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Assessment of Land Use and Land Cover Variations on Surface Temperature in Nasiriya City Using RS & GIS

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Abstract
Nasiriya City in Dhi Qar Province has undergone remarkable development in land use over the years, influenced by various economic and social transformations. The current study aims to analyze changes in Land-Use/Land-Cover (LULC), calculate the Normalized Difference Vegetation Index (NDVI) and Normalized Difference Water Index (NDWI) indices, and land surface temperature (LST) for the years 1990, 2000, 2013, and 2024, using ArcGIS 10.8 with Landsat-5 TM and Landsat-8 OLI images. The results showed that the highest NDVI value for Nasiriya city was 0.48 in 1990, while the highest value in 2024 was 0.49. The urban areas in Nasiriya significantly expanded between 1990 and 2024, growing from roughly 21 km² to 60 km². On the other hand, water areas decreased from 133 km² in 1990 to 99 km² in 2024 due to changes in land use, pollution, human activity, and the draining of marshes at the end of the 20th century. The findings show that the LST values increased from 22.8°C in 1990 to 39.4°C in 2024, indicating that the LULC categories changed during the study period. The study results emphasize the importance of implementing sustainable development ideas that balance environmental protection, conservation of natural resources, and urban growth.

Keywords: *LULC; NDVI; NDWI; LST; Landsat; Nasiriya district*

تقييم التغيرات في استخدامات الأراضي والغطاء الأرضي على درجة حرارة السطح في مدينة الناصرية باستخدام صور لاندسات

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الخلاصة
شهدت مدينة الناصرية بمحافظة ذي قار تطورًا ملحوظًا في استخدامات الأراضي على مر السنين، متأثرةً بالتحولات الاقتصادية والاجتماعية المتنوعة في المنطقة. تهدف الدراسة الحالية إلى تحليل التغيرات في استخدامات الأراضي والغطاء الأرضي(LULC) ، وحساب مؤشر الغطاء النباتي(NDVI) ، ومؤشر المياه

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(NDWI)، ودرجة حرارة سطح الأرض (LST) خلال الأعوام 1990، 2000، 2013، و2024، باستخدام صور الأقمار الصناعية Landsat 5 TM و Landsat 8 OLI.أظهرت النتائج ان اعلى قيمة لمؤشر NDVI لمدينة الناصرية سنة 1990 هي ٠.٤٨ بينما كانت اعلى قيمة لسنة ٢٠٢٤ هي ٠.٤٩ وكان هناك توسعًا ملحوظًا في المناطق الحضرية في الناصرية بين عامي 1990 و2024، حيث نمت مساحتها من حوالي 21 كيلومترًا مربعًا إلى 60 كيلومترًا مربعًا. من ناحية أخرى، انخفضت مساحة المياه من 133 كيلومترًا مربعًا عام 1990 إلى 99 كيلومترًا مربعًا عام 2024 نتيجةً للتغيرات في استخدام الأراضي، والتلوث، والنشاط البشري، وتجفيف المستنقعات في نهاية القرن العشرين. وأظهرت النتائج ارتفاعًا واضحًا في قيم مستوى حرارة سطح الارض من 22.8 درجة مئوية عام 1990 إلى 39.4 درجة مئوية عام 2024، وهو ما يعكس تغير فئات استخدام الأراضي وتملكها خلال فترة الدراسة. وتؤكد نتائج الدراسة على أهمية تطبيق مفاهيم التنمية المستدامة التي تحقق التوازن بين حماية البيئة والموارد الطبيعية والنمو الحضري.

