

Investigating Agricultural Land Degradation Using Remote Sensing Techniques between 2014-2024: A Case Study in Kadhimiya Area, Baghdad, Iraq,

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التحقيق في تدهور الأراضي الزراعية باستخدام تقنيات الاستشعار عن بعد بين عامي التحقيق في تدهور الأراضي الزراعية في منطقة الكاظمية، بغداد، العراق.

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المستخلص

تهدف الدراسة: تهدف هذه الدراسة إلى تقييم تأثير تدهور الغطاء النباتي في مديرية الكاظمية باستخدام تقنيات المعالجة الرقمية على صور الستاليت. على وجه التحديد ، يسعى إلى فهم التغييرات التي حدثت في الغطاء النباتي والتربة والمياه خلال فترة زمنية محددة ، وعلاقة هذه التغييرات بالتنمية المستدامة.

المنهجية: اعتمدت الدراسة على تحليل صور لاندسات ساتيليت من عامي ٢٠١٤ و ٢٠٢٤. تم تطبيق المعالجة الرقمية على هذه المرئيات لاستخراج عشرة مؤشرات طيفية متنوعة تغطي جوانب الغطاء النباتي والتربة والمياه. تضمنت هذه المؤشرات مؤشرات الغطاء النباتي ومؤشرات التربة (مثل مؤشر المروز ومؤشر الطمي الطيفي) ومؤشرات المياه (مثل مؤشر المياه ومؤشر الإجهاد المائي). وبعد حساب قيم هذه المؤشرات، تم تحليل التغيرات في مساحة ونسبة كل مؤشر بين سنتي الدراسة لتقييم مدى واتجاه التدهور.

أثر الدراسة على التنمية المستدامة: تسعى هذه الدراسة إلى توفير فهم واضح لمدى تأثير تدهور الغطاء النباتي على الموارد الطبيعية في مديرية الكاظمية. من خلال تحديد المناطق الأكثر تضررا وأنواع التدهور السائدة (سواء في الغطاء النباتي أو التربة أو المياه) ، يمكن استخدام نتائج الدراسة لتوجيه جهود التنمية المستدامة. على سبيل المثال ، يمكن أن تساعد النتائج في:

تحديد أولويات التدخلات: تركيز الجهود والموارد على المناطق الأكثر احتياجا للترميم والحفظ، وتطوير استراتيجيات فعالة: تصميم وتنفيذ خطط للإدارة المستدامة لموارد الأراضي والمياه ، بما في ذلك مكافحة التصحر وتدهور التربة. رصد وتقييم التقدم المحرز: استخدام المؤشرات المرئية كأدوات لرصد فعالية التدخلات وتقييم التقدم المحرز نحو تحقيق أهداف التنمية المستدامة المتعلقة بالبيئة والموارد الطبيعية.

النتائج الرئيسية: أظهرت الدراسة تغيرا واضحا في الغطاء النباتي خلال فترة الدراسة، مع امتد تأثيره إلى ما هو أبعد من النباتات ليشمل التربة والمياه. ولوحظ توسع في استخدامات الأراضي غير الزراعية على حساب الأراضي الزراعية، إلى جانب زيادة في مساحة الأراضي القاحلة وارتفاع في مؤشرات بروزة التربة والطمي. من ناحية أخرى، أظهرت مؤشرات المياه قيما سلبية عند دراسة التغير بين عامي ٢٠١٤ و ٢٠٢٤، مما يشير إلى تدهور حالة الموارد المائية

.الكلمات المفتاحية: المعالجة الرقمية، استخدام الأراضي، المؤشرات الطيفة، تدهور التربة، الغطاء النباتي.

Abstract

Study Objective: This study aims to evaluate the impact of vegetation cover degradation in Al-Kadhimiya district using digital processing techniques on satellit imagery. Specifically, it seeks to understand the changes that have occurred in vegetation cover, soil, and water over a specific time period, and the relationship of these changes to sustainable development.

Methodology: The study relied on the analysis of Landsat satellit imagery from the years 2014 and 2024. Digital processing was applied to thesevisuals to extract ten diverse spectal indices covering aspects of vegetation cover, soil, and water. These indices included vegetation indices, soil indices (such as the saliinity index and spectal silt index), and water indices (such as the water index and water stress index). After calculating the values of these indices, changes in the area and percentage of each index between the two study years were analyzed to assess the extent and direction of degradation.

Impact of the Study on Sustainable Development: This study seeks to provide a clear understanding of the extent to which vegetation cover degradation affects natural resources in Al-Kadhimiya district. By identifying the most affected areas and the prevailing types of degradation (whether in vegetation cover, soil, or water), the study's findings can be utilized to guide sustainable development efforts. For example, the results can help in:

Prioritizing interventions: Focusing efforts and resources on the areas most in need of restoration and conservation ,Developing effective strategies: Designing and implementing plans for the sustainable management of land and water resources, including combating desertification and soil degradation. Monitoring and evaluating progress: Using spectal indices as tools to monitor the effectiveness of interventions and evaluate progress towards achieving sustainable development goals related to the environment and natural resources.

