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FUTURE PREDICTED DYNAMIC MODEL URBAN GROWTH FOR BAQUBAH CITY

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ABSTRACT: Baqubah city is witnessed during the last decades a fast urban expansion because of the rapid economic growth. Which had its negative effect on the environment of the city through the sprawl of the expansion on the rural areas and the orchards surrounding the city. The objective of the research is to produce dynamic model and land use map of Baqubah city through employing the capabilities of Dinamica EGO software with assisted Arc GIS (Ver.10), remote sensing techniques ERDAS (Ver.13).No previous attempts have been taken to produce this model for study area.

The classified maps are used in the dynamic model to calibration, validation and simulation to get the finial simulation model in 2050 year by ten-sequence step of models. The maps of 2004 and 2010 are used for the transition probability matrix. The simulated map for the year of 2010, when compared with the real map, reached rate of similarity to 81.5 %. The simulation scenario for the year 2050 showed an increase in the medium residential, high residential and road by (40.2%, 104.4%, and 23.9% respectively). As well as a significant decrease the orchard, vegetation, water, open area and mix by (52.2%, 48.4%, 35.6%, 29.7%, and 12.5% respectively).

Keywords: Urban Growth, Dynamic Model, Classification, Dinamica Software

1-INTRODECTION

In Baqubah city, land use and urbanization have suffered an important variation due to faster growth since 1960. Urban growth has been speeded up, the random land developing houses; random commercial market and other factors create pressure on the planning for protection of urban fringe against urban sprawl. This is mainly real in the city where thorough rural land is disappearing every year, changing to urban or associated uses. Estimating the amount and form of all Iraq's urban development is a serious need. In addition, because of the absence of suitable land use planning and the measures for sustainable expansion, unplanned urban growth has been generating simple urban consequences.

Chang-Qing KE (2006), showed urban area expands very fast. The urban growth is predicted from 1998 to 2010 based on Cellular Automata, whereas the predicted result in 2010 will be checked by the future situations of urban development. The analysis of Cellular Automata suggests that the highest land-use attractor is the city of Nanjing. Fruitful agriculture land is the least stable categories. The approach can be concluded to similar areas of fast growth and urban land use change, especially in developing countries like China.

Soares-Filho, B. (2012) showed that the DINAMICA software model is used to multi –temporal and data from survey, the spatial transition probabilities of changes and transition matrices, (variables such as slope, distance to roads, etc.) to simulation trends and alternative scenarios.

Britaldo ,S.F., et al (2012), simulated the model is set to run of 30 years by annual time steps .using DINAMICA software and database from GIS such as soil, topography, infrastructure, population, protected area and vegetation. Additionally, the established of maps provided by the model facts out the fundamental role of governance in the management of this region.

Assela P., et al, (2012), conducted a focused study on the city of Mumbai, India: A landscape dynamics model Dinamica-EGO was used to develop a future urban growth scenario based on past trends. The predicted future land use changes, with current land use as control, were used as an input to the model. The model was integrated for four historical cases, which showed that, had these events occurred with the future land use.

Sathish, K., Aryab, D., et al. (2013), concluded the modeling urban growth and generating scenarios are essential for studying the impact and sustainability of an urban system. The dynamic transitions from one form of land use to another occur over a period. Therefore, a modeling framework that captures and simulates this complex behavior is essential for generating urban growth scenarios. Cellular Automata (CA)-based models have the potential to model such discrete dynamic systems. In this study, a constraint-based binary CA model was used to predict the future urban growth scenario of the city of Roorkee (India).

Eduardo E. M., et al. (2013), simulated the expansion of agricultural and activities within a watershed located in the suburbs, Brazilian Amazon. A spatially clear dynamic model of LUCC was used to run both past and future situations of forestry change into such rural activities. The modeling Dinamica EGO contains in a cellular automata neighborhood-based change algorithms and spatial feedback methods, and statistical validation checks were then displayed for the created past simulations (2000 to 2005), by means of many resolution fitting methods. Established on best calibration of past simulations, future developments were measured to figure out developments and spatial patterns of forest change in the study area for the year 2015. This modeling test shown the suitability of the approved model to simulate procedures of forest change. It also shows its possible more applicability in producing models of deforestation for areas with growing rural activities in the Amazon.

Wei ,Y. ; et.al (2012), developed dynamic models land use of china in 2005 ,the real map was compared with the simulation map by using DINAMICA and predicted land use change to 2020.The result shows grass land area would reduce, forest would increase ,water would stable and the greatest variety in built –up area.

Almeida M., et.al (2002), showed the model structure has been applied to town, Bauru, in the west of São Paulo State, Brazil. Infrastructural factors can be joint by the weights of evidence method that allows us to expect the probability of variations between land use categories in changed cells of the system. Forecasts for the town through the period 1979–1988 were generated, and statistical validation was then shown using a multiple resolution fitting process. This shows the relevance of the method for generating estimates of growth for Brazilian cities in particular and for worldwide cities in general.

2. RESEARCH METHODOLOGY

The study initially investigates understanding the dynamics and factors of growth for an urban systems, with complexity theory as a backdrop and the need of modelling the urban system. GIS technique is used to analyze Baqubah urban growth, with transportation network, and to evaluate the dynamic model in this city. The satellite image processing is used to rectify the images and enhance them to extract features that will be used in GIS (Ver.10) analysis. Image classification (ERDAS Ver. 2013) is an important part of the remote sensing, image analysis, and Dinamica EGO software for ten steps to recognize the forecasting the dynamic model as shown in Figure (1) the land-use and land-cover change simulation model. A framework for parameterization and integration of dynamic model is designed utilizing the temporal remote sensing data to provide the calibration data. The validation is designed to evaluate the model performance.

3. STUDY REGION

The study region is Baqubah city. Baqubah is located at the east of Iraq with geographic coordinates [latitude (37° 25 50) to (37° 40 52) N, longitude (45° 16 39) to (47° 55 32) E] on both sides of river Diyala.

Baqubah is the capital of Iraq's Diyala Governorate. The city is located some 50 km to the northeast of Baghdad, on the Diyala River. Baqubah served as a way station between Baghdad and Khorasan on the medieval Silk Road. New infrastructure including modern sewage, water, and highway facilities were built during this period. During the last 40 years, Baqubah city has grown fast due to region expansion, the agricultural land use and land habitats are transformed into land for housing, roads and industry. Figure (2) Shows location of the study region Baqubah within Iraq.

