Iraqi Journal of Science, 2022, Vol. 63, No. 12, pp: 5589-5603
DOI: 10.24996/ijs.2022.63.12.43

ISSN: 0067-2904

Detection of Spectral Reflective Changes for Temporal Resolution of Land Cover (LC) for Two Different Seasons in central Iraq

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Received: 10/1/2022 Accepted: 13/6/2022 Published: 30/12/2022

Abstract
The purpose of the study is the city of Baghdad, the capital of Iraq, was chosen to study the spectral reflection of the land cover and to determine the changes taking place in the areas of the main features of the city using the temporal resolution of multispectral bands of the satellite Landsat 5 and 8 for MSS and OLI sensors respectively belonging to NASA and for the period 1999-2021, and calculating the increase and decrease in the basic features of Baghdad .The main conclusions of the study were,

This study from 1999 to 2021 and in two different seasons: the Spring of the growing season and Summer the dry season. When using the supervised classification method to determine the differences, the results showed remarkable changes. Where he was in 1999 Normalized Difference Vegetation Index (NDVI) 925km^2 and Normalized Difference Water Index (NDWI) 75.3km^2 In the case of an increase during the growth period, while the values decreased during the period of dry to (NDVI) 390.8km^2 and (NDWI) 51.9km^2.As for Soil Adjusted Vegetation Index (SAVI) 1692.9km^2 and Normalized Difference Built up Index (NDBI) 782.1km^2 we notice a decrease in the growth period, while the values increase during the dry period to (SAVI) 2239.1km^2 and (NDBI) 1495.7km^2.

In 2021 (NDVI) 242.7km^2 (NDWI) 83.4km^2 in the case of an increase during the growth period, while the values decreased during the period of dry to (NDVI) 122.2km^2 and (NDWI) 73.2km^2 .As for (SAVI) 3016.3km^2 (NDBI) 1263.3km^2 we notice a decrease in the growth period, while the values increase during the dry period to (SAVI) 3702.3km^2 and (NDBI) 1882.2km^2.

Where most of the changes in LC were due to human activities, and the most prominent changes in LC were due to urban expansion on agricultural lands continuously in all years that resulted from land degradation.

Keywords: Remote sensing, Land cover, GIS, Satellite images, Supervised Classification.

الكشف عن التغيرات الانعكاسية الطيفية للتحليل الزمني للغطاء الأرضي ((LC) لموسمين مختلفين في وسط العراق

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الخلاصة

الغرض من الدراسة هو اختيار مدينة بغداد عاصمة العراق لدراسة الانعكاس الطيفي للغطاء الأرضي ولتحديد التغيرات الحاصلة في مناطق المعالم الرئيسية للمدينة باستخدام الدقة الزمنية المتعددة الأطياف وصور الاقمار الصناعية 5و8للاجهزة

MSSو OLIالاستشعار التابعة لناسا وللفترة 1999–2021 وحساب الزيادة والنقصان في السمات الاساسية لبغداد.

هذه الدراسة من 1999 الى 2021 وفي موسمين مختلفين:ربيع موسم النمو والصيف موسم الجفاف.اظهرت النتائج تغيرات ملحوظه عند استخدام التصنيف الخاضع للاشراف لتحديد الفروق.حيث كان في عام 1999 (NDVI) 925كم2و(NDWI) 75.3كم2 في حالة زيادة خلال فترة النمو بينما انخفضت القيم خلال فترة الجفاف الى (NDVI) 390.8كم2 و(NDWI) 51.9كم2 اما بالنسبة الى (SAVI) بلغ 1692,9كم2و(NDBI) 782.1كم2 لاحظنا انخفاضا خلال فترة النمو بينما تزداد القيم خلال فترة الجفاف الى (SAVI) (2239.1كم2) و (NDBI) 1495.7كم2.اما في عام 2021 (NDVI) 242.7كم2 و(NDWI) 83.4كم2 في حالة زيادة خلال فترة النمو بينما انخفضت القيم خلال فترة الجفاف الى (NDVI) 122.2كم2 و(NDWI) 73.2كم2 اما بالنسبة ل (SAVI) 3016.3كم2 و(NDBI) 1263.3كم2 نلاحظ انخفاض خلال فترة النمو وزيادة خلال فترة الجفاف الى (SAVI) 3702.3كم2 و(NDBI) 1882.2كم2. حيث كانت معظم تغيرات LC بسبب الانشطة البشرية وابرز التغيرات في LC كانت بسبب التوسع الحضري على الاراضي الزراعية بشكل مستمر في جميع السنوات الذي نتج عن تدهور الاراضي.

Introduction

Effective land cover change research and monitoring are necessary for environmental sustainability. Population expansion, urbanization, agricultural loss, climate variability, and other factors have resulted in rapid, unplanned, and uncontrolled changes to the earth's land cover. These changes have resulted in deforestation, degradation, biodiversity loss, agricultural mismanagement, and natural disasters [1,2]. Land cover (LC) refers to the conversion of different land cover types, and it is the result of complex interactions between humans and the natural world [1]. Land cover is necessary for the activities of planning and land Administration.[2] Detecting cover change is essential for better understanding changes in the nature of a phenomenon over time. Land cover change is a common occurrence, owing to our activity and natural events, which result in changes that affect natural ecosystems [3]. Remote sensing and geographic information systems are important technologies that analyze photographs to provide environmental data for a variety of urban applications [4,5]. Multiple indicators were employed in the study, including the (NDVI) ,(Normalized Difference Vegetation Index), the (NDWI), (Normalized Difference Water Index), the (SAVI), (Soil Adjusted Vegetation Index), and the(NDBI), (Normalized Difference Built-UP Index) [6]. The importance and capabilities of GIS and RS as effective and powerful instruments in assessing degradation and monitoring land changes have been demonstrated, as has the development of geographic systems and modern technology, including the importance and capabilities of GIS and RS as effective and powerful instruments in assessing degradation and monitoring land changes [7]. Remote sensing technology have improved significantly to include a suite of sensors that function at a variety of image scales that planners and land managers may find useful [8].