1. Introduction

The environment is vulnerable to many serious threats that affect its security and stability worldwide. Climate change and air pollution have become significant issues in both developed and developing countries in recent years. Dhi Qar is one of Iraq's southern provinces, and Nasiriyah is its administrative capital [1]. Due to its strategic and commercial location, the city was once a part of a historical region rich in culture and history. Urbanization has a major effect on the environment and is one of the primary drivers of changes in land cover. Remote sensing and Geographic Information System (GIS) techniques have become indispensable tools for monitoring changes in land use and land cover (LULC) [2]. The city's infrastructure and services are expanding, boasting some landmarks representing Iraqi traditional history. One of the cities that makes a major contribution to agriculture and livestock is the Nasiriya district. In order to estimate urban expansion in Nasiriya, the current study uses remote sensing techniques, such as Landsat images, to investigate the relationship between LULC categories. NASA and the U.S. Geological Survey jointly oversee a series of Earth-observing satellite missions known as the Landsat Program. In collaboration with NASA, the Earth Resources Technology Satellite (ERTS-1) was launched on July 23, 1972. Later, it was designated as Landsat 1. To provide the world with a library of remote sensing data, more Landsat satellites have been launched. Landsat 8 and Landsat 9 are currently in orbit and operational. To effectively track land use and document land changes resulting from climate change, urbanization, drought, wildfires, biomass changes (carbon assessments), and various other natural and artificial factors, Landsat satellites offer the best ground resolution and spectral bands [3]. Knowledge of how urban growth affects the city's vegetation cover and land use resources is necessary for making informed decisions about urban planning and environmental protection.[4]. Iraq is one of the nations most at risk from the economic and physical consequences of climate change [5]. Iraq is among the five nations most impacted by the dangers of drought, desertification, high temperatures, and little precipitation. Addressing concerns like climate change, global warming, environmental degradation, unchecked urbanization, and LULC shifts is becoming more and more difficult. The effects of climate change are already being felt. The Middle East and North Africa (MENA) are experiencing the harshest effects of climate change. The MENA area has become one of the world's hotspots for worsening extreme heat, drought, and aridity due to climate change [6]. The Normalized Difference Vegetation Index (NDVI) shows the amount of vegetation and its growth in a particular area. Lakes, rivers, and other bodies of water are described and examined using the Normalized Difference Water Index (NDWI) [7]. Iraq faces significant LULC challenges as a result of urbanization and climate change. Iraq is facing the consequences of climate change, including rising temperatures, dwindling water supplies, and altered precipitation patterns [8]. In megacities like Baghdad and Basra, Iraq's urban expansion has led to the conversion of agricultural land into urban areas, resulting in a reduction of green spaces and degradation of vegetation cover [9][10]. The temperature at which the "surface" of the Earth would feel hot to the touch in a specific place is known as the land surface temperature. A satellite view is considered the "surface" from its perspective when it looks down through the atmosphere. It might be ice and snow, lawn grass, a building's roof, or the leaves in a forest canopy. The air temperature in the daily weather report differs from the land surface temperature because surfaces absorb and store heat more efficiently than air. Materials such as concrete and asphalt also raise the land surface temperature, and the absence of vegetation increases the temperature of the land [11]. Numerous studies ha**ve** examined and observed urban growth and analyzed the LULC in wetlands using the Landsat series. Saud et al. (2023) [12] used GIS and remote sensing methods to study LULC in Al Hillah City. According to the results, the urban area expanded by 20.5 km between 1990 and 2022, with changes in water and agricultural land. Al Bayaty et al. (2024) [13] used GIS to identify and evaluate LULC changes in certain Euphrates River Riparian areas. The study aims to assess and identify changes in Land Use/Land Cover (LULC) in the major Euphrates basin regions of central Iraq from 1985 to 2022. According to statistics, the percentage of vegetative lands increased by 4.8% between 1985 and 1999, particularly in orchards, palm trees, and fruit plantations, while it declined by 12.88% in 2022. Al Zamili et al. [20], who used remote sensing to gain insight into understanding urban expansion and inform subsequent infrastructure planning and management, evaluated the urban area of Nasiriya city between 1989 and 2014 and forecasted its likely future growth. El Naggar et al. [21] precisely evaluated the agricultural lands of the Babil governorate from 1985 to 2015. Based on the three investigated vegetation indices (NDVI, TNDVI, and SAVI), the results showed a considerable decline in agricultural areas in the analyzed area between 1985 and 2015. Al-Aarajy et al. studied LST in Babylon City. The results showed a substantial change in temperature and concentration in different parts of Babylon between 2002 and 2022, as well as a correlation between LST and NDVI. The growth of urbanization in Babylon, at the expense of vegetation and unused land, is the primary factor causing a shift in the LST [22]. Ghodieh (2024) [27] found a similar result when studying the relationship between NDVI and LST in the West Bank, Palestine. On the other hand, the results showed a weak positive correlation between NDWI and LST values for all study years except 2013. The dominant relationship between the two variables is negative, while the positive relationship only appears under exceptional conditions, such as shallow and turbid water. Zhang et al. (2022) [29] reached a similar result in their study in China. The objectives of the current study are to utilize Landsat 5 TM and Landsat 8 OLI images from 1990, 2000, 2013, and 2024 to analyze changes in NDVI, NDWI, LULC, and LST, thereby evaluating urban expansion in the Nasiriya district [14]. The city of Nasiriya is the focus of this study, as it has not been extensively studied in prior research on vegetation cover (NDVI), surface water (NDWI), LST values, and LULC categorization. In addition to highlighting the effects of urban growth in the arid climate of Nasiriyah, this study employs RS and GIS techniques to analyze data over a multi-year period, thereby endowing its findings with a dynamic dimension that many earlier studies in land use analysis lack.

2. Materials and Methods

2.1 Study Area

2.1 Study Area

The city of Nasiriya, located in Dhi Qar province, southern Iraq, near the ruins of the ancient city of Ur, is approximately 370 km southeast of Baghdad. It borders the study area. It is situated in southern Iraq between latitudes (31°) north and longitude (46°) east. Administratively, it shares borders with the provinces of Missan to the east, Muthanna and Dewaniya provinces to the west and northwest, Wasit to the north, and Basra to the south [15]. Nasiriya experiences mild winters and scorching summers due to its hot desert climate. The average annual temperature of Nasiriya is 25.0 °C, with a high of 32.3 °C and a low of 17.8 °C. According to the latest official census in 2018, Nasiriya has a population of 558,446 [16].

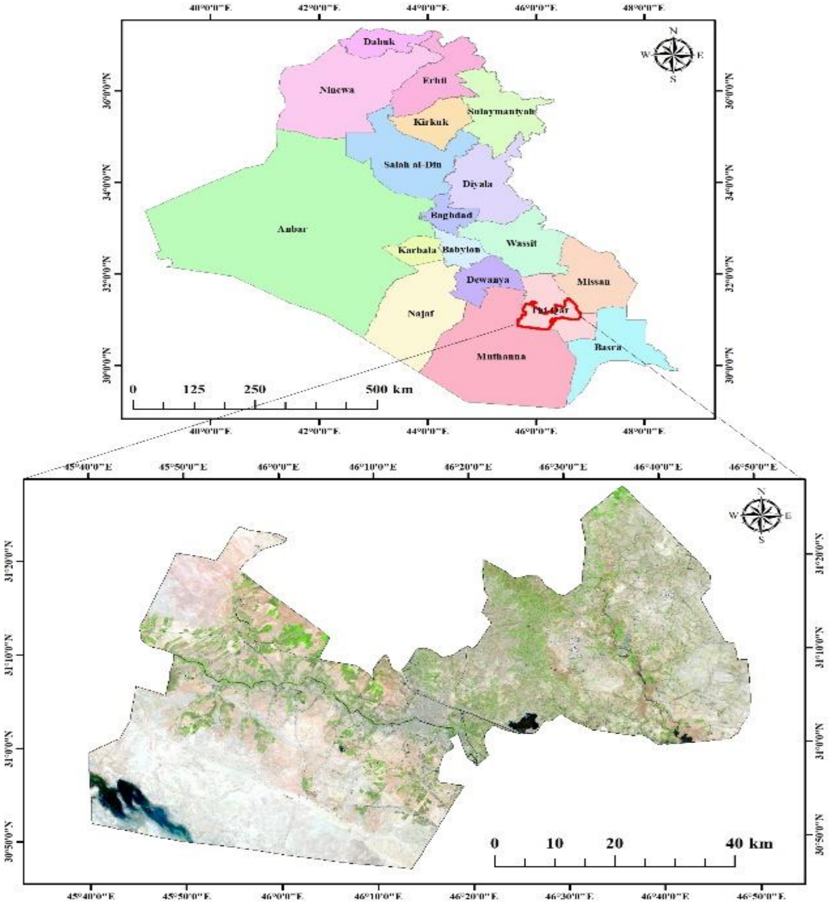

Figure 1: Nasiriya District's location inside the Dhi Qar province by Landsat 9-OLI2 image

