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Modeling the change of land cover and land uses in Khalis district between 1997-2021 and forecasting it up to 2031 using CA-MARCOV

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Abstract

It is important to know the changes in the land cover and the uses of the land that changed to other uses in a later period, and whether these changes were directed towards an increase or a decrease. Therefore, it was necessary to classify a satellite image for a previous and a later period and to know the changes that occurred in the land cover and the uses of the land through reliance in the classification process on a programmeERDAS IMAGING 14One of the most famous programs used in analyzing and processing visuals, on which the researcher relied on two satellite visualizations Land sat 5-8for my year1997And2021, And To reach an accurate classification of the satellite image have to be processed and improve it, And then cut off The study area from satellite images The two satellite visuals of the aforementioned years were classified into five categories (water, orchards, agricultural fields, barren land, and urbanization). And then it was done Conducting a change detection between the two years to obtain the amount and percentages of change for the types of land cover and land uses for the Khalis district.20.76,26.98%) successively, and this was at the expense of other categories, namely water, orchards, and agricultural fields, which recorded negative change rates that reached () successively between 1997 and 2021. In order to know the behavior of the land cover and land uses within the study area, a simulation was conducted using a modelCA-MARCOVTo predict changes in the land cover and land uses up to the year 2031, and it was found that the urbanization category will continue to expand until its percentage reaches (20.88% after it used to occupy (13.8%) in 1997 and (17.53%) in 2021, and the two categories of water and orchards will continue to decline in their area to reach (0.92, 3.39%), respectively, for each of them, respectively.

Keywords: *ERDAS IMAGING, urbanization.*

Introduction

The classification of satellite visuals into geographical units is one of the most important research issues based on remote sensing, and the classification of visuals is defined as the process by which the visual units on the satellite visual are assigned to categories, as each visual unit is treated as an individual unit and consists of numeric values in the packages Composite spectral units, and when comparing the image units with each other, they can be grouped in the form of groups that include spectral similar image units in the form of categories within an objective map.Despite the multiplicity of classification methodsdigitalHowever, the researcher will rely on directed classification proceduressupervised classification being more objective than undirected classification

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(which depends entirely on the spectral variation of the space visual), as the error rate can be measured in this classification, as well ascontain itDifferent classification methods give flexibility to the visual analyst in choosing the method that suits him.

First: the research problem

Is it possible to classify the land cover and land uses in the Khalis district for the years 1997 and 2021 based on visualizations?LandsatMedium spatial resolution? Is it possible to track the behavior of the land cover and land uses until the year 2031 through the application of a model?CA-MARCOVWhich combines cellular autonomic behavior with Markov chain analysis?

Secondly: Research hypothesis

The land cover and land uses for the years 1997 and 2021 for Khalis District can be classified using visualizations. Landsat has a medium spatial resolution, as it has ahistorical archive that can be used to perform the classification process, and it can also be based on a modelCA-MARCOVTo come up with cartographic models that predict what will happen to the land cover and land uses until 2031.

Third: the aim of the research

The research aims to make a classification of the land cover and land uses of the Khalis District between 1997 and 2021, predict its future changes, and come up with scenarios that can be relied upon in the planning process for sustainable spatial development.

Fourth: research methodology

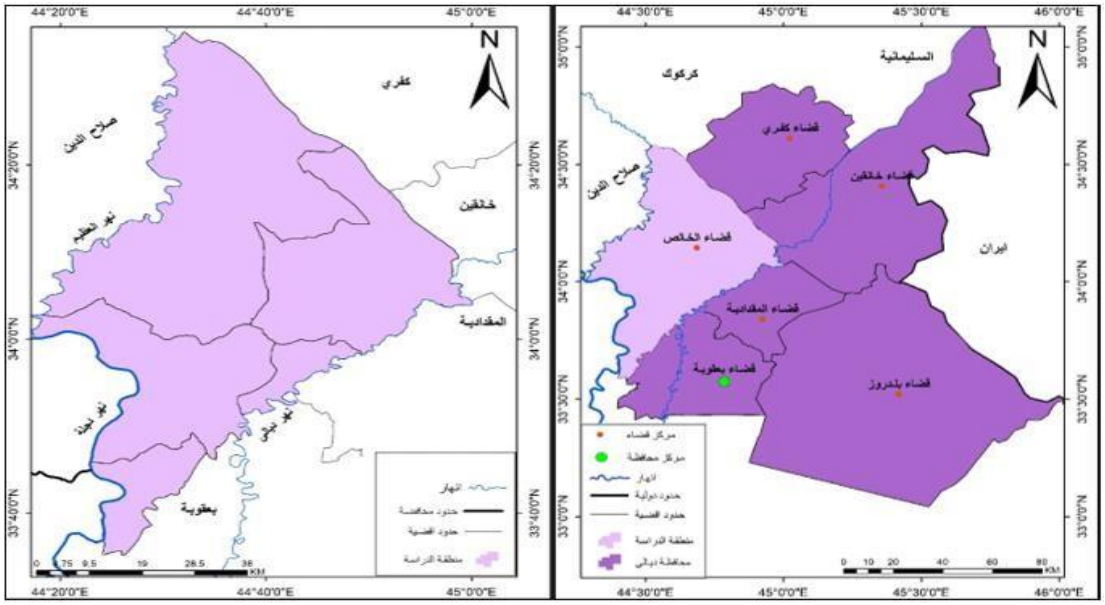
Adopting the historical, descriptive and analytical approach in classifying the land cover and land uses in the Khalis district between 1997 and 2021.

