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Using the Normalized Difference Vegetation Index (NDVI) to study the change of vegetation cover in Thi-Qar Governorate, southern Iraq for the period from 1990-2022

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Abstract
The study Aims to reveal the changes of vegetation cover in DhiQar Governorate, southern Iraq for the period (1990-2022) by using the Landsat satellite visualizations, as the spectral data of four satellite visualizations for the years 1990, 2000, 2010, 2010 and 2022 were analyzed and digital processing was performed on them in the Erdas Imagine 2014 program. And exporting it to the Arc GIS 10.5 program to study the spectral indicators of vegetation cover, as the Normalized Differtation Index (NDVI) was adopted to monitor the time sequence of the change in the vegetation area in the study area, as the research concluded that the vegetation cover in the year 1990 was in a very good condition, as it occupied 4721 km 2 and 34.1% of the total area of the study area of 13812 km 2, while the vegetation cover decreased in the year 2000 to cover 10.8% of the study area, and in the year 2010 the percentage of vegetation coverage reached 20.6%, but in the year 2022 the area of vegetation decreased significantly as It does not exceed 932 km 2 and is only 6.7% of the total area of the study area, recording a large change rate of 80% over the year 1990, which indicates land degradation and a decline in areas suitable for To cultivate and aggravate the problem of desertification resulting from climatic changes on the one hand and the significant decrease in the water revenue of the rivers of the study area on the other hand.

Keywords: NDVI, Vegetation change.

Introduction:

GIS technologies have contributed to detecting and monitoring the change of environmental systems, monitoring the degradation of vegetation cover, and providing spatial databases through the use of a time series of satellite visuals (1). The NDVI Vegetation Coverage Index is one of the most important applications used to achieve this goal. This indicator is one of the digital processors. Which is used in the production of vegetation cover maps, its distribution density and its spread area, by observing the biomass of the vegetation cover and the nature of its interaction with the electromagnetic radiation reaching it (2), especially the red and near infrared fields (2). NDVI represents the ratio between the difference of the spectral reflectances at the infrared wavelength and the red wavelength over the sum of these reflections at the mentioned wavelengths (4).

Research Problem

Geographical factors, whether natural ones related to climate changes and global warming, or human ones represented by water storage projects in the upstream countries of the Tigris and Euphrates rivers, contributed to the deterioration of vegetation cover and the increase of desertified lands in Iraq in general and in the study area in particular, so the problem of the study can be posed with several questions Of which:

1. What is the area of vegetation cover in the study area ?
2. What are the factors affecting the change of vegetation coverage area in the study area ?
3. What is the extent of change in the size of vegetation coverage over time in the study area?

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Literature review:

There are a large number of studies that dealt with the Vegetative Variation Index (NDVI) and its use as a measurement and comparison indicator of the state of vegetation cover and desertification around the world. However, in this study we will present the studieson Iraq, as the study area is part of it, and they are as follows:

1- Jassim K. Shallal et al., 2007. This study adopted the vegetation deficit index (NDVI) in assessing the state of pastures and the deterioration of vegetation cover in the Sinjar Mountain region in northern Iraq.
2- Jassim K. Shallal&Aiad A. Kalalaf, 2013, the study used the vegetation cover index (NDVI) to change pasture areas in the Bashiqa region in northern Iraq, as the study found an increase in desertification and a decline in grazing lands in those areas.
3- Mousa A. Ahmed &Walid A. Ahmed, 2013, the study adopted the Vegetation Coverage Index (NDVI) in the study of vegetation cover change in the vicinity of Lake Hamrin in Iraq, as the study relied on Landsat satellite data for the period 1976-1992, in analyzing and classifying the state of Vegetation.
4- Israa J. Muhsin, 2016. In this study, two satellite images of the Landsat satellite were used for two different periods, 2000 and 2014, for the purpose of comparison and detection of the change in the vegetation cover of the city of Baghdad.
5- 2017, Amjed H. mohammed&Israa J. Muhsin The study used the vegetative variation index (NDVI) to compare the vegetation cover change over four decades (1985, 1995, 2005, 2015) to determine the state of vegetation cover in Karbala Governorate.
6- Shahla Z. Tawfiq, 2019, the researcher relied on the vegetative variation index (NDVI) in determining the change in the areas of palm trees in the Abu al-Khasib region in Basra Governorate, southern Iraq for the period 1973-2018, as the study indicated a decline in the areas planted with palm trees from 410 km 2 in year 1973 to 133 km2 in 2018.
7- Sherine M. Al-Hamidawi&Nesreen A. Al-Gisani, 2020, used the Vegetative Variation Index (NDVI) to study and determine the droughts that Iraq suffers from.

Aim of the study:

The study aims to determine the size of the change in the vegetation cover in Thi-Qar Governorate by comparing four decades of time (1990, 2000, 2010, 2022) to shed light on the time sequence of land degradation and determine the extent of desertification, by adopting the NDVI plant variation index.

Study area location:

The study area is represented by the administrative boundaries of Dhi Qar Governorate in southern Iraq, which extends between latitudes (26, 30 o - 01, 32 o) to the north, and between longitudes (39, 45^{o} - 10, 47^{o}) to the east, as it is bordered from the north by the province Wasit, from the north-west, Al-Qadisiyah Governorate, from the east and northeast, Maysan Governorate, and from the west and southwest, it is bordered by Al-Muthanna Governorate, but from the south and south-west, it is bordered by Basra Governorate, see map (1). The study area occupies 2.9% of the area of Iraq, with an area of 13.812 km^2, and is divided into 20 administrative units, with five districts and fifteen sub-districts.

