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TEMPORAL VARIABILITY OF LAND DEGRADATION IN SADDHA AL-HINDIA DISTRICT USING REMOTE SENSING (RS) AND GEOGRAPHICAL INFORMATION SYSTEMS (GIS) TECHNIQUES

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Abstract

The study area was selected to study the temporal variation of soil and land degradation in Sidat Al-Hindiya city in Babylon province. As a result of its deterioration due to bad weather conditions and high salinity in its lands. The study area is located in the north-eastern part of Babylon province within the coordinates between the Longitude ("0.0 07' 44°" and "0.0 '26°44°44°E)" and latitude ("0.0'38°32°n" and "0.0 '48°32° north) and an area (281) km^2, Satellite data from Landsat 5,7,8 sensors TM, ETM+ and OLI for years 1998, 2008, and 2018, Satellite data were collected for the years 1998, 2008 and 2018. The supervised classification was conducted by The Maximum Likelihood Classifier and evidence of environmental degradation in land cover patterns was extracted. Plant indices (Normalized Difference Vegetation Index NDVI, Soil Adjusted Vegetation Index (SAVI) and Soil Indices Barren Soil Index BSI in addition to Normalized Difference water Index NDWI. For study periods to monitor the degradation of soil, land and cover, It was used supervised classification methods limiting classes and calculated area of each index by using ArcGIS 10.5 software. where the results indicated the presence of a spatial and temporal variation of these evidence in the study area, a reflection of the state of variance in the nature of the land coverings, The results of the NDVI index showed that it is possible to define vegetative cover varieties from other land coverings with high accuracy and to be able to Monitor the state of temporal variation in them. The results showed that there is a temporal variation and deterioration in the area of thick vegetation, as it constituted 19.43%, 23.85% and 19.64% for the years 1998, 2008 and 2018, respectively. The results confirmed that the most important manifestations of the prevailing deterioration and negatively affecting the areas of agricultural land in the study area during the period from 1998 to 2018 is mainly urban sprawl due to the large increase in the population as well as the economic factor that helped to leave the land and not Attention to the maintenance of the drainage systems and the accompanying high level of land water and the activity of salt operations that have transformed large areas of productive land into non-agriculturally productive land.

Key words : Land Degradation, Saddha Al-Hindia, RS, GIS.

Introduction

The rapid increase in the numbers of human and animal societies is one of the most important factors that cause land degradation and desertification As a result of the increased exploitation of the natural resources represented by the resource depletion, water, forests and Pasture through continuous cultivation, overgrazing, mismanagement of land and deforestation (EPA, 2001), Also, the difficulty in estimating and assessing land degradation lies in its relationship to many characteristics related to the susceptibility of the land to crop production and is of unspecified value resulting from a set of interaction operations, each of which has its own terms of ranges and limits for detection and follow-up, and that most of the methods for assessing land degradation depend on survey methods Soil field and vegetation maps and land suitability assessment (Hill,2000), Hermayat (2000) attributes land degradation to negative changes in climatic characteristics, which are among the important basic elements that are directly affected by behaviour and activities that are not safe for humans such as devastating fires, logging, Soil erosion, desertification, and emitted gases that ultimately lead to air and water pollution and depletion of natural resource. Adam, (2009)showed that land degradation is a group of negative processes that extend over large areas of land, and that the best methods for reduced land degradation processes are physical, geographical, social, as well as economic factors and the social role of human. PACA,(2010) explained that there are several factors that lead to the deterioration of the vegetation and most of It is due to the influence of human activities and wrong practices on the land that leads to the land deterioration. Al-Juraisi and Al-Rawi (2014) showed when studying land degradation for the Al-Saqlawiyah and Ayman Al-Furat projects for the period between 1985 and 2012 that there is a slight increase in the areas of land with a slight deterioration, with a decrease in the areas of a moderately degraded land and an increase in the areas of lands is very deteriorating and due to the causes of the deterioration to the high amount of salinity in the soil and the decline of vegetation as well as Urban sprawl(population) on agricultural soils and converted into residential homes. Abbas and Mhemed (2011) studied the possibility of using remote sensing technologies in the North Kut Survey project and following up the spatial distribution of water soil content as well as supporting the results achieved with the results of fieldwork, Khaled (2012) employed remote sensing techniques and GIS techniques to collect information and data for the natural resources in the city of Tal Afar / Mosul, Monitor its changes, including soil degradation for the years (2009-2010-2011), Use of the global positioning system (GPS) and satellite imagery from the Landsat7. Ali and Mhemed (2016) studied the state of the temporal variation of the prevailing land cover in Baghdad province using remote sensing methods and geographic information systems(GPS) during the years 1976-1994-2014. Using the SAVI index and Supervised Classification Method, they noted that the climatic conditions and economic situation of the country affected the proportions and areas of the prevailing land cover. They also noted the existence of activity for the degradation of agricultural lands with time and showed the effect of the urban expansion and salinity factor on the areas of land cover and the state of temporal variation. Therefore, this study aims to determine the state of temporal variation in the areas of manifestations of soil degradation prevailing in the study area, employing some spectral indicators to assess the state of soil degradation in the study area by applying remote sensing and GIS technologies.