Key Findings: The study showed a clear change in vegetation cover during the study period, with its impact extending beyond plants to include soil and water. An expansion of non-agricultural land uses at the expense of agricultural lands was observed, along with an increase in the area of barren lands and a rise in soil saliinity and silt indices. Water indices, on the other hand, showed negative values when studying the change between 2014 and 2024, indicating a deterioration in the state of water resources

.Keywords :digital processing, , land use, spectal indices, soil degradation, vegetation

1. Introduction

Agricultural land management represents an important and effective means of investing the potential and capabilities of agricultural land in any part of the earth, which contributes to better resource resources in a way that achieves the desired benefitfrom production and investment. Agricultural land represents the mainstay of the economy of all countries, in addition to other economic sectors. The world faces major challenges as a result of the continuous deterioration of the vegetation cover, which threatens biodiversity and increases the severity of climate change. Restoring the degraded vegetation cover is vital to achieving the goals of sustainable development, especially with regard to food security and water management. Agricultural land degradation is defined as a state in which the quantity and quality of land resources, necessary to support the functions of the ecosystem and its services and enhance food security, are stable or increasing within specific time and space ranges.

Iraq has been classified as one of the most vulnerable countries in Arab countries to climate change, and has been recognized as the fifth most exposed country globally to climate change indicators In recent years Iraq has suffe Red from the increasing frequency and severity of extreme heat events and their consequences in the context of regional climate change [1].

The use of remote sensing (RS) and geographic information systems (GIS) techniques has spread in estimating and assessing the map of vegetation cover changes due to their availability and their characteristics of speed of completion, accuracy, covering a large area, and saving effort and budget. Therefore, theoretically,

it is the prefer Red method for assessing the change in land cover at the local and global levels.

The research aims to detect the change in vegetation cover, determine the type and amount of change, in addition to determining the spatial patterns of change for a period of 10 years, from January 1 to December 31, 2014 -to January 1 to December 31, 2024 and employing automated processing of spacevisuals based on a number of spectal indicators related to soil, water, and plants in Al-Kadhimiya District. Studies have shown that soil degradation in developing countries ranges from moderate to severe in 33 percent of the lands due to soil erosion, depletion of nutrients, acidification, salinization, compaction and pollution with chemicals. The soil in Iraq suffers from the problem of deterioration in chemical and mechanical properties and the impact of this deterioration and shrinkage on agricultural production. The problem of the study can be summarized as the exit of large areas of agricultural land and their transformation into other uses that may be urban or rural, which affects the image of the geographical distribution of agricultural production and the future of future generations in providing daily food needs.

Modern geographic technologies and their spatial employment have provided many possibilities through which it is possible to monitor, analyze and p Redict a number of changes at the spatial level. Hence, the importance of the study in revealing the most important spectal indicators related to agricultural production and what is related to soil and water, as they represent an important factor in the change in agricultural land uses, in addition to many other human factors. The research aims to reveal the area of vegetation cover in Al-Kadhimiya District, The Al-Kadhimiya district was chosen for this study due to a range of factors, including urban pressure and expansion, the general

environmental challenges facing Iraq, and pressure on water resources The study area is characterized by demographic, economic, and environmental diversity, which has significantly influenced land uses within the region. Consequently, the natural environment has experienced changes due to the conversion of substantial agricultural land (nine units) by human activity from agricultural use to other residential, |commercial, and service purposes.

The role of modern technologies represented in remote sensing and geographic information systems in monitoring the change deterioration in geographical phenomena, including vegetation cover, in addition to creating a database supported by maps that show its geographical extension and distribution. The issue of vegetation cover deterioration is a very important global challenge, and directly and indirectly affects the achievement of the sustainable development goals adopted by the United Nations. And creating maps of vegetation cover in the study area based on the indicators adopted in the study, which are related to the vegetation condition, soil and water condition in the study area. Remote sensing data have proven their accuracy in providing information about various natural resources, due to their repeated coverage of natural resources, and their contribution to the analysis. They are also the ideal means for detecting changes in land targets and following them temporally and spatially.

2. Data and Methodology

The study area, represented by Al-Kadhimiya district, is located within the borders of Baghdad Governorate, with an area of 288 km2, which constitutes a total area of 567 km2 and a percentage of 11.7% of the total area of Baghdad Governorate.

Astronomically, the district is located between the latitudes 33.38306°N 44.34°E, as shown in Figure 1, and administratively includes the center of Al-Kadhimiya district, Dhat Al-Salasil district, and Al-Taji district. The area of the study area is distributed, the spectal indicators adopted in the study were classified based on the categories in each indicator, which show the proportions and area of each category of spectal indicators adopted in the study.

