be used in MOLUSCE plugin.



Map2:Boasher Landuse 2000



Map3:Boasher Landuse 2010

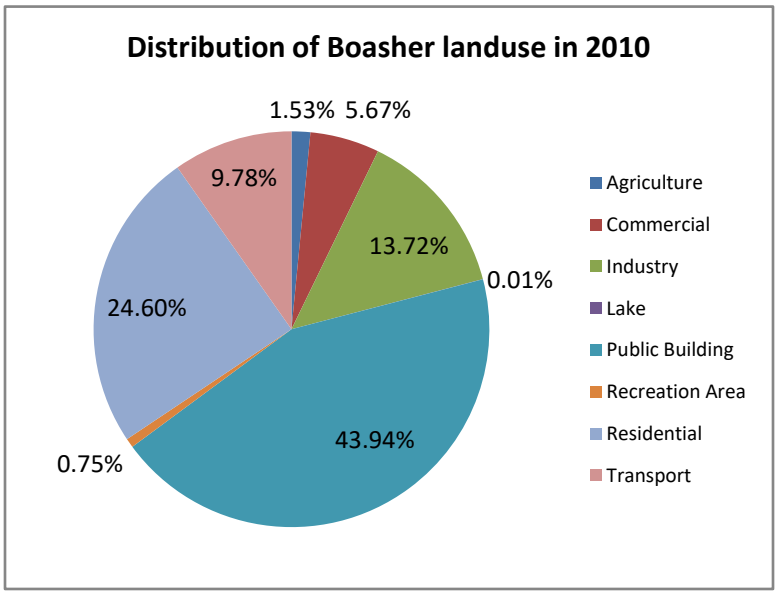


Chart 1 : Distribution of Boasher landuse in 2010

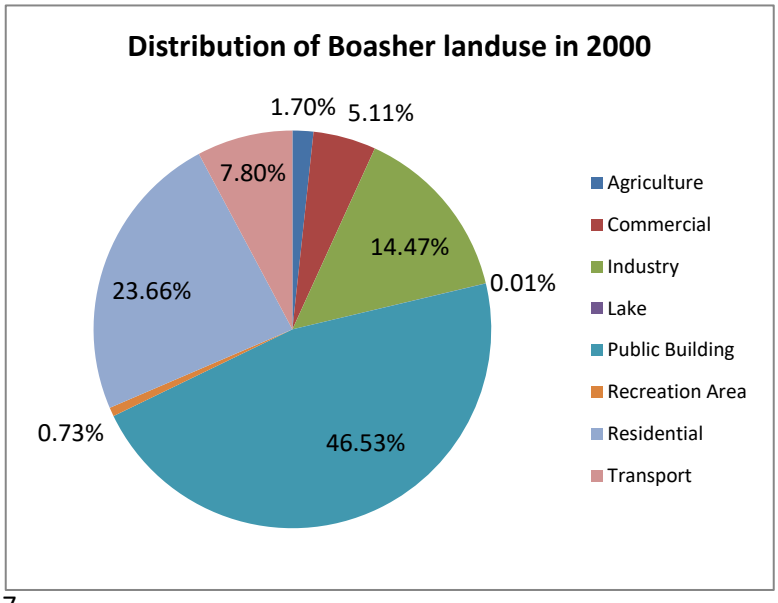
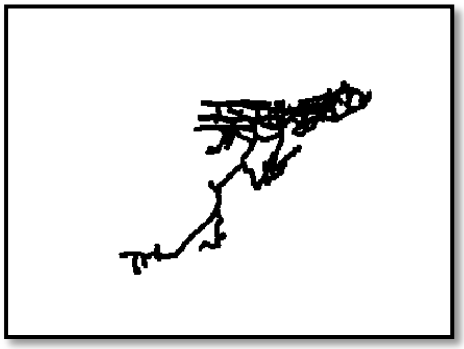


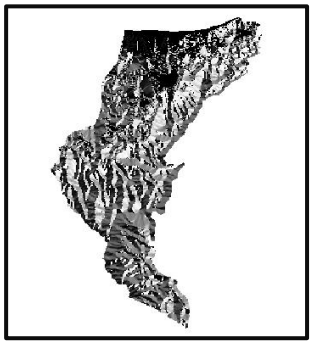
Chart 2 : Distribution of Boasher landuse in 2000

Spatial variables:

Boasher slope



Boasher roads



Boasher aspects

Boasher wadies

2.6 QGIS platform:

2.6.1 MOLUSCE:

MOLUSEC offers a user-friendly and intuitive plugin, which make it easier for users to perform modeling and simulation. The graphical user interface (GUI) is comprised of seven main component:

1- Inputs :

The initial (period 1) and final (period 2) land use/ land cover maps as well as spatial variables such as slope, road, aspect, and wadies loaded in the panel of spatial variables. The land use/ cover change information and the spatial variable well be used for modeling and simulating land use/ cover changes in Boasher. In this step will check geometry if all inputs matched then moved to next step.