Materials and Methods

The study area (Sidat Al-Hindiya city) is located in the northeastern part of Babylon province within the coordinates between the longitude (3 0.0 07 ‘° 44 and 3 0.0’26 ° 44 E) and two latitudes (3 0.0' 38 ° 32 and 3 0.0 ‘ 48 ° 32 N), bordered to the north by the Al-Musayyib and Alexandria district, From the south, the Hilla district and the Abi Ghark district, and from the east, the Mahawil district and the Musayyib project region, and from the west Karbala province. As for its location in terms of the Landsat 8 track, it is within Path 167 and Row 37, and the study area is 281 km^2 (Fig. 1).

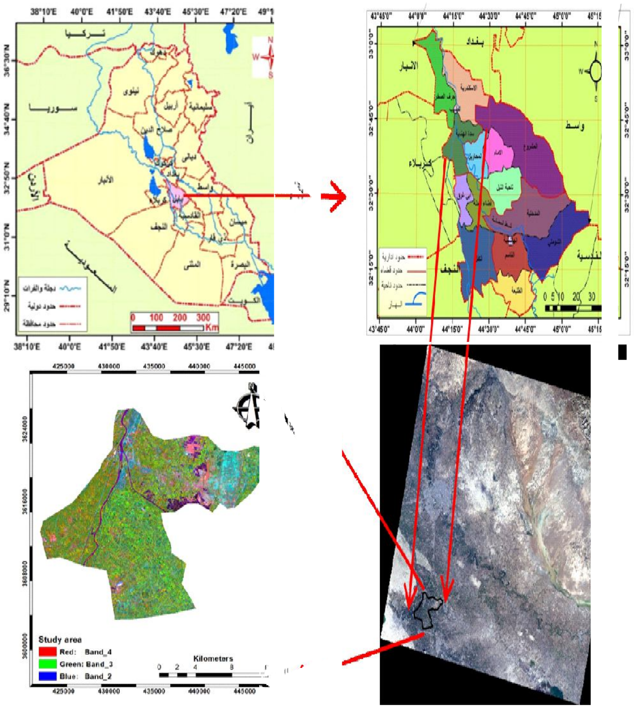

Fig. 1: The map of Iraq showing the location of the study area.

Satellite imagery was obtained from the Internet from the official USGS Global visualization viewer, with path 168, description 37 of the US industrial satellite Landsat 5,7,8 for ETM +, OLI TM sensors, respectively and through it, space data were collected for the years 1998, 2008 and 2018 to monitor the temporal change of the study area as shown in (Table 1).

Table 1: Capture date for satellite images used in the study.

Temporal	Sensor	Satellite Type	Rank
8-12-1998	TM	Landsat 5	1
25-11-2008	ETM+	Landsat 7	2
13-11-2018	OLI	Landsat 8	3

Some operations were performed to process space data depending on the nature of that data and what it needs from improvement, As some of them had been processed and corrected from the source, while others needed to do some treatment. Some of these steps include the following: Geometric Correction: The satellite data were corrected using the ERDAS Version 14 program, based on the coordinates of the land points recorded in the field using the GPS device. Spectral Enhancement of this data was also performed. Evidence used in the study,A number of spectral markers were used in this study for the purpose of diagnosing and determining the nature of the dominant land cover in the study area, and the most important spectral evidence is as follows:

1. Normalized Difference Vegetation Index (NDVI)

It is an equivalent index to a simple ratio and they represent a non-linear relationship with each other and it is proposed by Rouse *et al.,* (1974) is derived from the ratio between the difference between Package 4 and Package 3 to their sum of the ETM + and TM sensors of the Landsat. As the numerical data number of the visuals was used to know the changes in the values of the natural plant, it was also used from Huete *et al.,* (2002) according to the following formula:

NDVI = (B4 – B3) / (B4+B3)

2. Soil Adjusted Vegetation Index (SAVI)

The NDVI equation represents adding 0.5 to the denominator representing the soil reflection and multiplying the result by (L + 1), so L represents the Soil Adjusted Factor. Therefore, its value is always higher than the value of NDVI. Its value ranged between (0-1) according to the plant density, since Huete *et al.,* (1988) The optimum value L = 0.5 according to the following equation:

SAVI = [(B4-B3) / (B4+B3 +L)]*(L+1)

3. The Bare Soil Index (BSI)

This index is used to distinguish soil free from vegetation, as in the following equation (Jamalabad Abkar (2004):

(NIR + G) - R) / (NIR + G + R) BSI =

4. Normalized Difference Water Index (NDWI)

This index is used to detect water bodies as in the following equation McFeeters (1996)

NDWI = (Green-NIR) / (Green + NIR)

After verifying the accuracy of the results for the diagnosis and determination of the areas of the span of the prevailing land cover in the study area by relying on the methods of classification of space data and a number of evidence of the land cover and the method of its land verification implemented in 2018.The results of all effective methods close to natural reality were generalized after removing the interaction case between some types of covers and to an acceptable degree and were circulated to the rest of the space data for the time periods used in this study for the purpose of clarifying the case of temporal variation of the land cover expressing some aspects of land degradation that affected the areas Used for agricultural purposes, and previous steps were adopted to achieve this and as follows: -

Supervised Classification for space data

The Supervised classification process for the space data for the study area was conducted for the years 1998, 2008 and 2018 for the purpose of explaining the temporal variation in the type, areas, and the ratio of the land cover, which express some appearances of degradation land prevailing in the study area, The results shown in table 1 and Fig. (2, 3, 4) indicate that the water bodies in the study area showed the least areas and percentages they occupy compared to the rest of the other land covers and this is consistent with the nature of their environmental distribution at the global level due to the nature of the environmental conditions prevailing in Iraq, The results showed that the water bodies showed clear temporal differences in the area and the ratios they occupy, as the water bodies formed 2.65% in 2018 and that stage was characterized by the abundance of the quantities of river water, while this was reflected in the presence of some water bodies in several locations of the study area, The results indicated that the areas and ratio of water bodies of various types were decreasing during the years 1998 and 2008 as the ratios were 0.92 and 2.18% respectively, and this reflects the nature of climatic conditions that were directed towards drought and lack of rain, as well as a decrease in the amount of water received from its main sources Represented by Iran and Turkey, These results agree with Al-Jumaili (2012) showed that imports of the Euphrates River were 16.3 billion m^3 at the Al-Qaim plant for the water year 1999-2000 and decreased to 12.3 billion m^3 for the 2009-2010 period. The results also indicate an increase in the ratio of water bodies present in the study area in 2018, and may be the result of a slight increase in water releases from its main sources as well as an increase in the areas of land affected by water-logging due to the high rates of rain.

Use of Spectral evidence

Some Spectral evidence has been used for the purpose of determining some of appearing deterioration and land coverings in the study area and for specific types in order to bypass some cases of interaction between types of land cover that show close values of the reflective spectrum, especially urban areas and barren lands. The following are applications of some of these directories:

1. Normalized difference vegetation index (NDVI)

Mainly used in this manual for the purpose of separating and limiting plant coverings from other types of land coverings for the purpose of minimizing the effect of interaction conditions between them. The index of the difference in NDVI was calculated according to the formula. The results also indicated in Figs. (5, 6 and 7) that there is a spatial and temporal variability in the calculated NDVI values for the space data for the study area for the years 1998, 2008 and 2018, and this is mainly due to the nature of the variation in the type of land cover

Table 2: Status of Temporal variation of the types of land cover prevailing in the study area using the Supervised Classification.