4. RESULT AND DISCUSSION:

4.1 Determine Weights of Evidence Ranges

This model calculates ranges in order to categorize continuous variables for deriving the Weights of Evidence. It selects the number of intervals and their buffer sizes aiming to better preserve the data structure. As a result, its output is used as input for the calculation of Weights of Evidence coefficients. Dinamica EGO can incorporate dynamic layers into the simulation, which are so called because they are updated during model iteration. Therefore the model will include the variable "distance-to-5 (medium residential), distance-to-6 (high residential), and distance-to-8 (roads), as a dynamic map. For this purpose, the model employs the functor calc. to distance map.

4.2 Calculating Weights of Evidence Coefficients

The Weights of Evidence approach was used to measure the suitability and significance of variables of the model. The Weight of Evidence method has advantage over other statistical methods, such as Logistic or Linear Regression, in that it is not constrained by statistical assumptions of parametric methods (which spatial data respect). The only assumption for Weight of Evidence method application is that all variables are spatially independent. Thus, a pair wise test of spatial variable maps measuring Cramer's Coefficients, the Contingency Coefficient and the Joint Information Uncertainty are applied to measure the existence of a correlation between two variables. Figure (3) shows the model of calculating weights of evidence coefficients .This set includes (Slope, DEM, Hill shad, Commercial zone, Industrial zone, Education zone, Bridges, Intersections and Garages). Since Weights of Evidence, coefficients are obtained for map categories of each spatial variable under analysis, all continuous gray-tone maps needed to be categorized. For elevation and hill shad, we used regular intervals, respectively, of 30 m (from 0 to 90 m) and (from 0 to 240). For distance variables, such as distances to commercial zone ,industrial zone ,education zone ,bridges ,intersections and garages, the distance classes followed geometric ranges(1-7) (for example, 0–500, 500–1000, 1000- 1500,1500-2000, 2000-3000,3000-4000,4000-5000 m) in order to obtain buffers. A basic assumption for the Weights of Evidence method is that the variables must be spatially independent. The Weights of Evidence method is applied in Dinamica EGO to produce a transition probability map, as shown in Figure (4), which depicts the most favorable areas for a change (Soares-Filho et al. 2002, 2004). Weights of Evidence consists of a Bayesian method, in which the effect of a spatial variable on a transition is calculated independently of a combined solution. The Weights of Evidence represent each variable's influence on the spatial probability of a transition $i \Rightarrow j$ .The Contrast measures the association / repelling effect. Near zero, there is no effect at all, whereas the larger and more positive it becomes, the greater is the attraction; on the other hand, the larger and more negative the value, the greater is the repelling effect. Dinamica EGO is not just a land-use change model, but also an environmental modeling platform. While other models employ a steady scheme with fixed parameters, which can only be altered by changing their coefficient values, Dinamica EGO presents a wide-open possibility for the design from the very simple to the very complex space-time model. Notice that the first ranges show a positive association, favoring urban, especially the first, in contrast, the final ranges show negative values, thus repelling urban. The middle range shows values close to zero, meaning that these distance ranges do not exert an effect on open area. The calculation of the local transition probabilities, i.e. the probabilities of land cover change for each cell, is based on the values of the positive weights of evidence (W+). Tables (1), and (2) present the values of W+, contrast and significant for each distance range of the dynamic variable 'distance –to-5', Distance-to-6', distance -to-8' and to the static variable , respectively. Figure (5) shows graphically present the behavior of the W+ values in relation to the successive distance ranges of these eleven explaining variables. The curve of W+ for the variables (distance to 5,distance to 6 , distance to 8 ,commercial zone ,and hill shad) were revealed the concentration of weights with the greatest values in the first distance ranges. The curve of W+ for the variables (the bridges zone and intersection zone) were revealed the concentration of weights with the greatest values in the middle distance ranges. The curve of W+ for the variables (DEM and education zone) were revealed the concentration of weights with the greatest values in the latest distance ranges. DINAMICA upon basis of the values of the positive weights of evidence (W+), together with their respective land use transition probabilities maps.

4.3 Analyzing map correlation

The only assumption for the Weights of Evidence method is that the input maps have to be spatially independent. A set of measures can be applied to assess this assumption, such as the Cramer test and the Joint-Uncertainty Information. As a result, correlated variables must be disregarded or combined into a third that will replace the correlated pair in the model. The spatial independence of the aforementioned variables are used the Crammer coefficient (V) and found that all variables, have values lower than an empirical threshold (V < 0. 5), and thus are spatially independent agree with (Almeida et al., 2003). Bonham (1994) holds the threshold of 0.5 to decide on the inclusion (V or u < 0.5) or exclusion (V or u > 0.5) variables in the model. The values obtained for the Cramer´s Coefficient (V) and the Joint Information Uncertainty (U) for the pairs of variables used to explain the same type of land use transition. As none of the association measure values exceeded the threshold of 0.50 simultaneously for both indices, no variables preliminarily selected for modeling have been discarded from the analysis.

4.4 The maps transition probabilities

The Weights of Evidence method is used to select the variables most related to observed landscape changes as well as to quantify their influences on each of the modeled transitions. This method produces as a result transition probability maps that represent the integrated influence of proximate causes on the modeled transitions**.**

The maps were generated by DINAMICA upon basis of the values of the positive weights of evidence *(W+)*, together with their respective land use transition maps are seen in Figure (6) ,the blue ,green and red color are indicated to low ,moderate and high probability transition change respectively. The influences employed to explain the transitions (7_5, 7- 6 and 7_8) in the period 2004-2010 are valid to justify these same transitions in the current simulation period. The expansion of the education zone in the southwestern sector of Baqubah city still demands the nearness of such areas to the previously existent industrial use and the availability of road access.

4.5 Simulation of future scenario

The simulation of future scenarios is an important tool to aid in regional planning and environmental, because it provides important data on the dynamics of the landscape. The process of scenario modeling conducted in this study simulated the landscape of the Baqubah city for the year 2050. The input is the old/new land use maps and the new weights of evidence coefficients and the transition matrix. The outcome of the model is the simulated map of year 2010. Land cover maps of the years 2004 and 2010 were used as the initial and final land cover maps; Dinamica-EGO simulation was implemented from 2010 to 2050 at time steps of 5 years. This model is using so far the Functor patcher, which can create new seeds and start new clusters of land uses in new areas in accordance with the probability map. The model will be extended to use the functor expander than can continue the growth of existing clusters of land use. The scenarios simulation until the year 2050 was performed using the parameters of "Expander" and "Patcher" validated in simulation the year 2010.The process resulted in forty (40) annual statements for the period 2011 to 2050.Since DINAMICA transition functions employ a stochastic cell selection mechanism, 10 repeats were produced for each model tested. The simulation model to 2050 can be seen in Figure (5), the values for each class area (hectare) of use are shown in Table (2). The urban growth of the city and the future land-use up to 2050 was projected by deploying the land-use simulation model (Dinamica-EGO), as shown in Figure (6).