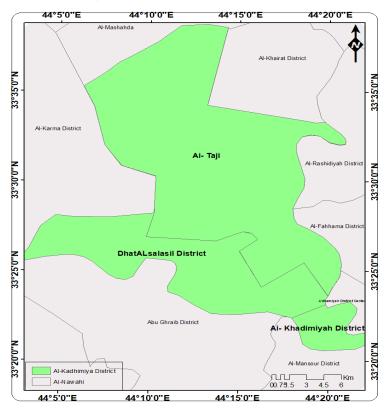


Figure 1: Location of the study area in Baghdad Governorate Source: General Authority for Survey, Administrative Map of Baghdad Governorate at a scale of 1:1,000,000 for the year 2012 As for the working methods, several methods were used to achieve the research objective, as the satellitvisuals were downloaded from the USGS websi te

https://earthexplorer.usgs.gov/ for the base year 2014 and the comparison year 2024, and the Landsat-8 OLIvisuals were downloaded from Earth Explorer, and these previously radiometric downloadedvisuals processed through were calibration and atmospheric correction obtain to surfacereflecatnce data using radiometric calibration and with a spatial Rezlution of 30X30 meters, as well as data correction and map correction (geographical reference) And represent this on the base map of the study area.

The selected contrast indices included Bands and these indices are:

First: Vegetation status indicators, which are:

- Application of the Normalized Difference Vegetation Index (NDVI)
- Optimal vegetation index (EVI)
- SAVI attempts to reduce the effects of soil
- Chlorophy ii Index (Ci green)
- Chlorophy ii Index (CI Red)

Second: The following soil indicators were studied studied:

- Green Normalized Difference Index (GNDVI)
- Normalized Difference Saliinity Index (NDSI)
- Bare Soid Index (BSI)

Third: Water indicators were represented by the following indicators:

- Normalized Difference Water Index (NDWI)
- Moisture stress index (MSI)

The area and ratio of each category extracted from the indicators were calculated and selected for the study and represented by maps Objectivity.

Table 1	The	role	of	satellits	in	the	study	of	environmental
changes									

Satellit	Rezlution	Her	Date	Geographic	
Satemi	M	number		reference	
			January 1		
Land Sat	30	168 Path	to	WGS-84	
7-ETM	30	Raw 36	December		
			31, 2014		
			January 1		
Land Sat OLI 9	30	168 Path	to	WCC 94	
		Raw 36	December	WGS-84	
			31, 2024		

- 3. The work steps are done after calling the selected satellit visuals for the study area, selecting the spectal indicators, and then using the mathematical equations, the visual processing process takes place, and then the study area is deducted, the visual is recolo Red and encoded appropriately for each indicator Discussion and Results
- 3.1Digital Processing of Spectal Agricultural Land Degradation Indicators in Al-Kadhimiya District

Digital processing of satellitvisuals and the extraction of spectal indices is one of the most important modern applications in geography. It encompasses multiple aspects, ranging from the analysis of spatial and temporal changes in natural and human phenomena, to resource assessment, environmental monitoring, and decision-making support in urban planning, disaster management, and other fields, including those related to improving the satellit image, removing distortion processes, and computational processes at the intermediate level of processing, the process of understanding or realizing "making sense" of a set of elements that have been identified [2] Vegetation indices play

an important role in monitoring differences in vegetation cover, and different wavelengths provide the basis for using reflecatnce using broadband radiometers typical of current satellit platforms or hyperspectal sensors that measurereflecatnce at narrow wavelength bands. Understanding leafreflecatnce has led to different vegetation indices for crop canopies to determine different agricultural parameters, for example, leaf area, crop cover, biomass, and yields (LincolnDigitalCommons 2017). A number of indices were relied upon to study the degradation of vegetation, including those related to plants, plant health, soil, and water, which together play an important role in assessing the state of degradation in the vegetation cover of the study area, namely:

3.1.1: *Vegetation status indicators, including*:

First: Application of the Normalized Difference Vegetation Index (NDVI)

It is one of the digital spectal enhancement processors that is useful in monitoring plants and is based on the relationship between near infra Red and Red band.s with a wavelength of $(0.63, 0.69 \, \mu m)$ as the plant's reflectivity is high in the near infra Red range NIR and low in the visible range R [3]. This index can be calculated based on the following equation: [4]

$$NDVI = (NIR - RED)/(NIR + RED)$$

Equation 1

Where:

NDVI = Natural Greenness Index

NIR= near infra Red range

RED= Red rays

In general, the range of values obtained from applying this indicator ranges between -1_ '+ If the number is positive and close to 1, this indicates that the vegetation cover is dense, and vice versa. If the values are negative, this indicates a low vegetation density or that the area is devoid of vegetation cover (analyze/ndvi-function.htm).