Change 1998-2018		2018		2008		1998		Land cover class
%	Area km^2	%	Area km^2	%	Area km^2	%	Area km^2	
18.26	51.3	41.24	115.90	21.17	59.51	22.98	64.6	Agriculture land
7.72	21.68	30.38	85.38	41.54	116.75	22.66	63.7	Natural vegetation
-34.83	-97.86	12.07	33.94	27.37	76.92	46.9	131.8	Bare land
7.37	20.72	12.56	35.32	5.82	16.36	5.19	14.6	Building
1.73	4.85	2.65	7.45	2.18	6.14	0.92	2.6	Water body
-0.26	-0.74	1.05	2.96	1.87	5.28	1.31	3.70	River
0.0	0	100	281	100	281	100	281	Total

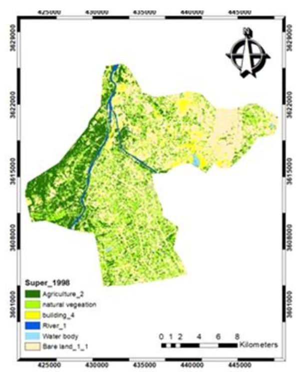

Figure 3: The Spatial distribution of the land cover using the Supervised Classification for the year 1998

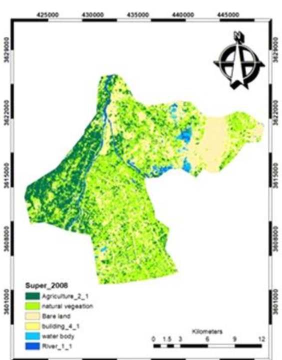

Figure 2: The Spatial distribution of the land cover using the Supervised Classification for the year 2008

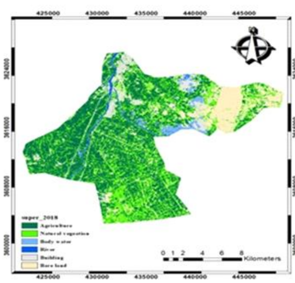

Figure 4: The Spatial distribution of the land cover using the Supervised Classification for the year 2018

in the study area spatially and temporally, as shown in a (Table 16). It is noted from the results that the values of the NDVI index different from year to year, as they ranged between 0.40 and 0.64 in 1998 and 0.37-0.72 in 2008. The results shown in Table 16 and Figure 21, 22 and 23 are confirmed. Positive values were high in 2008 (0.72) and this corresponds to the nature and density of vegetation prevalent in that year.

The results shown in table 3 indicate the presence of heterogeneity in the area and type of vegetation, as we note that the dense plant variety characterized by NDVI

Table 3: Status of variance in NDVI values for the study years.

Year	Max	Min
1998	0.64	-0.40
2008	0.72	-0.37
2018	0.50	-0.16

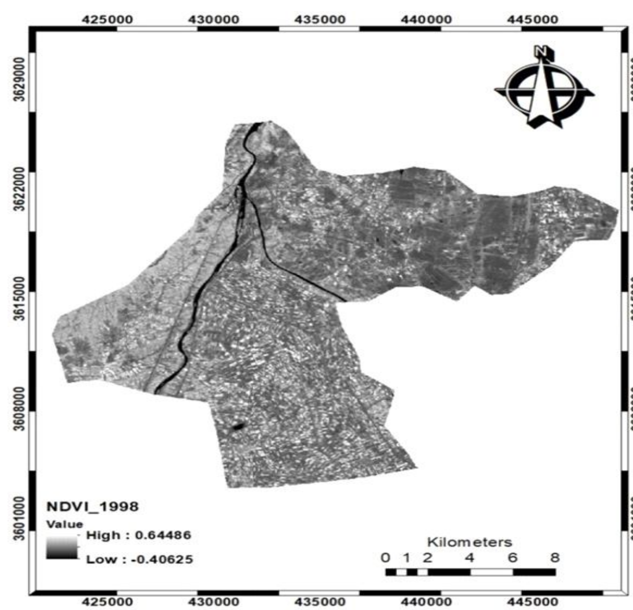

Fig. 5: Spatial distribution of NDVI values for 1998.