2.2 Data Sources

Used Landsat 5 TM and Landsat 8 OLI imagery for Nasiriya during the clear, cloudless months of March and April. These images were taken from the US Geological Survey (www.earthexplorer.usgs.gov) [16]. Images captured by Landsat 5 TM on March 9, 2000, and March 14, 1990. On the other hand, Landsat 8 OLI images were taken on April 4, 2024, and April 14, 2013, respectively. These images have 28.5 m resolution bands to be consistent with Landsat 9 images. Tables 1 and 2 show the image bands for Landsat 5 TM, 8 OLI, and 9 OLI-2, respectively.

Table 1: Landsat5 TM bands details [4]

Band No.	Wavelength (μm)	Resolution (m)	Band details
1	0.45-0.52	30	Blue
2	0.52-0.60	30	Green
3	0.63-0.69	30	Red
4	0.77-0.90	30	NIR
5	1.55-1.75	30	MIR
6	10.40-12.5	120	Thermal
7	2.09-2.35	30	MIR

Table 2: Landsat 8 OLI and Landsat 9 OLI-2 TM bands details [6]

Band No.	Wavelength (μm)	Resolution (m)	Band details
1	0.43-0.45	30	Coastal
2	0.45-0.51	30	Blue
3	0.53-0.59	30	Green
4	0.63-0.67	30	Red
5	0.85-0.88	30	NIR
6	1.57-1.65	30	SWIR1
7	2.11-2.29	30	SWIR2
8	0.50-0.68	15	Pan
9	1.36-1.38	30	Cirrus
10	10.60-10.19	100	TIRS1
11	10.50-12.51	100	TIRS2

2.3 NDVI

Understanding vegetation density and evaluating changes in plant health are two benefits of using the NDVI to estimate vegetation greenness [17]. Traditionally, the NDVI is computed as a ratio of the red (R) and near-infrared (NIR) values [28]:

$$NDVI = \frac{(NIR - RED)}{(NIR + RED)} \tag{1}$$

NDVI is calculated as (Band 4 – Band 3) / (Band 4 + Band 3) in Landsat 4-7. NDVI is calculated as (Band 5 – Band 4) / (Band 5 + Band 4) in Landsat 8 and 9. [18]

2.4 NDWI

Changes in the water content of bodies of water are tracked using the NDWI. Water bodies are highlighted by NDWI using green and near-infrared bands because they absorb a significant amount of light in the visible-to-infrared portion of the electromagnetic spectrum [26]. It can lead to overestimating water bodies and is sensitive to the presence of built-up land. McFeeters (1996) proposed the index. Description of values: Index values larger than 0.5 often represent water bodies. Built-up areas often equate to values between 0 and 0.2, whereas vegetation typically corresponds to much smaller values [30].

NDWI is calculated using reflectance values in the green and near-infrared (NIR) bands of the electromagnetic spectrum [12]. The NDWI calculation formula in Eq. (2) is:

$$NDWI = \frac{(\mathrm{NIR} - \mathrm{SWIR})}{(\mathrm{NIR} + \mathrm{SWIR})} \tag{2}$$

2.5 Land Surface Temperature

LST maps for Nasiriya District for 1990, 2000, 2013, and 2024 were created by preprocessing thermal bands (Band 6) from Landsat 5 TM and (Band 10) from Landsat 8 OLI/TIRS using ArcGIS 10.8. Two steps were used to determine the LST from Band 6 in the Landsat TM 5 image. Using equation (3), the image's digital number (DN) was converted to spectral radiance in the first two steps. [19]:

$$L_\lambda - \frac{(DN - M_{in})}{M_{out} - M_{in}} \times (Q_{max} - Q_{min}) + Q_{min} \tag{3}$$

Where:
- L_λ= Radiance (W/m²·sr·µm)
- DN = Digital Number from the thermal infrared band
- M_{in}, M_{out}= Radiometric calibration constants
- Q_{max}, Q_{min} = Maximum and minimum radiance values

To convert this radiance to **brightness temperature (T_b) in Kelvin, Planck's Law is applied**:

$$T_b = \frac{K_2}{ln(\frac{K_1}{K_\lambda}+1)} \tag{4}$$

Where:
- T_b = Brightness temperature (Kelvin)
- K_1, K_2 = Calibration constants for the thermal infrared bands
- L_λ = Radiance calculated earlier

A single band (Band 10) offers more precision for LST than Bands 10 and 11 combined, because Band 11 is subject to a significant calibration uncertainty. Band 10 was utilized in this investigation to perform LST using equation (5) for Landsat 9 OLI-2. [7]

$$LST = \frac{T_B}{1+(\lambda\times\frac{T_B}{\alpha})\times\ln(\epsilon)} \tag{5}$$

Where λ is the wavelength of the radiation that is emitted (10.8 µm), T_B is the brightness temperature in degrees Celsius, LST is in degrees Celsius, and α is 14,388 µMk.

3. Methodology

A remote sensing technique, typically involving three or more years, is used to compute the change in land use and land cover (LULC) for each region. The overlay-weighted technique was combined with the analysts' spatial tools in the GIS environment to assess the geographical appropriateness and identify the best regions for possible future growth. The study focuses on the different approaches to Landsat image analysis:

1. NDVI and NDWI computation;
2. Landsat image classification
3. Calculation of (LST);
4. All Landsat image processing operations, including NDVI and NDWI analysis, were performed using ArcMap 10.8. The main factors that have an impact are determined by the attribute qualities and their assessment level. Tables (1) and (2) describe the features of both Landsat 5 and Landsat 8.