spectral accuracy is required to determine the details of the targets such as water, vegetation cover and types of soil. It is possible to distinguish between these materials due to the difference in spectral reflectivity [9]. Spectral Reflectance for Plants low for the red and blue wavelengths of the visible spectrum due to the absorption process by chlorophyll while the reflectivity is higher for the green wavelength. in the near infrared wavelengths [10]. the reflectivity of pure water is often low and this reflectivity increases within the range of the visible region when the water contains sediments, plankton or high concentrations of chlorophyll. As the wavelength increase by more than 0.7 µm, the reflectivity of the water decreases, that is, the absorption of radiation increases. In the blue part of the visible wavelengths, the water has the highest reflectivity while water has a higher absorption of near infrared rays (NIR), and appears completely black [11]. The reflectivity of soil depends on its components, where the reflectivity of dry soil is higher than that of wet soil because of the lower water content of dry soil. The reflectivity increases with increasing wavelength as there is higher reflectivity within the (SWIR) band and lower reflectivity within the red band. There are two factors that influence soil reflectivity, surface roughness and organic matter content [12]. The diversity in the building material has led to a variation in the spectral reflectivity of urbanization. The spectral reflectivity decreases in the infrared region at the same time, the absorption of red ray decreases and the reflectivity increases in the green area. Spectral interference often occurs in urban areas that contain surrounding plants. Often there is an overlap between the spectral reflectivity of urbanization with the spectral reflectivity of the rocky soil, because the spectral reflectivity of the two is similar, as rocks are an essential component of buildings [13,14].The main purpose of the research was to explore how different spectral indices affected the outcomes. These indices were created using satellite photos from 1999 to 2021, and analysis yielded change results for each of the time periods studied, displaying the size and type of changes. Using supervised classification, the best combination for identifying land cover changes in the research area was established [15].They were able to establish and quantify variation in land cover categories by comparing the land cover maps in space [16].

Study area

The current research area is located in Baghdad, Iraq's capital and most important administrative center. Baghdad is in the heart of Iraq, on both sides of the Tigris River, with latitude 33.452°N to 33.184°N and longitude 44.189°E to 44.576°E. Baghdad is Iraq's largest and most densely populated city. The highest point in the capital is 48 meters high. The one in the capital's south is 23 meters above the water level [17,18].Baghdad's population has nearly doubled in the last decade (8,780,422). The Tigris River divides the town into two sections: Karkh (west) and Rusafa (east) The Diyala watercourse extends across the eastern region, connecting the Tigris River to Baghdad's southwest [13,19].

Figure 1: Map of Baghdad capital of Iraq.

Materials and Methods

Satellite Imagery Acquisition

Data processing was done based on the nature of the data and needed to improve the distorted image data. To produce a clear model of the original Landsat 5 and Landsat 8 images, the image data was corrected using ArcGIS software version 10.4, this has resulted in development in the information to extract land cover information from remote sensor data ,Landsat satellite image were used in our research because of their free cost, especially in relation to the region covered. Another benefit of Landsat image is that they are copyrighted, allowing for legal sharing. data sharing across government departments, universities, and philanthropic organizations. There are two different sorts of satellite images.Landsat-5 TM satellite image (15/4/1999),(22/4/1999) and (6/9/1999),(13/9/1999), and Landsat-8 OLI satellite image (2/4/2021),(11/4/2021) and (1/8/2021),(8/8/2021) with (Path 168/ Row 37). The satellite image utilized in this study came from the USGS Earth Explorer database [14].

Table 1: Information about the data that was utilized

ID	Satellite Image	Sensor	Path/Row	Acquisition Data	Source
1	Landsat-5	Thematic Mapper (TM)	168/37	15/4/1999 22/4/1999 6/9/1999 13/9/1999	USGS Earth Explorer Database
2	Landsat-8	Operational Land Image (OLI)	168/37	2/4/2021 11/4/2021 1/8/2021 8/8/2021	USGS Earth Explorer Database

Pre-processing Satellite Image and Land Cover Classification.

In this study, ArcGIS v10.4 was employed, and the satellite data was loaded into ArcGIS v10.4. The resulting data was clipped to define the research region. The land was implemented using supervised classification, which is based on the probabilities of pixels. [1,13,14] The study defines four different forms of land cover: (i)vegetation land (ii) water bodies (iii) soil, and (iv) Built up [20]. As the ultimate goal of these operations, classification is the most critical stage in digital image processing .After changes, information is extracted from the image, which can be characterized as an organizational way of aggregating comparable categories, or the process of transforming the image into an objective map containing similar categories .information on the phenomena in the categorized area [21] , where the pixels are divided into groups or categories These pixels are divided into categories based on their digital number spectrum standards [16]. analyzing spatial images Landsat 8 and Landsat 5 bands (7,5,3) and (7,4,2), respectively, were employed to identify changes in land cover. [22] see table (2).

Table 2: Bands that are utilized to create classification maps [22]

Landsat 5 (TM sensor)	Wavelength (µm)	Resolution (m)
Band 7	2.08-2.35	30
Band 4	0.76-0.90	30
Band 2	0.52-0.60	30
Landsat 8 (OLI and sensor TIRS)	**Wavelength (µm)**	**Resolution (m)**
Band 7	2.11-2.29	30
Band 5	0.77-0.90	30
Band 3	0.53-0.59	30

Spectral Indices

To avoid any overlap between land cover types that exhibit close spectral reflectivity values, various spectral indices have been utilized to identify the dominant land cover patterns in the study.

Normalized Difference Vegetation Index (NDVI)

It is the most accurate way of digital processing of satellite pictures in the display of vegetation for diagnosing, detecting, and removing the condition of overlap between the vegetation class and other types of land coverings, which are often overlapping. It is based on the fact that plants reflect light well .Low reflectivity in the near-infrared wavelength range and high reflectivity in the red wavelength range. It denotes the proportion of on a total basis, the difference between spectral reflections at near-infrared and red wavelengths is as shown in the following equation [21];

$$NDVI = (NIR - red) / (NIR + red) \quad \ldots\ldots (1)$$

Where; red is a red band,
NIR is a near infrared band

Normalized Difference water Index (NDWI)

McFeeters first suggested the NDWI in 1996 to detect surface waters in wetland environments and to enable for the determination of surface water extent [20]. The NDWI is calculated using Equation:

$$NDWI = (green - NIR) / (green + NIR) \quad \ldots\ldots (2)$$

Where; green is a green band,
NIR is a near infrared band.

Soil Adjusted Vegetation Index (SAVI)

Huete created it in the late 1980s at the University of Arizona in the United States. The goal was to create a global model for monitoring soil and determining vegetation variance using remotely sensed data. It's comparable to the NDVI, but with an adjustment factor (L) added, and its value can range from 1.0 to 2.0.It is represented by the for low vegetation densities, 0.5 for intermediate values, and 0.25 for high densities [21]. The SAVI is calculated using Equation:

$$SAVI = (NIR - red) / (NIR + red + L) . (1 + L) \quad \ldots\ldots (3)$$

Where;
If L = 0 the NDVI = SAVI
red is a red band,
NIR is a near infrared band.