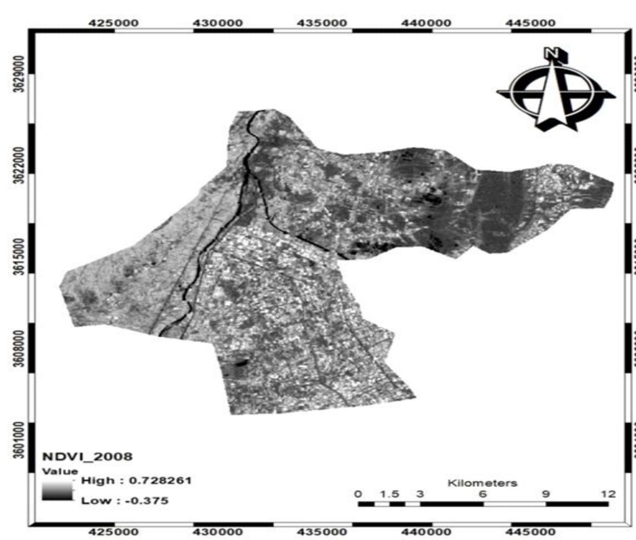

Fig. 6: Spatial distribution of NDVI values for 2008.

index values of more than 0.4 had an area of 54.67 and 55.26 km^2 in 1998 2018 and constituted 19.43% and 19.64% Respectively, This indicates an increase in the

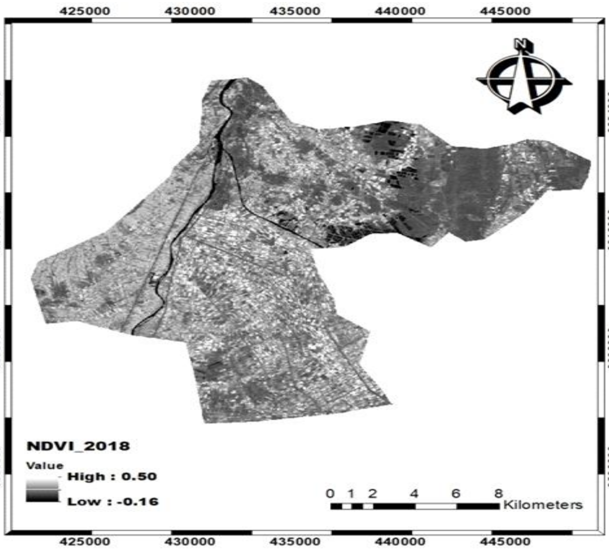

Fig. 7: Spatial distribution of NDVI values for 2018.

area by about 0.59 km^2 annually, while the time period 1998 to 2008 increased the area of this variety to 67.11 km2, by 23.85%, indicating that the increase rate was 1.2 km^2 annually, and these results are consistent with the nature of the pattern of change shown by the plant cover variety in time.

2. Soil Adjusted Vegetation Index (SAVI)

I use this Index mainly for the purpose of minimizing the influence of soils on vegetation and identifying vegetation and separating it from other types of another land cover. The index of adjusted vegetation cover for soil effect SAVI was calculated according to the formula. The results shown and Figs. (8, 9, 10) indicate that the SAVI has shown a spatial and temporal variation in the values of the evidence depending on the nature of the locational factors affecting the nature of vegetation and the nature of the soil on the reflectivity of different sites in the study area for the years 1998 2008 2018. As the values ranged between -0.6-0.66 in all study years and this reflects the state of variation in the nature of the prevailing land cover in the study area and as shown in table 4, the values of the evidence SAVI ranged between (0.60-0.96) in 1998, which indicates to the presence of a clear diversity in the types of land cover, including water bodies and soil waterlogged, which were characterized by low values (less than zero), as for vegetative covers, It was characterized by the highest values of the index (greater than 0.1). The results also indicate a decrease in the value of the index is 2008 (0.21 - 0.67), and this reflects the effect of the general conditions of the country that prevailed at that stage (the fragility of economic and agricultural conditions) and the negative impact on the vegetation cover in the type and quantity, which helped to decrease Directory values, While it is noticed that the index values increased in 2018, as they were between (0.25 and 0.75). This also corresponds to the nature of the environmental and internal conditions that Iraq has gone through and which have had a major impact on land use.

It is also noticed from the results table 5 that there is a clear variation in the areas and proportions of land cover

Table 5: Temporal variation of SAVI values during study years.

Year	Max	Min
1998	0.96	- 0.60
2008	0.67	-0.21
2018	0.75	-0.25

variety between the years of study. As it went through three stages of variation, in the period from 1998 to 2008 we find there is a decrease in the area of dense plant lands from 47.11 km^2 to 18.1 km^2, i.e. an annual drop rate of 2.9 km^2. And that this area turned into non-agricultural lands (abandoned and urban areas). In addition to the conversion of the category of poor-density agricultural lands to non-agricultural lands, as it decreased from 93.12 km ^{2} for the year 1998 to 80.1 km^2 in 2008 and the variation rate for this category was (1.30) km ^{2} annually, and the category of non-agricultural lands decreased from 137.5 for the year 1998 to 107.5 for the year 2008 And the rate of 2.9 km ^{2} annually.