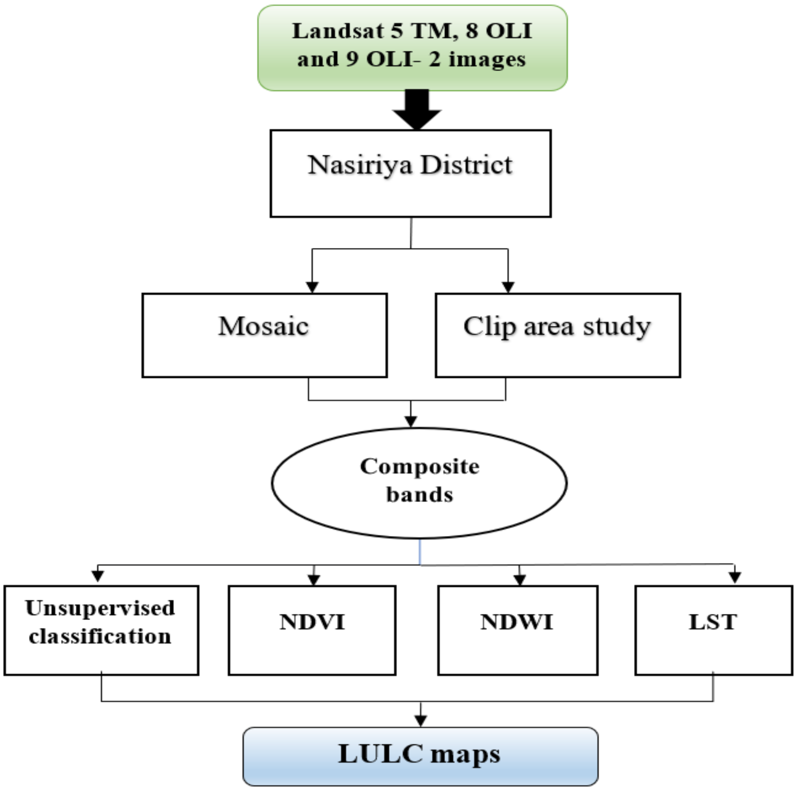

Figure 2: A diagram illustrating the methodological steps employed in this study.

4. Result and Discussion

This section presents the results of LULC analysis in Nasiriya city for the years 1990 to 2024. The impact of urbanization on NDVI, NDWI, LST, and LULC was studied through the analysis of satellite images and spatial data using ArcGIS 10.8. The relationship and its impact between LST and NDVI, as well as between LST and NDWI, were also studied.

4.1 Classification of Landsat Image Results using NDVI

The natural vegetation index values for Nasiriya district in the Dhi Qar Governorate for the years 1990, 2000, 2013, and 2024 are displayed in Figure (3). According to the findings in Figure (3), the district's eastern region had the highest natural vegetation index value in 1990, which was 0.48. As seen in Figure (3b), the natural vegetation index had its maximum value in 2000 at 0.37. The green spaces in the Nasiriya district were primarily located in the eastern and northwest regions, with a small amount on the southwest side. Because of the marsh drainage practices in the 1990s, the central marshes were experiencing dryness, and since the vegetation cover was dispersed throughout the middle and east of the region, particularly in the central marshes, which recovered during that time as a result of Iraq's marsh and wetland rehabilitation efforts, Figure (3c) demonstrated that the highest value of the natural vegetation index was 0.38 in 2013. Despite the rehabilitation measures implemented in the marshes over recent years, the most significant vegetation cover index value, 0.49 (Figure 3d), was recorded in 2024. This value was centered in the middle, northeast, and northwest of the Nasiriya district.

4.2 Classification of Landsat Image Results using NDWI

Figure 4 shows the NDWI values in the Nasiriya district between 1990 and 2024. As seen in Figure 4a, the results indicated that the marshes east of the Nasiriya district had the highest NDWI value in 1990, which was 0.16. Because of the drainage measures, the greatest NDWI value in 2000 was 0.16. As seen in Figure 4c, the NDWI in 2013 had a value of 0.17 and was centered in the southwest of the Nasiriya district. Following the restoration of the marshes and wetlands in the twenty-first century, specifically starting from 2004, the NDWI had a value of 0.17. The NDWI value in 2024 was 0.26 (Figure 4d).