Normalized Difference Built up Index (NDBI)

It represents the proportion of spectral reflectance differences that are different. The NDBI is used to extract the built-in features. It has a number of indications ranging from (-1 to 1), with negative values signifying water bodies and positive values indicating development zones [18]. Equation was used to determine the NDBI.

$$NDBI = (Blue - NIR) / (Blue + NIR) \quad \ldots\ldots (4)$$

Where;
Blue is a blue band,
NIR is a near infrared band.

Results and Discussion

The earth's surface features widespread in the research area were diagnosed and identified using four spectral indices: NDVI, NDWI, SAVI, and NDBI. At first, we pre-processing the satellite images:

Mosaic Image

A mosaic tool is a link or merger of two or more images. In ArcGIS Version 10.4, through this tool, a single raster dataset from multiple raster datasets. It can be created by mosaicking them with each other. This tool is used to include all parts of the province of Baghdad, using ground markers in the areas of the installation between neighboring images.

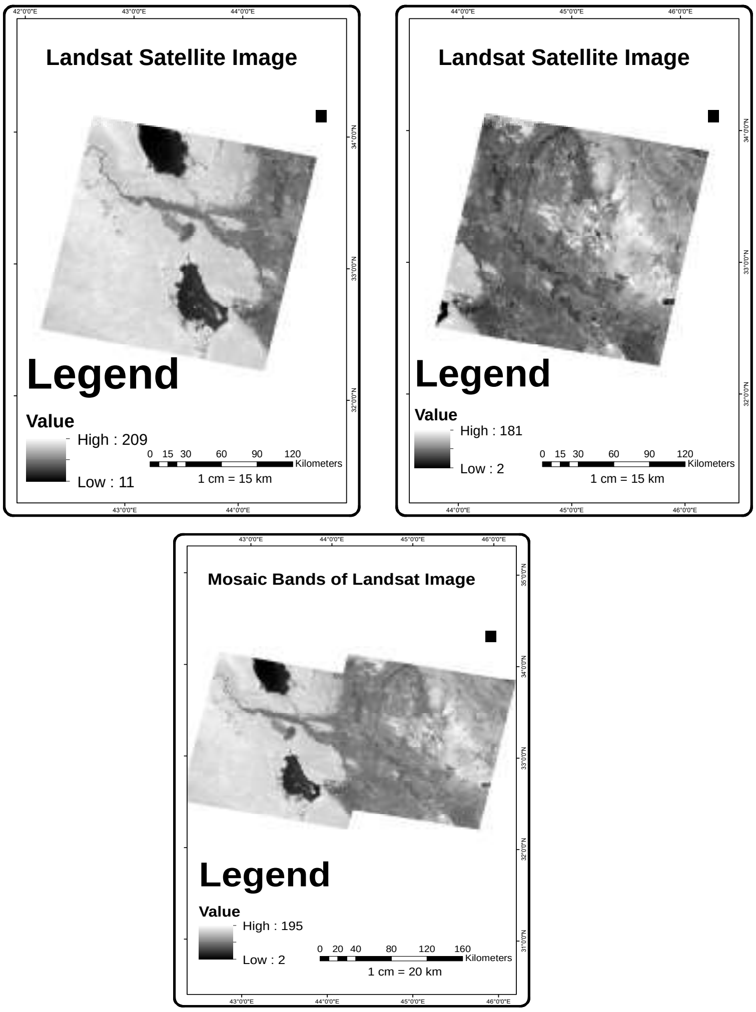


Figure 2: The mosaic bands of Landsat images processing.

Extraction of The Study Area

The extraction tool is used to cut off parts of the Landsat image that forms the study area. thus, the image extraction increases the accuracy of the work.

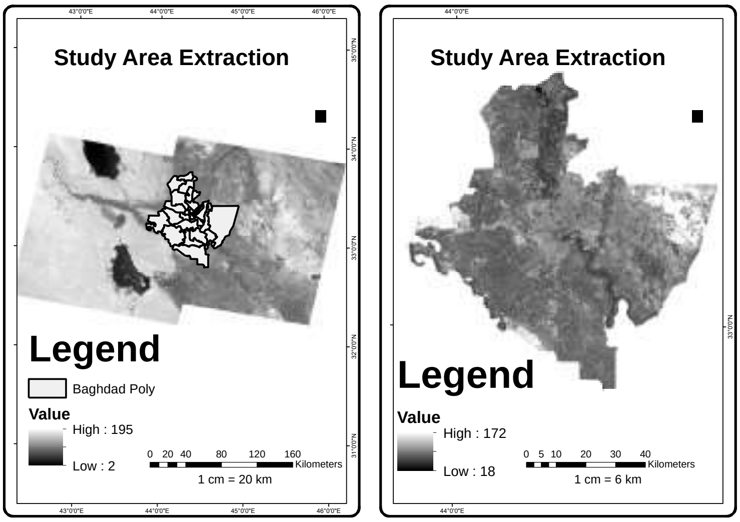


Figure 3: The Extraction of study area of landsat image.

Composite Bands

Because satellite images for a specific region are collected in black and white bands, a composite picture is created by combining information from two or more bands to convert a greyscale image to an RGB image. shown as a Red, Green, and Blue image, the comparison of spectral properties of land features in various bands (color composites) .