2- Evaluation correlation

This tab comprises three methods, namely the person's correlation, joint information uncertainty, and crammer's coefficient, which are used to check correlation among the spatial variables.

3- Area change:

In this tab, land use/ cover change and transition probabilities are computed. Also land use/ cover change map produced. The land use/ cover units can expressed in square meter, square kilometer, and hectares.

4- Transition potential modeling:

While many method available for computing transitional potential map, Artificial Neural Network (ANN), Multi Criteria Evaluation (MCE), Weights of Evidence (WoE), and Logistic Regression (LR) are available in this plugin. Each method uses land use/cover information and the spatial variable as inputs for calibrating and modeling land use / cover change.

5- Cellular Automata simulation:

Transitional potential map, certaincy function, and simulated land use/ cover maps are generated under this process. The cellular automata approach is based on Monte Carb algorithm.

6- Validation:

Validation computes Kappa statistics (standard kappa, kappa histogram, and kappa location, misses and false alarms are produced under this component.

7- Message:

This tab presents the progress of the modeling and simulation, error message or warning to the user.

Chapter 3: Results and Discussion:

3.1 correlation evaluation:

3.1.1: person's correlation:

	roads	slope	aspect	wadis
roads	--	-0.0227145380041	-0.0144882709321	-0.211447986127
slope		--	0.996956383188	0.0367265712751
aspect			--	0.0411970584039
wadis				--

Table1: person's correlation between spatial variables

- The above table showed the correlation ratio between the four variables (slope, roads, aspect, and wadis). It is noticed from the result that the roads layer is inversely related to the other variables, which are inversely affected. The roads often need an equal area in order to facilitate street construction. While other variables are linked by direct links for example, the correlation between slope and aspect is almost 100% (0.9969) because the aspect is Angle between vertical and direction of steepest slope. And both them Calculated from a grid of elevations (a digital elevation model). The valleys (wadis) were correlated with a simple percentage with slope and aspect because wadis are depressed ground and consist of side slopes which can be.

3.2 Land use change from 2000 to 2010:

- The table study shows the tremendous impact on land use composition and configuration in the past at Boasher willayat. Urbanization and comprehensive development policy by the local governments have significantly contributed to the rapid land use change in this region. It is apparent that large urban areas have replaced agriculture lands within the study period. Agricultural areas of 1.707% in

2000 have reduced to 1.58% in 2010, and the average of change was -0.027% which equivalent to (10800 sq.m). On other hand, Residential area has significantly increased with total percentage of 0.055% and Public Building use is the largest portion of area development. Similarly, the other urban land uses such as commercial, industry, and also transportation increased with different scales. Meanwhile, lake area was increased in very small percentage. As regard to the changes, table 2 indicates the different percentage of each land use change in the 2000 and 2010. Overall, all the land uses have different trends of changes. Agricultural area decreased whereas others increased expanded, removing the other land uses.

Class	color	2000	2010	Δ	2000	2010	Δ
Agriculture		976500sq.m	965700.00 sq.m	-10800 sq.m	1.7072645	1.5894883	-0.027776197
Commercial		3138300 sq.m	3141000 sq.m	2700 sq.m	5.1699167	5.1654608	-0.0044440494
Industry		8950500 sq.m	8985600 sq.m	35100 sq.m	14.732023	14.7897964	0.0029626996
Lake		7200 sq.m	9000 sq. m	1800 sq.m	0.01185079	0.014813498	0.0029626996
Public Building		2873160 sq.m	28762200 sq.m	30600 sq.m	47.290611	47.340977	0.050365893
Recreation Area		425700sq.m	455400.00 sq.m	29700 sq.m	0.70067845	0.74956300	0.0488845435
Residential		14408100sq.m	14441400 sq.m	33300 sq.m	23.714929	23.7697389	0.0548099428
Transport		3997800 sq.m	4114800 sq.m	11700 sq.m	6.58015	6.77273131	0.0192575474