Fifth: Research limits

1- Spatial boundaries: It is represented by the boundaries of the Khalis district and its administrative units, as the district is located in the north and northwest of Diyala Governorate, between two latitude circuits(34°.15-_33°.15-)North and longitude(44°.15-_45°.28-east, with an area of (3153) square kilometers.

2- Temporal limits: The temporal limits of the research are to classify the land cover and land uses between 1997 and 2021 and predict them until the year 2031.

Map (1) The spatial boundaries of Khalis district



Source: From the researcher's work, based on the General Commission for Survey, a mapof the districts of Diyala Governorate, at a scale of 1:500,000 for the year 1987 AD.

The first topic

First: Classification of land cover and land uses in Khalis district for the years 1997-2021

The general goal of classifying space visuals is to automatically make all visual elements into categories of land cover and land uses. Despite the multiplicity of classification methods, the researcher will rely on guided classification procedures.supervised classificationBeing more objective than the undirected classification (which depends entirely on the spectral variation of the satellite visual), as the error rate can be measured in this classification, in addition to containing different classification methods that give flexibility to the visual analyst in choosing the method that suits him) Jia, 2006, p.193- 194, Guided classification depends on observing the process of classifying the pixels that make up the space visual by the visual analyzer by determining through computer algorithms the numerical descriptions of the different patterns of land cover in the scene, so different sample locations are used for a specific type of land cover and the uses of the land are called training samples that serve as an interpretation guide A numerical description of the spectral characteristics of each type of feature studied (Thomas, 1994,p.885)The choice fell on the method of greatest probabilityMaximum Likelihood)) in the classification process as it is the most accurate and used directed classification method. After examining the researcher about the global classification systems for land uses and land cover, the choice was made on the classification of the American systemUSGSDeveloped by Anderson, being comprehensive and flexible, as well as designed to match the visuals ofLand satmedium-resolution satellite, which was relied upon in this study (Anderson, 1976, p4 (,It is worth noting that the training samples were selected within the first and second levels of the Anderson classification.

Through the reflectivity of land uses and land cover within the study area, Table (1), Figure (1), five categories were reached, these categories were distributed as follows:

1- Bodies of water:When observing the water bodies for the year 1997, it was found that they had occupied an area of (60.78) km2, at a rate of (1.92%) of the total area of the study area, while their percentage decreased to (0.95%) in 2021, with an area of (30.22) km2.

2- The orchards:The orchards occupies an area of (253.15) square kilometers, at a rate of (8.02%), while this area decreased in 2021 to become (118) square kilometers, at a rate of (3.75%) of the total area of the study area.

3- Agricultural fields:In 1997, the agricultural fields occupied an area of (928.45) km2, at a rate of (29.44%) of the total area of the study area. .

4- Urbanization:The built-up occupied an area of (435.41) km2, at a rate of (13.80%) of the total area of the study area in 1997, and its area increased in 2021 to become (552.92) km2, at a rate of (17.53%) of the total area of the study area.

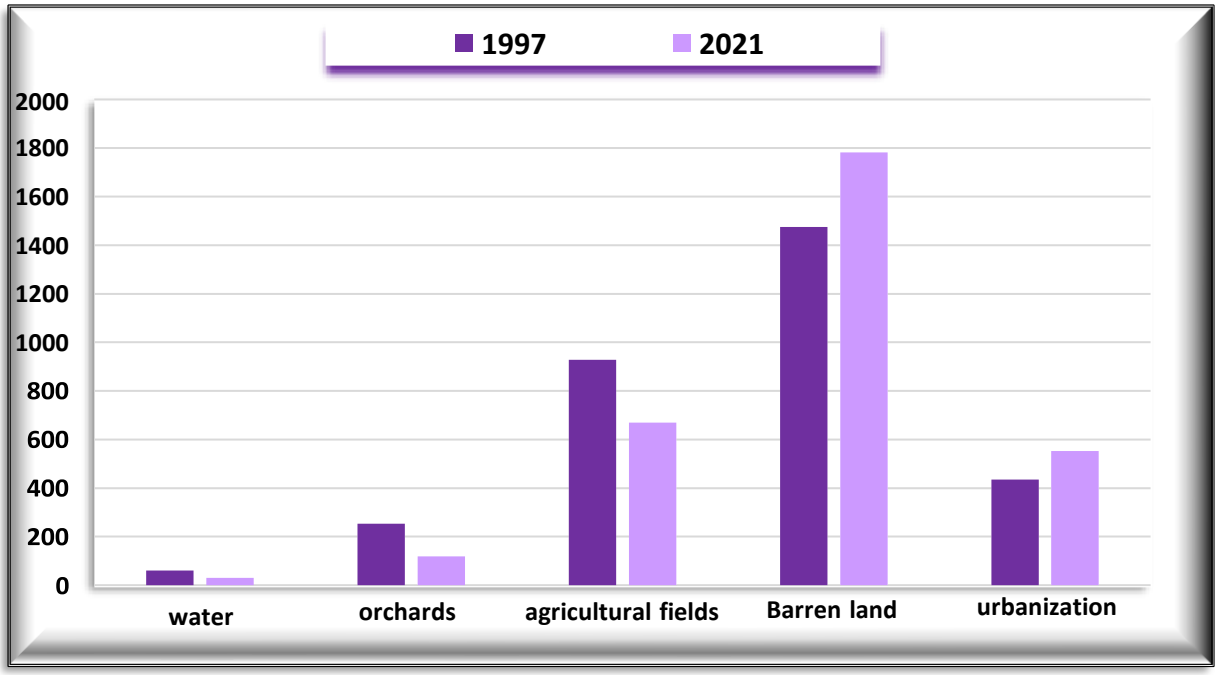
5- Barren Lands:In 1997, the category of barren lands occupied the first place in terms of area, as its area reached (1475.21) km 2, at a rate of (46.78%) of the total area of the study area, and then this area changed positively in 2021, as the area occupied by barren lands increased to become (1781.58) square kilometers, or (56.50%) of the total area of the study area.

