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Analysis of Vegetation Cover Change in Babil Governorate Using Spectral Indicators (Ndvi Ndmi)

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Abstract

The study aimed to uncover environmental deterioration in Babil Governorate and determine the extent of the extent of desertification in the region, through the optimal use of geographic technologies like GIS (geographic information systems and remote sensing) that show us the values and percentages of degraded areas in the region.The area of the study area was (6467 km2), as the study relied on natural and human data for the region. The study included satellite digital processors, and the application of the Normalized Difference Vegetation Index (NDVI) Normalized Difference Mosture Index (NDWI) approach was relied upon.The post-classification comparison method is used to distinguish two types, namely the density of vegetation cover and the water content of the soil (moisture).In order to produce digital maps of the vegetation cover for the period (2013-2022) for the region, by using two satellite images of Babil Governorate that were captured by the Landsat Oil 8 satellite, the spectral bands (bands) were distinguished as a basic step in the research work and then the indicators were applied, as the results showed a wide In the areas of desertification and the lack of water content in the region, this is done by calculating the difference in areas of two images taken in different periods from 2013 to 2023, as the area of cultivated land in 2013 reached (4352) km2, representing 67% of the area of the total area, while the cultivated land reached 3631 km2 in 2023, representing 55.8% , while the aridity index indicated a decline in wetlands, as their percentage reached 70.1% in 2013, while their percentage reached 45.1% in 2023. This change occurred within a short period of time, 10 years, and this indicates environmental deterioration. The area of barren lands expanded at the expense of cultivated lands.

Keywords*: Vegetation, Babil, GIS, NDWI. Rainfall, Desertification.*

1. Introduction

Vegetation cover is an indicator and measure of environmental deterioration. This is based on the change that occurs in the densisty of vegetation cover, and since this change has a direct impact on land cover and land use in general, there must be continuous monitoring of vegetation cover, which represents a factor in revealing the state of the environment.

The concept of the environment can be defined from a geographical standpoint. It is the entire geographical area, including the living organisms that live in it and the surroundings that interact with it. This includes both the living parts, such as humans and plants, and the non-living parts, such as the weather and the terrain around it. The problem lies in raising several questions, including:

1. Is the phenomenon of environmental degradation (desertification) expanding in the study area?

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2. Do geographical factors (natural and human) have an impact on increasing the extent of desertification?
3. What is the ability of the spectral indicators used in the study area to monitor the changes occurring?

The research hypothesis is summarized in an answer to the questions posed in the problem and includes:

1. The phenomenon of environmental deterioration is expanding, and its impact on the vegetation cover of the region is increasing.
2. Natural and human geographical factors have an effective role in increasing the areas of desertification.
3. The indicators have the ability to show the change in cover by calculating the cultivated and uncultivated areas.

The justifications for the research appear through a discussion of the growing idea about what has been revealed by satellites for monitoring land cover and predicting accurate information about land use and the changes occurring in it, which contributes to early detection of environmental dangers in the study area, especially since vegetation is a strong indicator of environmental degradation and desertification. By changing the values and percentages of vegetation density in the region, through data extracted from the Landsat Oil 8 satellite between the years (2013-2023) and applying vegetation indicators to it, to reach spectral indicators that allow us to detect the changes that occurred in the region. And the extent of the phenomenon of desertification in the region

2. Methodology

First: Detection Through the Land Sat-Oli Satellite

-1To detect (NDVI vegetation index) by applying the mathematical equation for the Land sat-OLI satellite, which is :

$$\boldsymbol{NDVI} = \frac{(\boldsymbol{B5} - \boldsymbol{B4})}{(\boldsymbol{B5} + \boldsymbol{B4})}$$

The beams in the Land sat-Oli satellite represent:

B4- RED

B5- NIR

2To detect the Water Cover Index (NDWI), using Landsat-OLI and Sentinel satellite visual data dated 1/10/2013 and 2/23/2023, and by applying the satellite's mathematical equation. Land sat-Oli which are :

$$\boldsymbol{NDWI} = \frac{(\boldsymbol{B3} - \boldsymbol{B5})}{(\boldsymbol{B3} + \boldsymbol{B5})}$$