Table2: The land use class area distribution and change 2000 and 2010

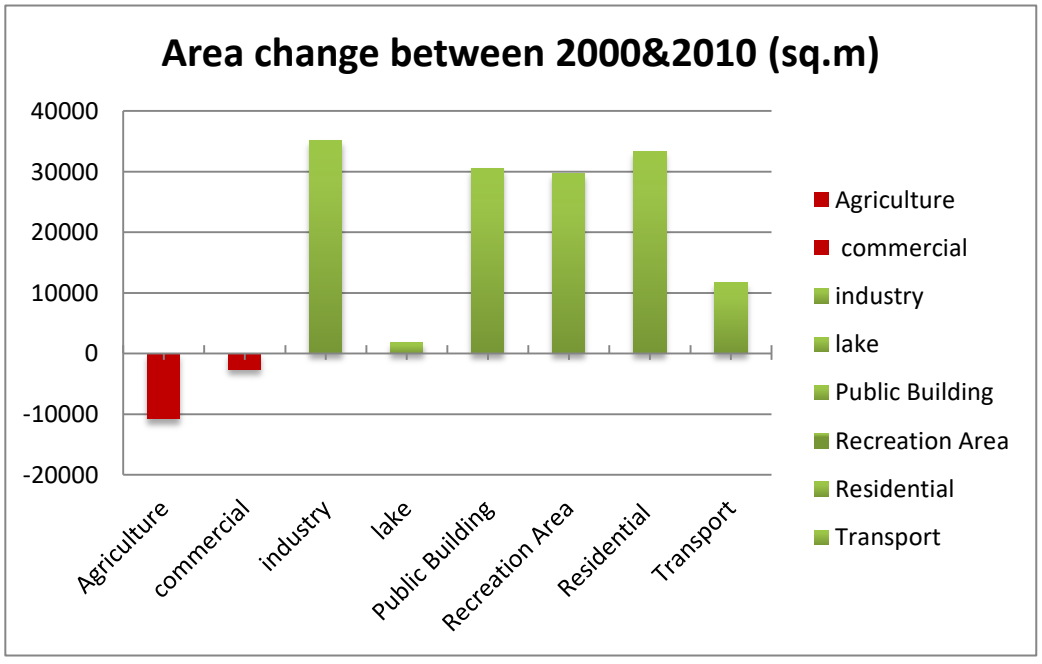
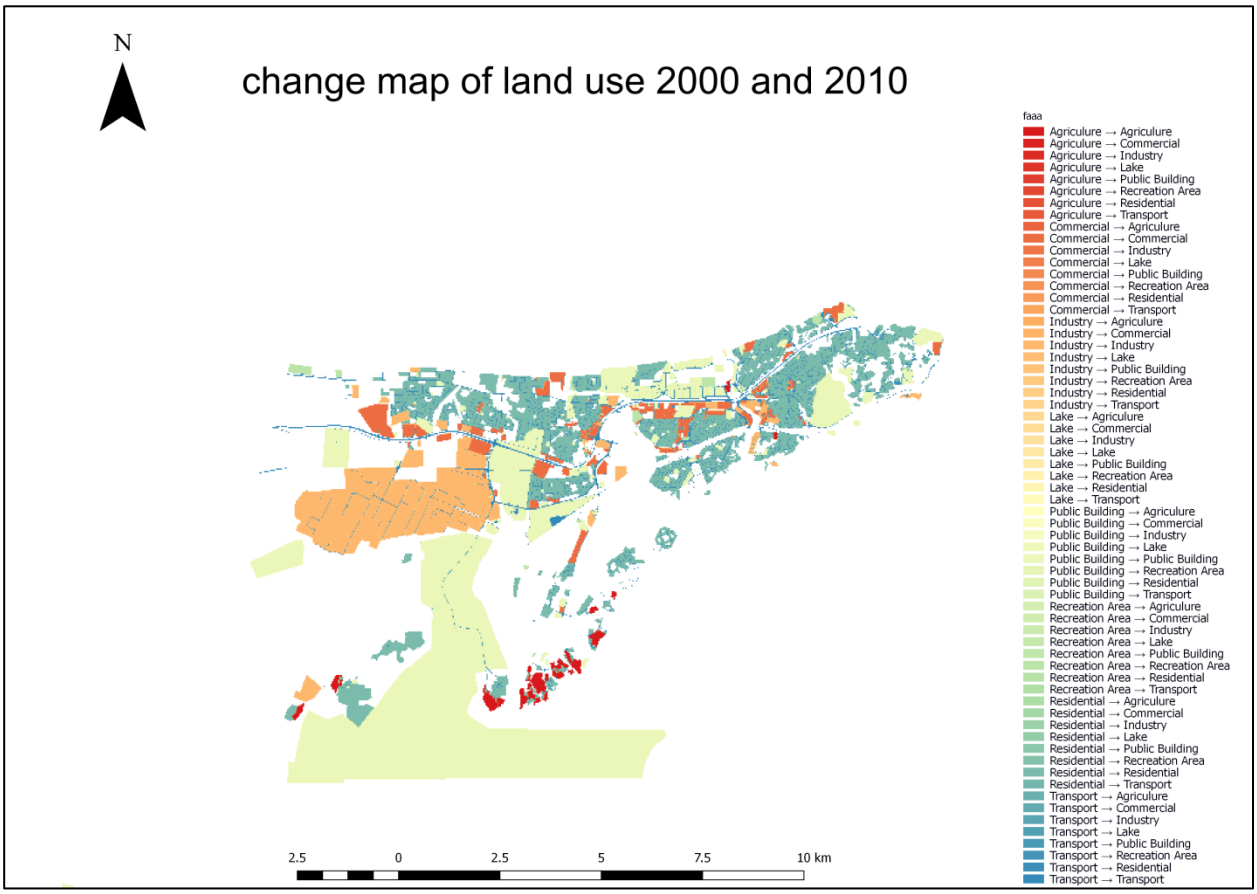