The trajectory of simulation results reveals the difference of urban expansion from West. Traditional western urban growth takes place from highly urbanized city cores to pair-urban areas or suburbs that contain low density of urbanized, residential areas. The suburbanization process drives urban sprawl in Western cities and creates huge residential areas with low urban density. Table (3) is shown the percent of area for each class during the simulation period (2010-2050).Urbanizing areas are expanding not only from urban centers, but also from rural areas that have a certain proportion of impervious areas, with a mixed land use type of industrial and residential functions, under the growth of population. However, compared with simulation result in Taipei metropolitan area from 2001 to 2050.To carry out an analysis with larger specificity, the quantification of each change forecasts use class and coverage of earth 2010-2050, noting that for all the classes, are shown in Table (3) and Figure (7). These results from the scenario indicate that the orchard, vegetation, water, open area and mix classes will decrease area occupying from the total city area by approximately (51%, 50%, 40%, 32% and 16% respectively) from 2010 to 2050. The medium residential, high residential and road will increase area occupying from the total city area by approximately (34%, 96%, and 18% respectively) from 2010 to 2050, therefore the cellular automata modelling has been found to be the most suitable for use in simulating growth of urban areas.

5. CONCLUSION

1. Spatial dynamic models, of which CA is one of the best representatives, are still the most promising means for representation land cover change simulations communicable and transparent to politicians, and planners. The cellular automata modelling has been found to be the most suitable for use in simulating growth of urban areas.
2. Land cover maps of the years 2004 and 2010 were used as the initial and final land cover maps ;Dinamica-EGO simulation was implemented from 2010 to 2050 at time steps of 5 years, it will become a densely populated city by 2050. A unique feature of the urban growth of Baqubah is the high growth and densification along road.
3. Baqubah rapid change in spatial structure and pattern during the past 50 years, also dynamic modelling was rapidly gaining popularity among geographers and urban planners as a tool for urban and landscape simulation.
4. The model can be integrated with GIS in order to take full advantage of the existing technologies related to urban studies. The role of GIS and remote sensing in cellular automata-based urban modelling is essential, particularly for input data preparation, model calibration and verification.
5. Dynamic models for simulating land use and land cover, consists in very important tools for studies dedicated to the exploration of future scenarios. The simulations for the years 2004 and 2010 reached similarity indices 81.5%.
6. Land development in Baqubah city has resulted in a heavy loss of natural vegetation, open spaces and the medium, high residential, roads are increased during the period of simulation of model (2010 to 2050).
7. The simulation scenario for the year 2050 showed an increase in the medium residential, high residential and road by (40.2%, 104.4%, and 23.9% respectively). As well as a significant decrease the orchard, vegetation, water, open area and mix by (52.2%, 48.4%, 35.6%, 29.7%, and 12.5% respectively).

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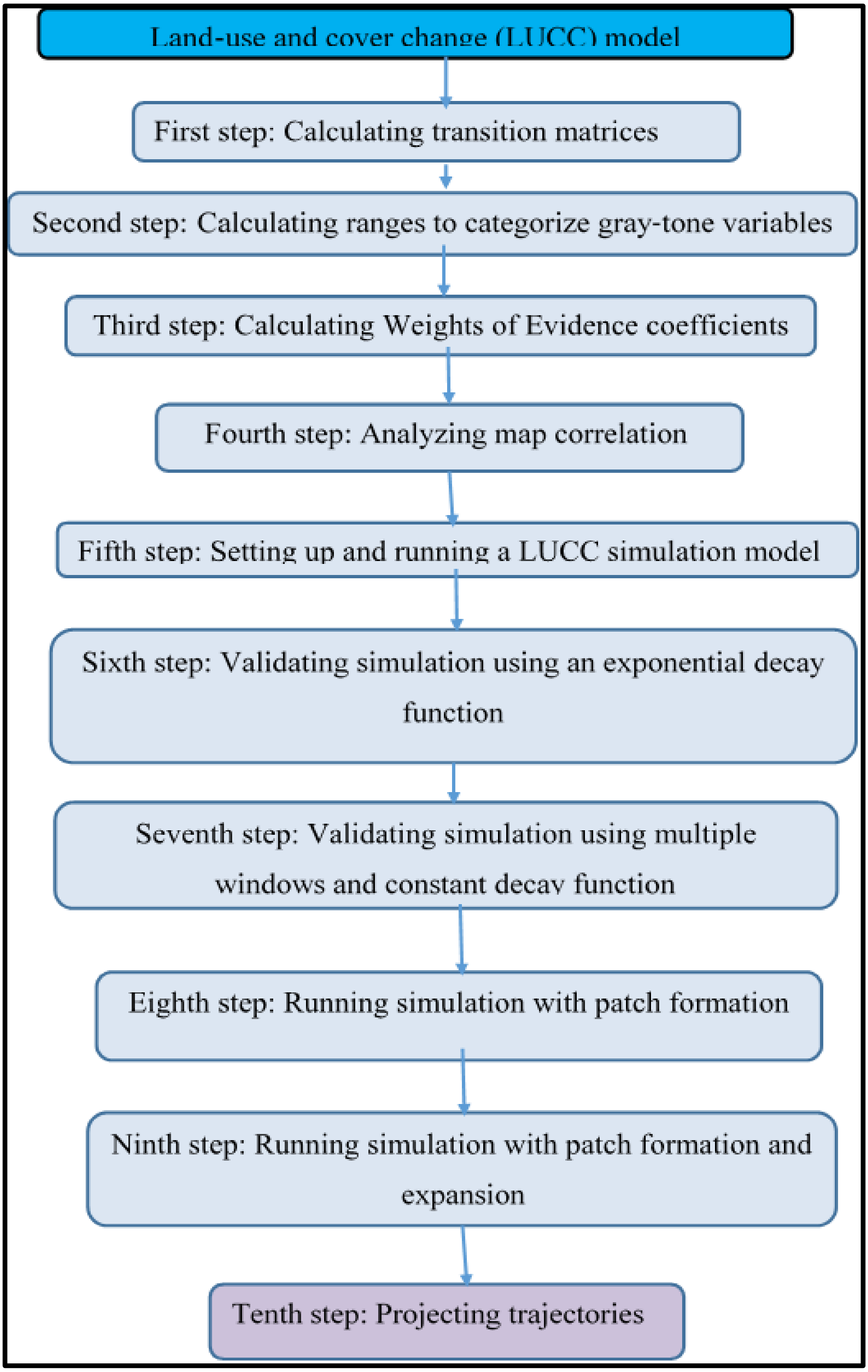