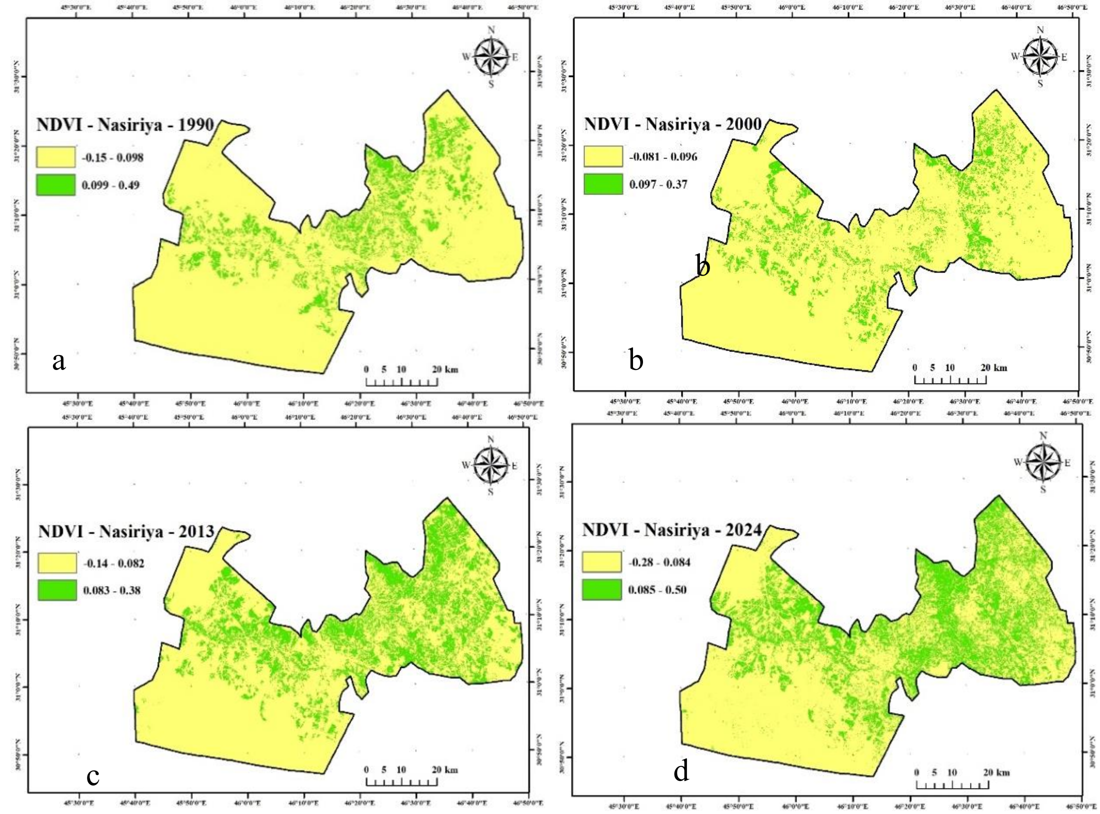

Figure 3: NDVI of Nasiriya district in (a) 1990, (b) 2000, (c) 2013, and (d) 2024

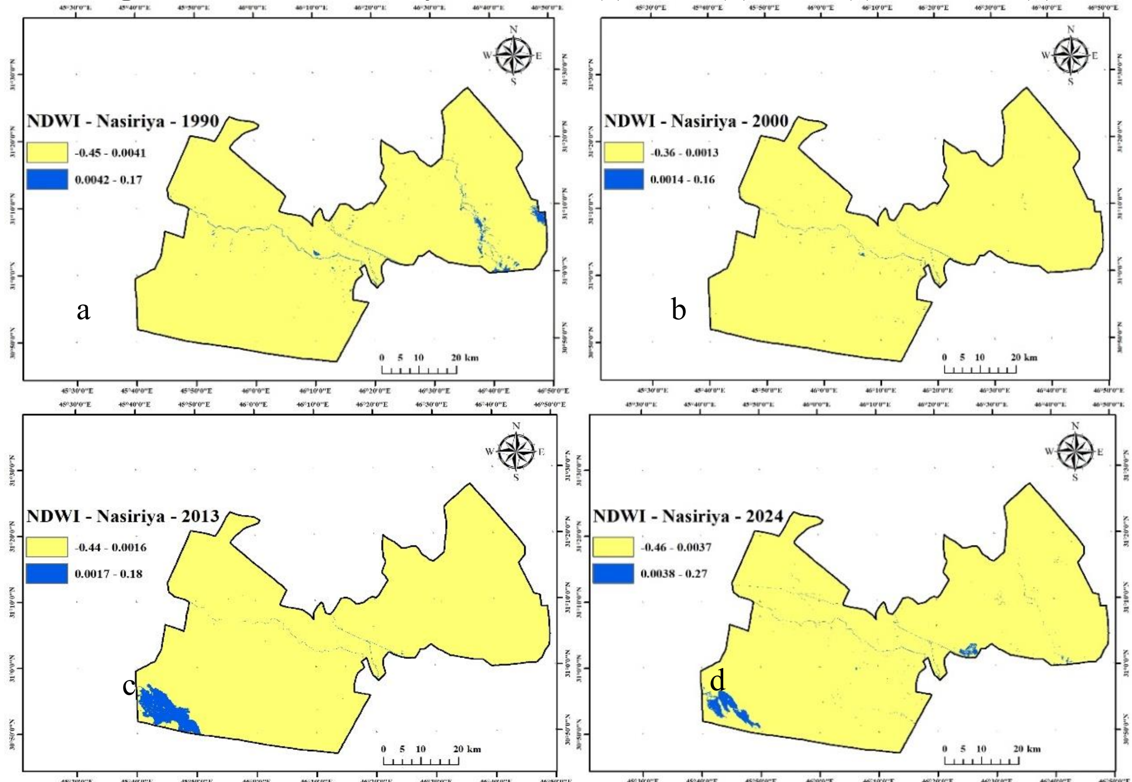

Figure 4: NDWI of Nasiriya district in (a) 1990, (b) 2000, (c) 2013, and (d) 2024

4.3 Classification of Landsat Image Results using LULC

Figure (5) shows the land use and land cover analysis in Nasiriya district for 1990, 2000, 2013, and 2024. The area of water in 1990 was 133.4 km^2, while the vegetation areas were visible, reaching an area of 293 km^2 in Figure (5a). The area of the sabkha and urban areas, which were concentrated in the center of Nasiriya district on both sides of the Euphrates River, reached 636 km^2 and 21.6 km^2, respectively, while the barren area, which covers large areas in the north, south, and west of the district, recorded a value of 2989.7 km^2. The total area of petroleum sites was 49.7 km^2, while industrial areas were 1.84 km^2. The military areas covered 39.4 square kilometers, and the archaeological sites spanned 5.6 square kilometers. As a result of the drying up of the marshes and the scarcity of green spaces, a study of land use conducted in Nasiriya district in 2000 (Figure 5b) showed a significant decrease in the area of marshes and water bodies due to drought, as the area of water area reached 8.5 km^2, the area of vegetation decreased to 207.4 km^2, the area of barren areas increased to 3247.5 km^2, while the area of sabkha areas was 579.8 km^2. The area of petroleum sites was recorded at 49.7 km^2, and the area of industrial areas was 1.84 km^2. Urban areas increased to 29.8 km^2, military areas to 47.1 km^2, and archaeological sites to 5.6 km^2.