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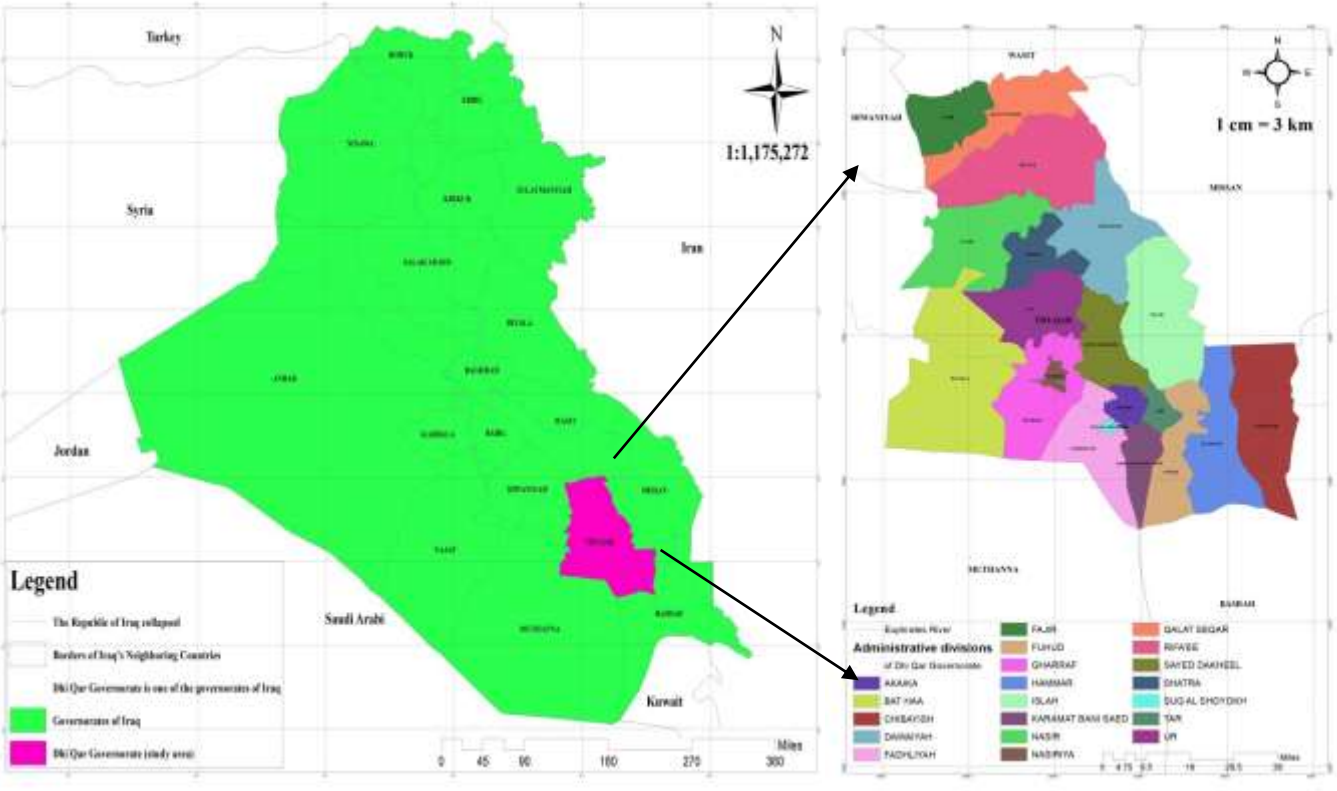
Map 1: Location of the study area



Study data:

The satellite images used in the study were downloaded from the (United States Geological Survey) website and its abbreviation (USGS), as it provides data for some satellites, including the Landsat satellite, which was used to provide the study visuals, see Figure (1) and Table (1). The study area is roughly defined in the interface of the program to display the numbers of visualizations that cover the study area to be configured and exported to the GIS program (Arc Map10.5) to perform digital correction and processing and matching with the borders of the study area, see Figure (2).

Figure (1): Download the satellite images of the Landsat satellite from the US Geological Survey website