3. Built up index (BI)

The class of buildings was isolated from the rest of the other types of lids more accurately and closer to the actual reality using the equation and the results shown in Figs. (11, 12, 13) and table 6 indicate that the values of

Table 4: Temporal variation in vegetation in the study area using the NDVI index.

Change 1998-2018		2018		2008		1998		Land cover class
%	Area km^2	%	Area km^2	%	Area km^2	%	Area km^2	
1.22	3.41	2.71	7.61	1.88	5.29	1.49	4.20	Water
-7.46	- 20.98	38.86	109.32	37.90	106.62	46.32	130.30	No vegetation
6.03	16.97	38.79	109.13	36.37	102.32	32.76	92.16	Low vegetation
0.21	0.59	19.64	55.26	23.85	67.11	19.43	54.67	Dense vegetation
0	0	100	281	100	281	100	281	Total

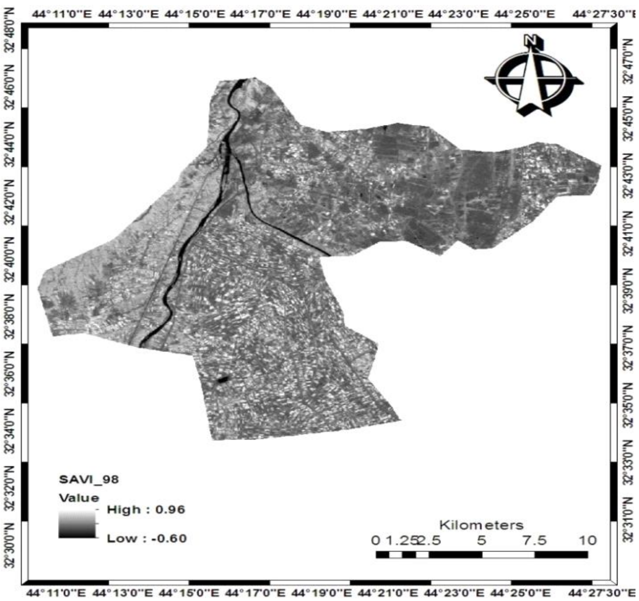

Fig. 8: Spatial distribution of the SAVI index values for 1998.

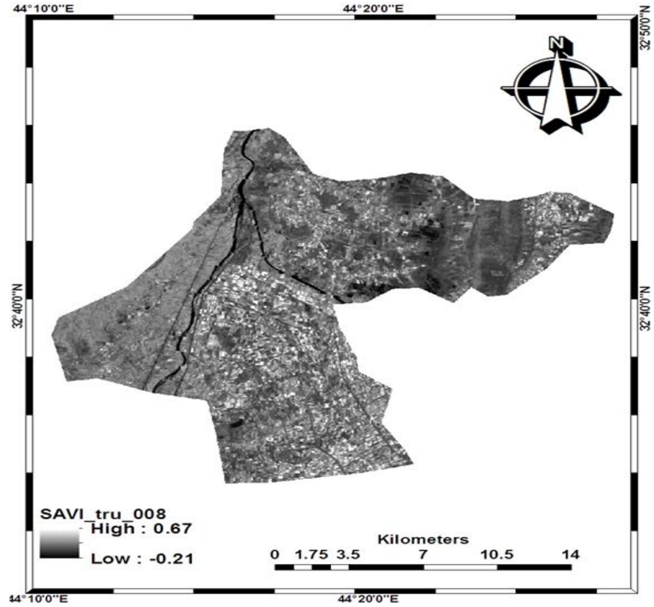

Fig. 9: Spatial distribution of the SAVI index values for 2000.