Table (1) Percentage distribution of land cover areas and land uses in Khalis district for the year1997-2021

2021		1997		varieties	
The ratio%	Area/km2	The ratio%	Area/km2		T
0.95	30.22	1.92	60.78	water	1
3.75	118.26	8.02	253.15	orchards;	2
21.25	670.02	29.44	928.45	agricultural fields	3
56.5	1781.58	46.78	1475.21	Barren land	4
17.53	552.92	13.8	435.41	urbanization	5
100	3153	100	3153	the total	

Source: from the researcher's work based on map (2)

Figure (1) The area of land cover varieties and land uses in Khalis district for the years 1997-2021

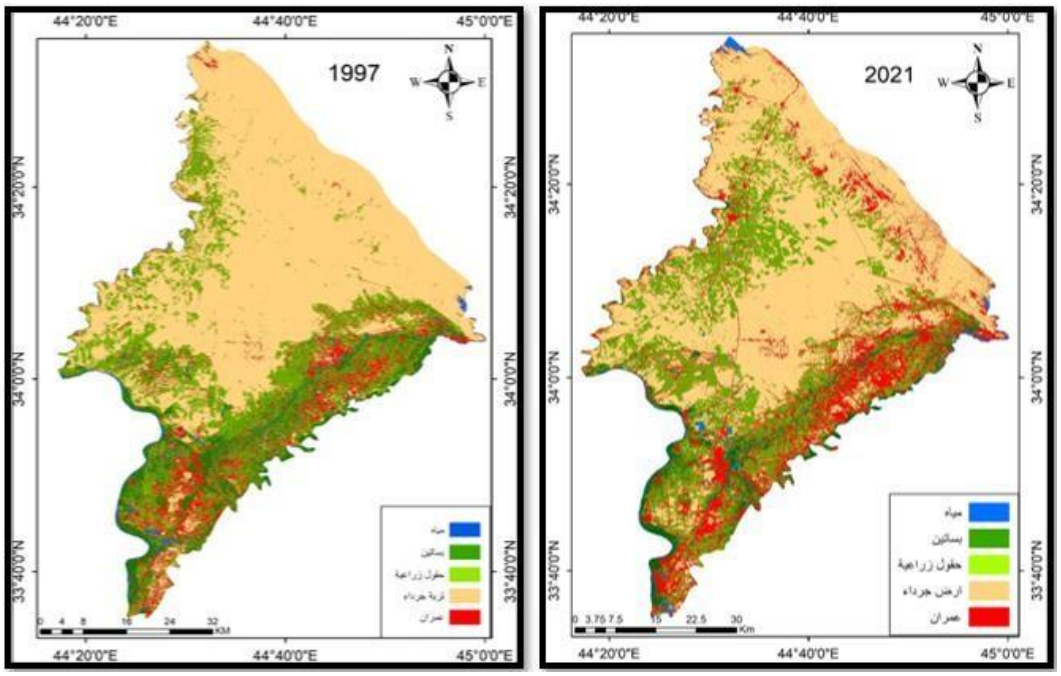


Source: The researcher's work based on Table (1).

Second: Detection of the change in land cover and land uses in Khalis district between 1997-2021

through analysisa map(2)and schedule (2)shape (2),It appears that the types ofland cover and land uses have undergone an important and disturbing change between 1997 and 2021, as follows:

Map (2) Classification of land cover and land uses in Khalis district for the years 1997-2021



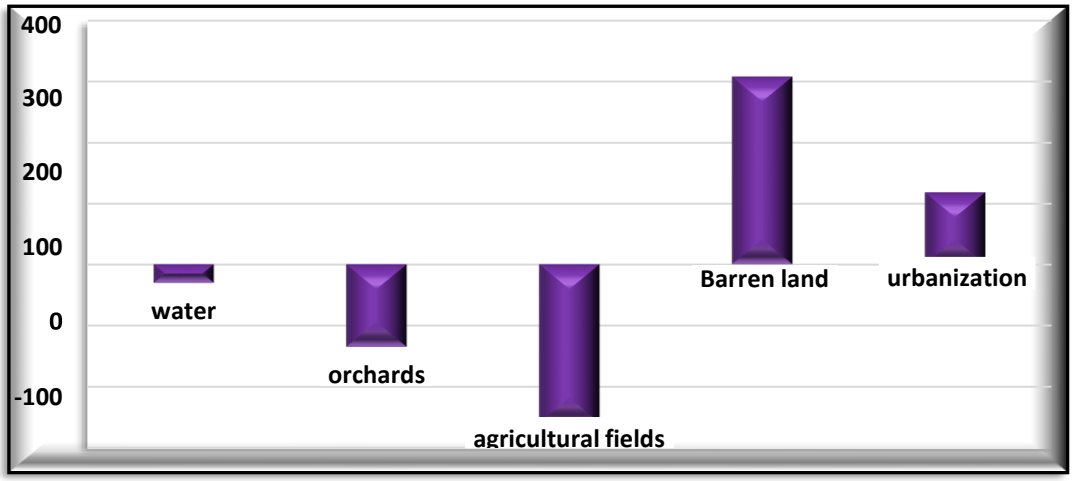
Source: From the researcher's work, based on 1- The General Commission for Survey, a map of the districts of Diyala Governorate for the year 1987, at a scale of 1:500,000, 2- Using the programERDAS based on the two Landsat-8.5 visualizations for the years 1997and 2021.