B3- GREEN

B5- NIR

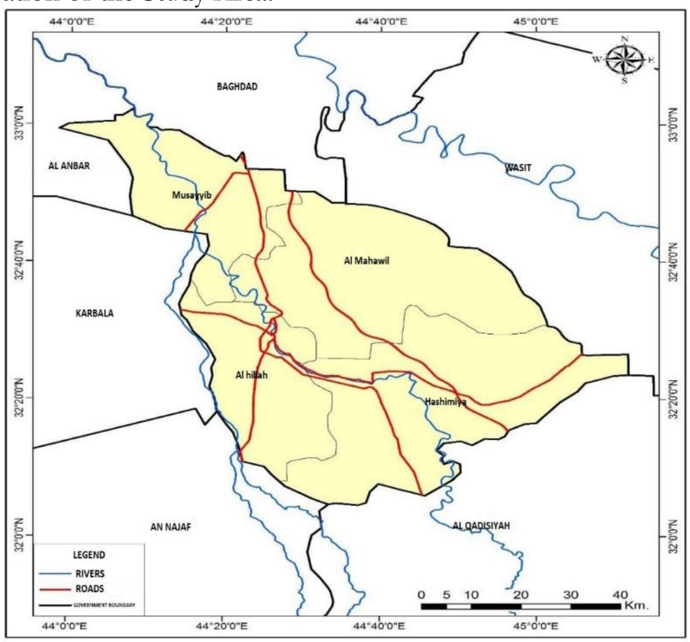
Boundaries of the study area (spatial and temporal)

Spatial boundaries of the study

The study area is located within the alluvial plain, in the central part of Iraq, and is bordered by Baghdad Governorate to the north, Anbar and Karbala to the west, Wasit to the east, and Najaf and Qadisiyah to the south, as it is bounded by the longitude (43´ 42°) and (50´ 45°) to the east, and between the two circles of Width (7´ 32°) and (8´ 33°) north, as Babil Governorate occupies an area of (6467) km2, as shown in map.(1)

Time limits: the period from one year (2013 to 2023).

Map No. 1*,* Location of the Study Area.



Source: The Researcher based on the Topographic Map of Iraq for the Year 2013

Second: The Geological Formation of the Study Area

The study area is part of the alluvial plain, as it is within the unstable shelf, especially since the alluvial plain continues to sink and is filled with quaternary river deposits. (Buddy, 1963, p347) The geological findings of the study area included the Injana Formation dating back to the Miocene era and one depositional cycle dating back to the Quaternary deposits, which consists of Pleistocene and Holocene deposits, Map(2)

1. **Injana Formation**
2. **Quaternary Deposits**

1- Ingana Formation

The chronological age of this formation dates back to the third era of the Miocene (formerly the Upper Persian), and it consists of clay and silty rocks and red or gray silicate sand rocks.

(Maala 2007 p14) The Injana Formation is exposed in limited areas in the northeast of the region, represented by the Hindia Dam .