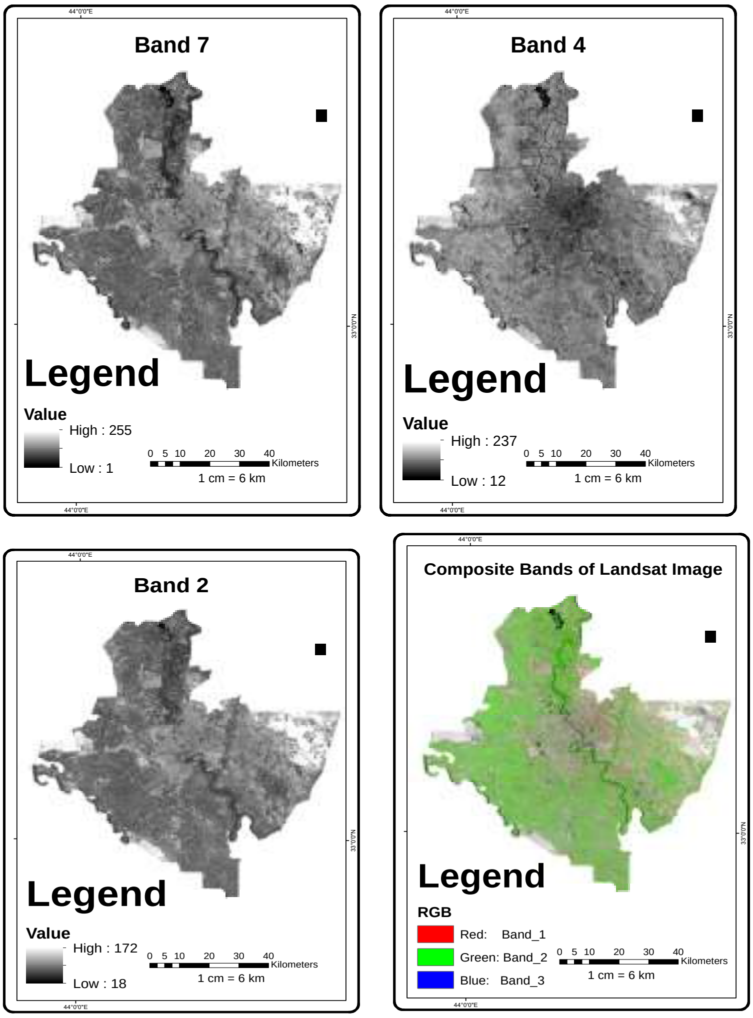


Figure 4: Composite Bands of Landsat Satellite Images.

Supervised Classification

Supervised classification is the kind of machine learning in which training Samples is specified and based on training samples the classification process is applied. In remote sensing, classification process is the most widely used classification algorithm. The most effective part of the supervised Landsat image classification technique is the training sample, the classification accuracy is highly dependent on the samples chosen for training. After completing this process, the output image is classified according to each class.

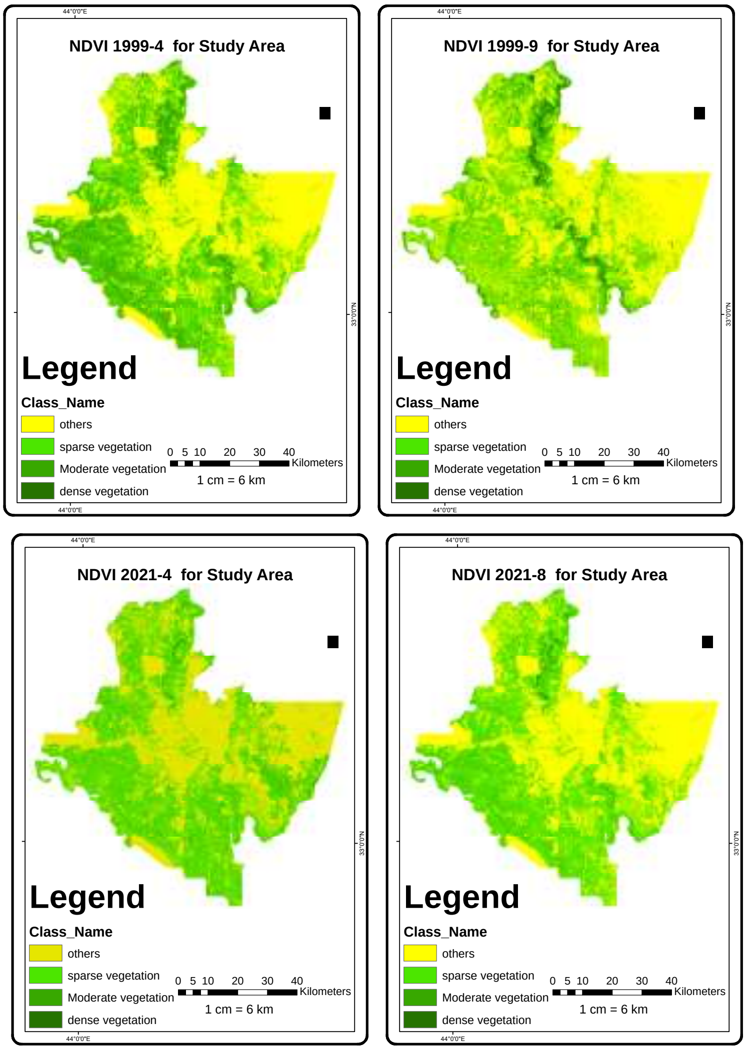


Figure 5: Supervised Classification for NDVI of Landsat images

Table 3: The value of NDVI for Landsat images

Land cover	Years	Area in km^2
Sparse vegetation	1999-4	2542.3
Moderate vegetation		1747.3
Dense vegetation		925
Sparse vegetation	1999-9	2895.2
Moderate vegetation		1928.7
Dense vegetation		390.8
Sparse vegetation	2021-4	2473.3
Moderate vegetation		2498.6
Dense vegetation		242.7
Sparse vegetation	2021-8	2577.9
Moderate vegetation		2514.5
Dense vegetation		122.2

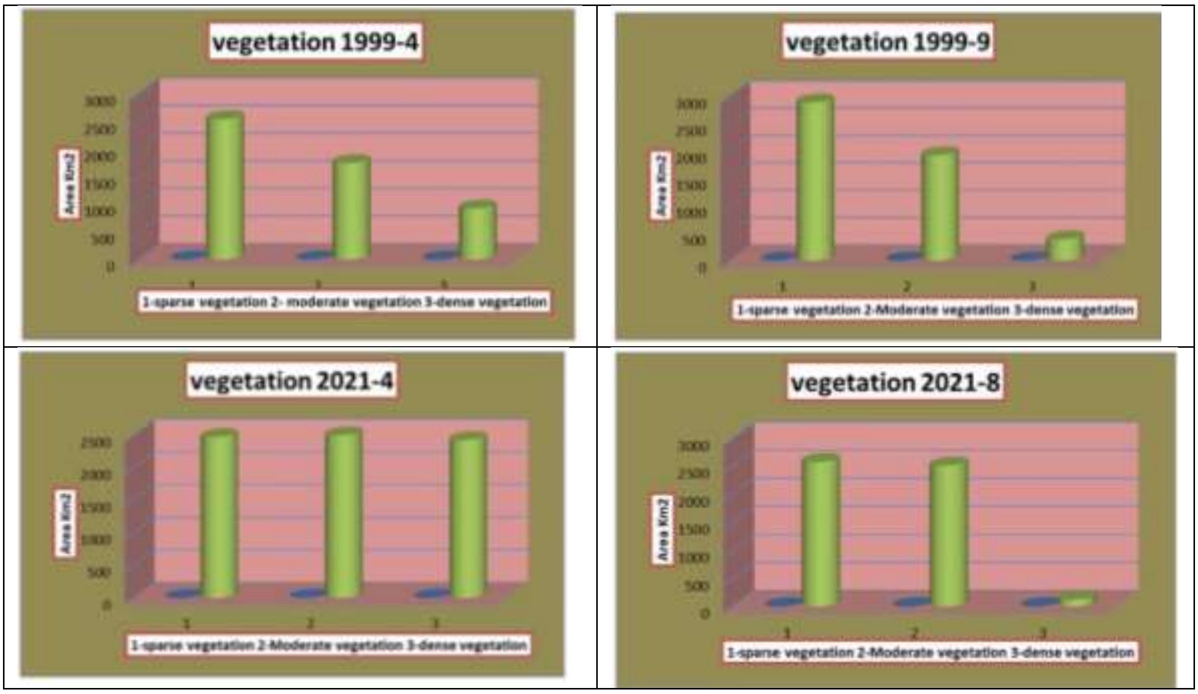
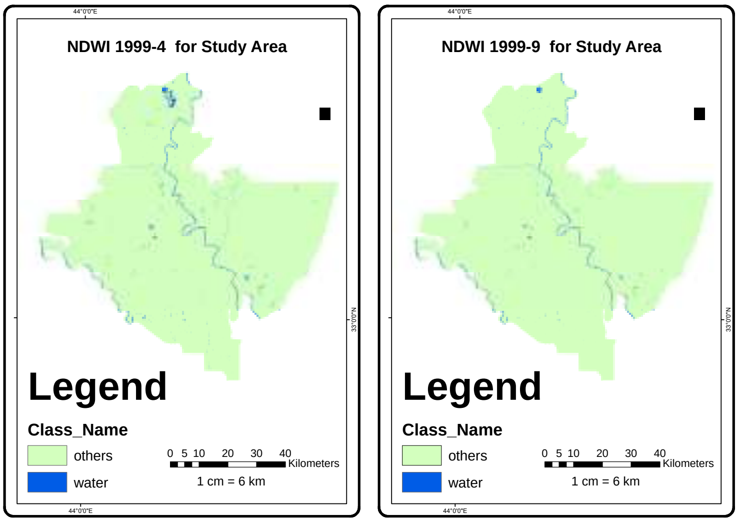