Figure (1): Building Land-use and Land-cover Change Simulation Model Methodology

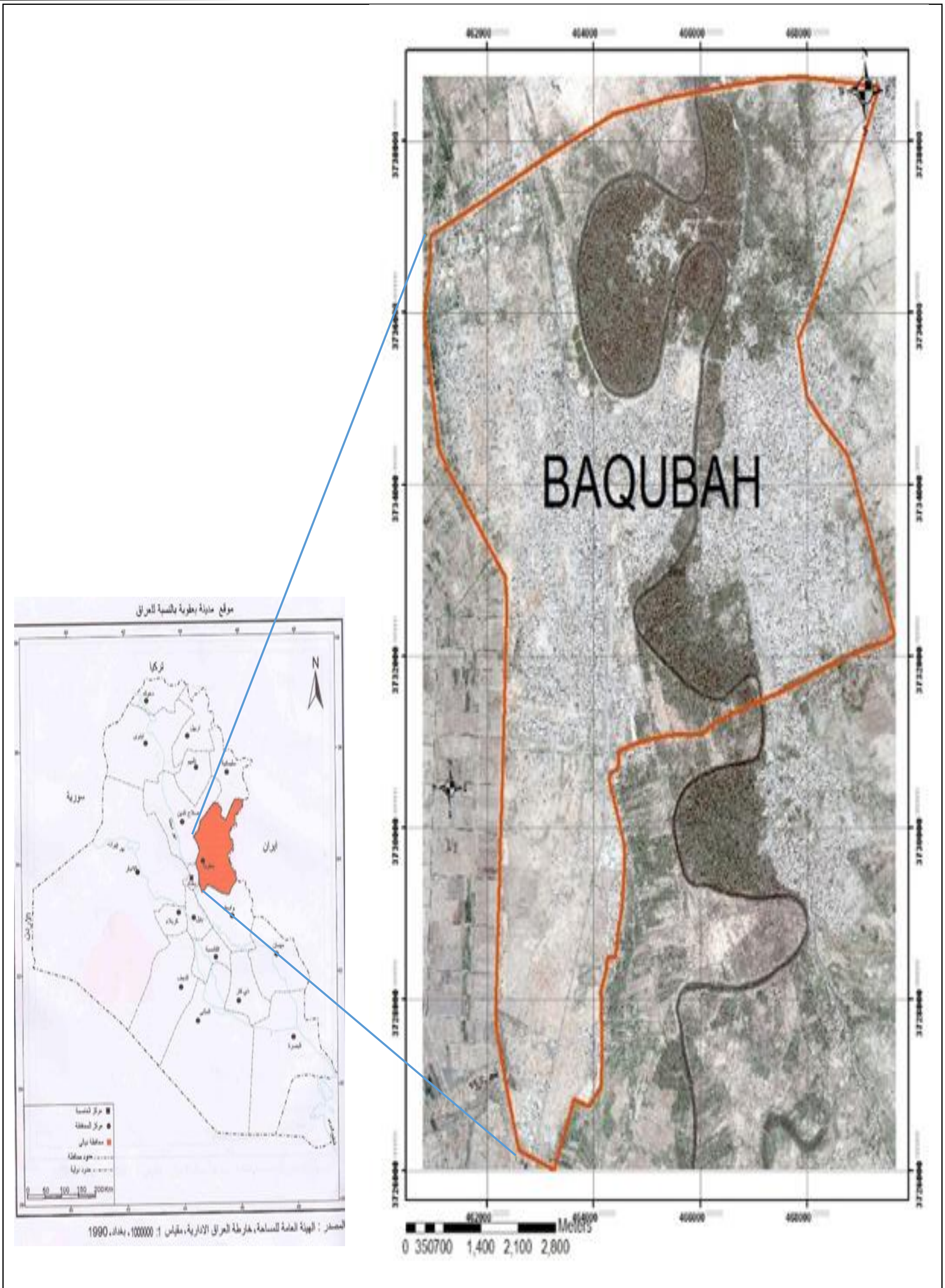


Figure (2): The +Study Area Location

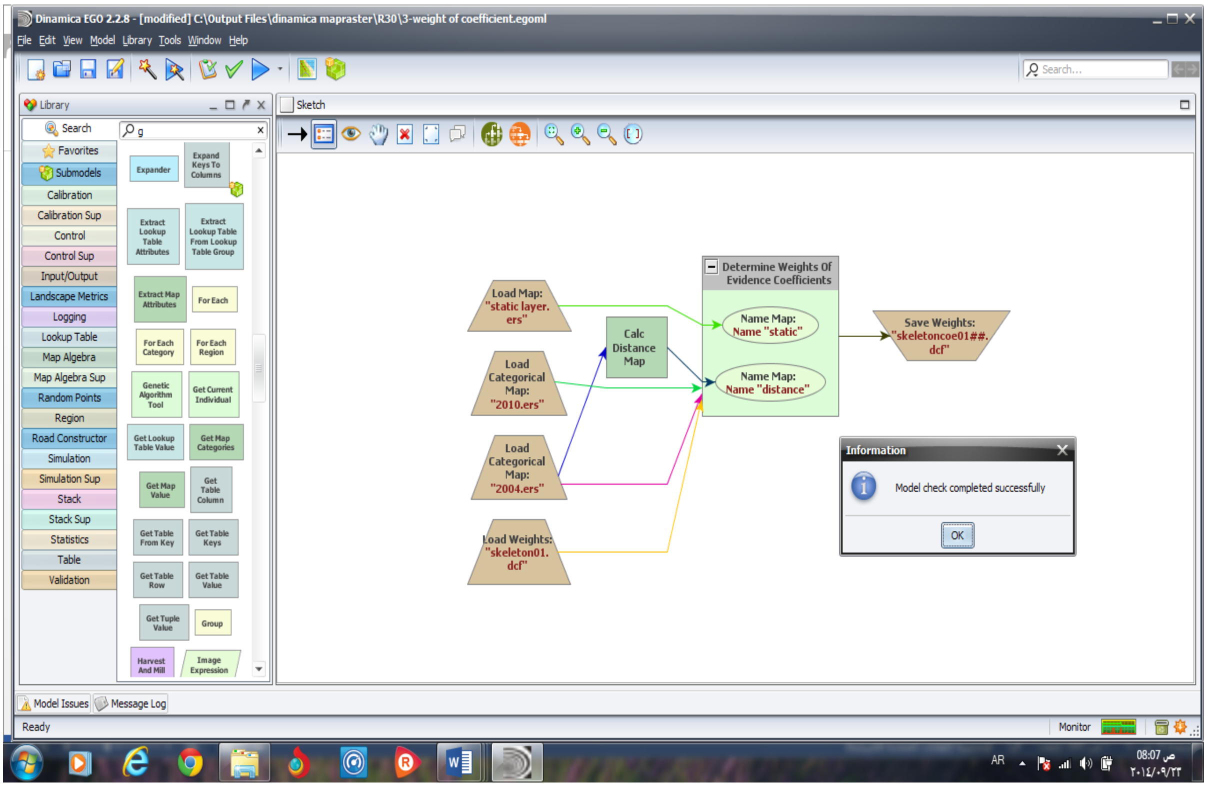


Figure (3): Calculating Weights of Evidence Coefficients Model