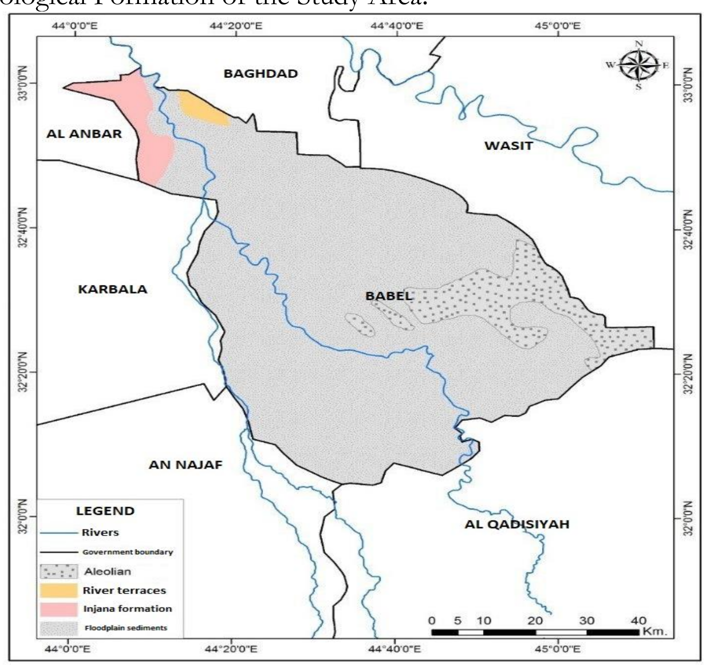
2- Quaternary Sediments

These deposits were formed during the rainy period in the Pleistocene era, as Iraq's climate was more humid, but the period between the rainy and dry periods is similar to the current climate. This change in climate brought about many real changes to the natural situation of Iraq. (Jawaharl, 1980, P4) It is represented by the deposits of the Pleistocene and Heliocene eras. It includes different types of deposits due to their origins, as follows:

A. Flood plain deposits: Floodplain sediments are spread over a wide range of the region due to the sediments of the Euphrates River, as they are represented by a loose silt and sand layer, as well as poorly cohesive sediments rich in salts.
B. River Terraces: It dates back to the Pleistocene era and is found in the northwestern part of the study area and on the left bank of the Shatt al-Hilla.
C. Aeolian deposits (sand dunes).

Wind erosion factors, especially in the summer seasons, contributed to transporting sand from its places and depositing it in a new depositional environment through wind erosion processes, in large quantities in various places in the alluvial plain area, which was covered by new wind deposits in the Holocene era. (Al-Kaabi, 2001, p. 9) These deposits are spread in the southeastern parts of the study area, and these deposits consist of fine to medium-grained sand, silty clay, and alluvial pieces .

Map No. 2 Geological Formation of the Study Area.



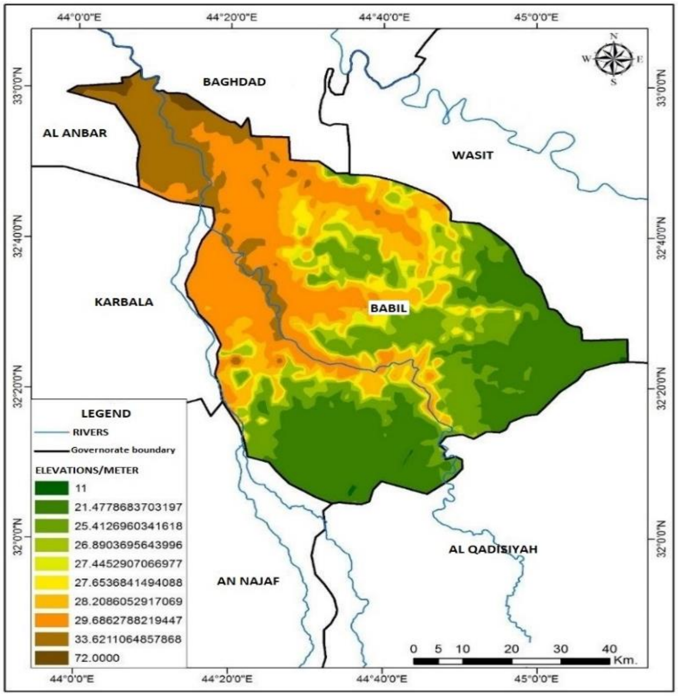
Source: The Work of the Researcher based on the Geological Map of Iraq at a Scale of 1: 250,000, Issued by the Ministry of Water Resources, General Authority for Survey, Map Production Department.