Figure 6: variation of NDVI area.

During the study period, , the number of changes in vegetation areas between 1999And 2021 for the months of April, the growing season, and August, the dry season, was as follows: sparse vegetation and Moderate vegetation were in a state of decrease during the month of April and increase in the month of August, while dense plants were in a state of increase during the month of April and decreased in August. This change can be referred to several reasons, including the of rain, human activity, overgrazing, migration of agricultural lands, and the conversion of many agricultural lands to buildings.



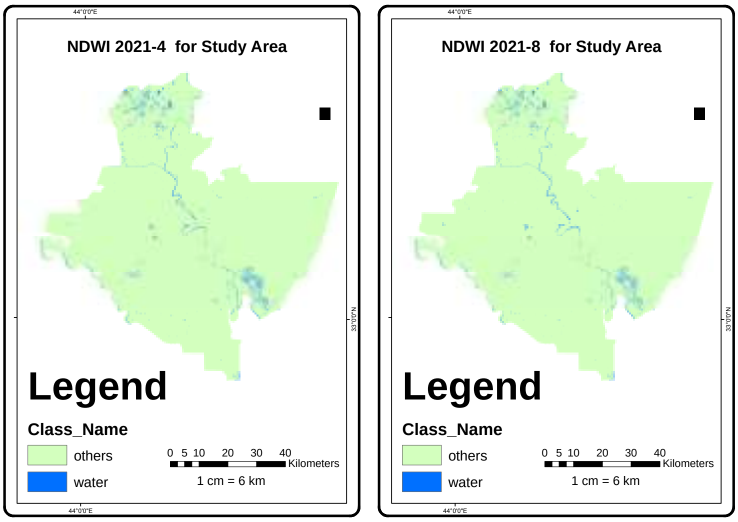


Figure 7: Supervised Classification for NDWI of Landsat image.

Table 4: The value of NDWI for Landsat images

Land cover	Years	Area in km^2
water	1999-4	75.3
	1999-9	51.9
	2021-4	83.4
	2021-8	73.2

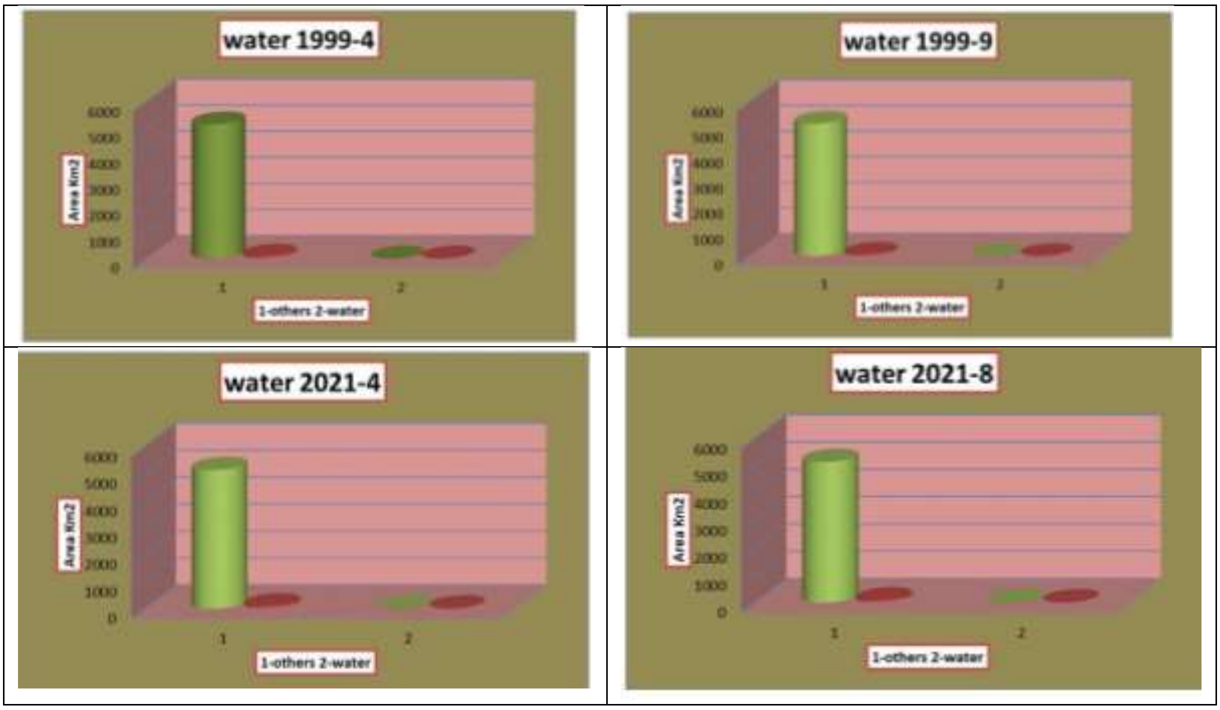


Figure 8: Variation of NDWI area.