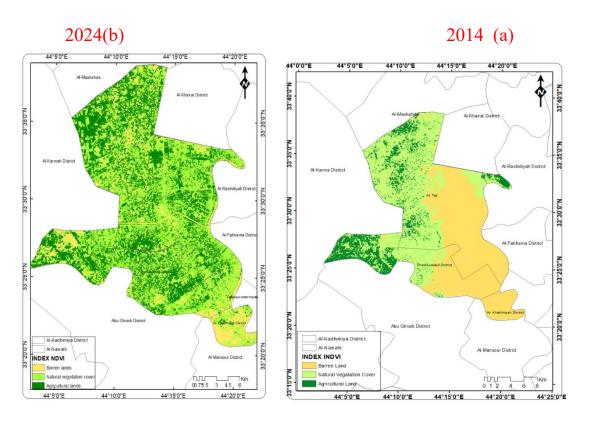


Figure 2:ndvi index for Al-Kadhimiya district for the year 2014, 2024

Source: Based on LandSat 5, 9 visualization for the year 2014, 2024 using Arc map 10.1.8 program.

Through the maps refer Red to, the area was classified in terms of vegetation cover into three vegetation zones: natural vegetation cover, agricultural lands, in addition to areas devoid of vegetation cover, which may be occupied by many land uses, whether urban, such as residential or commercial, or service (religious, educational, and health), in addition to vacant lands devoid of vegetation cover.

By observing the maps above, we find that the percentage of each type of vegetation cover between the years 2014, 2024 has also varied, as it is clear from the figure that agricultural lands in 2024 have decreased compared to what they were in 2014, and the same is the case with other types that constitute the natural vegetation cover, while the area and percentage of barren lands have increased between the years 2014 and 2024.

Second: Enhancd Vegetation Index (EVI)

It is the most common vegetation index, but it may be affected by some factors such as soil brightness and atmospheric humidity. EVI is an improvement overndvi, taking these factors into account and providing a more accurate measure of vegetation cover, especially in areas with dense vegetation or high brightness soils. The Enhancd Vegetation Index (EVI) proposed by MODIS Land Discipline Group and the Normalized Vegetation Index (NDVI) are two global vegetation indices that aim to provide consistent spatial and temporal information regarding global vegetation cover. The Enhancd Vegetation Index (EVI) ranges from -1 to +1 where healthy vegetation values typically range from 0.20 to 0.80. The Enhancd Vegetation Index is defined by the given formula [5]. This index can be calculated based on the following equation:

$$EVI = 2.5 * \frac{(NIR - Red)}{(NIR + 6 * Red - 7.5 * Blue + 1)}$$

Equation 2

By applying this indicator to the study period, Figure 3 is observed.

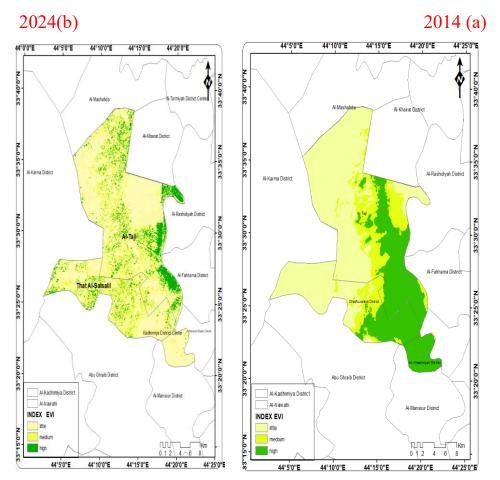


Figure 3: EVI index in Al-Kadhimiya district for the years 2014, 204

Source: Based on LandSat5, 9 visualization for the years 2014, 2024 using Arc map 10.1.8 program.

Third: SAVI attempts to reduce the effects of soil

It is a vegetation index that attempts to Reduce the effects of soil brightness using a soil brightness correction factor. This index is commonly used in arid regions vegetation cover is low. The correction factor (L) is used to Reduce the effect of soil brightness, its value ranges from 0 for dense vegetation to 1 for very sparse vegetation, the most commonly used value is 0.5 for medium-density vegetation. This index is calculated according to the following equation:

$$SAVI = (NIR - RED)/(NIR + RED + L)) * (1 + L)$$

Equation ^{\(\tilde{\pi}\)}

Where:

SAVI= Soil Adjusted Vegetation Index

NIR = Near Infra Red

RED = Red

L = The constant value of the soil line and is Ranging from 1,0

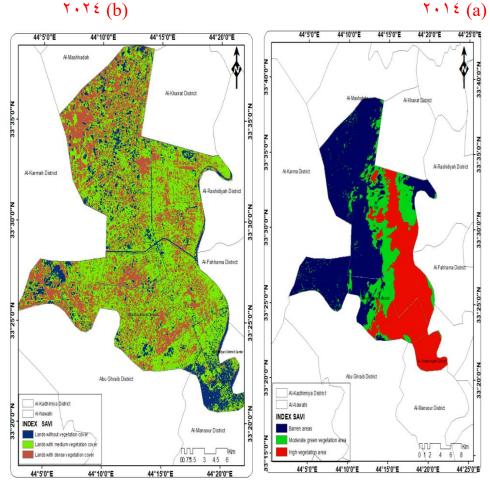


Figure 4: SAVI index for Al-Kadhimiya district for the year 2014, 2024

Source: Based on LandSat 5, 9 visualization for the year 2014, 2024 using Arc map 10.1.8 program.