Chart 3: The change of land use/cove in 2000 and 2010

The table below showed transition matrix which presented the replaced of land use to other land use. The highest probabilities of change, at (0.312117), are that transport was converted to residential area, while the lowest probabilities were presented in lake. Agricultural area has been replaced by other land use activities such as residential (0.048848) and transport (0.021198). While it's replaced from residential may due to Planting of houses (0.002249). Some residential areas and public buildings replaced into commercial and industrial uses. This may be due to the conversion of the use of buildings or have been built for the use of residential and then been leased. The lakes have remained constant and have not been converted into other uses and have not expanded. Finally urbanization has led to rapid land use change and contributes to remarkable increase of residential areas from 23.66% in 2000 to 24.6% in 2010. Besides that, residential areas were also converted to other land use activities like institution, infrastructure, and industry and commercial. This situation happened due to the regeneration of urban land use in Boasher willayat Within 10 years it shows that the changes are very rapid. Demography aspects and comprehensive development policy have caused high competition of land development and created complexity in the study region. Parallel to the development boom of residential area is the expansion of institution, industry and commercial, transportation, infrastructure and utilities areas.

	Agricultural	Commercial	Industry	Lake	Public Building	Recreation Area	Residential	Transport
Agricultural	0.929954	0	0	0	0	0	0.048848	0.021198
Commercial	0	0.902579	0.007163	0	0.007450	0.001146	0.016332	0.065330
Industry	0	0.001709	0.973253	0	0.000704	0	0.000603	0.023731
Lake	0	0	0	1	0	0	0	0
Public Building	0.000188	0.001096	0.000188	0	0.983805	0.000188	0.003947	0.010588
Recreation Area	0	0.002114	0	0	0.002114	0.974630	0.012685	0.008457
Residential	0.002249	0.001936	0.000875	0.000125	0.007246	0.000750	0.897683	0.089137
Transport	0.004812	0.055337	0.056868	0	0.087708	0.005031	0.312117	0.478128

Table3: transition matrix of land use/cove in 2000 and 2010



Map4: change area between 2000 and 2010

3.3 Transitional potential modeling:

3.3.1 Artificial Neural Network (ANN):

Which are computational intelligence elements. The justification for their use is that they are applicable in solving problems in which we have to deal with a large amount of input data and in which the algorithm to solve the problem is unknown or difficult to implement [SUZUKI 2013]. There are multiple parameters entered into the analysis, related to topography or land cover, and a universal algorithm of operation is extremely difficult to implement. Artificial neural networks implement the requirements of fuzzy logic, and that is why we will be able to determine the usability of terrain in a continuous range, e.g. 0 and 1 (we are not limited to the binary classification). Therefore, it is possible to generate a continuous Index, which characterizes the terrain in a range from 0 to 1. The core element of the artificial neural network is interactions between neurons (connected to each other) and the modification of the weight connections between them. This modification depends

on input data and the expected output from the network as well. This process is called "neural network learning".).