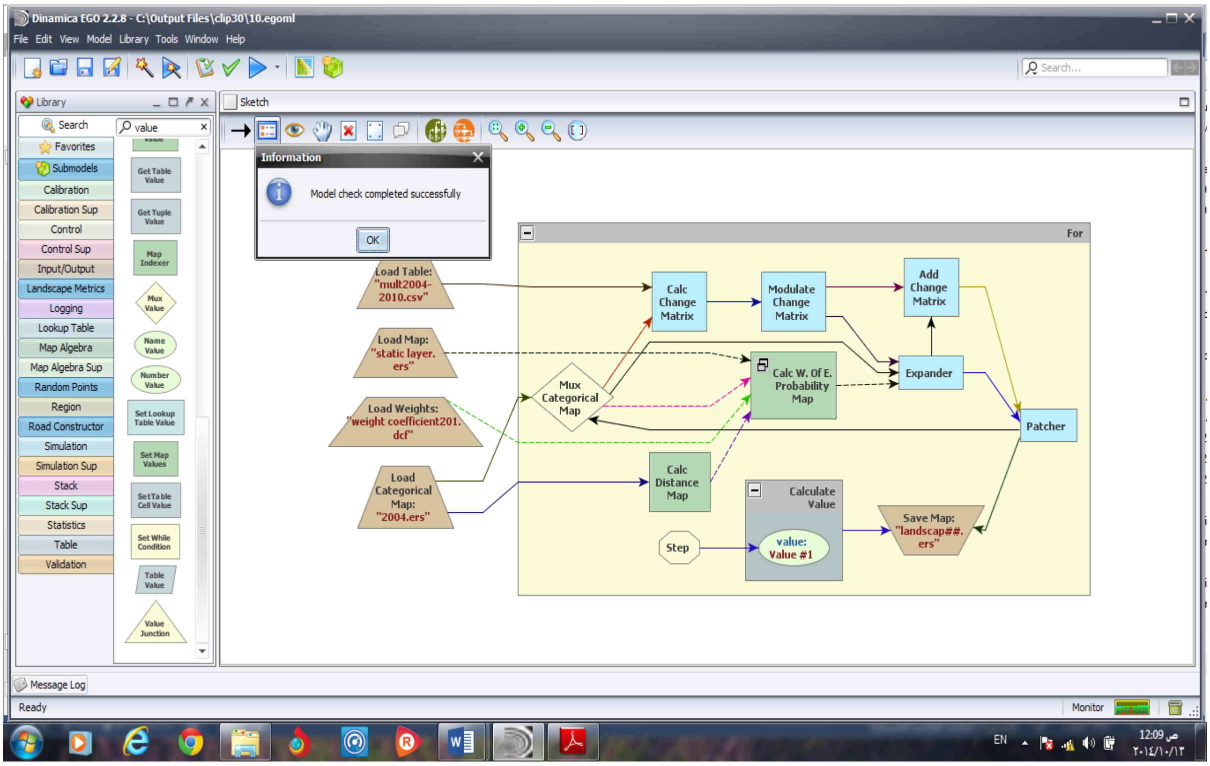
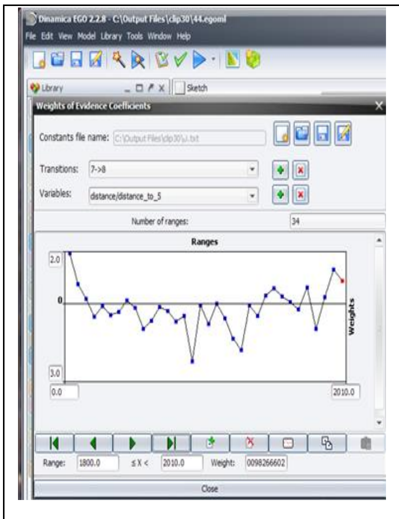
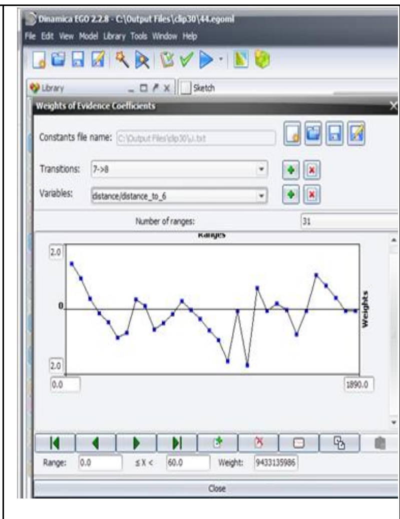


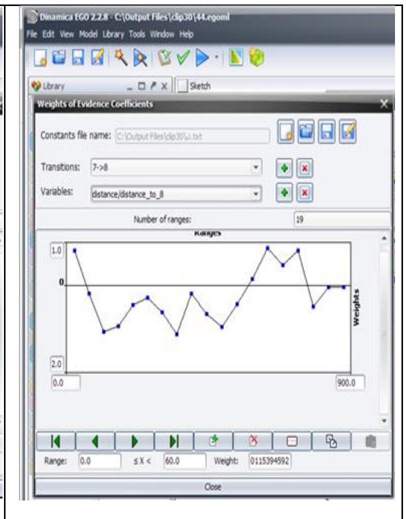
Figure (4): Simulation of Future Model Scenario