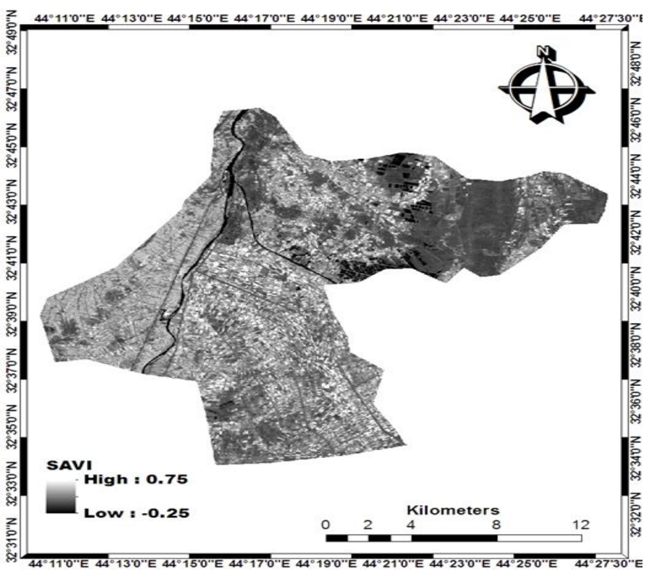

Fig. 10: Spatial distribution of the SAVI index values for 2018.

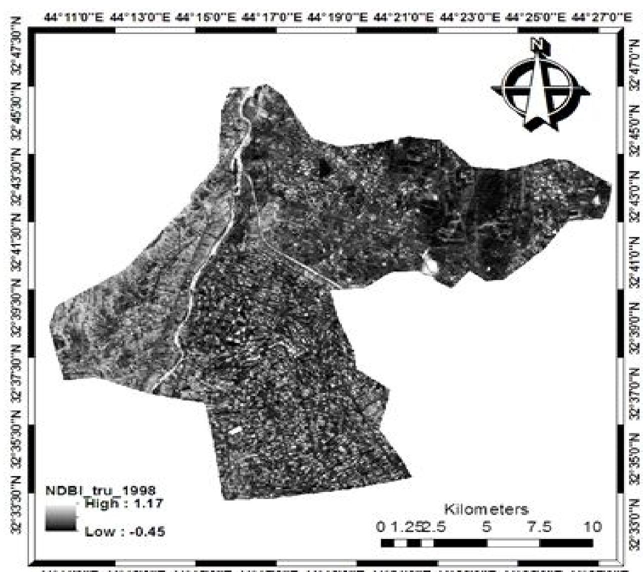

Fig. 11: Spatial variation of NDBI values for years 1998.

the BI evidence showed a spatial and temporal variation in the study area where the values were The index ranges from (-0.30 to 1.52). It is noted from the figures that the class of buildings appears in light color due to the high positive index values, while the rest of the land covers appear in the darkest color due to the decrease in negative index values and this is due to the nature of the spectral beams used to calculate the evidence values and their relationship to the spectral reflectivity values of those packages shown by the environmental components, as

Table 6: Temporal variation of vegetative cover by using SAVI index.

Change 1998-2018		2018		2008		1998		Land cover class
%	Area km^2	%	Area km^2	%	Area km^2	%	Area km^2	
1.4	3.94	2.86	8.04	26.9	75.7	1.46	4.1	Water
-7.2	-20.5	41.5	116.5	38.3	107.5	48.76	137.02	No vegetation
2.9	8.4	36	101.5	28.5	80.1	33.14	93.12	Low vegetation
2.9	8.19	19.7	55.3	6.4	18.1	16.83	47.11	Dense vegetation
0	0	100	281	100	281	100	281	Total

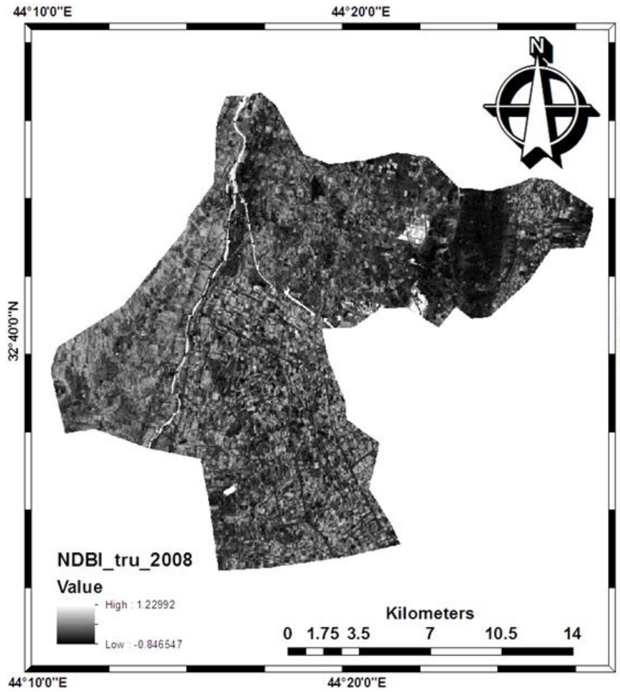

Fig. 12: Spatial variation of NDBI values for years 2000.