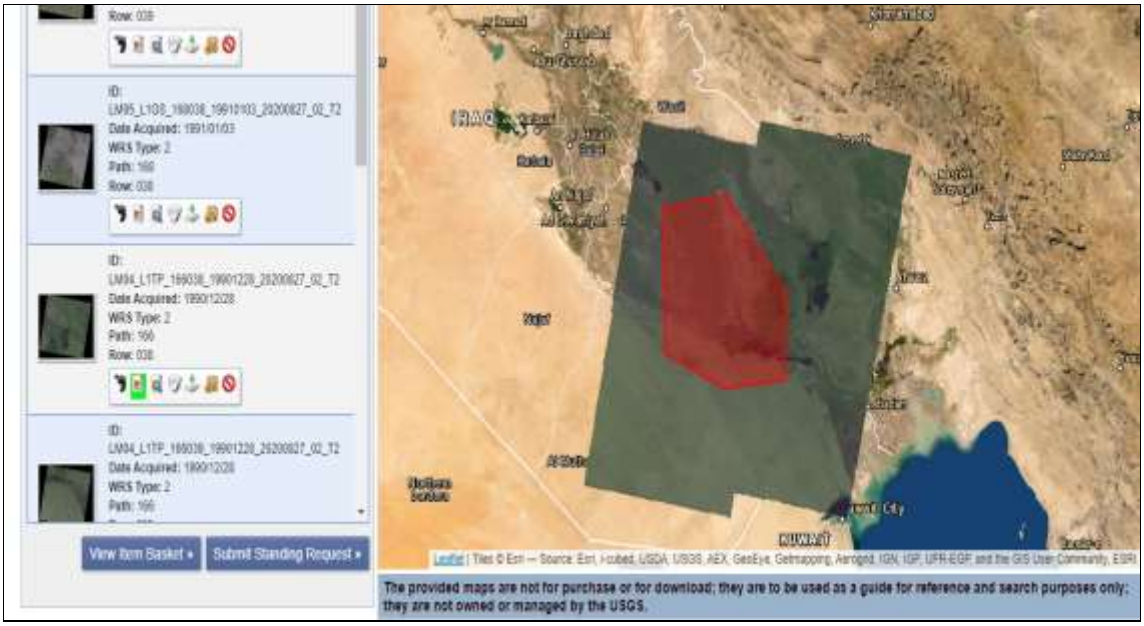


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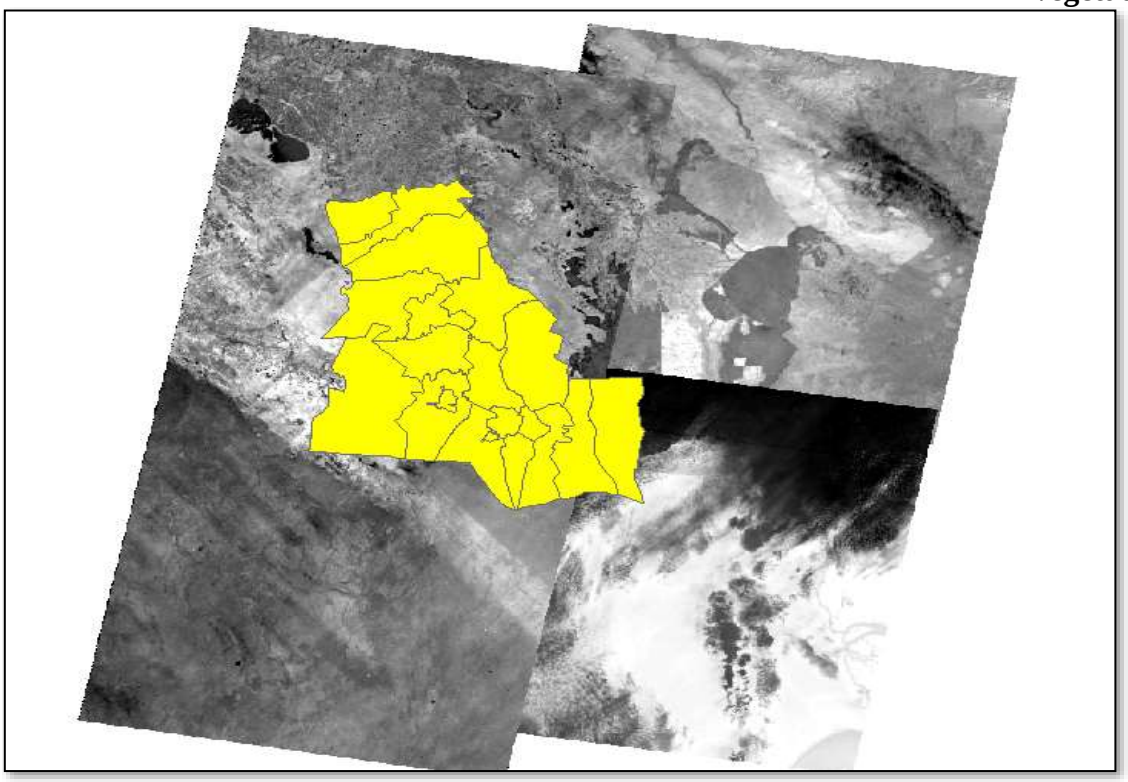
Table (1): Satellite information used in the research.

The name of the satellite	Study year	launch date	distance from the ground	Scanner type	number of bands
Landsat 5	1990	1984	900	TM	4
Landsat 7	2000	1999	705	MTN	8
Landsat 8	2010	2003	705	OLI	11
Landsat 8-9	2022	2021	705	TIRS 2 – OLI 2	11

Figure (2): The location of the study area from the satellite images used to detect the change in vegetation cover.



As the visualizations of the study area were uploaded for four different decades according to the bands used in the study, and as listed in Table (2), then the bands for the Vegetation Coverage Index were merged and the NDVI data was derived and output in final maps.

Table (2): Numbers and dates of visualizations used in the research.

Study year	scene number	Scene description path	capture date
1990	1	167 -38	1990/01/25
	2	166-39	1990/01/02
	3	167-39	1990/01/25
	4	166-38	1990/01/02
2000	1	167 -38	2000/02/06
	2	166-39	2000/01/30
	3	167-39	2000/01/21
	4	166-38	2000/01/14
2010	1	167 -38	2010/11/08

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	2	166-39	2010/10/16
	3	167-39	2010/11/08
	4	166-38	2010/10/16
	1	167 -38	2022/01/09
	2	166-39	2022/01/18
	3	167-39	2022/01/09
2022	4	166-38	2022/01/18