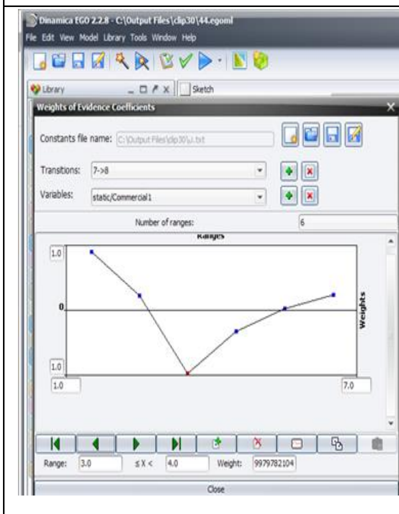
Distance-to-5



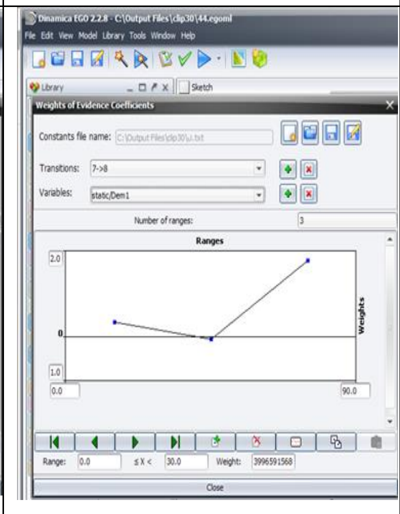
Distance-to-6



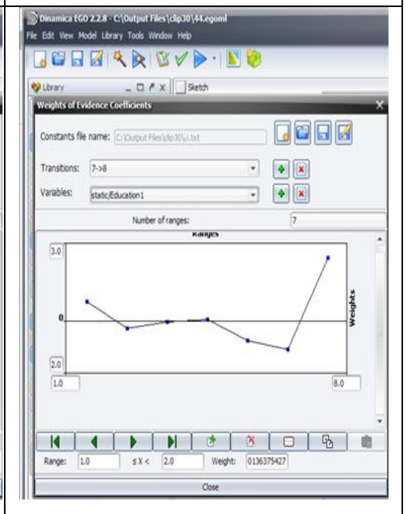
Distance-to-8



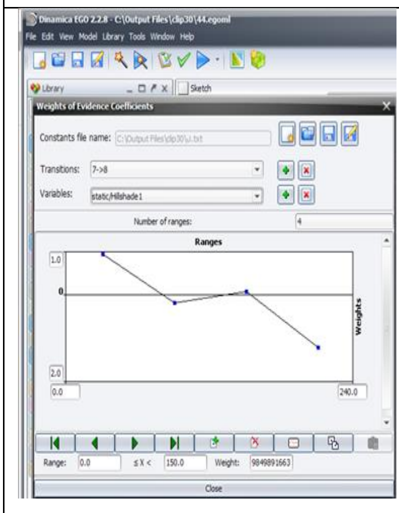
Commercial



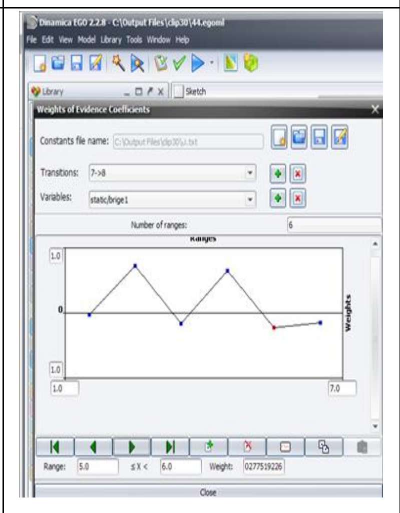
Dem



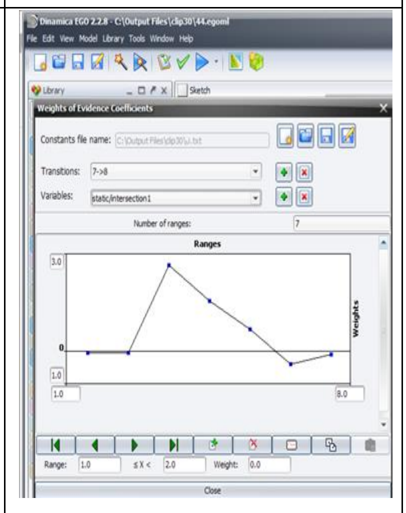
Educational



Hill shad

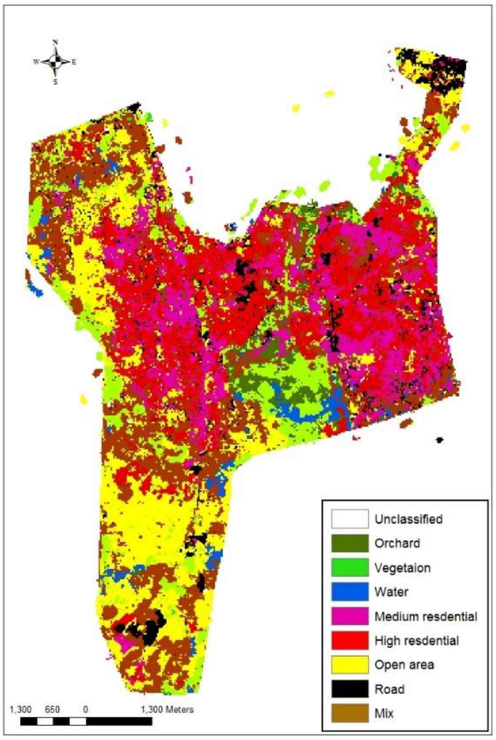


Bridge

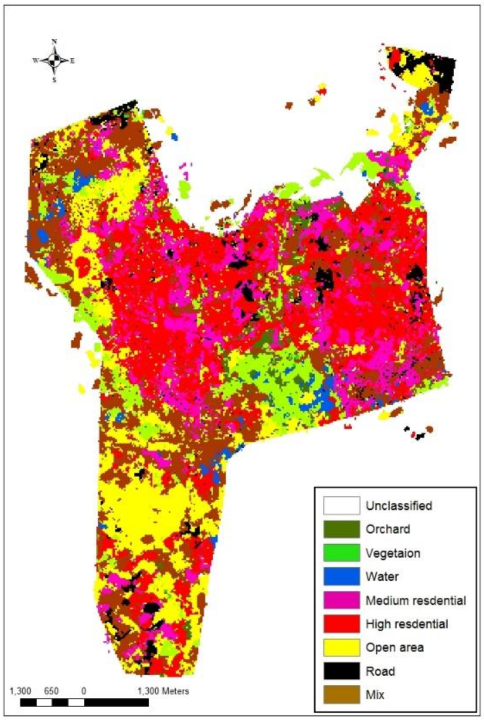


Intersection

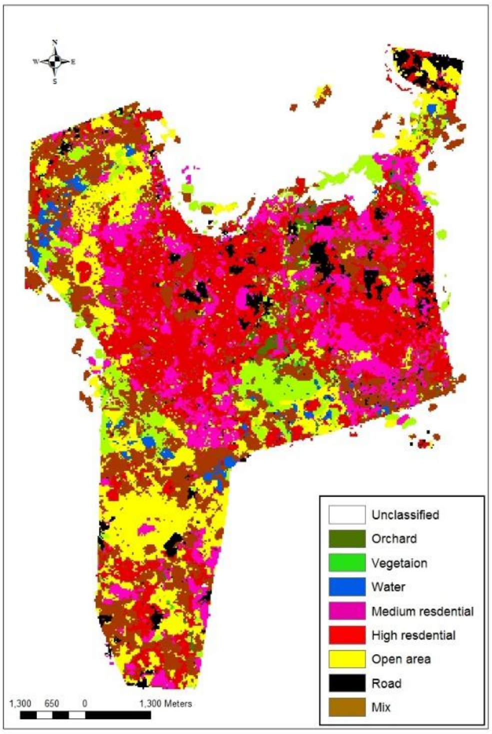