Fourth: Chlorophy ii Index green (Ci green)

Chlorophy ii content in leaves is a very important indicator for describing crop growth conditions, photosynthetic capacity and physiological status. The dynamic change characteristics are also of great importance for monitoring crop growth conditions and understanding the exchange of materials and energy between

environment [6]. By crops and the measuring spectalreflecatnce of chlorophy ii in plants from space, we can monitor the status of crops on a regular basis. For this reason, the chlorophy ii plant index is used. If interpreted correctly, the chlorophy ii index can provide food producers with crucial information about crop development. This information can be used to increase field productivity, thus obtaining better yields and higher profits. This is due to the high saturation of the natural vegetation index data in the visuals. Saturation occurs because the natural vegetation index is used to estimate biomass density, which is not always related to crop health. Some experts have found that the need to replace the natural vegetation index with the chlorophy ii index arises when the canopy closure is about 80%. Therefore, measuring the chlorophy ii content in plants is a more reliable method for determining crop status. This index can be calculated using the following

$$CI green = \rho NIR - \rho green - 1$$

Equation 4

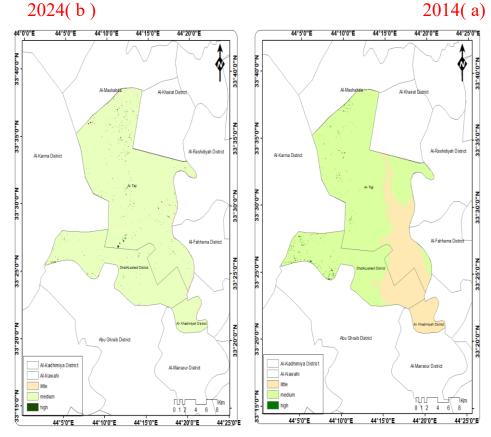


Figure 5: (Ci green) index for Al-Kadhimiya district for the year 2014, 2024

Source: Based on LandSat5, 9 visualization for the year 2014, 2024 using Arc map 10.1.8 pro

Five: Chlorophy ii Index Red-Edge (CI Red)

The Chlorophy ii- Red-Edge Index (CIRE) is a plant index for estimating the chlorophy ii content of leaves. This index was developed to estimate the chlorophy ii content of leaves, Chlorophy ii is a good indicator of plant production potential. It can also be used to understand plant nutrient status, water stress, and disease outbreaks. This index can be found using the equation below:

$$CIred - edge = \left(\rho NIR - \rho red_{edge}\right) - 1$$

Equation 5

This indicator was applied to the study area to show the results as shown in Figure 7

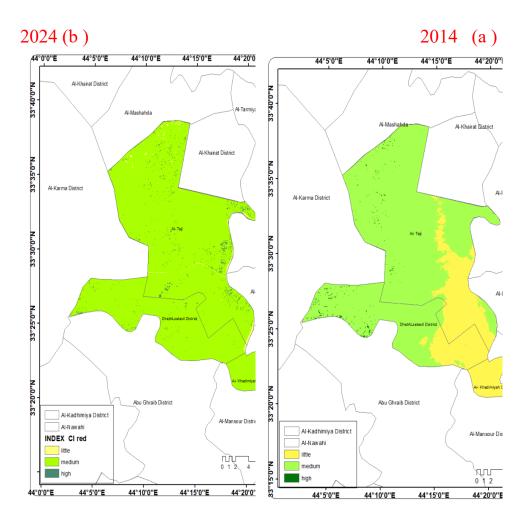


Figure 6: (Cl Red) index for Al-Kadhimiya district for the year 2014, 2024

Source: Based on LandSat 5, 9 visualization for the year 2014, 2024 using Arc map 10.1.8 program.

3.1.2: Soil indicators, including:

First: Normalize Difference Saliinity Index (NDSI)

Soil saliinity is one of the most common soil degradation processes, especially in arid and semi-arid regions. Under such climatic conditions¹, soluble salts accumulate in the soil, leading to deterioration of soil properties and ultimately Reduced crop yield. The purpose of this study was to analyze the relationship between soil saliinity level and the main spectal indices obtained from Landsat satellit data [7]. This index is extracted based on the equation below:

NDSI = (Red - NIR)(Red + NIR)

Equation 6

Where:

NDSI = NDSI

Red = represents the Red band

Nir = represents the infra Red

Analysis of Land Use Land Cover Change Detection of Bostanlik District, ¹ Uzbekistan, Mukhiddin Juliev and others, Pol. J. Environ. Stud. Vol. 28, No. 5 (2019), 3235-3242, https://doi.org/10.15244/pjoes/94216,p12.