By analyzing satellite images and calculating water areas inside the city of Baghdad during the study years of 1999, 2021during month April the growth season and month August the dry season we clearly view a decrease in water bodies in the years 1999,2021 during August the dry season and it increasing for 1999,2021 during April the growth season .These changes in water bodies for the month of April increase and decrease for the month August They the result of the main factor, which is the rate of precipitation.

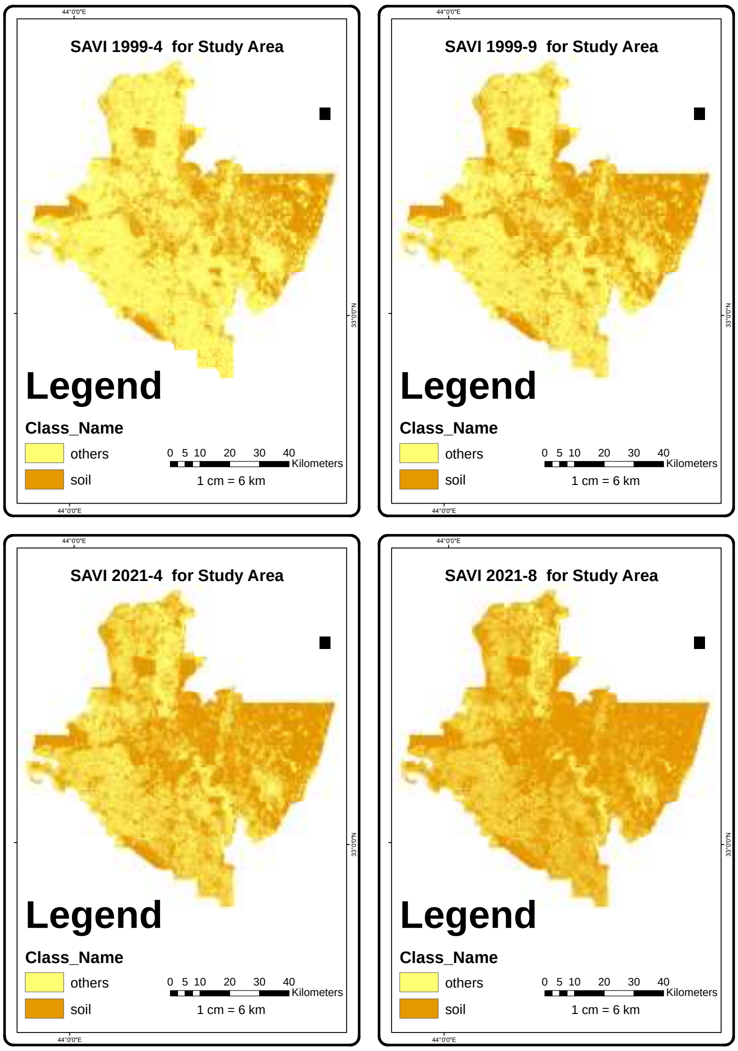


Figure 9: Supervised classification for SAVI of Landsat images.

Table 5: The value of SAVI for Landsat images

Land cover	Years	Area in km^2
Soil	1999-4	1692.9
	1999-9	2239.1
	2021-4	3016.3
	2021-8	3702.3

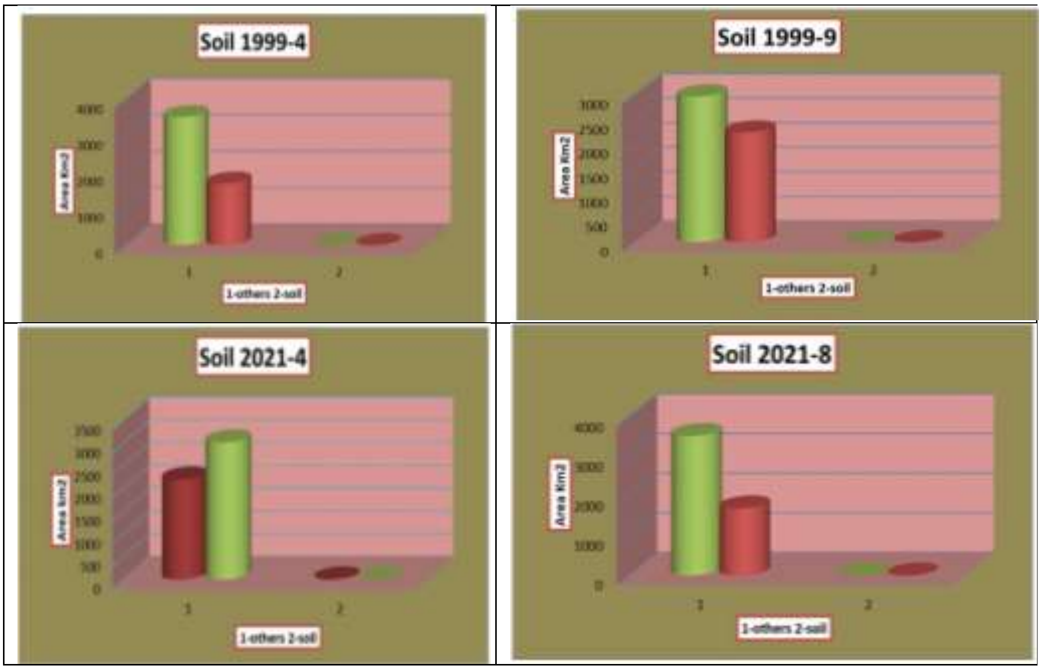


Figure 10: Variation of SAVI area.

The soil in August is larger than it was in April., and the reason is the wide area of barren soil caused by land degradation probably due to economic, safety and other problems that led to leave the ground unattended.