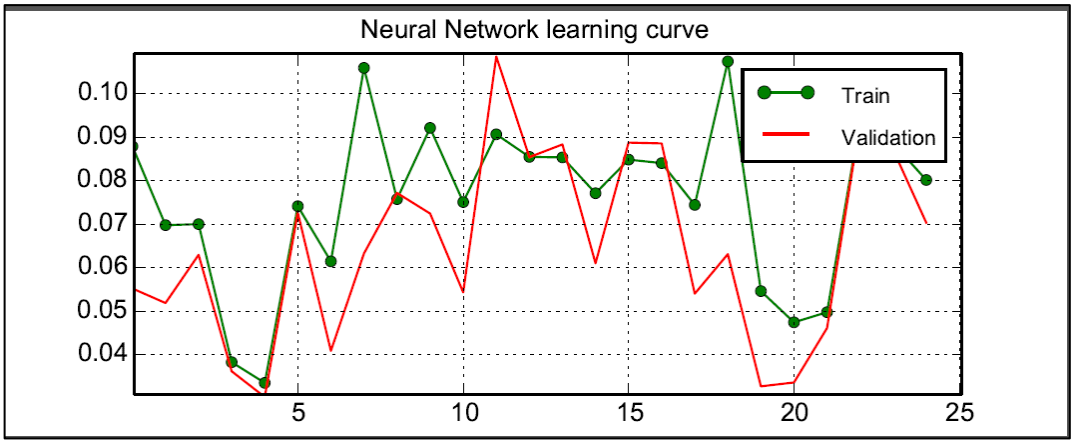
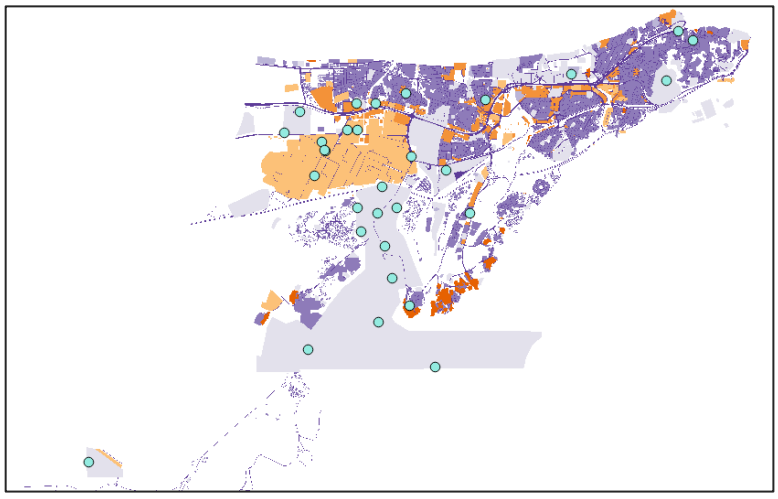


Chart 4: Neural Network learning curve

3.3.2 Logistic Regression (LR):

Regression analysis establishes relationships between numerous input variables and presents the relationships in a succinct manner, usually as a number or a series of numbers. Regression is a multivariate analysis that is available in Plugin Workstation. Guidelines in the field of statistics defining the significance of the numbers exist to assist in interpreting the relationships. In logistic regression, the magnitude of occurrence of the phenomenon being modeled by the dependent variable is unknown. Instead, the known values of the dependent variable are represented by the presence or absence of the phenomenon at the sample locations. Logistic regression can be used to predict the probability that a phenomenon will exist at an unsampled location.