Table (2) Percentage distribution of land cover areas and land uses by non-directed classification method for Khalis district between 1997-2021

			2021		1997		
type of change	percentage change	The amount of change / km2	The ratio %	Area/km2	The ratio %	Area/km2	categories
decrease	-50.27	-30.56	0.95	30.22	1.92	60.78	water
decrease	-53.28	-134.89	3.75	118.26	8.02	253.15	orchards;
decrease	-27.83	-258.43	21.25	670.02	29.44	928.45	agricultural fields
more	20.76	306.37	56.50	1781.58	46.78	1475.21	Barren land
more	26.98	117.51	17.53	552.92	13.80	435.41	urbanization
	-83.64	-2.2737	100	3153	100	3153	the total

Source: from the researcher's work based on map (2)

Appearance (2) percentage change in Land cover classes and land uses in Elimination of salvation between the years 1997–2021



Source: From the researcher's work based on Table (2).

1-Water bodies:When observing water bodies to distinguish them from other lands, it was found that they had changed in a remarkable negative way, as the percentage of their change increased to (50.27-%), which indicates a serious shrinkage of the areas covered by water bodies, and justifies this with the lack of rainfall during recent years and the successive periods of drought, as well as the control of neighboring countries over the water quotas of Iraq and exceeding them, which was reflected in the decrease in water levels, rivers and streams within the study area, represented by Rivers (Tigris, Diyala and Azim).

2- The orchards:The orchards came with a clear rate of change, as the rate of change reached (-53.28%) This is justified by the successive years of drought and high temperatures in recent years, in addition to the agricultural policy followed in Iraq and the mismanagement of water resources, which exacerbated the water scarcity crisis and the increase in the size of the population, which is offset by the need for residential constructions and other types of services and the insistence on housing The horizontal, which needs large areas of land, which started bulldozing the orchards, especially those close to city centers, with the absence of the application of the rule of law and the absence of proper planning that leads to sustainable development of environmental resources. Especially in the centers of these districts, which indicates a clear urban expansiontowards agricultural lands within the study area.

3- Agricultural fields:The agricultural fields came with a negative rate of change, as the rate of change reached (-27.83%, the percentage of areas covered by agricultural fields decreased from (29.44%) of the total area of the study area in 1997 during the economic blockade imposed onIraq at that time, which strengthened agricultural activity to support Iraqi food securityto me(21.25%) in 2021, with a negative change amount that reached (-258.43) km 2. This justifies the decline in the yields of agricultural activity resulting from successive periods of drought and high temperatures in recent years and the opening ofthe import door wide, which flooded the Iraqi market with agricultural products that compete with prices for Iraqi agricultural products and the reluctance to Practicing agricultural activity and engaging in other professions that secure stable incomes, and despite the decrease in the total proportions of cultivated areas in the district, there is a spatial change in the areas cultivated in agricultural fields, if Map (24) indicates anoticeable spread of this variety in Al-Azim district for the year 2021, whichI figured

createThe Al-Azim Dam Project in 2000, which was reflected in the increase in the sub-district's share of water, in addition to the dependence of the sub-district in some parts of it on well water.)Diyala Agriculture Directorate, 1997-2021, pp. 21-22).

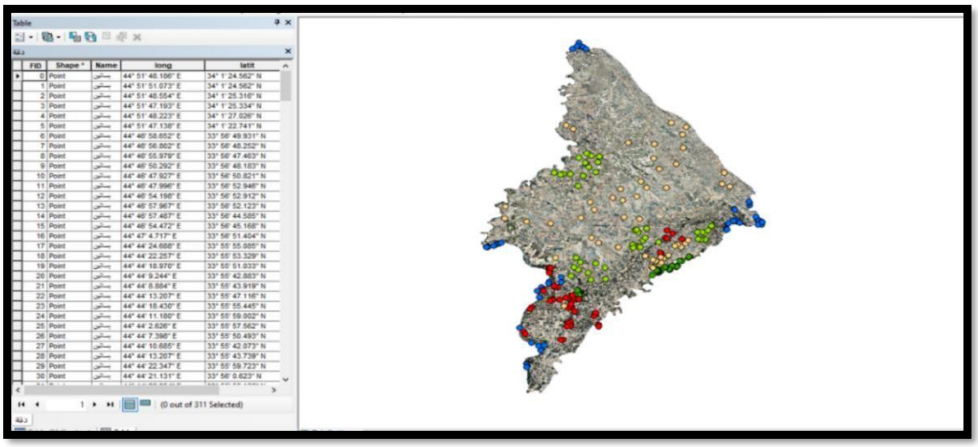
4- Urbanization:The increase in the percentage of urbanization, as this category camewith a positive change rate that rose to (20.76% between the aforementioned two years, with an amount of change that reached (306.37) km 2, and it is natural for the percentage of urbanization to increase, as we know that the population of Khalis district has increased from (230,977) people in 1997 to (348,842) people in 2021(The Republic of Iraq1997, p. 82).,The percentage of urbanization has increased within the sub-districts (Al-Salam, Habhab, Al-Khalis district center), that is, in the eastern and southeastern parts of the district, being close to rivers, water sources, administrative centers, and then the services represented by transportation methods, health, educational and recreational services, and the rest of the other uses of the land.