Third: The Surface

The region is part of the alluvial plain, which is characterized by little topographical variation, so it is a flat area with some site elevations resulting from ancient and modern irrigation canals as well as ancient river courses. And some linear local terrain such as hills. Map.(3)

1. The heights ranged between (11-72) meters.
2. The highest value was recorded in the northern parts (72 m).
3. Other areas distributed in the region ranged in height.(29-27) .
4. The southern parts of the region recorded (21-25) m, while the extreme south reached (11 m) .This contrast is due to the presence of depressions represented by marshes such as Marsh Al-Shuk and Abi Naj.

Map No. 3*,* The Surface in Babil Governorate.



Source: 2007 DEM.

Fourth: Climate:

Climate is one of the factors that directly affects natural activities such as agriculture, so studying climate and its elements is extremely important. On the other hand, climate appears to have a significant impact on human activities.

To understand this effect in the study area, we relied on the climatic information available at Babylon station, and the following is an explanation of the most important climatic elements.

Fifth: Temperature

Temperature is one of the most important elements of climate, in addition to its important impact on life above the Earth's surface

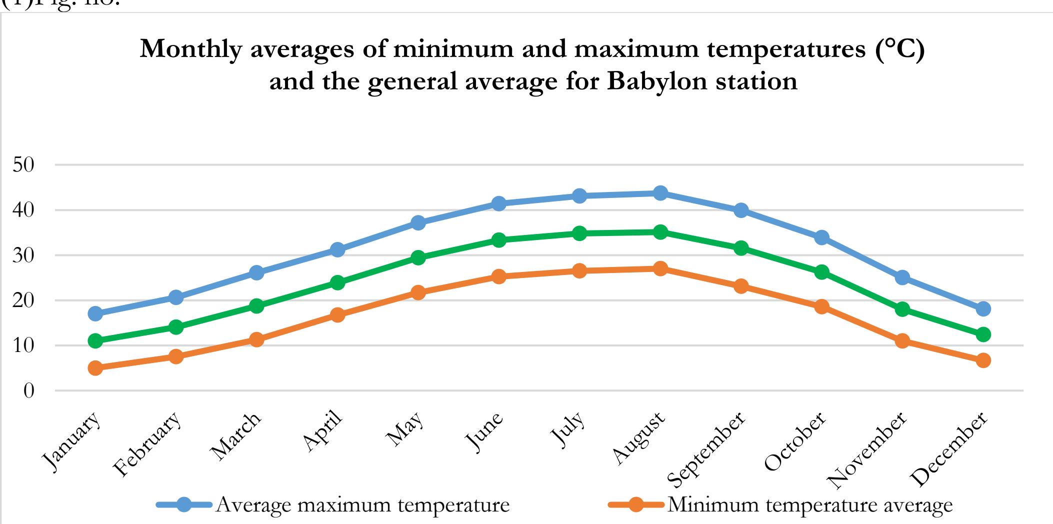
From Table (1) we see the following.Temperature rates vary greatly between the months of the year, with the highest rates being recorded during the months of July and August, when they reach (43.1-45.7) C°, respectively. This is because the sun is vertical or close to vertical with an increase in the number of hours of sunshine. The actual sun, in addition to the clarity of the sky, results in an increase in thermal values in a way that increases the amount of evaporation. Its lowest rates were recorded in the month of January, recording (17.0) °C .

Table (1) Monthly Averages of Maximum and Minimum Temperature (°C) and the General Average, for the Period (2022-2013)

Monthly rate	**Temperature rate**	**Temperature rate**	**Months**
year/m°	Min/°C	Maximum/°C	January
11.0	5.0	17.0	February
14.0	7.5	20.6	March
18.7	11.3	26.1	April
23.9	16.7	31.2	May
29.4	21.7	37.1	June
33.3	25.2	41.4	July
34.8	26.5	43.1	Dad
35.1	27.0	45.7	September
31.5	23.1	39.9	October
26.2	18.6	33.9	November
18.0	11.0	25.0	December
12.4	6.7	18.1	Annual rate

Source: Republic of Iraq, Ministry of Transport and Communications, General Authority of Water Weather, Climate Division, unpublished data 2022.

(1)Fig. no.



Source: Researcher Based on Data in Table (1).