Figure (5): graph variable of model range with Weights of Evidence Coefficients



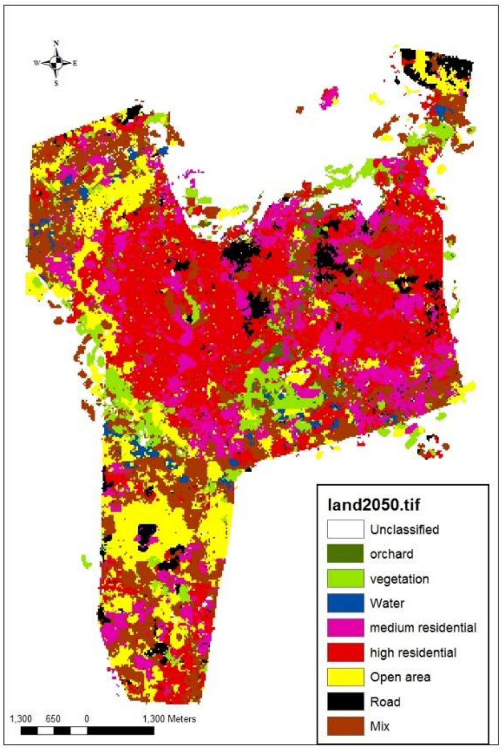
Expect image classification at 2020



Expect image classification at 2030



Expect image classification at 2040



Expect image classification at 2050

Figure (6): Simulation Future Model at 5 Years for Baqubah City [redacted]

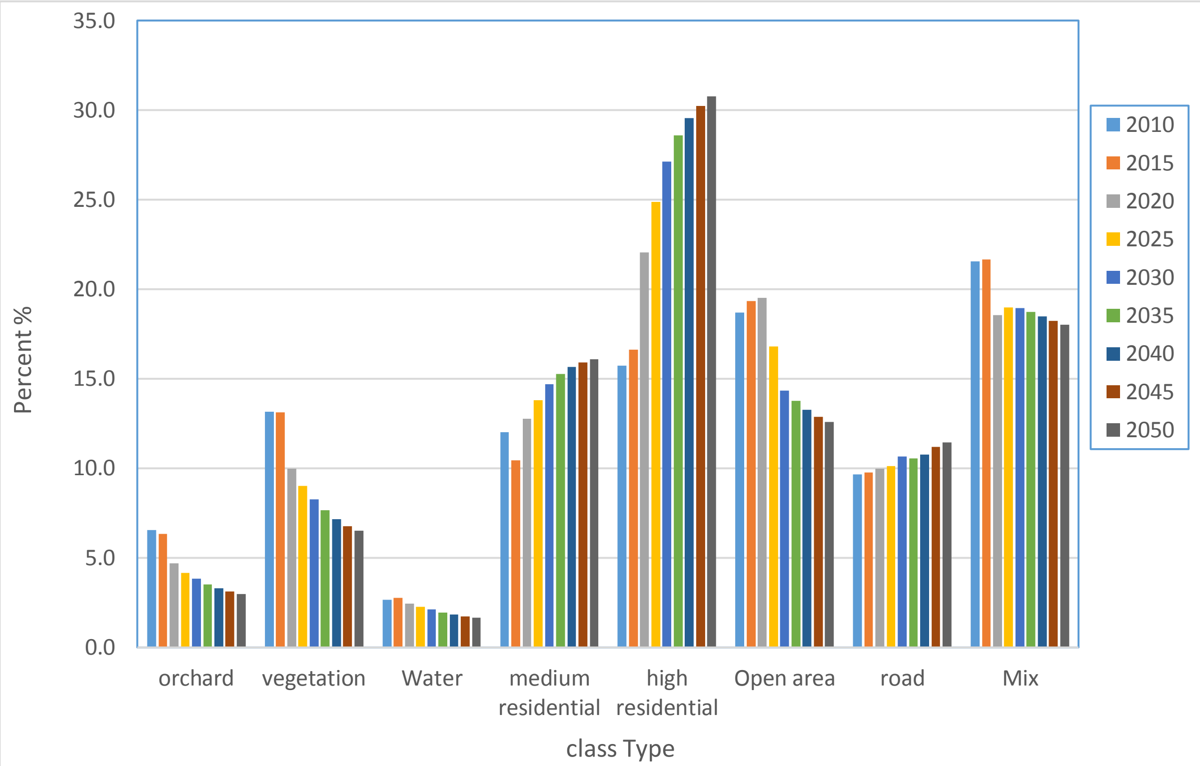


Figure (7): Percent Area Classes from 2010 to 2050 for Baqubah City

Table (1): Result Weight Coefficient and Contrast for Transition from Open Area to Road Dynamic Variable