5- Barren Lands:After the classification process, it became clear that a clear change occurred in the percentage of the barren land category, as it changed positively, as its percentage increased.46.78% of the total area of the study area in 1997 became occupied by (50.56%) in 2021, with a change rate that reached (26.98%), and this was clearly embodied in the partsThe northern and eastern parts of Al-Mansuriya district, north and northwest of Al-Azim district and in the north of the district center, due to the distance of these areas from the surface water sources represented by the rivers (Tigris, Diyala and Al-Azim) and the lack of precipitation and then the successive periods of drought.

Third: Assessment of the accuracy of classification of land cover and land uses in Khalis district

It is important to evaluate the accuracy of the map that represents the land cover and land uses within the study area produced from remote sensing data. This process is done in several ways. Its conclusion is to compare the classification results with an external source that represents the real conditions of the earth's surface at the time of taking the satellite image. Among these methods is the use of the error matrix method (Error Matrix)which are used to initiate different statistical assessments, some of which are partial at thelevel of one category, and some of them are total at the level of the map in all its categories (Ahmed,2022, p. 544).In order to make the classification accuracy, the researcher randomly selected (242) training samples (reference points), Figure (3), each group of which represents a specific cover or a specific use, Table (3), and the accuracy ofthe classification is affected by the number of reference points and how they are distributed. Accuracy of its classification Based on this, error matrices were built for the map of land cover and land uses for the year 2021, so the classification results for themap were of high accuracy, whether at the level of each category or at the level of themap in all its categories.

Figure (3) Training samples to measure the accuracy of classification of land cover and land



Source: From the researcher's work, based on 1- The General Authority for Survey, a mapof the districts of Diyala Governorate for the year 1987, at a scale of 1:500,000, 2- On a visualLandsat-8 for 2021 SAS.Planet.Release.211230[geojamal.com]-3for the year 2021.

1- Partial Classification Accuracy: It is designed to assess the accuracy of land cover classification and ESTmoneyt lands for eachclass,soThis helps to determine the degree of classification accuracy for data estimated for each individual use, obtained by dividingThe number of points that have a correct ratingon the total numberDamro pointsBain a hundred.This accuracy varied between (87 to 100%) Table (3).

2- Overall classification accuracy:It is calculated by dividing the total points with the correct classification for all covers and uses by the total score multiplied by one hundred, thus the total accuracy of the classification reached 94%, and thus it is considered an excellent classification accuracy (Table 3).

After analyzing Table (3) represented by the error matrix to assess the accuracy of the classification for each category of land cover and land uses in Khalis district, the following appears:

Table (3) Error matrix for evaluating the accuracy of classification of land cover and land uses in Khalis district for the year 2021

total samples	5	4	3	2	1		Number of items	T
	Barren lands	Omran	agricultural fields	orchards	waters	item		
51	0	0	0	0	51	waters	1	1
44	0	0	0	43	1	orchards	2	2
43	2	0	41	0	0	agriculturalfields	3	3
49	4	45	0	0	0	Omran	4	4
55	48	0	7	0	0	Barren lands	5	5
242	54	45	48	43	52	Total notes for each class		6
4	2	0	1	0	1	The number of errors in each category		7
%	12	8	5	2	0	The percentage of error in each class		8
%	87	92	95	98	100	Accuracy percentage for each category (partial accuracy)		9
94%						overall accuracy ratio		10

Source: From the researcher's work, based on the land cover classification map and land uses in Khalis district for the year 2021.

A- Water:The water came with the highest classification accuracy, as its accuracy reached (100%), which was obtained from (51) random samples, and this indicates that it was classified very accurately due to the difference in the spectral reflectivity of water from the rest of the other varieties.

B- The orchards:The orchards category came in second place in terms of high accuracy, as it recorded an accuracy of (98%), resulting from (44) randomly selected samples.

C- Agricultural fields:Agricultural fields recorded a classification accuracy of (95%), which was obtained from (43) randomly selected samples, and this percentage came because of the overlap between them and the orchards class due to the close spectral reflectivity of these two classes.

D- Urbanization:The Al-Omran category recorded excellent classification accuracy, amounting to (92%) out of a total of (45) selected samples distributed randomly over the study area.

The barren lands:Barren lands came with a very good accuracy rate, but it is the least among the other varieties as it reached (87%). Confusion has occurred between this category and the urban category due to the similarity of the spectral response of urban andbarren lands.

After applying the accuracy matrix, it was found that the total classification accuracy of the map for the year 2021 amounted to (94%), with a total error rate of (6%). Since the total accuracy does not take into account the possibility of coincidence in the accuracy of the results, and therefore an indicator is often attached to the total accuracy that takes into account Considering the occurrence of chance in the accuracy of the results when comparing the classification with the ground facts in remote sensing software according to the law of probability called the Kappa coefficientKappa Coefficient. The Kappa coefficient, if it is confined between (1-0.75), indicates that the result is good in evaluating the classification map.(Ismael , 2021 s 83)according to table (20) The Kappa coefficient was (0.92), which is an excellent result.

Schedule (4) The kappa coefficient of the classification accuracy matrix Kappa is unlikely

Note kappa	standard error	95 confidence interval	
0.9276		minimum	the highest rate
The first way	0.0188	0.8908	0.9644
The second way	0.0188	0.08908	0.9644
The maximum possible amount of kappa is unlikely given the observed marginal frequencies of 0.969			
Observed as a percentage of the maximum possible 0.9573			

kappa with weighting

kappa observed	standard error	95 confidence interval	
		minimum	the highest rate
0.9423	0.0157	0.9115	0.9731

Source:From the researcher's work, based on the following websitehttp://vassarstats.net/kappa.html.