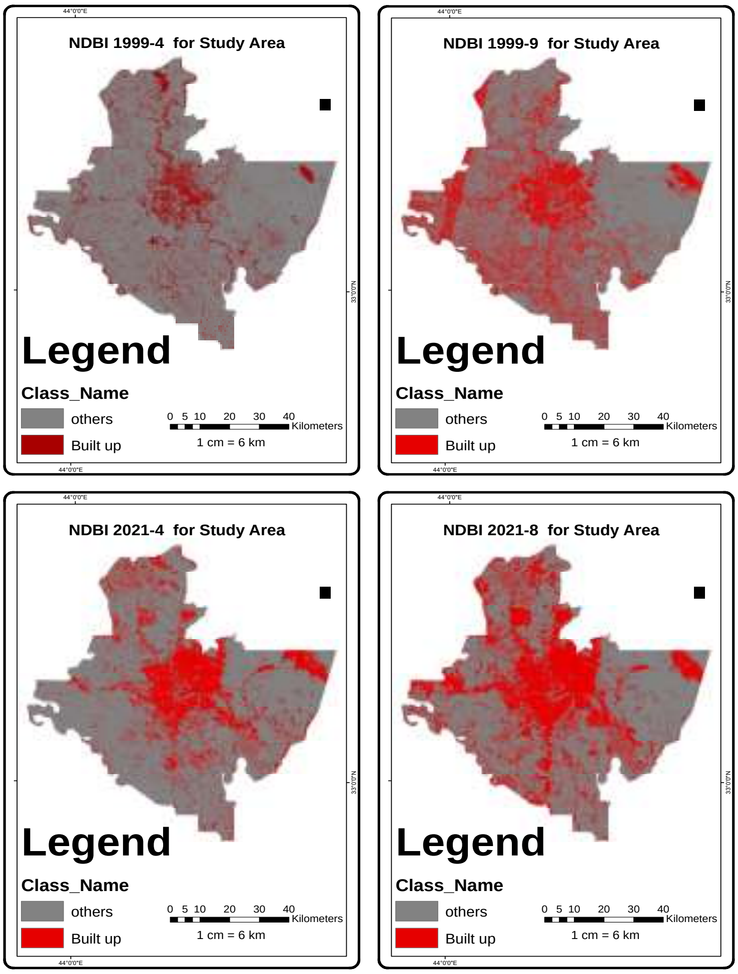


Figure 11: Supervised classification for NDBI of Landsat images.

Table 6: The value of NDBI for Landsat images.

Land cover	Years	Area in km^2
Built up	1999-4	782.1
	1999-9	1495.7
	2021-4	1263.3
	2021-8	1882.2

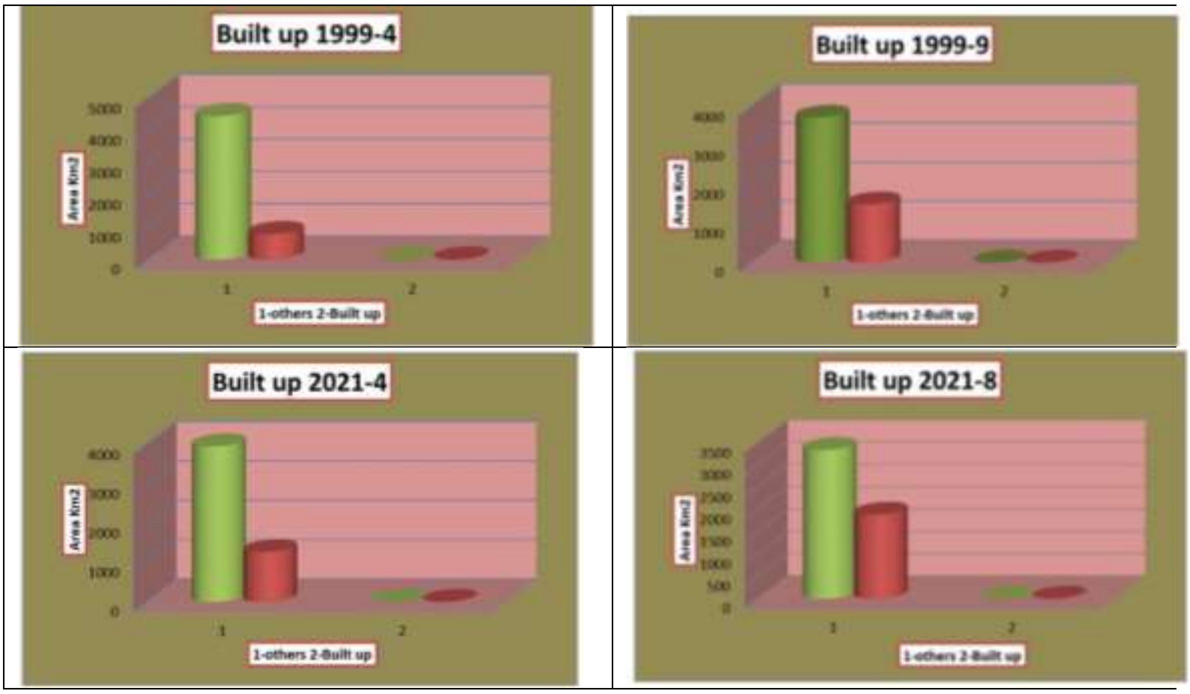


Figure 12: Variation of NDBI area.

There is continuous increase in the built-up category was verified during the study period . most of this increase was observed in 2021 in August where reached (1882.2 km^2). these results corresponded significantly to the reality of the annual rate of population increase in the Baghdad Province, where variation was observed from time to time may be due to human economic conditions successively affecting Iraq during the study period, which had a major effect on urban expansion in a study area.

CONCLUSION

In this study, the effect of changing LC was analyzed using a statistical approach, through the analysis of satellite images of Landsat 5 and 8. The method of detecting and recognizing changes in land cover is critical for tracking changes and developments in land cover and analyzing the factors that influence them. during through satellite images analysis ,between (1999 -2021), there were significant changes in land cover area, including changes in vegetation and water as well as soil and Built up, The results showed that the area of plants and water during the growing month in 1999-4 and 2021-4 is greater than the area during the dry month in 1999-9 and 2021-8, The area of dense vegetation reached 925km^2 in 1999-4, decreased to 390.8 km^2 in 1999-9, reached 242.7 km^2 in 2021-4, and decreased to 122.7 km^2 in 2021-8. The water area reached 75.3 km^2 in 1999-4, decreased to 51.9 km^2 in 1999-9, and reached 83.4 km^2 in 2021-4, decreased to 73.2 km^2 in 2021-8. As for the soil and Built up, we notice that their area decreased during the growth month in 1999-4 and 2021-4, and increased during the dry month 1999-9 and 2021-8. After reaching 1692.9 km2 in 1999-4, the soil area increased to 2239.1 km2 in 1999-9, 3016.3 km2 in 2021-4, and 3702.3 km2 in 2021-8.

The Built up reached 782.1km^2 in1999-4, increased to1495.7 km^2 in 1999-9, and reached to 1263.3 km^2 in 2021-4 increased to 1882.2 km^2 in 2021-8.

We note through the above results that plants and water bodies during the growth period are in a state of increase and buildings and soil are in a state of decrease, but during the drought period we notice a decrease in plants and water bodies and an increase in buildings and soil.

most of the changes in LC were due to human activities, and the most prominent changes in LC were due to urban expansion on agricultural lands continuously in all years that resulted from land degradation. This change can be referred to several reasons, including the of, human activity, overgrazing, migration of agricultural lands, and the conversion of many agricultural lands to buildings. where variation was observed from time to time may be due to human economic conditions successively affecting Iraq during the study period, which had a major effect on urban expansion in a study area.