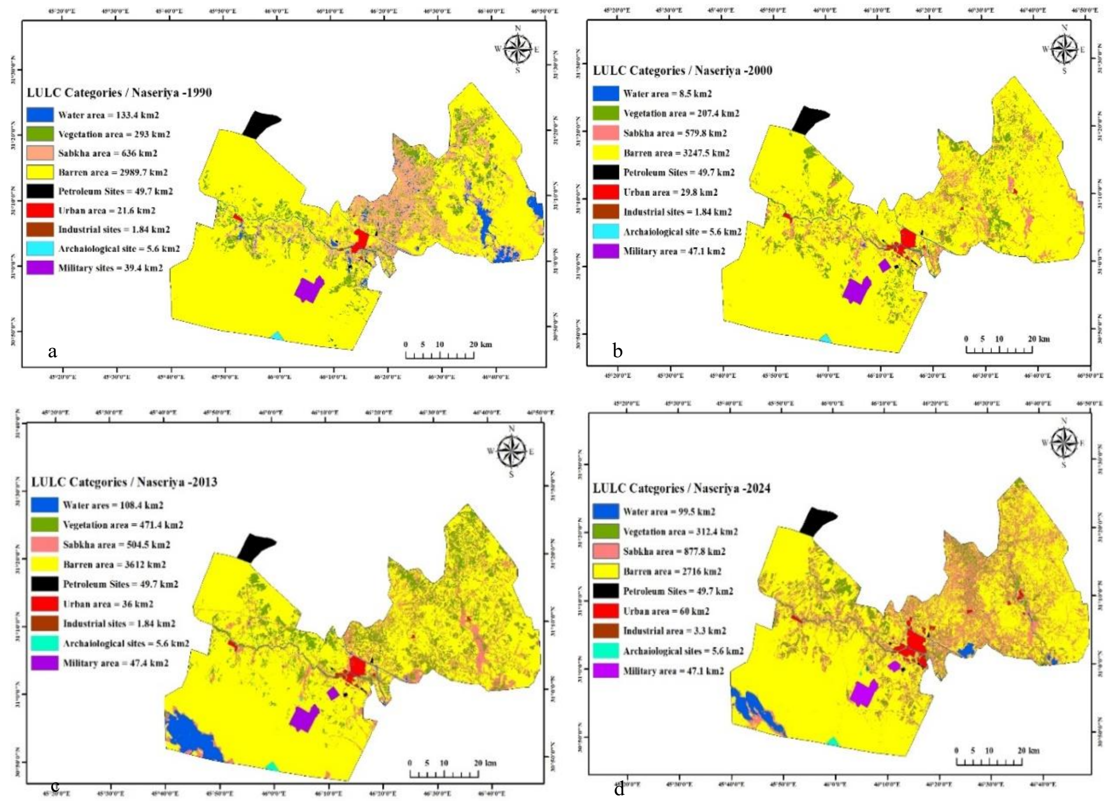

Figure 5: LULC analysis of Nasiriya district

Figure 5c shows the LULC analysis of the Nasiriya district in 2013. It revealed that the area of wetlands and water had increased to 108.4 km^2. Additionally, the area of agricultural and green spaces increased significantly to 471.4 km^2. Furthermore, the sabkha areas and barren lands expanded to 504.5 km^2 and 3,612 km^2, respectively, due to the rains, drought, and water shortage that year. Due to the urban growth and population expansion in Nasiriya city, the extent of urban areas also increased, reaching 36 km^2. Additionally, there were approximately 49.7 km^2 of petroleum sites and 1.84 km^2 of industrial sites. While archaeological sites remained constant at 5.6 km^2, the size of military areas increased slightly to 47.4 km^2. The land use in Nasiriya city in 2024 is depicted in Figure 5d, showing a notable decline in agricultural areas to 312.4 km² and water to 99.5 km². Additionally, the barren area decreased to roughly 2716 km² due to the increase in sabkha areas, as well as the expansion of urban areas. The petroleum sites remained the same at 49.7 km², whereas the sabkha areas increased to 877.8 km². While military areas covered 47.4 km², urban areas expanded to 60 km², industrial areas reached 3.3 km², and archaeological sites maintained their 5.6 km² extent.

Table 3: The differences between the LULC groups in 1990, 2000, 2013, and 2024

Category	**Area (km²)**		**Difference (km²)**	**Area (km²)**		**Difference (km²)**	**Area (km²)**		**Difference (km²)**
	1990	**2000**		**2000**	**2013**		**2013**	**2024**	
Water	133.4	8.5	**-124.9**	8.5	108.4	**99.9**	108.4	99.5	**-8.9**
Vegetation	293	207.4	**-85.6**	207.4	471.4	264	471.4	312.4	**-159**
Barren	2989.7	3247.5	257.8	3247.5	3612	364.5	3612	2716	**-896**
Sabkha	636	579.8	**-56.2**	579.8	504.5	**-75.3**	504.5	877.8	373.3
Urban	21.6	29.8	8.2	29.8	36	6.2	36	60	24
Petroleum	49.7	49.7	0	49.7	49.7	0	49.7	49.7	0
Industrial	1.84	1.84	0	1.84	1.84	0	1.84	3.3	1.46
Archaeological	5.6	5.6	0	5.6	5.6	0	5.6	5.6	0
Military	39.4	47.4	8	47.1	47.4	0.3	47.4	47.4	0

4.4 Classification of Landsat Image Results using LST

Figure 6 shows the LST values in the Nasiriya district, whereas Figure 6a shows the greatest temperature, 22.8 °C, recorded in 1990. Figure 6b shows a slightly higher LST value in 2000, which was 28.3 °C. As seen in Figure 6c, the city's drought and lack of precipitation caused the surface temperature to rise sharply in 2013 to 43.2 °C, but in 2024, it marginally dropped to 39.4 °C, as shown in Figure 6d.