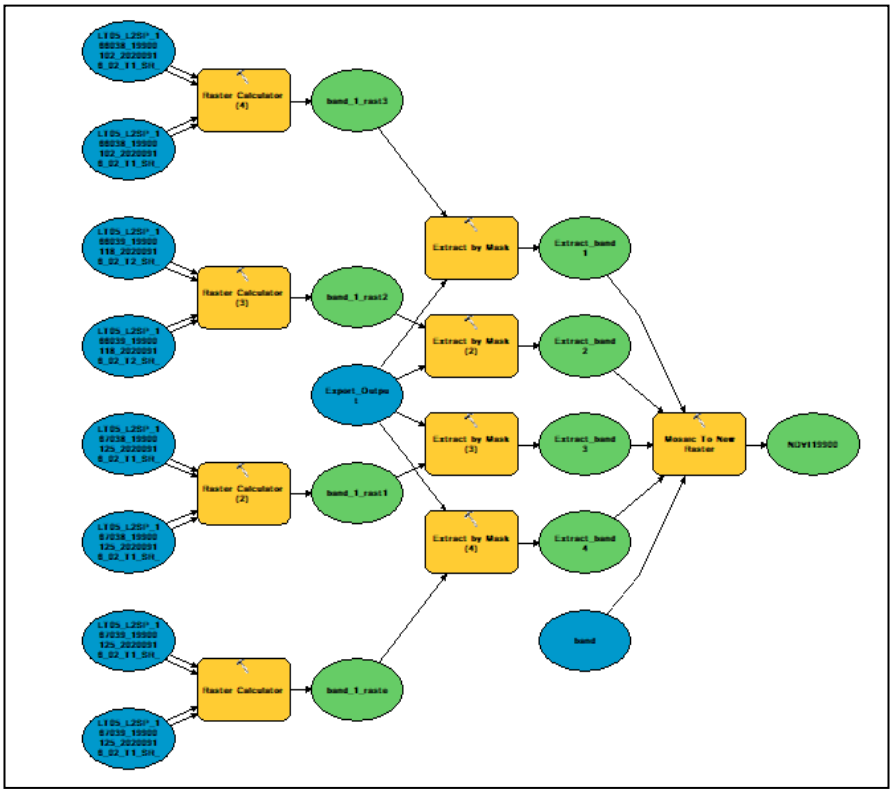
Calculating the Normalized Difference Vegetation Index (NDVI) for the study area:

This indicator is one of the programs used to make maps of plant production, its distribution density, and its spread area, by monitoring the biomass of vegetation cover and the nature of its interaction with the electromagnetic radiation reaching it, especially the red and near-infrared fields. As NDVI represents the ratio between the difference of spectral reflections at the infrared wavelength and the red wavelength over the sum of these reflections at the aforementioned wavelengths, see Figure (3), (Anejionu, 2013) and express it in the following relationship:-

$$NDVI = \frac{Band\ NIR - Band\ Red}{Band\ NIR + Band\ Red}$$

Gradual values are obtained from -1 to +1, and these values have special indicators, as values approaching +1 represent the density of vegetation, while negative values approaching -1 indicate barren lands and exposed rocks (Aghasi, 2011: 992-997).

Figure (3) :The digital model used to calculate the vegetation cover index (NDVI) for the study area.



1- Calculating the NDVI for the year 1990:

The values of the plant variation index in this period ranged between 0.625 - 0.834, as this period is the best at the level of the years studied in terms of vegetation coverage, as we note from Map 2 the density of vegetation cover in the study area, as the vegetation area reached 4721 km^2, by up to 34.1% of the total area of the study area which is 13.812 km^2 See Table 3. The reason for this is due to the increase in

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the discharge of the rivers of the study area, as well as the increase in the amounts of precipitation during that period compared to the periods that follow.

Map 2 : Distribution of vegetation cover in the study area for the year 1990.