The second topic

Future predictions of land cover change and land uses for Khalis district for the year 2031 using Markov model

Preface

The future of geographical research is directed towards studies that focus on computer simulation applications that represent the method and evaluation of a system that aims to bring the real world closer, which is difficult to provide because of the material cost or practical difficulties. Computer simulation has entered the field of planning as a result of the rapid change in land uses and land cover, which motivated scientists to Searching for techniques that enable them to simulate that change while anticipating its future trends, which enables them to draw a scenario for what will happen in the future, and then work to avoid the expected negative effects to achieve sustainable spatial development.

First - Simulating the future change of land cover and land usesin the district of Khalis

In order to simulate the change of land cover and land uses within the study area, with the expectation of future changes until 2031, and in order to understand the results of this change, the application of the Markov chain was relied upon.Markov, which is a series of random values whose probabilities in a period of time depend on the value at the previous time. The main factor of the Markov chain is the transition probability matrix that determines the directions of change from the past to the present and then the future (Abdul Karim, 2020, p. 98).

It took the name of its Russian creator(Anderi Markov) It is a dynamic model concerned with the behavior of the photo cell and its relationships with neighboring cells and the possibility of cells moving from one category to another from agricultural to urban use, for example. Several studies confirmed after using the Markov model and the geospatial technique together that they are able to capture the spatial and temporal trend in the land cover pattern. And land uses in the studied areas (Baroud, 2019, pp. 366-367).

And the Markov matrix (P) as follows (Ayasra, 2018, p. 4).

$$\mathbf{P} = (\mathbf{pij}) \begin{bmatrix} P11 & P12 & \dots & Pn1 \\ P21 & P22 & \dots & Pn2 \\ \dots & \dots & \dots & \dots \\ Pn1 & Pn2 & \dots & Pnn \end{bmatrix}, = 1 \sum_{j=1}^{n} P_{ij}$$

sothat :

P = Markov transformation matrix.

Pi, j = type of land cover for the first time period and the second time period
Pij = probability of land use of type i of land use of type j.
ij = Probability of moving old varieties (i) to newer varieties (j)

It is worth noting that the Markov chain does not provide any geographical significance, and it is not relied upon alone in the future prediction process, as it gives quantitative information about the size of the changes and not spatial information, and thus does not give knowledge of the spatial distribution of the studied phenomena. To add the spatial component, cellular self-behavior must be used.CA MARCOV (Cellular Automata)

because of its importance in developing projections of change for spatial phenomena in the future because it combines different modeling elements, and is one of the most used models for modeling the temporal and spatial change probability of land cover and land uses. Al-Khalis district, as the program environment allows the application of the CA MARCOV model, which combines cellular self-behavior and Markov chain analysis, as well as prediction procedures for land uses and land cover that would add the spatial communication element and then knowledge of the potential spatial distribution. On the use of the land cover map and land uses in the recent year in the process of simulating change and the use of the matrix of transition probability areas from Markov analysis, as the amount of expected change in the land cover and land uses for each layer is determined in the direction of the layersTable (5)

After classifying my visuals for the years 1997 and 2021 in a program environmentImaging 2014 ERDASinto five categories, namely (water, orchards, agricultural fields, barren land, urbanization) and knowing the areas and proportions of each type of land cover and land uses, a program was used17.0 IDRISI Selva To simulatethe future change of land cover and land uses within the study area, and before startingthe simulation process through the application of the Markov chain, several steps must be prepared, including:

1- Using the two classified maps of land cover and land uses for the years 1997 and 2021, Map (2), which were classified to calculate the transformation probability matrix and the transformation areas matrix.

2- Convert categorized visuals toRaster through the environment of the ARC GIS program because the Al-Idrisi program does not deal with vector data.

3- Convert the converted image within step (2) into filestext File from the Raster to ASCII tool in ARC GIS software.

4- Standardize the size of the cells according to the discriminatory accuracy of the visuals used in the prediction process.

5- Grouping items based on the reclassification techniqueReclass under the IDRISI Selva program.

secondly -Using the Markov technique, the two classified maps of land cover and land use were analyzed for the years 1997 and 2021 for Khalis district and produced:

1- The change probability matrix: It is represented by a text file that records the probability that each category of land cover and land use will change to other categories, Table (5).

2- Conditional Probability Pictures:Refers to the possibility of each class of land use and land cover appearing in each image unit after the specified number of time units. These images are calculated as projections from the two input images of land cover and land use. A group file can be created.Raster includes conditional probability images.

Table (5) Simulation of the probability of change at the level of sham units for land cover classes and land uses in Khalis district for the years 2921-1997