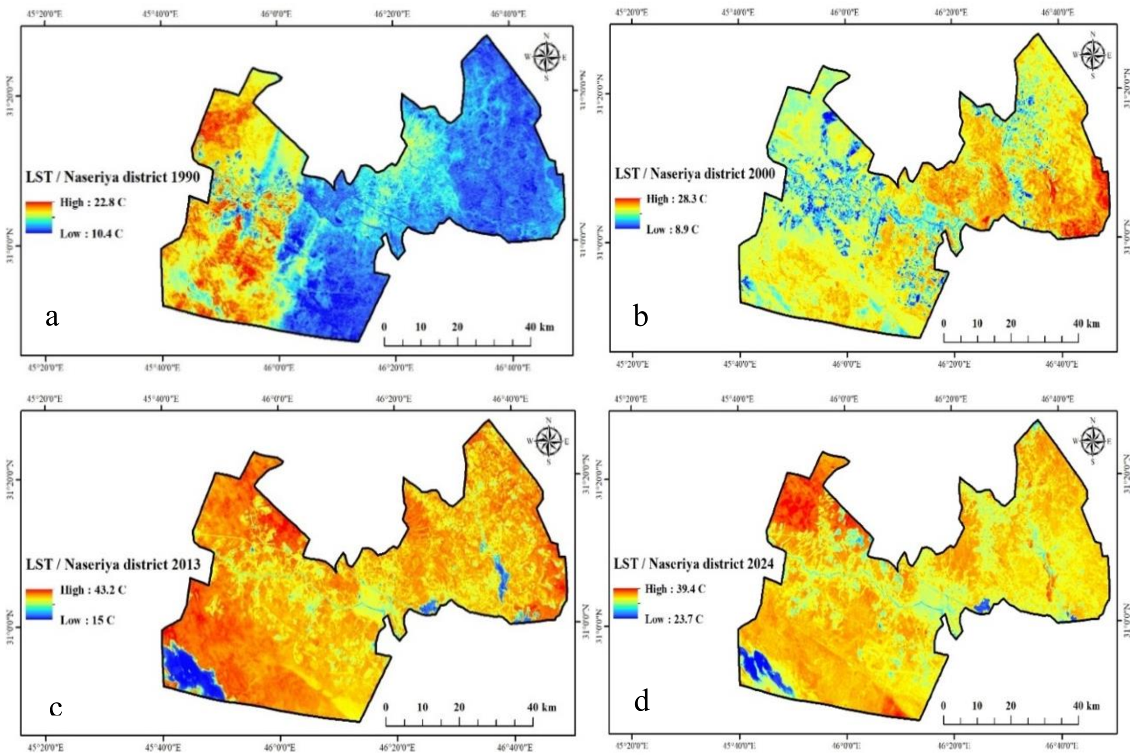

Figure 6: LST values in Nasiriya District, a 1990, b- 2000, c- 2013, d- 2024

5. Relationship between NDVI and LST

The relationship between NDVI and LST is an important indicator in climate and environmental studies. NDVI reflects the density of vegetation cover in a region, while LST represents the heat emitted from the Earth's surface. Several relationships suggest an inverse relationship between NDVI and LST, with increased vegetation density resulting in decreased LST. A relationship was established between NDVI and LST for the study years, and the results showed that in 1990, the relationship had an R^2 of 0.0365, indicating a weak inverse relationship. In contrast, in 2000, the relationship had an R^2 of 0.2452, representing an inverse relationship that transitioned from weak to medium. In 2013, $R^2 = 0.0348$ indicates a very weak linear relationship, and in 2024, $R^2 = 0.0849$ indicates a weak inverse relationship. As shown in Figure 7. The NDVI–LST connections have relatively low R^2 values (e.g., 0.0365–0.24), indicating weak or extremely weak linear relationships. This should not merely be published; it should be thoroughly examined.

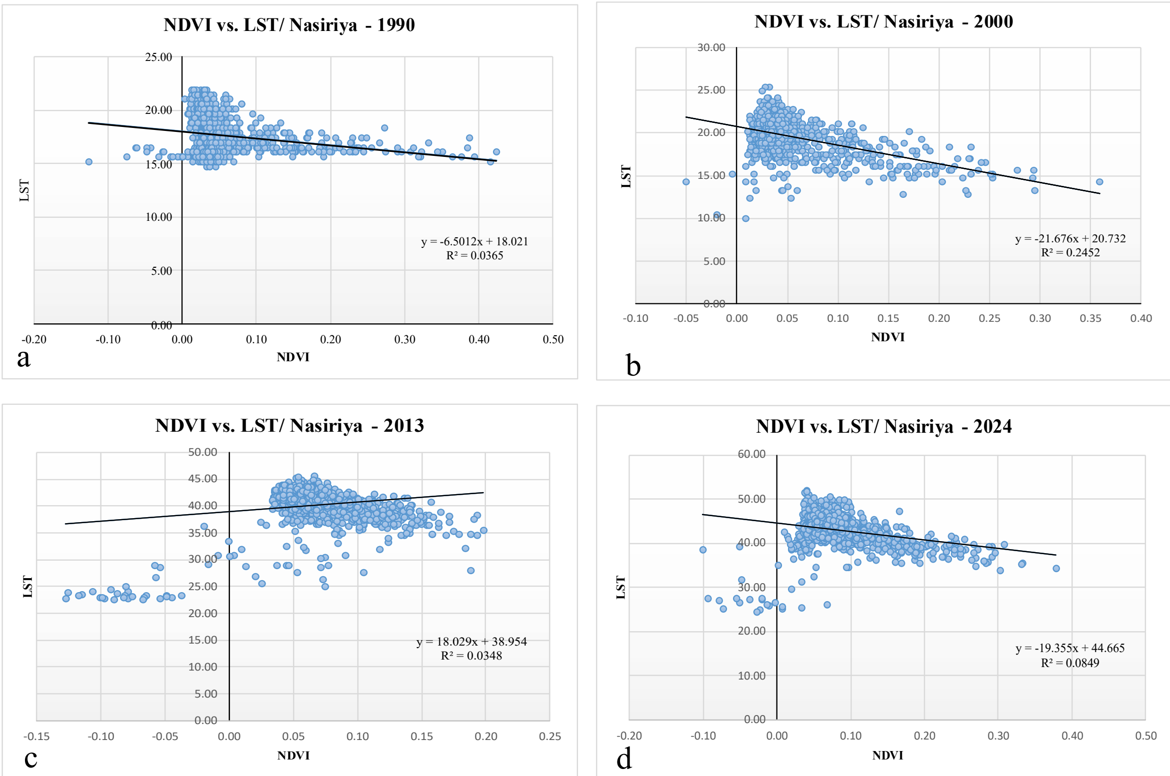

Figure 7: The relationship between NDVI and LST in Nasiriya District 1990, b- 2000, c- 2013, d- 2024

6. Relationship between NDWI and LST

The NDWI represents the water and moisture content of the soil or vegetation and is generally used to determine water availability in surface areas or plants. Many previous studies have indicated an inverse relationship between the NDWI and LST, meaning that the higher the NDWI value, the higher the moisture content, which leads to a lower LST level. A relationship was established between the NDWI and LST for the study years, and the results indicate that in 1990, the relationship had an R^2 value of 0.233. A linear relationship is almost non-existent, while in 2000, $R^2 = 0.1748$, it is considered a weak linear relationship. In 2013, $R^2 = 0.193$ indicates a weak inverse relationship. In 2024, $R^2 = 0.0039$ also indicates a weak or almost non-existent relationship. As shown in Figure 8. Weak or extremely weak linear correlations are suggested by the relatively low R^2 values for NDWI–LST relationships (e.g., 0.0039–0.193). Instead of merely being reported, this issue needs to be thoroughly examined.