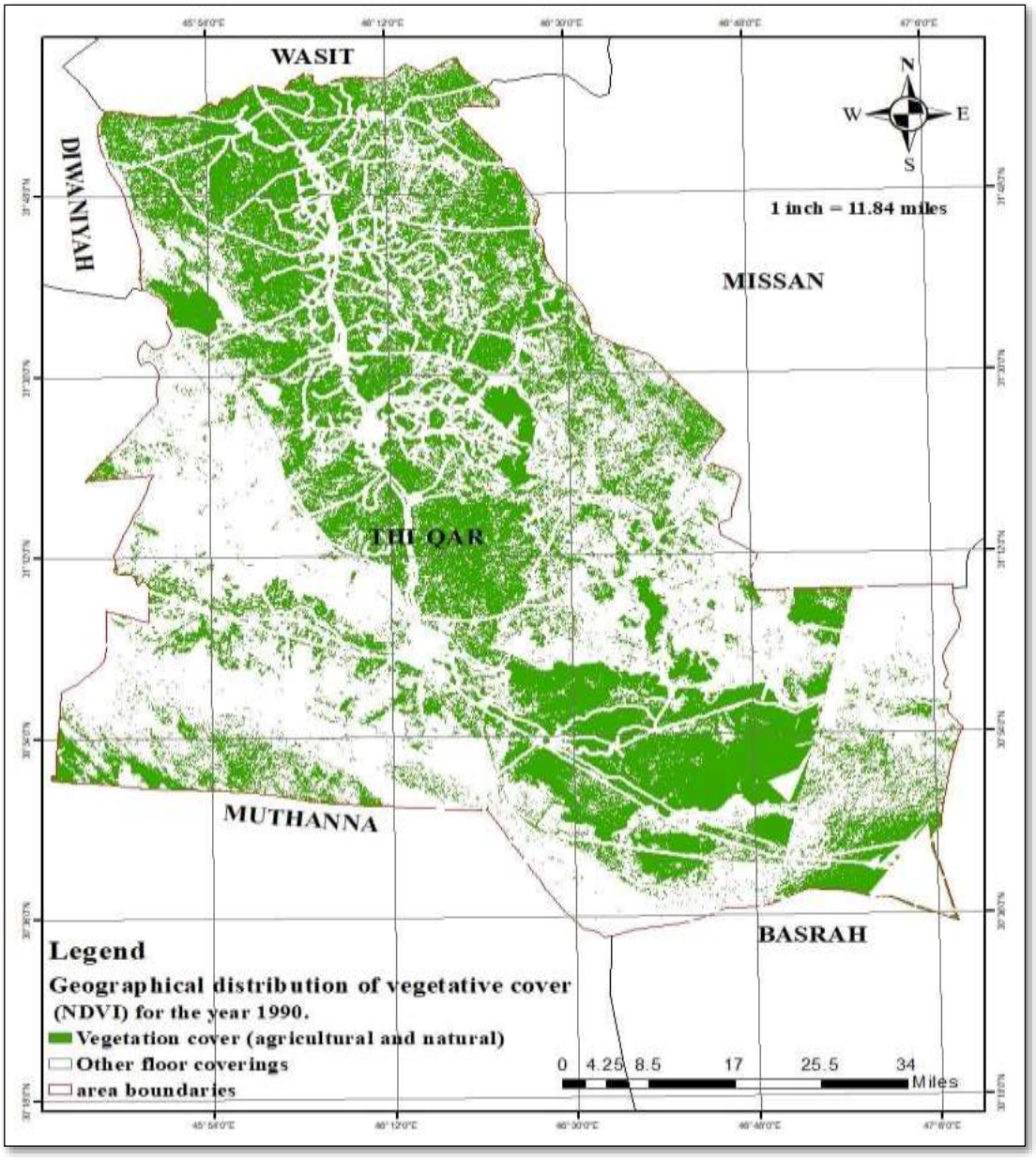

Table (3) The area of vegetative cover and its percentage of the study area for the years (1990-2000-2010-2022).

Study year	Area NDVI (KM)	% of study area
1990	4721	34.1
2000	1497	10.8
2010	2856	20.6
2022	932	6.7
ThiQar area		13.812 (km^2)
Thirteen thousand eight hundred and twelve (square kilometers)		

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2- Calculating the NDVI for the year 2000:

The area of vegetation cover in the study area for the above period was 1497 km^2, occupying 10.8% of the total area of the governorate, as the NDVI values for this year ranged from 0.125 - 0.274, Table 4, as the nature of plant growth in this period is classified as average, Table 5, and it is noted from Map 3 Variation in the distribution of vegetation cover in the study area, as we note the concentration of its spread in the marsh areas in the southern and southeastern part of the governorate, and in the western part in Al-Nasr district, which is famous for cultivating grain crops, and the vegetation cover spreads in the rest of the governorate in a scattered manner.

Table (4)NDVI index values .

Study year	Rate the NDVI between (-1) and (+1)
1990	0.625 - 0.834
2000	0.125 - 0.274
2010	0.321 - 0.342
2022	0.092 – 0.123

Source:NDVIMaps 2,3,4,5 .

Table (5) Classification of plant quality according to the vegetation cover index (NDVI).

pointer value	Cover quality	study samples
0.01 >	weak plant	-
0.01 – 0.3	Medium plant	2000 / 2022
0.300 – 0.5	Good plant	2010
0.5 <	Very good plant	1990

Source: Mahmoud Ali et al., Pre-processing of Landsat images to map NDVI in the forests of northern Lattakia, Tishreen University Journal for Research and Scientific Studies, Biological Sciences Series, Volume (40), Issue (5), 2018.

Map 3: Distribution of vegetation cover in the study area for the year 2000.