Tr._ From	Tr. _ To	Variable	Range_Upper _Limit	Weight _ Coefficient	Contrast	Significant
7	8	distance/distance_to_5	60	1.997889	2.102789	1
7	8	distance/distance_to_5	90	0.798129	0.845006	1
7	8	distance/distance_to_5	180	0.264204	0.304388	1
7	8	distance/distance_to_5	930	.0.5984	.0.62222	1
7	8	distance/distance_to_5	1110	.2.16702	.2.18063	1
7	8	distance/distance_to_5	1170	.0.72188	.0.72935	0
7	8	distance/distance_to_5	1200	0.069045	0.070109	0
7	8	distance/distance_to_5	1230	.0.50879	.0.51347	0
7	8	distance/distance_to_5	1260	.1.27426	.1.28332	0
7	8	distance/distance_to_5	1290	.1.73257	.1.74074	0
7	8	distance/distance_to_5	1350	.0.40343	.0.40693	0
7	8	distance/distance_to_5	1380	0.372408	0.376246	0
7	8	distance/distance_to_5	1410	0.658814	0.666484	0
7	8	distance/distance_to_5	1770	0.312189	0.314547	0
7	8	distance/distance_to_5	1800	1.388328	1.394913	1
7	8	distance/distance_to_5	2010	0.946496	0.95295	1
7	8	distance/distance_to_6	60	1.455191	1.551875	1
7	8	distance/distance_to_6	90	1.002814	1.114337	1
7	8	distance/distance_to_6	120	0.365826	0.392834	1
7	8	distance/distance_to_6	150	.0.08685	.0.09117	0
7	8	distance/distance_to_6	240	.0.35818	.0.40404	1

7	8	distance/distance_to_6	270	.0.82725	.0.85037	1
7	8	distance/distance_to_6	450	.0.66614	.0.75884	1
7	8	distance/distance_to_6	480	0.338506	0.345672	0
7	8	distance/distance_to_6	720	0.152267	0.178924	0
7	8	distance/distance_to_6	1110	.0.88972	.0.91819	1
7	8	distance/distance_to_6	1170	.1.55025	.1.56998	1
7	8	distance/distance_to_6	1320	.1.66672	.1.68958	1
7	8	distance/distance_to_6	1440	0.225178	0.226951	0
7	8	distance/distance_to_6	1560	0.018841	0.019005	0
7	8	distance/distance_to_6	1620	.0.73194	.0.73382	0
7	8	distance/distance_to_6	1680	1.100646	1.104152	0
7	8	distance/distance_to_6	1710	0.782193	0.784091	0
7	8	distance/distance_to_6	1740	0.407499	0.408084	0
7	8	distance/distance_to_8	60	0.83915	1.239318	1
7	8	distance/distance_to_8	90	.0.14186	.0.1633	0
7	8	distance/distance_to_8	120	.1.03352	.1.10126	1
7	8	distance/distance_to_8	150	.0.90044	.0.94613	1
7	8	distance/distance_to_8	180	.0.41631	.0.44525	1
7	8	distance/distance_to_8	450	.0.6234	.0.6453	1
7	8	distance/distance_to_8	690	.0.4575	.0.45851	0

Table (2): Result Model for Area Classification of Baqubah City

Class Type	Area 2010	Area 2015	Area 2020	Area 2025	Area 2030	Area 2035	Area 2040	Area 2045	Area 2050
Unclassified	6218.82	6314.95	6148.17	6106.59	6065.01	6023.07	5981.4	5940	5898.6
orchard	335.45	325.78	244.75	216.46	196.72	182.52	173.34	165.63	160.12
vegetation	674.91	675.67	520.19	467.89	426.59	397.4	375.65	359.1	348.3
Water	136.26	141.93	127.89	117.27	108.09	100.89	95.13	91.44	87.66
medium residential	616.14	538.83	666.9	717.75	758.07	792.09	820.35	844.11	863.91
high residential	807.46	856.63	1151.64	1293.48	1399.95	1483.56	1550.52	1605.42	1650.78
Open area	960.02	996.89	1019.07	874.34	739.89	714.67	695.77	683.08	674.7
road	495.1	503.43	520.67	526.89	550.52	546.64	564.76	593.78	613.56
Mix	1106.15	1116.78	968.46	987.56	976.87	972.61	968.92	966.94	966.94
City area (ha.)	5131.49	5155.94	5219.57	5201.64	5156.7	5190.38	5244.44	5309.5	5365.97
Total area (ha.)	11312.73	11312.7	11312.7	11312.7	11312.7	11312.7	11312.7	11312.7	11312.7

Table (3): Future Percent for Area Classification of Baqubah City

Class Type	Area 2010 %	Area 2015 %	Area 2020 %	Area 2025 %	Area 2030 %	Area 2035 %	Area 2040 %	Area 2045 %	Area 2050 %
orchard	6.5	6.3	4.7	4.2	3.8	3.5	3.3	3.1	3.0
vegetation	13.2	13.1	10.0	9.0	8.3	7.7	7.2	6.8	6.5
Water	2.7	2.8	2.5	2.3	2.1	1.9	1.8	1.7	1.6
medium residential	12.0	10.5	12.8	13.8	14.7	15.3	15.6	15.9	16.1
high residential	15.7	16.6	22.1	24.9	27.1	28.6	29.6	30.2	30.8
Open area	18.7	19.3	19.5	16.8	14.3	13.8	13.3	12.9	12.6
road	9.6	9.8	10.0	10.1	10.7	10.5	10.8	11.2	11.4
Mix	21.6	21.7	18.6	19.0	18.9	18.7	18.5	18.2	18.0
Total Area %	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

التنبؤ المستقبلي للموديل الديناميكي للنمو الحضري لمدينة بعقوبة

الخلاصة:

شهدت مدينة بعقوبة خلال العقود الأخيرة توسع حضري سريع بسبب النمو الاقتصادي وهذا أدى تأثير سلبي على بيئة المدينة وكذلك التمدد والتوسع على المساحات الريفية والبساتين المحيطة بالمدينة .الهدف من البحث الحصول على موديل ديناميكي لخارطة استعمالات الأرض لمدينة بعقوبة من خلال استعمالات قدرات برنامج (Dinamca EGO) وبمساعدة برنامج Arc GIS وكذلك برنامج التحسس النائي (13).ERDAS Ver .لا توجد محاولات سابقه للحصول على مثل هذا الموديل في منطقة الدراسة.

الخرائط المصنفة استعملت في الموديل الديناميكي للمعايرة والشرعية والنموذجة للحصول على الموديل المنمذج لسنة 2050 بواسطة عشر موديلات متتابعة .الخرائط 2004 و2010 استعملت في المصفوفة الاحتمالية الانتقالية .الخارطة المنمذجة لسنة 2010 تم مقارنتها مع الخارطة الحقيقية ووصل معدل التشابه الى 81.5%.السيناريو المنمذج لسنة 2050 بين زياده في السكن المتوسط والسكن العالي والطرق بمقدار (40.2% و104.4% و23.9%)بالتتابع . اضافة الى تناقص في البساتين والمزروعات والماء والمساحات المفتوحة والمختلط بمقدار (52.2%,58.4%,35.6%,29.7% و12.5%) بالتتابع.

مفاتيح الكلمات: نمو حضري ,داينمك موديل ,تصنيف ,داينميكا سوفت وير