Rain is an important climate element. The study area is located within the dry regions, on the basis that the amount of rainfall is small.

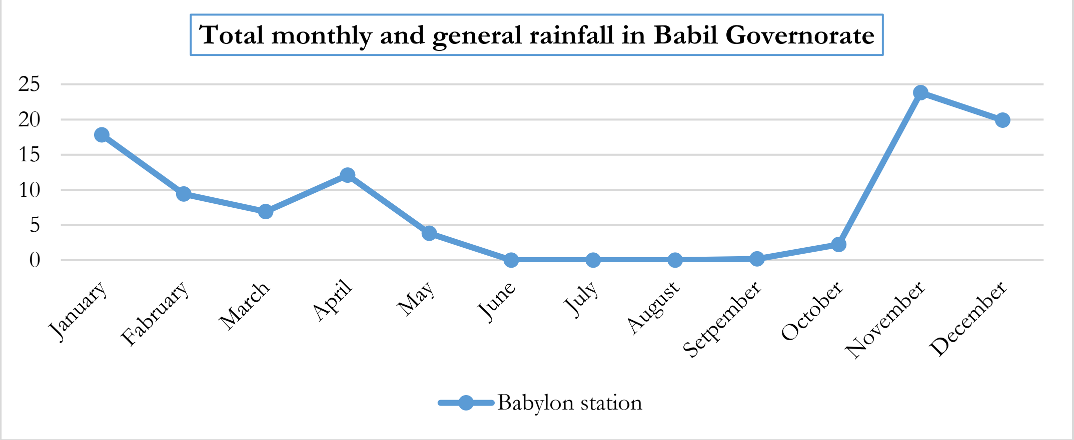
It is clear from this that the study area is characterized by seasonal rainfall, as it falls over relatively distant periods and forms showers.

From Table (2), it is clear to us that the period of rainfall is limited to the months of October until the month of May, and its annual total reaches (96.1) mm, and it is not distributed uniformly throughout this period, as it reaches (23.8) mm in the month of October, which is very little. While it reaches (19.9) mm in December .It stops completely in June and July due to high temperatures.

Table (2) Total Monthly and General Rainfall (Mm) in Babil Governorate for the Period (2013-2022).

Average	Dec.	Nov.	Oct.	Sep.	Aug.	Jul.	Jun.	May	Apr.	Mar.	Feb.	Jan.	Months
96.1	17.8	9.4	6.9	12.1	3.8	0.0	0.0	0.0	0.2	2.2	23.8	19.9	Babylon station

Source: Republic of Iraq, Ministry of Transport and Communications, General Authority for Meteorology, Climate Department, unpublished data 2022.



Source: Researcher Based on Data in Table (2)

Detect change and deterioration in vegetation in the study area.

Vegetation cover is an important indicator and measure of the deterioration of agricultural lands and land uses in general. It is necessary to continuously monitor the vegetation cover and analyze the changes, whether positive or negative.

Processing is used, which is a group of operations performed on the visual, aiming to increase the ability of visual interpretation in order to be able to sort and distinguish the features of the Earth's surface. This is done using software designed for this purpose that magnifies the small differences between the confined targets to make them easier to notice visually.

One of the main goals of remote sensing applications in agricultural fields is how to use satellite data to diagnose the type, density, and nature of the distribution of vegetation and the environmental conditions affecting the region, and evidence of cases of deterioration and decline.

Applying of the natural urban dissimilarity index :

Applying of the Normalized Difference Vegetation Index (NDVI)

The natural vegetative difference index was proposed by (Rouse, et, al. 1974). The most common indicator for measurement is the image resulting from calculating the Difference Index (NDVI) equation, which describes the state and distribution of vegetation cover. It appears with high reflectivity (in white) in areas with dense cover, and with low reflectivity in areas with little cover, as the density of vegetation is proportional. Its vitality is directly proportional to the NDVI value.