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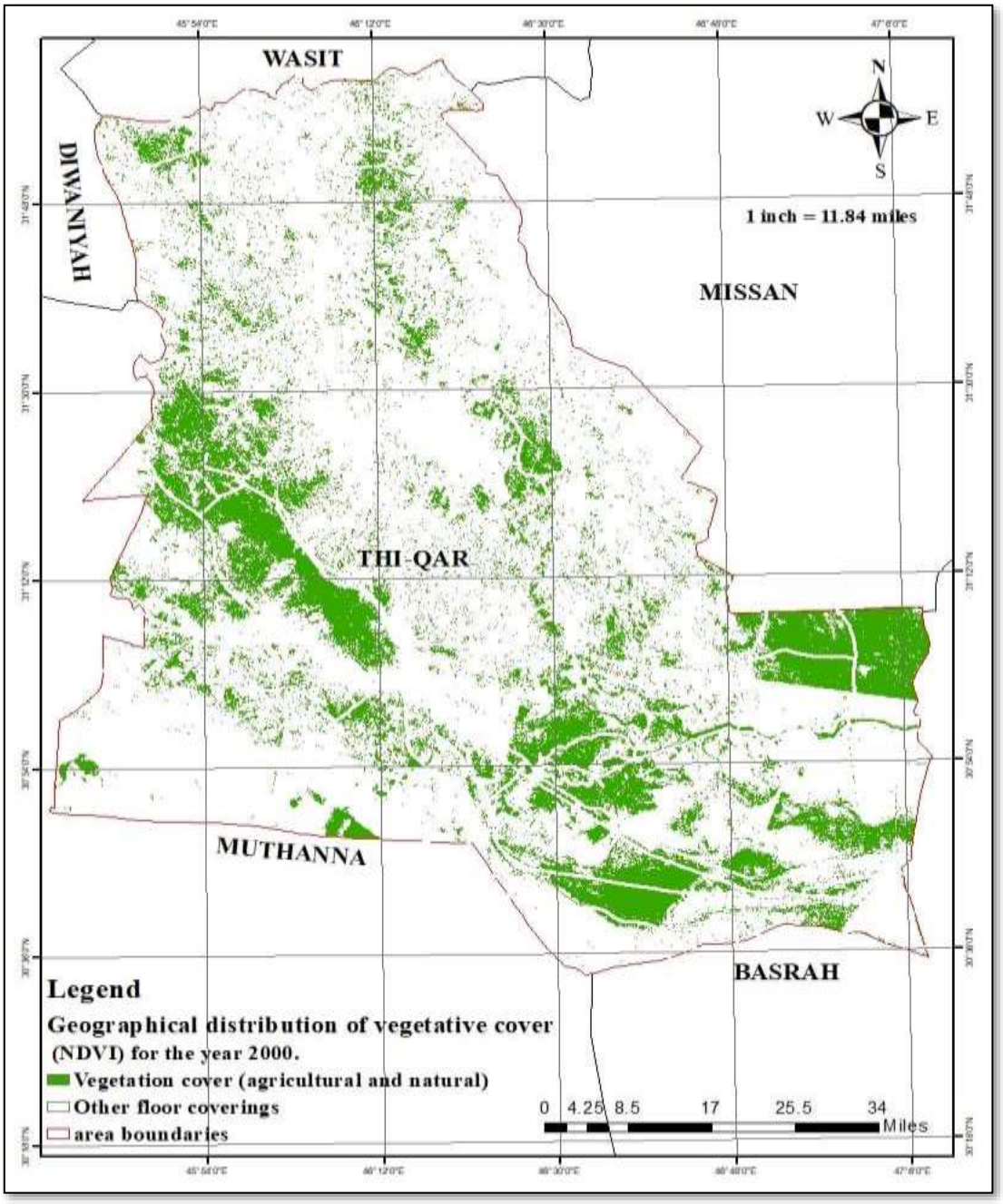

3- Calculation of the NDVI for the year 2010:

The NDVI values for this year amounted to 0.321 - 0.342, as the vegetation cover is described as well-spread, as its spread area reaches 2856 km^2, which is 20.6% of the total area of the study area, as we notice from Map 4 the spread of vegetation cover in almost all parts of the governorate, and it spreads in a manner It is dense in the southern and southeastern parts of the study area, in which marshes are spread that are covered with reeds and papyrus as well as other aquatic plants. These areas are also fertile agricultural regions that produce various agricultural crops, especially the district of Suq Al-Shuyukh and Al-Islah.

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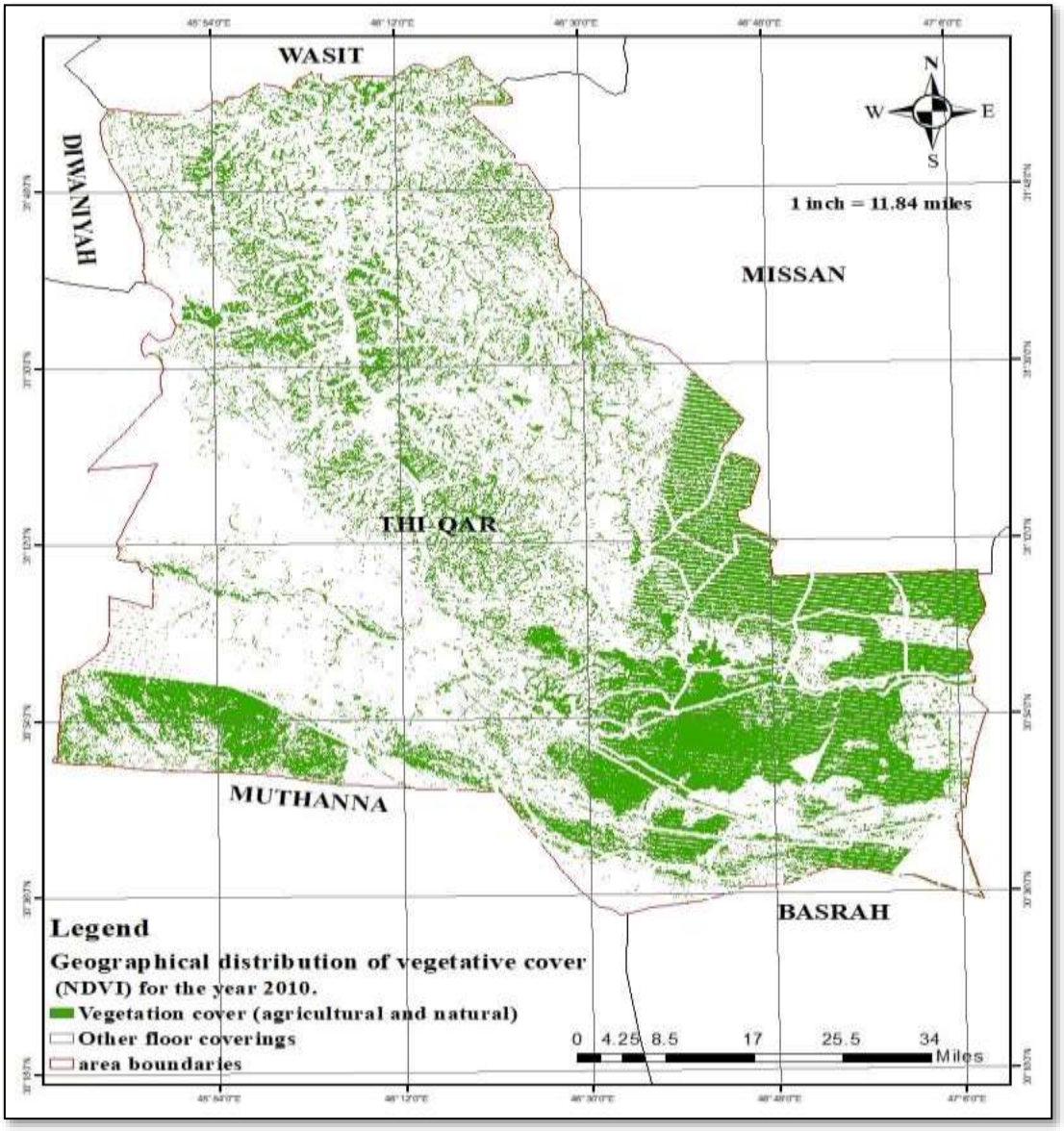
Map 4: Distribution of vegetation cover in the study area for the year 2010.