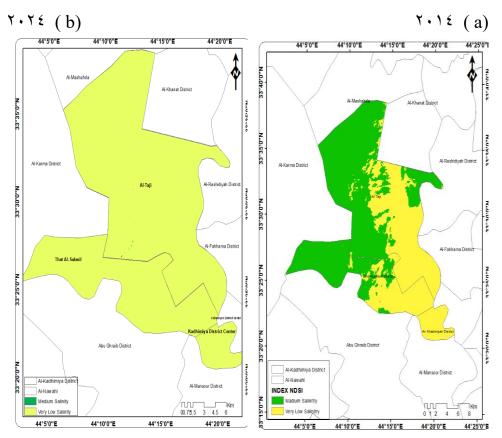


Figure 7: NDSI index for Al-Kadhimiya district for the year 2014, 2024

Source: Based on LandSat 5, 9 visualization for the year 2014, 2024 using Arc map 10.1.8 program

Second: Bare Soil Index (BSI)

The Bare Soil Index (BSI) is a combination of the Natural Vegetation Index (NVI) and the Standardized Built-Up Difference Index (SDI), a spectal index that enhances the detection of exposed soil surfaces and unvegetated areas². The Natural Vegetation Index (BSI) provides unique spectal information that can be used to differentiate soil from all other

Applying Built-Up and Bare-Soil Indices from Landsat 8 to Cities in Dry - ² Climates, Azad Rasul, Land 2018, 7, 81,P1.

land covers. Bare Soil (BSI) is based on soil properties to extract exposed soil pixels, and values range from -1 to 1, with a higher value indicating more bare soil. The index is mostly used in forestry studies to separate bare soil from other cover classes. Another benefit of the BSI is to separate vegetation from other background types (completely bare, sparse canopy, or dense canopy). The equation below can be used to extract the value of this index for soils [8]:

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BSI = ((SWIR + RED) - (NIR + BLUE))((SWIR + RED) + (NIR + BLUE))
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Equation 7

Where:

RED = Red

NIR = Near Infra Red

SWIR = Short Infra Red

BLUE = Blue Range

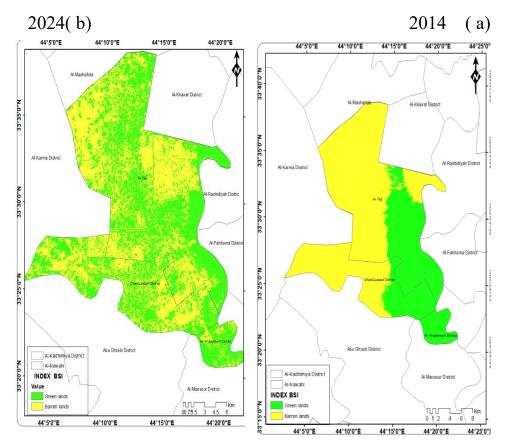


Figure 8 : BSI index for Al-Kadhimiya district for the year 2014, 2024

Source: Based on LandSat 5, 9 visualization for the year 2014, 2024 using Arc map 10.1.8 program

Third: Green Normalized Difference Vegetation Index (GNDVI)

It is similar to the NDGI except that instead of the Red spectrum it measures the green spectrum in the range of 0.54 to 0.57 microns. It is an index of the photosynthetic activity of vegetation; it is often used to assess moisture content and nitrogen concentration in plant leaves. Compar rred to the NDGI, it is more sensitive to chlorophy ii concentration. It is used to

assess deteriorating and aged vegetation. This index is calculated based on the following equation: [9]

$$NIR - GREEN/NIR + GREEN = GNDVI$$

Equation 8

Where:

NIR= pixel values of near infra Red range GREEN= Green Rays

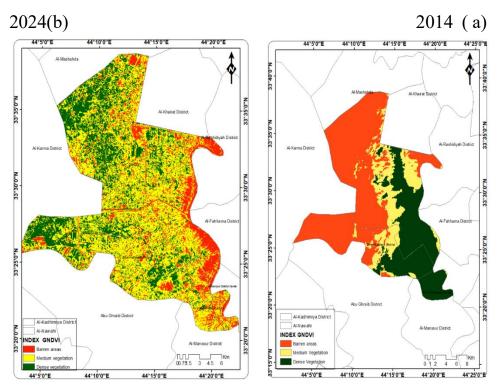


Figure 9 : GNDVI index for Al-Kadhimiya district for the year 2014, 2024 .