The values of the index (NDVI) range from (-1) to (+1), noting that plants in general do not have values for this index close to zero, which indicates that this index is within its previous advantages. It can be used to explain conditions prevailing in nature, whether they are plant bodies, water bodies, rocks, or "barren soil," as values close to (+1) indicate "the presence of dense vegetation cover and it is in a good state of health." The lower the value and the closer it approaches zero, the more the condition indicates the presence of my plant cover is scattered and not dense, and the value of the index of natural vegetative variation is calculated according to the following equation: (Al-Harbo, 2017, p. 95.)

$$NDVI= \left(\frac{\text{Nearinfrered- Red}}{\text{Nearinfrered+ Red}}\right)$$

So that :

NDVI = Normalized Difference Vegetative Index value.

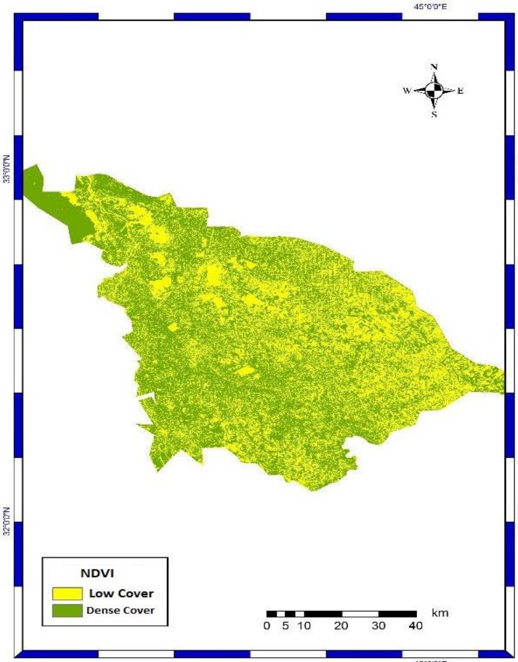
Nearifrered = infrared.

Red = red rays.
By analyzing table (3) for the year (2013 - 2023) and observing the map (5,4), it becomes clear to us.

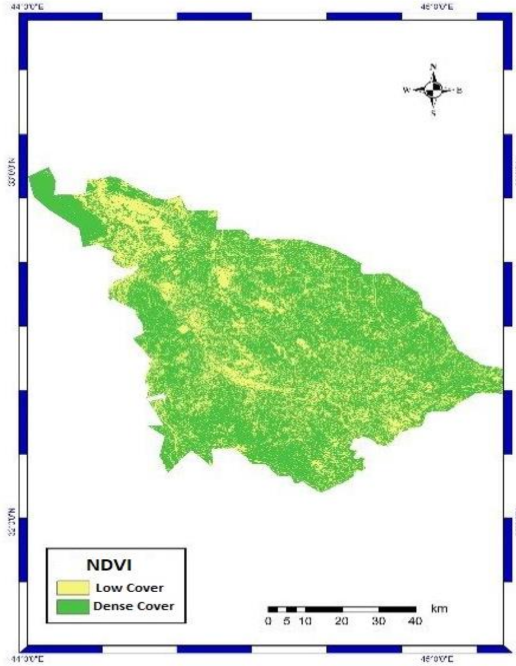
1- The cultivated area amounted to 4352 km2, about 67.3% of the total area of the region, which amounted to 6467 km2 in 2013, while the percentage of cultivated lands decreased in 2023, as the area of cultivated areas reached 3631 km2 about 55.8% of the area of the region, a decrease in cultivated areas.
2- As for the uncultivated lands (barren), their area reached 2,015 km2, about 32.7 km2 of the area of the region in 2013, while the year 2023 recorded an increase and expansion of the uncultivated areas, as their area reached 2,954 km2, about 44.2 km2 of the total area of the region, which amounted to 6,467 km2.

Table 3 . Cultivated and Uncultivated Areas in the Governorate for the Year 2013-2022.