Map5: sample location was taken for LR Modeling

Coefficients | Standard deviations | P-values

	1.0 → 1.0	3.0 → 3.0	5.0 → 5.0	7.0 → 7.0	8.0 → 8.0
β0	0.500025798825	0.424447865534	0.935015210459	0.211943712961	0.261349248306
β1	0.135407400849	0.467456010874	0.0994506878352	0.209007974036	0.688309550789
β2	0.0862054951426	0.257733188966	0.109803810859	0.826005200231	0.596951614143
β3	0.743486512063	-2.225241418	0.791593645016	1.53450273703	1.0757916407
β4	0.0793948186437	0.835490154834	0.515773267938	0.522537663489	0.804342884079
β5	1.31050531901	1.11386858754	-1.67022341833	1.53318411926	0.774060159662
β6	1.17401492672	0.755498090487	0.153136491492	0.747127408848	0.370143076841
β7	6.51338568642	2.11035884742	2.7555188289	-4.13427565189	-4.17028925036
β8	0.718242312556	0.306058563351	0.838757162862	0.968746626151	0.00806660013406
β9	0.726112008496	0.203863013784	0.66127986683	0.413131014422	0.510343767929
β10	1.62643809642	-2.16915698003	1.38417055434	1.06775647124	1.17484337917
β11	0.430489582702	0.92688221129	0.827240978517	0.559106101263	0.368360204536
β12	0.729896471295	0.636889171345	-2.3506333565	1.59728753132	0.502593038388
β13	0.927217556867	0.633598078344	0.0255788883799	0.260629787711	0.100819250091
β14	6.67057253269	1.69001994812	2.53419256735	-4.00292446166	-4.67858282189
β15	0.723476947684	0.251273473241	0.632268376524	0.313903934133	0.736980793753
β16	0.810226714848	0.468066197425	0.846953915624	0.222617078246	0.101140518076
β17	0.331452426312	-0.698574721...	1.01767047567	1.27261119997	0.420619640503
β18	0.921413492838	0.565425412968	0.00563413672...	0.0096432630...	0.136517507582

Table4: LR modeling for 31 samples

3.4 Cellular Automata Simulation:

In order to predict likely future trends and change in the study area. Cellular Automata, based in change in LULC between 2000 and 2010, was used transitional potential modeling (ANN, LR) to forecast future changes. The result indicates that the probabilities of increasing area will be cover by residential area, industry, and Public building. The reasons for these changes are that the method is based on previous change in pixels according to 2010. Also this method affect by the spatial variables that I used such as slope, aspect and road network. The chart 5 show the change in each land use, its predict that agricultural will decrease more and its will cover about 1.49% from study area in 2025, while the rest of land use will increase in different scale.