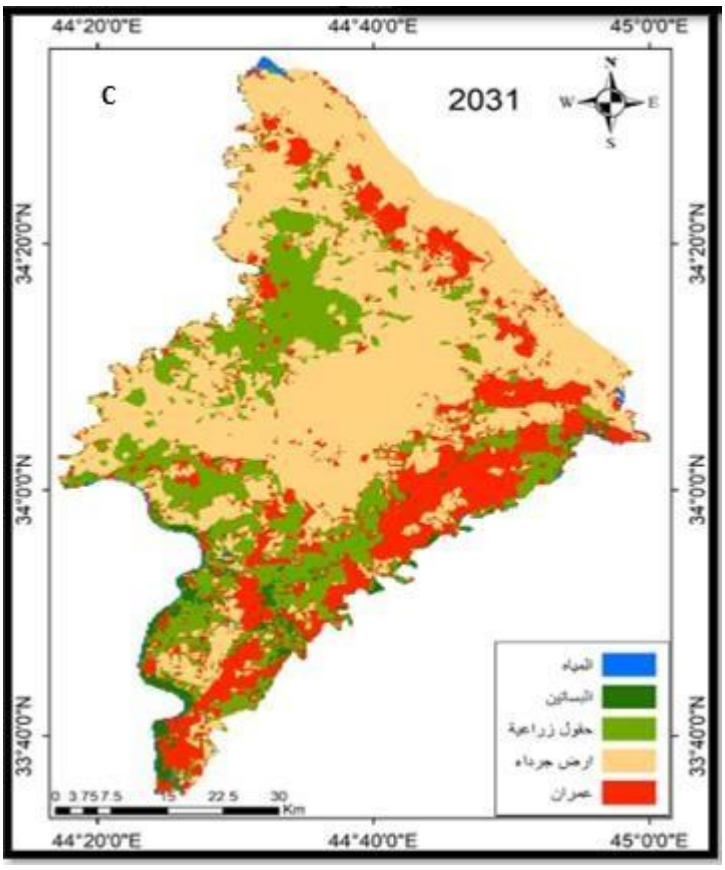
		2021				
1997		**water**	**orchards;**	**agricultural fields**	**The ground is barren**	**urbanization**
	water	0.4295	0.1327	0.2833	0.0332	0.1213
	orchards;	0.0100	0.5857	0.3676	0.0000	0.0367
	agricultural fields	0.0051	0.0530	0.4020	0.2566	0.2834
	Barren land	0.0006	0.0000	0.1546	0.7448	0.0999
	urbanization	0.0156	0.0114	0.1883	0.2499	0.5347

Source: From the researcher's work, based on the Markov modelMarkov

Table (5) reveals the possibility of changing land cover varieties and land uses within the study area for almost all varieties indicating the possibility of their transfer to other varieties except for the bare land, as the probability of their stability reached (74%) in the northern and central sections, while the eastern sections, which are represented by Al- Azim district, it turns out that There is a possibility of the transition of barren lands to agricultural fields, and it was also found that the category of urbanization will continue to extend by (53%), as a result of the continuous increase in the number of populationwithin the study area, and with regard to the category of agricultural fields, it was found that there is a possibility of its transfer to the category of barren land by (25%)) and tothe category of urbanization by (28%) in the eastern and southern sections and along the Khalis creek, which are represented by the districts (Mansouriya, Al-Salam, the center of the Khalis district and Habhab), due to the increase in population numbers and the proximity of these areas to administrative centers and services.

Third-After using form (CA-MARCOV) to predict the future changes that may occur on the land cover varieties and land uses for the Khalis District for the year 2031 based on the matrix of the probability of the transition of the varieties and starting from the year 2021 the results related to the future change of the areas of the land cover varieties and land uses were obtained for the year 2031 Map (3), Table (6), Figure (3), as follows:

Map (3): Land cover and land uses for Khalis District for the years 1997, 2021, and 2031.



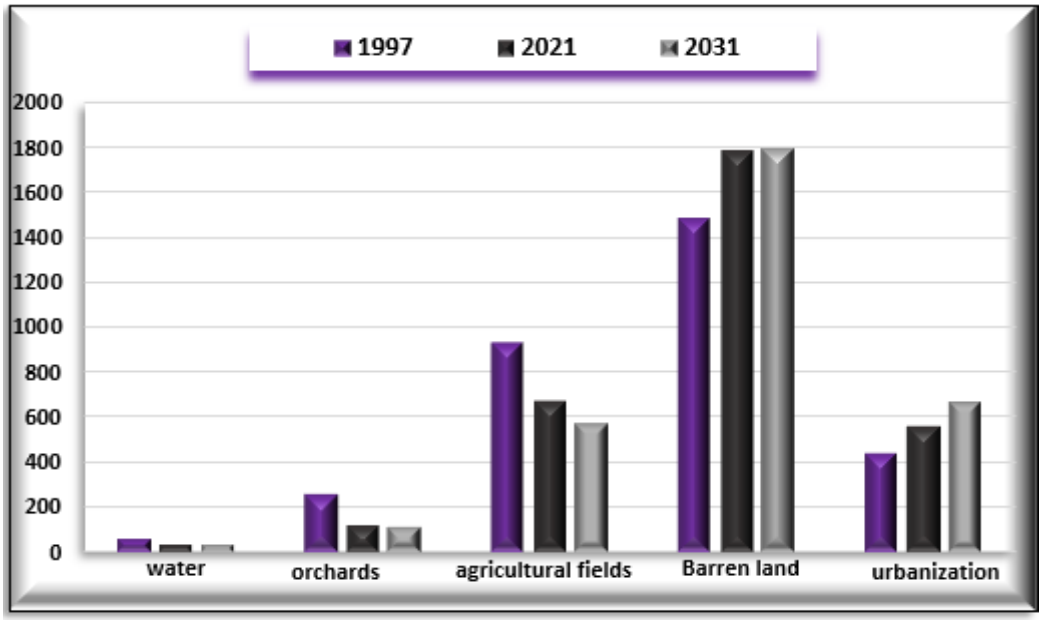
Source: From the researcher's work, based on the General Commission for Survey, themap of the districts of Diyala Governorate, and the programIDRISI SELVA.

Table (6) Change in land cover area and land uses in Khalis district, and its forecasts forthe year 2031

2031		2021		1997		varieties
The ratio	space	The ratio%	Area/km2	The ratio%	Area/km2	
0.92	29.03	0.95	30.22	1.92	60.78	water
3.39	107.12	3.75	118.26	8.02	253.15	orchards;
17.80	561.33	21.25	670.02	29.44	928.45	agricultural fields
56.98	1796.87	56.5	1781.58	46.78	1475.21	Barren land
20.88	658.65	17.53	552.92	13.8	435.41	urbanization
100	3153	100	3153	100	3153	the total

Source: from the researcher's work, based on map (3) and a programIDRISI SELVA

Figure (3) The difference in percentages of land cover classes and land uses for the years 1997-2021-2031



Source: From the researcher's work based on Table (6).