Source: Based on LandSat5, 9 visualization for the year 2014, 2024 using Arc map 10.1.8 program

3.1.3: Water indicators. The following indicators were relied upon:

First: Normalized Difference Water Index (NDWI)

The Normalized Difference Water Index (NDWI) is a fundamental parameter of the land surface that reflects drought conditions in agricultural areas, where soil moisture variations significantly affect agricultural production³. The Normalized Difference Water Index (NDWI) uses reflected near-infra Red and visible green light to enhance the presence of such features while eliminating the presence of soil and terrestrial vegetation features. The single-band method uses digital data or photographic products of reflected near-infra Red radiation (NIR). This approach was used because near-infra Red radiation is strongly absorbed by water and equally strongly reflected by terrestrial vegetation and dry soil. It is then possible to quickly and efficiently estimate the area of open water surface in such digitalvisuals using image processing software. In addition, the Open Water Index may prove to be a useful tool in studying water quality issues [10]. The following formula can be used to obtain the NDWI.

$$NDWI = \frac{Green - Nir}{Green + Nir}$$

Equation 9

Where: Green = green rays nir = near infra Red band

Assessment Land Cover Change Using Normalized Difference Water - ³ Ind(NDWI) In Bakun Reservoir, Sarawak,Ricky Anak and Oliver Valentine Eboy, , University Malaysia Sabah, Jalan UMS,88400 Kota Kinabalu, Sabah, Malaysia, Journal of Engineering and Science Research 5 (1): 01-04, 2021e-ISSN: 2289-7127.2021,p1.

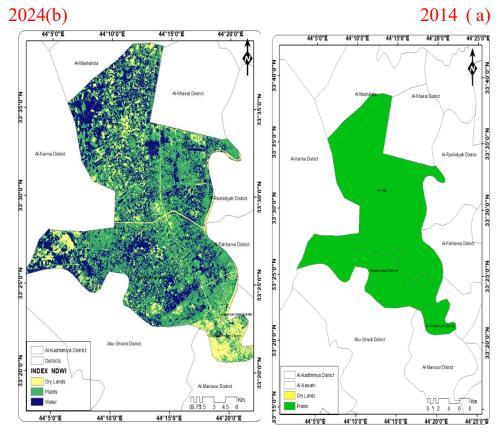


Figure 10: NDWI index for Al-Kadhimiya district for the year 2014, 2024

Source: Based on LandSat5, 9 visualization for the year 2014, 2024 using Arc map 10.1.8 program

Second: Moisture stress index (MSI)

A common practice is the use of bands beyond the visible and NIR as input for LULC classification approaches. However, it was restricted to a few research groups for a long time due to costs associated with image acquisitions, storage and access, and

the required specialized skills and software to transform imagery into actionable information⁴

This index is used to measure moisture stress in vegetation and is calculated by dividing the reflection value in the near-infra Red part of the electromagnetic spectrum by the reflection value in the Red part of the spectrum. Its value ranges from (Moisture stress index (MSI) values typically range from 0 to more than 3. The common range of green vegetation is from 0.4 to 2) [11]. This index can be calculated based on the following equation:

$$MSI = \frac{p1599}{p819}$$

Equation 10

Recent Applications of Landsat 8/OLI and Sentinel-2/MSI for Land Use and 4 Land Cover Mapping: A Systematic Review by Michel E. D. ChavesMichel E. D. Chavesand others, Remote Sens. 2020, 12(18), 3062; https://doi.org/10.3390/rs12183062.

7.75 (b) 7.15 (a)

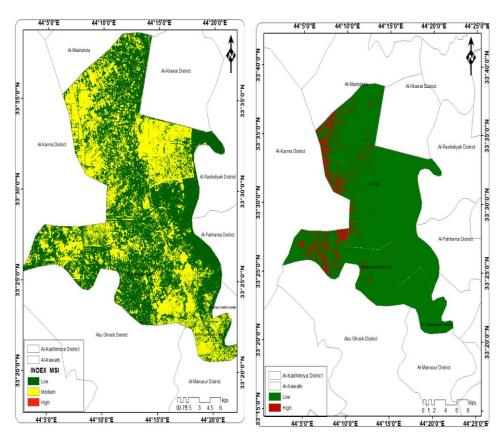


Figure 11: MSI index for Al-Kadhimiya district for the year 2014, 2024

Source: Based on LandSat5, 9 visualization for the year 2014, 2024 using Arc map 10.1.8 program

3.2Detecting the change in the vegetation cover of agricultural lands in Al-Kadhimiya District

Change detection is defined as the process of identifying differences in the state of an object or phenomenon by observing it at different times. This is an important process in monitoring land use changes and land use changes because it provides a quantitative analysis of the spatial distribution of the population in question. This makes the study of land use changes and land

use changes an important topic in remote sensing applications [12]. To calculate the efficiency of each of the indicators that were relied upon, the area and proportions of each category into which the indicators were divided must be taken into account. It was found that there was a clear change in the proportion and area of each indicator between the years 2014 and 2024. The indicators adopted in the study were classified into vegetation indicators, water indicators, and drought indicators. The indicators that were relied upon for vegetation status arendvi, CI GREEN, CI RED, SAVI, EVI, and water indicators are NDWI, MSI, and drought indicators are NDSI, BSI, GNDVI, as follows:

• NDVI,CI GREEN , CI RED,SAVI,EVI

When calculating the change between the baseline and comparison years for the study indicators, the relative change equation was used. The vegetation indices table shows clear and significant changes between vegetation categories, supporting the results shown in the maps analyzed previously. For example, the negative decline in the natural vegetation index between 2014 and 2024 indicates

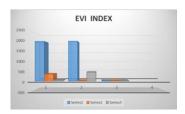
There is a significant shift in large areas of agricultural land to non-agricultural uses, potentially commercial or residential, negatively impacting the agricultural area surrounding Baghdad. This general trend applies to the rest of the vegetation indices covered by the study, with the exception of the red chlorophy ii and red chlorophy ii indices.