Percentages%	Area km2	Categories	The year
67.3	4352	Cultivated lands	2013
32.7	2015	Barren lands	2013
55.8	3631	Cultivated lands	2022
44.2	2954	Barren lands	2022



Map (4) Urban Difference Vegetation Index
Source: Researcher, based on visual information
(Landsat 8) for the year 2023



Map (5) Vegetative Difference Index of Vegetation Cover
Source: Researcher, based on visual information
(Landsat 8) for the year 2013

Source: Researcher Based on Satellite Image for the Year (2023-2013) .

3. Drought Indicators

The natural environment is changing clearly in its life systems, due to its being affected by some natural conditions and human factors prevailing in the region. The climate changes that some regions of the world have experienced have led to the occurrence of waves of drought, which have had a severe impact on water resources and cover. Plant health, given the seriousness of drought, the effects of which are not limited to a limited area, monitoring and control indicators amounting to more than (80) drought indicators were created (Al-Harbo, 2017, p. 97). Spectral indicators are an effective method in monitoring the change in plant health, as in the twentieth century, spectroscopic indicators emerged to detect plant stress .

A. Soil moisture index NormalizedDifferrnce Mosture Index

This indicator is used to identify water areas to monitor changes in the water content of surface water in which plants may be exposed to moisture stress, to detect drought. (Hassouna, 2021, seventh session)

$$NDMI = \frac{BAND4 - BAND5}{BAND4 + BAND5}$$

Ndmi = Soil moisture indicator.

BAND4 = infrared.

BAND5 = short infrared .

It is clear from Table (3) and Map (7,6) that:

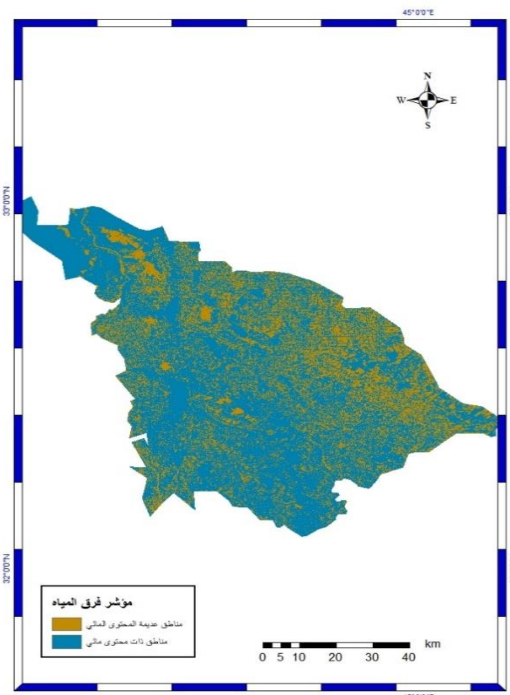
1. The year 2013 recorded an area of 1934 km2 about 29.9% areas with no water content, represented by dry and semi-arid areas, while the year 2022 recorded areas with no water content about dry, 3555 km2 of the area of the region, it increases in dry areas in the study area. Clear increase
2. The area of wetlands in the region in 2013 amounted to 4533 km2, i.e. 70.1% of the area of the region, while in 2023 wetlands recorded 2912 km2 about 45.1% .

Table (3) Aridity Index (Soil Moisture) for the Region.

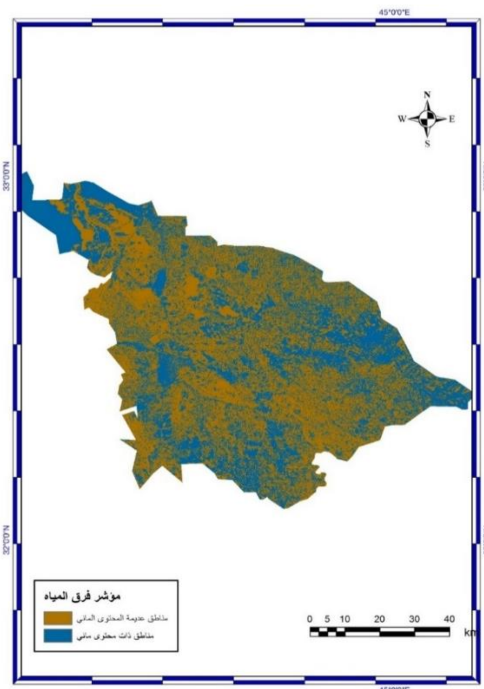
Percentage%	Area km2	Categories	The year
29.9	1934	Dry lands	2013
70.1	4533	Wetlands	2013
54.9	3555	Dry lands	2023
45.1	2912	Wetlands	2023