4- Calculating the NDVI for the year 2022:

The state of the vegetation cover in this period is classified as sparse in comparison to the previous years, and the reason for this is due to the decline in the discharge of rivers in the study area due to water retention in the upstream countries, as the annual discharge rate of the Euphrates River water decreased from 111 m^3/s in the year 1990 to 25 m^3/s In the year 2022, see Figure 4, in addition to the climatic changes that led to higher temperatures, decreased amounts of precipitation, and increased evaporation, all of which contributed to reducing the vegetation cover areas, as the NDVI values for this period reached 0.092 - 0.123, which indicates a limited spread, as it does not exceed Its coverage area is 932 km^2, with a rate of 6.7% of the total area of the study area, as it is noted from Map 5 that the plant is scattered in limited parts in the areas adjacent to the Euphrates and Gharf rivers that run in the study area.

Figure 4: Annual discharge rate of the Euphrates River

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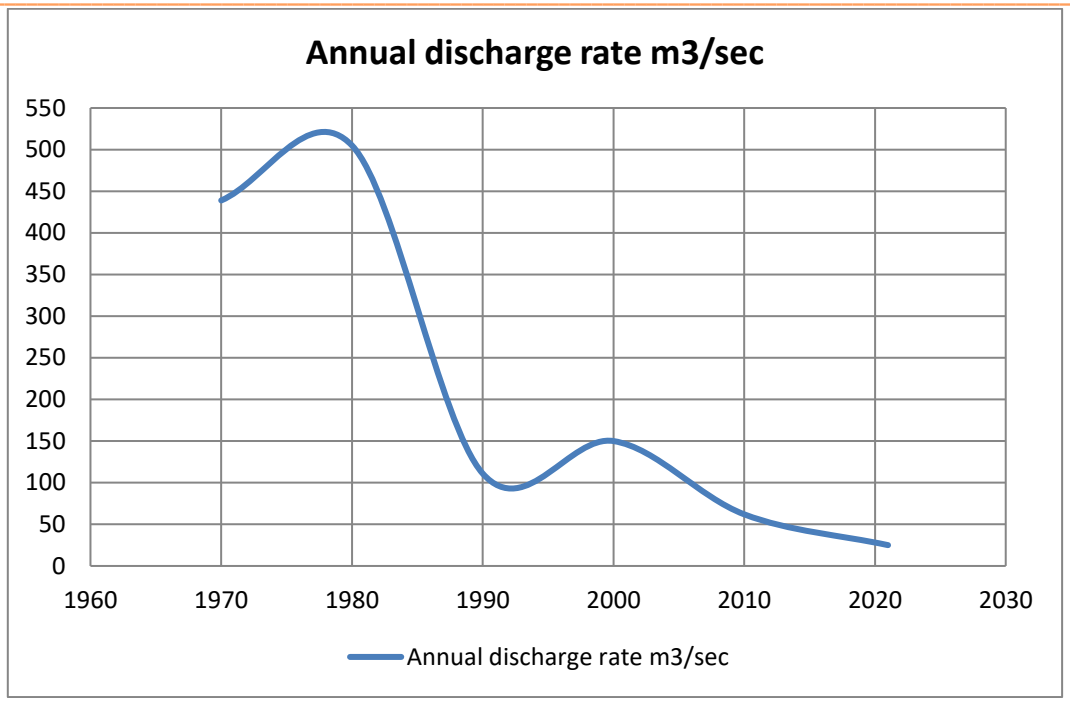

Source: Iraqi Ministry of Water Resources, 2022.

Map 5: Distribution of vegetation cover in the study area for the year 2022.