1-It is clear from the data of Table (6) and Figure (3) that the built-up land area has increased, after it used to constitute a percentage of (13.8% in 1997, it clearly increased tobecome (17.53%) in 2021, and it is expected to reach (20.88%) in 2031, as a result of the continuous increase in the population and the accompanying increase in demand for land to meet the population's need for units Residential, commercial and services, and this increase in urbanization was at the expense of green lands represented by orchards and agricultural fields.

2-The percentage of areas covered by water bodies will continue to decline clearly, as its area has decreased to (30.22) km 2 in 2021, after it occupied an area of (60.78) km 2 in 1997, and it is expected that its area will reach (29.03) km 2 in 2031, according to future predictions. In the rivers (Tigris, Diyala, Al-Azim, Al-Khalis Creek) precipitation has decreased significantly in recent years, which led to successive droughts on the one hand, and the arbitrary policies carried out by the upstream countries on the other hand, Table (6).

3-It is also expected that the area occupied by orchards will continue to decline in 2031 toreach (107.12) km2, according to future predictions, after it occupied an area of (118.26, 253.15) in the years 1997-2021 respectively, and this is often the result of human factors represented by overgrazing and the bulldozing of orchards and the conversion of their gender to residential land (table (6).

4-From the data of Table (6), it appears that the barren lands will continue to expand atthe expense of other varieties, significantly, as the percentage of their stability and extension increased according to future predictions for the year 2031 until it reached (56.98% of the total number of the study area after it was reported in 1997 (46.78%) and (56.5%) in 2021.

Conclusions

1- The results of the classification of the two satellite visuals proved the possibility of using visualsLand sat with medium spatial resolution in detecting changes in land covers and land uses in Khalis district.

2- The results of the classification of the two satellite visuals show that the category most subject to change is the category of barren lands, as its area has increased significantly as a result of climatic changes represented by the lack of precipitation and high temperatures, as well as the human factors represented by the bulldozing of orchards, overgrazing and the increase in the population.

3- By simulating future changes using the Markov chain model to perform the prediction process, it was possible to predict the changes that might occur for the year 2031, basedon the changes that occurred in the year 2021, and it became clear that the two categories of urbanization and barren land will continue to expand and expand until the year 2031 at the expense of the types the other.

Proposals

1- Build a strategyTAnd taking measures to reduce the impact of climate change by afforestation of bare areas of vegetation and preventing encroachment on green lands.

2- Seeing the latest findings of modern technologies in detecting change and establishing special scientific centers for monitoring and controlling environmental changes.

3- Paying attention to water resources and developing them, applying the integrated water management program, paying attention to modern irrigation techniques, using drip and sprinkler irrigation methods to irrigate crops, and reduce the evaporation process for openchannels by covering them.

4- Monitoring the change in land cover and land uses based on modern technologies and activating the role of geographers in the planning process, as they are able to produce cartographic models based on modern technologies that can be relied upon in planning and sustainable development processes.

References

First: books

1- Baroud, Khamis Fakher, Remote Sensing Applications in Geographic Information Systems ProgramArc GIS, 1st Edition, Gaza, 2019, pp. 366-367.

2- Abdul Karim, Ashraf Ahmed Ali, Applications of Geographic Information Systems in Urban Planning, 1st Edition, Obeikan Publishing and Distribution, Riyadh, 2020

3-. Lillesand, Thomas M., Dalf, and Kiefer, Remote Sensing and Visual Interpretation, The Arab Center for Arabization, Translation, Authorship, and Publishing, Damascus, 1994.

Second: letters, dissertations, research and periodicals

1- Ahmed, Fathi Abd al-Latif Ahmed, Evaluation of the Accuracy of Classifications of Satellite Visuals in the Period 1990-2020 by Application to the Northwest Coast of Egypt, Journal of Arts, Issue 2022, 57.

2- Ismael, Omar Abdullah, Integration of Geospatial Geographical Information Systems and Remote Sensing in Cartographic Modeling of Land Uses, the Erbil Plain as an Example, PhDthesis (unpublished), College of Education for Human Sciences, University of Mosul, 2021.

3- Ayasrah, Thaer Mutlaq Muhammad, Simulation of urban growth based on self-cellular behavior and modeling of land change, an applied study on the Sakib region in Jordan, Journal of Architecture and Planning, Riyadh, Issue 1, 2018.

Third: Foreign sources

1- Anderson, James R, et al. A land Use and land cover cclassification system for use writh Remote Sensor Data, vol.464.US Government printing office. 1976, p4.

2- Jia, John A.Richards and Xiuping, Remote Srnsing Digital Image Anaiysis An Introdction,Edition, Springer, USA, 2006, p.193-194.

Fourth: government sources

1- The General Commission for Surveying, a map of the districts of Diyala Governorate for theyear 1987, at a scale of 1:500,000.

2- Diyala Agriculture Directorate, Planning and Follow-up Department, annual report for the years 1997 and 2021.

3- Republic of Iraq, Planning Commission, Central Statistical Organization, results of the general population census for the year 1997.

Fifth: Websites

1-http://vassarstats.net/kappa.htmi.

2-http://erathexplorer.usgs.gov

3- https://eos.com/landsat-5-tm

4-https://eos.com/landsat-8-oil