Table: From the researcher's work based on satellite visualization for the year(2023-2013)

Map (7) Soil Moisture Index



Source: The work of the researcher based on visual information (Landsat 8) for the year 2013



Source: The work of the researcher based on visual information (Landsat 8) for the year 2023

It became clear from this that Babil Governorate is suffering from the expansion of the phenomenon of desertification and that it has reached a significant degree of impact on the economic, social and health aspects, and that the reasons for the variation in the density of vegetation cover and the amount of soil moisture in the study area for the years (2013, 2023) are due to several reasons, including natural and human.

1. Climate changes: The climate and its characteristics have an effective role in explaining and distributing the density of vegetation cover, especially the elements of temperature and rain have a significant impact on the variation in the ratios. The rise in temperatures and the significant decrease in rainfall have a direct impact on the density of vegetation cover and soil moisture due to increased values. Evaporation, especially since the location of the study area is located within the arid and semi-arid climate. It can be noted that the northern parts of the region have dense vegetation cover and a rise in the values of the humidity index, as the northern parts are represented by the Hadiyah Dam. Therefore, we find that these parts contain dense vegetation cover and areas with Watery (wet). In addition, there is a range of vegetation spread around the Shatt al-Hilla, which passes through the middle of the study area. When observing the map, we find a widespread range of vegetation and a recording of soil moisture .
2. The rise in the groundwater level has led to salinization and waterlogging of the lands, which is why the waterlogged soil has become unsuitable for agriculture.
3. The encroachment of sand dunes and their threat to large areas of the region, especially (Jurf Al-Nasr, Al-Haswa, Al-Madhatiya district, the Nile, and Al-Haswa Al-Shamaliyah)
4. The human factor had a large and effective role, as the high population growth generated pressure on the lands (represented by urban sprawl) on productive lands and the emergence of a state of lack of self-sufficiency, especially in cutting down trees and destroying orchards.
5. The expansion of the salinity problem, as the percentage of lands salted or affected by salinity reached 14.47%, observed in the Al-Qasim, Medhatiya, Shomali, and Nile regions.
6. Overgrazing by large numbers of animals on lands with little vegetation and abandoned land, which increases wind erosion activity, as these areas generate hotspots of local dust .

4. Conclusions

1. Babil Governorate suffers from widespread desertification and an increase in barren lands in the region.
2. High temperatures and low rainfall are attributed to soil salinity, which led to a decrease in cultivated areas.
3. Urban expansion at the expense of cultivated lands in the region, in addition to the effects of wars, especially in 2015 in Jurf al-Nasr and the destruction of many orchards.
4. Detecting and identifying areas of change by applying indicators to the area, as the cultivated areas were concentrated around the Hadiyah Dam and on the banks of the Shatt al-Hilla.
5. The study identified places with high water content (rutba), as it indicated the Hindiyah Dam and Shatt al-Hilla, meaning that it matches the vegetation cover and its distribution in the region.
6. Conduct detailed studies on the causes of environmental deterioration in the governorate to reveal the degree of desertification in cultivated lands.

7. To quickly address and control the problem of encroachment of active sand dunes, especially in Jurf Al-Nasr, Al-Madhatiya and the Nile area.
8. Follow a controlled grazing system by creating pastures that meet the requirements of animals in the governorate while providing dry fodder.
9. Legislate and activate a law related to protecting the environment and natural resources from degradation resulting from human practices.
10. Preparing studies and plans to confront the expected population pressure on the governorate's vital resources because of population growth.

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