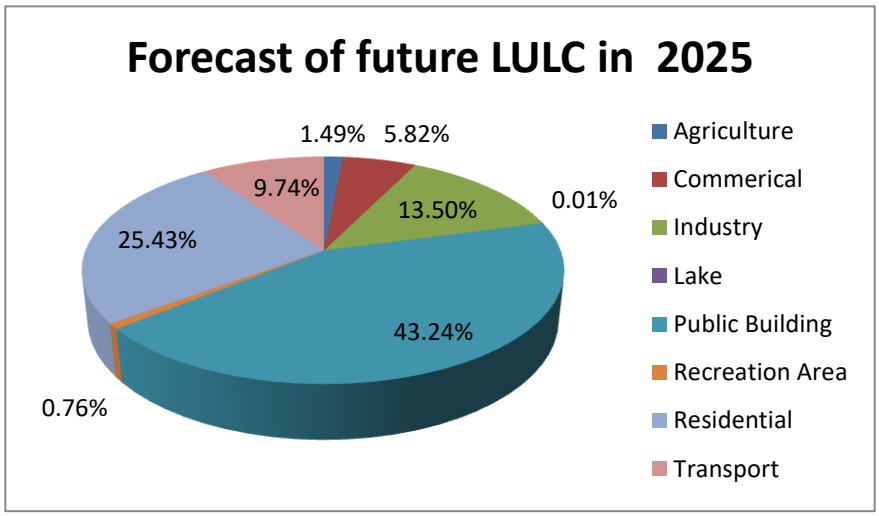
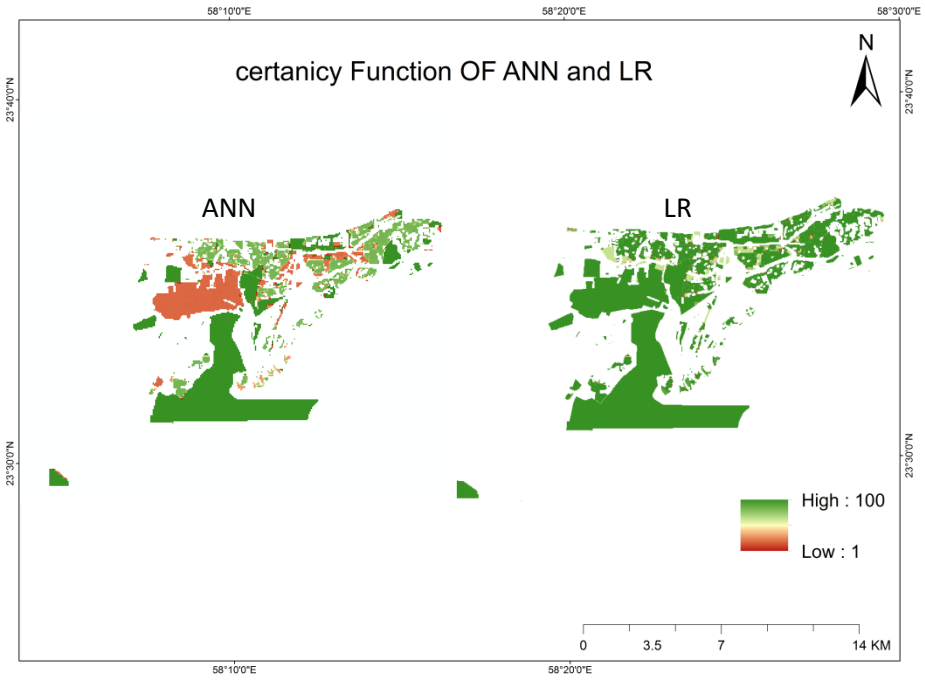
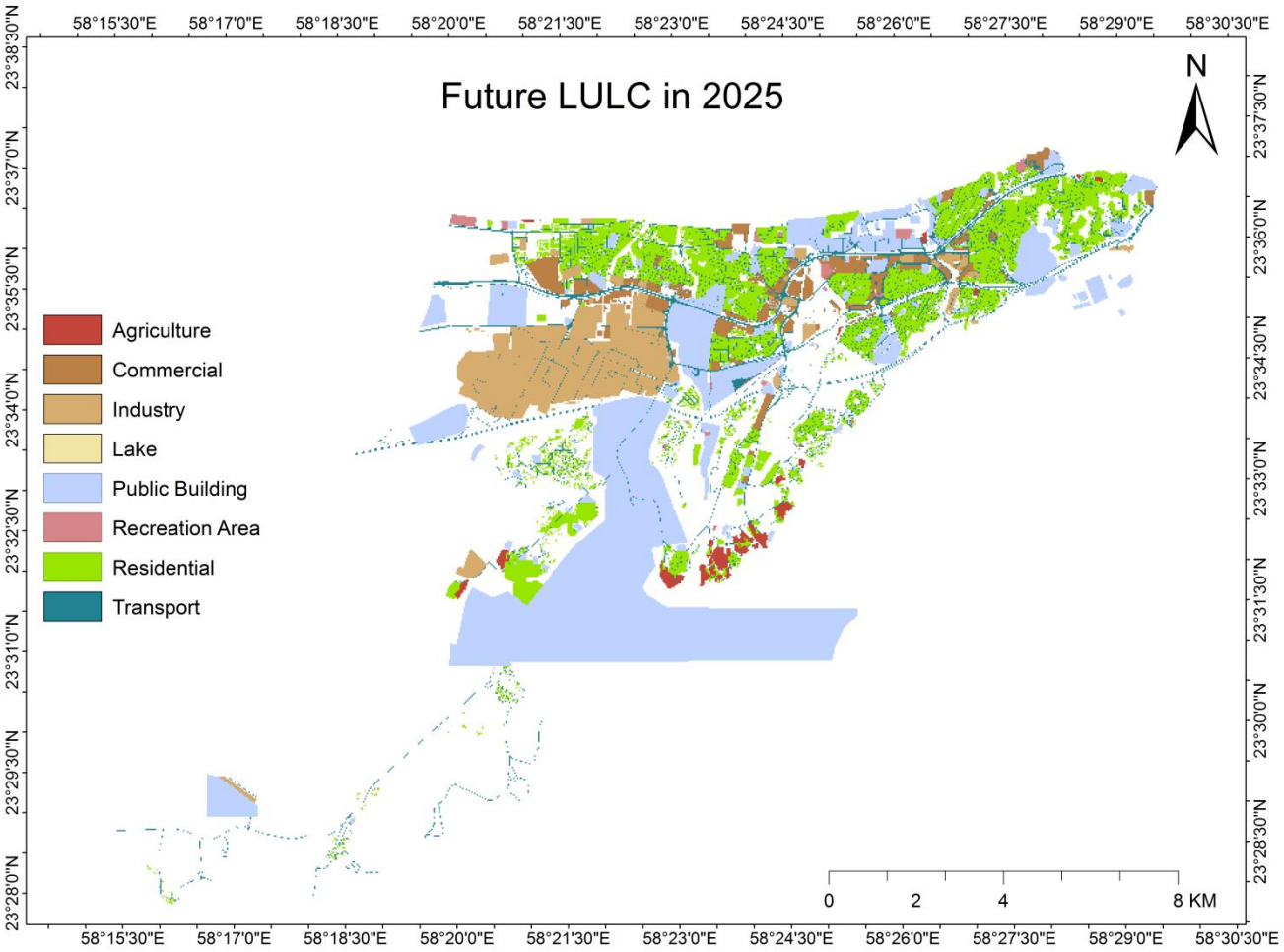