Table 2: Analysis of changes in spectal indicators ndvi , CI GREEN , CI RED, SAVI, EVI In the Kadhimiya area

Index	7.15	7.75	Percentage of
mucx		1.12	change
NDVI	60.2	51.5	-0.15
	229	36.2	-0.85
	159.53	12.2	-0.93
EVI	348	0.00414	-0.1
	45.6	449	8.85
SAVI	65.4	82.2	0.26
	234	140	-0.41
	149	227	0.53
Ci green	4.76	24.2	4.09
	442	147	-0.67
	1.92	278	143.80
CI Red	22.5	3.97	-0.83
	423	439	0.04
	3.24	5096	1571.84

See the following forms:





Source: Prepared by the researcher based on Table 2

• NDSI , BSI ,GNDVI

Table 3: Calculation of the percentage of change for soil indicators NDSI, BSI, GNDVI

Index	2014	2024	Percentage of
muex		2024	change
NDSI	0.00475	23	4841.10
	449	146	-0.67
BSI	96.6	72.9	-0.24
	136	116	-0.14
	216	260	0.20
GNDVI	29.5	24.2	-0.17
	138	147	0.06
	281	278	-0.01

Source: Based on the relative change equation and maps $,^{\wedge},^{\vee},^{\uparrow}$

See the following forms:



Series1 Series2 Series3

300 200 100





Source: Prepared by the researcher based on Table 3

• Calculating the percentage of change in water indicators NDWI , MSI

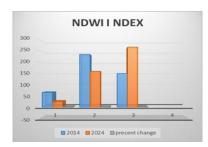
Table 4: Calculating the percentage of change for water indicators NDWI, MSI

Index	7.15	۲.۲٤	Percentage of change
NDWI	65.4	24.3	-0.63
	234	159	-0.33
	149	266	0.79
MSI	106	444	3.19
	343	4.97	-0.99
	0.00081	0.0037	3.57

Source: Based on the relative change equation and figures ,\.

See the following forms:





Source: Prepared by the researcher based on Table 4

The water indicators NDWI, MSI also showed a decreasing trend, which reinforces the concept of shifting from agricultural lands to other uses and thus changing the economic structure of the district during the study period, so that the drought indicators appea Red in an increasing trend, especially the NDSI, which warns of the danger of salinization of agricultural soil and its effect on groundwater seeping from between soil layers, carrying with it the quantities of salts generated on the surface.

4. Conclusion

This research has effectively demonstrated the utility of remote sensing technology, specifically leveraging Landsat 8 OLI imagery, for robust environmental monitoring. The study highlights the inherent flexibility of integrating geospatial technologies and diverse digital processing methodologies in the analysis of satellit imagery, enabling the precise calculation of crucial digital indicators and evidence. Our findings unequivocally validate the capacity of Landsat 8 OLI to visualize various spectal vegetation indices and accurately reflect the state of vegetation deterioration within the defined study area. Furthermore, the comparative analysis of these indices has elucidated their differential sensitivity to varying plant growth conditions, with the presented vegetation indices generally exhibiting a strong numerical correlation with vegetation distribution and extent.

The observed decline in vegetation cover is attributed to a complex interplay of factors, broadly categorized as urban expansion and sprawl, water scarcity and declining water quality, environmental pollution, management deficiencies, adverse climatic conditions, and demographic pressures. Notably, the widespread presence of heavily saline soils across the study area, exhibiting significant spatial variability potentially linked to the conversion of agricultural land for urban development, warrants further in-depth investigation to elucidate the specific environmental and anthropogenic drivers of soil salinization.

The significant and continuous vegetation deterioration identified in this study, characterized by a reduction in both

the condition and spatial extent of vegetation cover across a large scale, poses substantial implications for food security and resource provision for the residents of the study area and adjacent regions. Given that this area represents vital agricultural suburbs of Baghdad and serves as a key production zone for perishable agricultural commodities (vegetables and fruits), the observed trends underscore a critical challenge. The quantitative results and spatial insights derived from this research offer valuable information for decision-makers and land management officials, particularly in identifying key factors contributing to soil saliinity and vegetation decline. These findings can inform development of targeted interventions and sustainable land management strategies aimed at mitigating environmental degradation and ensuring the long-term ecological and socioeconomic well-being of the region. Future research should focus on quantifying the specific contributions of each identified stressor to vegetation decline and soil saliinity, as well as evaluating the effectiveness of potential remediation and adaptation measures.

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