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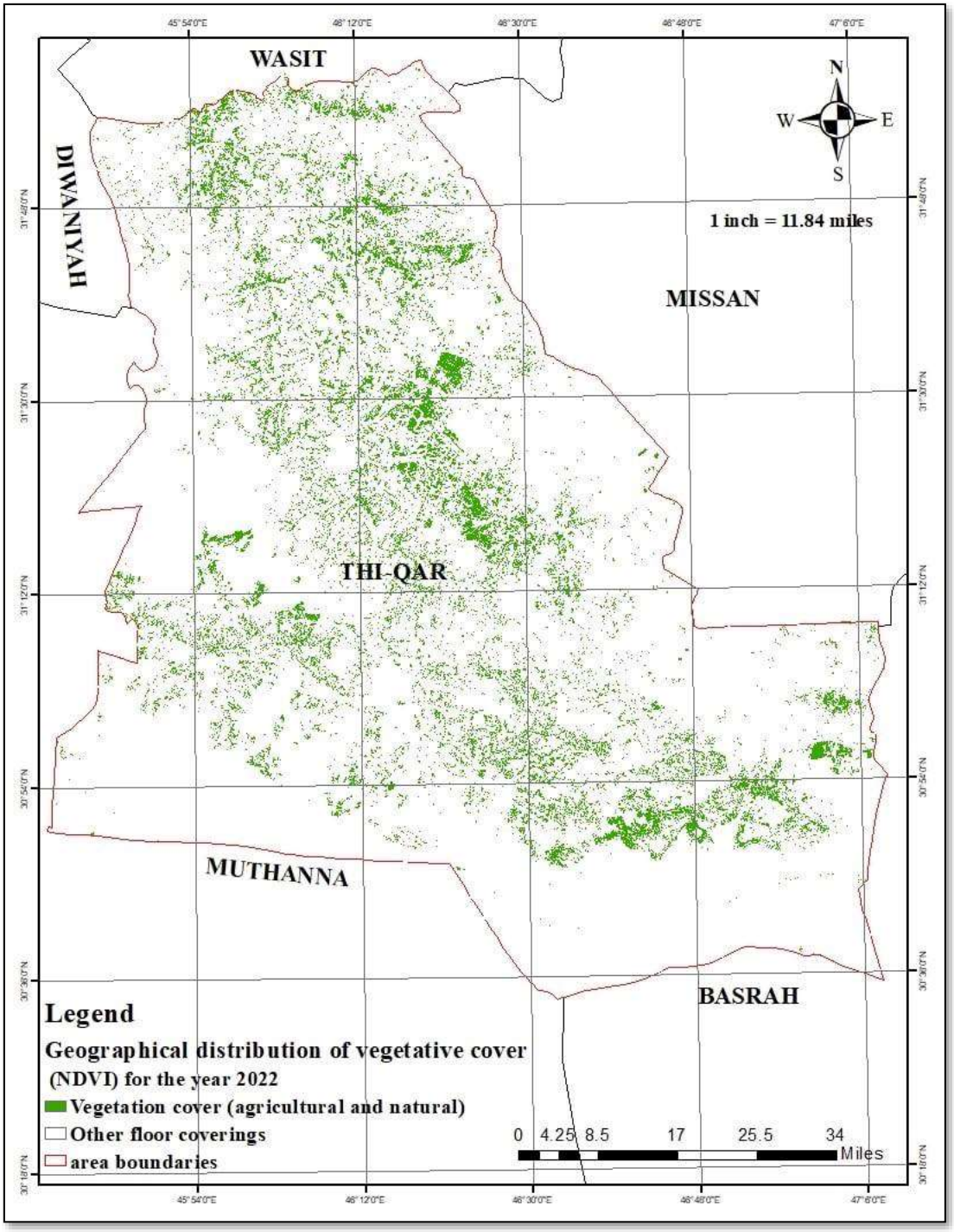

Estimating the time sequence of the change of vegetation cover areas in the study area:

Iraq in general, including the study area, witnessed a significant decline in the areas of vegetation cover, due to the prevalence of drought conditions resulting from climatic changes and the accompanying significant decrease in the water revenue of the Tigris and Euphrates rivers, all of which contributed to the decrease in the areas of vegetation cover and the increase in desertification, especially in the study area, it is noted from Table 6 the significant change in the vegetation cover area, as the rate of change between 1990 and 2022 reaches 80%, which indicates a decline in the vegetation cover area to 20% in 2022 compared to what it was in the year 1990, and this is a serious indicator of the deterioration of agricultural lands pastoral areas, as well as the decline of marsh areas in the study area.

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Table (2): percentage change in vegetation cover for the years 1990-2000-2010-2022

Study year	Area NDVI (KM)	V.R = (MAX - MIN / MIN) × 100	the extent of thechange[1•]
1990	4721		-
2000	1497	(1497-4721/4721)= 0.682* 100	68%
2010	2856	(2856-4721/4721)= 0.395 * 100	39%
2022	932	(932-4721/4721)= 0.802* 100	80%

•- The extent of the change was calculated according to the following equation:
V.R = (MAX - MIN / MIN) × 100
while :-
V.R = Contrast Ratio
MAX = retrograde period
MIN = period of increase
Source: Ayser Muhammad Al-Shama`a, Batoul Muhammad Al-Azzawi, Hydrochemical Pollution of Groundwater in the Badra-Jasan Basin / Eastern Iraq, Diyala Journal of Agricultural Sciences , No. (3), Volume (2), 2011, p. 673.

The Results:

1- The integration of the relationship between the techniques of remote sensing systems and geographic information systems has an effective role in detecting the state of the plant, its rate of change and the nature of its spread.
2- Depending on the vegetation variation index (NDVI), four time periods were identified to study the state of vegetation change in the study area, through four satellite images of the Landsat satellite captured for the years 1990, 2000, 2010, and 2022.
3- The results indicated that the state of the plant flourished in the year 1990, as its coverage rate was 34.1% of the total area of the study area,and the percentage of vegetation cover decreased in the year 2000 to 10.8%, and the state of the plant in 2010 is classified as good, reaching 20.6%, while in the year In 2022, the study area witnessed a significant deterioration in the state of the vegetation cover, as its area decreased to 932 km 2, or 6.7% of the total area of 13,812 km ^{2}.
4- The study concluded that the rate of change between the years 1990-2022 amounted to 80%, which is a serious indicator of the deterioration of the ecosystem, the shrinking of arable areas and the increase in desertification due to water scarcity and climate changes.

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