Chart 5: **Forecast of future LULC in 2025**



Map6: Certaincy Function of (ANN and LR) modeling



Map7: Future forecast of LULC in 2025

3.5 Validation:

Making better use of accuracy data in land change studies: Estimating accuracy and area quantifying uncertainty using stratified estimation. Validation compute kappa statistic. The kappa statistic is frequently used to test inputs accuracy. The importance of rater reliability lies in the fact that it represents the extent to which the data collected in the study are correct representations of the variables measured.

Simulation Method	% of correct prediction	Kappa
ANN	88.96394	0.41176
LR	92.79175	0.89522

Table5: Validation results of simulation for 2010

Chapter 4:

Conclusion and Recommendation:

This research aim to detect and evaluate LULC change using QGIS especially MOLUSCE plugin, to predict likely future change using Cellular Automata Simulation, the study have five objection in order to achieve these , preparing data in ArcMap, and QGIS were used and these method were able to meet the research objective. LULC was classified into eight classes: Agriculture, Commercial, industry, Lake, Public Building, Residential, and Transport. Classified images from 2000 and 2010 were used to project the likely changes in 2025.

The outcomes of classification indicates a significant growth of some landuse mainly residential area and public building during the study period , with a decrease in other land cover type, especially agriculture and commercial. Due to political changes which led to more urban growth in Boasher.

The result of LULC change projection, which was carried out using (C-A). suggest that residential area and public building will continue to increase in Boasher. And this will have an effect on the other land cover types such as agriculture and lake area. The distribution of population growth will increase due to the increase of residential area and Focus of ministries and institutions in Boasher willayat, so People prefer to live near their place of work.

In summary, the methods used here to answer the research questions and achieve the aims of the study have been very good. This software with the other software such as aldrisi and erdas provide tools which are play a powerful role in studies of this type which are very helpful for planner or to address problem which arise due to environmental change and human activities. This study offers some recommendation that will be helpful to future planning and policy making. It is also helpful for government officials and planners to observe such development pattern in this willayat to enable them to use land source in better way, these are as follow:

1- The rapid urban growth in the Boasher willayat has affected other important type of land cover such as agriculture and Boasher sands. Government should encourage and help people to use barren land for building rather than agriculture land. Or to prevent people from building in the willayat because of the high population density.

2- Planner should develop urban planning in the study area by providing short and long term planning since urban area has expanded and is distributed over the study area this will affect land cover types. Furthermore, the absence of urban planning has allowed uncontrolled growth.

3- Government should take responsibility for providing a master plan for the study area. This is required because the ratio of agriculture land has decreased. Green space should be increased rather than allow it to be transformed to built-up area.

4- Using satellite image with high resolution such as Ikonos and quick-bird with 1-m resolution are more suitable and significant to classified LULC , and will led to small scale of error.

5- In order to project a trend of urban growth or LULC in the future, an additional methods is needed which consider other variables, such as suitability. Because suitability method take other variable into consideration such as water, road network and slope, which mean not only based on previous change.

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