References

[1] R. A. Pielke *et al.*, “Land use/land cover changes and climate: Modeling analysis and observational evidence,” *Wiley Interdiscip. Rev. Clim. Chang.*, vol. 2, no. 6, pp. 828–850, 2011, doi: 10.1002/wcc.144.

[2] F. K. Mashee, A. A. Zaeen, and G. S. Hadi, “Monitoring Vegetation Growth of Spectrally Landsat Satellite Imagery ETM + 7 & TM 5 for Western Region of Iraq by Using Remote Sensing,” *Iraqi J. Sci.*, vol. 53, no. 4, pp. 1162–1166, 2012.

[3] E. A. Mohammed, Z. Y. Hani, and G. Q. Kadhim, “Assessing land cover/use changes in Karbala city (Iraq) using GIS techniques and remote sensing data,” *J. Phys. Conf. Ser.*, vol. 1032, no. 1, 2018, doi: 10.1088/1742-6596/1032/1/012047.

[4] Z. K. I. A. B. Fouad K. Mashee Al Ramahi, “Estimation of Suaeda aegyptiaca Plant distribution regions at Iraq using RS & GIS Applications,” *Iraqi J. Sci.*, vol. 58, no. 2A, pp. 767–777, 2017.

[5] H. M. Abduljabbar, “Satellite Images Fusion Using Modified PCA Substitution Method,” *Ibn AL-Haitham J. Pure Appl. Sci.*, vol. 30, no. 1, pp. 29–37, 2017.

[6] A. J. Abdalkadhum, M. M. Salih, and O. Z. Jasim, “The Correlation Among Land Cover Spectral Indices and Surface Temperature Using Remote Sensing Techniques,” *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 1090, no. 1, p. 012024, 2021, doi: 10.1088/1757-899x/1090/1/012024.

[7] F. H. M. and F. K. M. Israa J.Muhsin, “Multi Spectral Scanner ‘MSS’ and Panchromatic Components Difference of Al- Haditha Dam Region Using GIS and Remote Sensing Techniques,” *Al- Mustansiriyah J. Sci*, vol. 23, no. 6, pp. 233–242, 2012.

[8] J. Rogan and D. M. Chen, “Remote sensing technology for mapping and monitoring land-cover and land-use change,” *Prog. Plann.*, vol. 61, no. 4, pp. 301–325, 2004, doi: 10.1016/S0305-9006(03)00066-7.

[9] A. Orych, P. Walczykowski, A. Jenerowicz, and Z. Zdunek, “Impact of the cameras radiometric resolution on the accuracy of determining spectral reflectance coefficients,” *Int. Arch. Photogramm. Remote Sens. Spat. Inf. Sci. - ISPRS Arch.*, vol. 40, no. 1, pp. 347–349, 2014, doi: 10.5194/isprsarchives-XL-1-347-2014.

[10] E. Dyring, “Principles of Remote Sensing.,” *Ambio*, vol. 11, no. 3, pp. 57–69, 1973, doi: 10.4324/9780203714522-9.

[11] R. G. Congalton, *Remote Sensing and Image Interpretation. 7th Edition*, vol. 81, no. 8. 2015.

[12] D. E. Bowker, R. E. Davis, D. L. Myrick, K. Stacy, and W. T. Jones, “Spectral Reflectances of Natural Targets for Use in Remote Sensing Studies.,” *NASA Ref. Publ.*, 1985.

[13] A. K. Mohammed Ali and F. K. Mashee Al Ramahi, “A study of the effect of urbanization on annual evaporation rates in Baghdad city using remote sensing,” *Iraqi J. Sci.*, vol. 61, no. 8, pp. 2142–2149, 2020, doi: 10.24996/ijs.2020.61.8.29.

[14] Z. A. Abdullah and H. M. Abduljabbar, “The water bodies in the Southern East of Iraq before and after 2018,” *AIP Conf. Proc.*, vol. 2307, 2020, doi: 10.1063/5.0033124.

[15] C. Polykretis, M. G. Grillakis, and D. D. Alexakis, “Exploring the impact of various spectral indices on land cover change detection using change vector analysis: A case study of Crete Island, Greece," *Remote Sens.*, vol. 12, no. 2, 2020, doi: 10.3390/rs12020319.

[16] M. M. El-Hattab, "Applying post classification change detection technique to monitor an Egyptian coastal zone (Abu Qir Bay)," *Egypt. J. Remote Sens. Sp. Sci.*, vol. 19, no. 1, pp. 23–36, 2016, doi: 10.1016/j.ejrs.2016.02.002.

[17] A. Mohammed Ali and F. Mashee Al Ramahi, "The Study Air temperature Annual Rates Effect for Urban of Baghdad City by Using Remote Sensing Data Techniques," *Eng. Technol. J.*, vol. 38, no. 2B, pp. 66–73, 2020, doi: 10.30684/etj.v38i2b.532.

[18] Y. C. Bukheet, B. Q. Al-Abudi, and M. S. Mahdi, "Land Cover Change Detection of Baghdad City Using Multi-Spectral Remote Sensing Imagery," *Iraqi J. Sci.*, no. 0067–2904, pp. 195–214, 2018.

[19] F. K. M. A. R. A.-R. B. A. Ali K. Mohammed Ali, "Evaluation of impact of vegetation decrease on precipitation rates in Baghdad City using remote sensing technique," *Biotechnol. Environ. Sci. Eco. Env. Cons*, vol. 25, no. November, pp. S44–S50, 2019, doi: 10.13140/RG.2.2.14171.11046.

[20] S. K. McFeeters, "Using the normalized difference water index (ndwi) within a geographic information system to detect swimming pools for mosquito abatement: A practical approach," *Remote Sens.*, vol. 5, no. 7, pp. 3544–3561, 2013, doi: 10.3390/rs5073544.

[21] F. K. M. S. N. K. Abdulrahman B. A, "Study Spectral Indices of Land Cover Around Al-Shari Lake and Produce Mapping by Using Remote Sensing Technique," *Indian J. Nat. Sci.*, vol. 8, no. 49, pp. 14215–14224, 2018.

[22] F. K. Mashee and G. S. Hadi, "Study the Wet Region in Anbar Province by Use Remote Sensing (RS) and Geographic Information System (GIS) Techniques," *Iraqi J. Sci.*, vol. 58, no. 3A, pp. 1333–1344, 2017, doi: 10.24996/ijs.2017.58.3a.18.