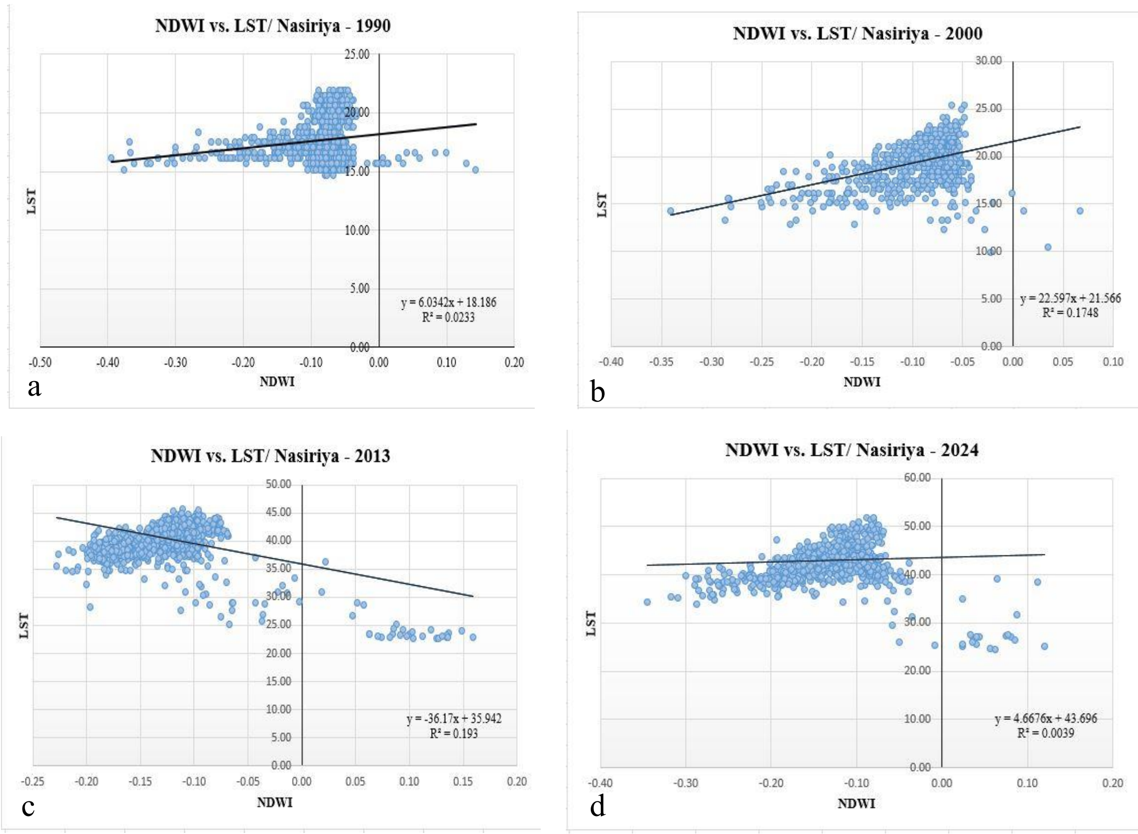

Figure 8: The relationship between NDWI and LST in Nasiriya District, a 1990, b- 2000, c- 2013, d- 2024

7. Conclusions

This work demonstrates how new advances in GIS and remote sensing techniques offer a potent tool for mapping and identifying changes in NDVI, NDWI, and LULC, as well as computed LST. Using Landsat data, it is possible to foresee future changes and comprehend changes in LULC and present sites. The results of this study, which classified LULC in Nasiriya district from 1990 to 2024, showed how different areas changed. Nasiriya district's rapid urban expansion is one of its defining features throughout this period, as urban areas expanded significantly over a 34-year period. A significant decrease in water areas, especially in marshes and small bodies of water, resulted from environmental and industrial changes, occasionally leading to increased arid regions and water scarcity. The green spaces fluctuated, first shrinking following the drought in the 1990s and then somewhat expanding. In 1990, their area was 293 km², but due to their reliance on groundwater and irrigation, it expanded to 312 km². The findings show that the LST values increased from 22.8 °C in 1990 to 39.4 °C in 2024, indicating the change in LULC category during the study period. The results showed that between 1990 and 2024, the district's urbanization increased from 21.6 km² in 1990 to 60 km² in 2024, negatively impacting green and agricultural areas due to this population growth. The results showed a weak positive correlation (R^2 = 0.0348) between NDVI and LST values in 2013, unlike in the other study years. This may be due to temperature being the limiting factor for plant growth.

This implies that prompt action is necessary to protect natural resources and direct growth sustainably, thereby preserving environmental balance. Based on these results, it is recommended that sustainable development plans be developed for the Nasiriya district, with a focus on restoring water resources and expanding green spaces. The government should reevaluate the policies that apply to the area and the surrounding areas that have an impact on the development of the study area, both directly and indirectly, in light of the unfavorable changes in land use and the need for better sustainable development in the city In order to more precisely assess the reasons of changes, future study directions will involve creating environmental monitoring techniques and combining meteorological and hydrological data by connecting variations in LULC with long-term rainfall, humidity, and temperature data. To estimate changes in land cover and temperatures over the ensuing decades, future forecast maps will also be created using predictive modeling. To offset rising temperatures, plans to restore marshes and enhance vegetation cover will be developed to present environmental and management alternatives.

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