Table 7: Temporal variation of BI values during the study years.

Year	Max	Min
1998	1.17	-0.45
2008	1.22	-0.84
2018	1.52	-0.30

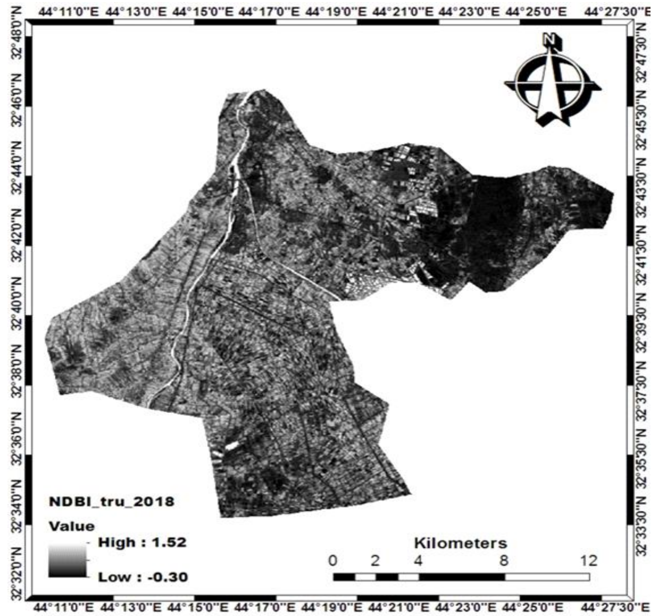

Fig. 13: Spatial variation of NDBI values for years 2018.

Table 8: Temporal variation in the buildings class in the study area using the BI index.

Change 1998-2018		2018		2008		1998		Land cover class
%	Area km^2	%	Area km^2	%	Area km^2	%	Area km^2	
-16.2	-5.9	42.7	120	45.6	128.2	48.6	136.2	Bulit
16.4	5.9	20.9	58.7	16.8	47.3	15	42.3	Water
-0.4	-0.3	36.5	102.5	37.7	105.8	36.8	102.9	Other
0	0	100	281	100	281	100	281	Total

the equation indicates This index is for using the near-infrared beam and the short infrared beam.

The results indicated in table 7 and Figs. (36, 37 and 38) that there is a temporal variation in the area of the class of buildings in the study area, as well as the presence of a continuous decrease in the class of buildings as it occupied an area (136.2, 128.2 and 120 km^2) for the years 1998 and 2008 and 2018, respectively, and it is noted from the results that there are varying annual decline rates between the years used in the study. As the decrease for the two periods from 1998 - 2008 and 2008-2018 has reached approximately 0.8 km ^{2} annually, as it showed a difference from one stage to another due to the state of variation in economic and human conditions that passed through Iraq during the years of the study of instances of stability and lack thereof, which directly affected the urban movement in the country and then on the heterogeneity in agricultural areas, These results agree with Kumar (2015) who used the NDBI index to extract built land and calculate the expansion of built land in Ranchi and noted the expansion of the built area by 39% over the period from 1972-2010.

4.Normalized difference water index (NDWI)

The temporal variability of water bodies in the study area has been studied for the years (1998, 2008 and 2018). The results shown in (Table 8, 9) and Figs. (14, 15 and 16) indicate that the values of this index have shown clear spatial and temporal variations. As the index values ranged between (0.67- and 0.70) and that was in 2018. These results agree with the areas and proportions of water bodies that were high in 2018 compared to the rest of the years. This index has been used mainly to diagnose, identify and isolate water bodies from the rest of the classes of land covers, especially those with reflectivity close to water bodies, and to remove the state of interaction between them. Whereas, water bodies, in general, led to the highest values of the NDWI index, compared to the rest of the other environmental components.

The results indicated that there was an increase in the category of water bodies as they occupied an area (5.20, 113.9 and 8.5 km^2 in 1998 2008 2018 respectively)

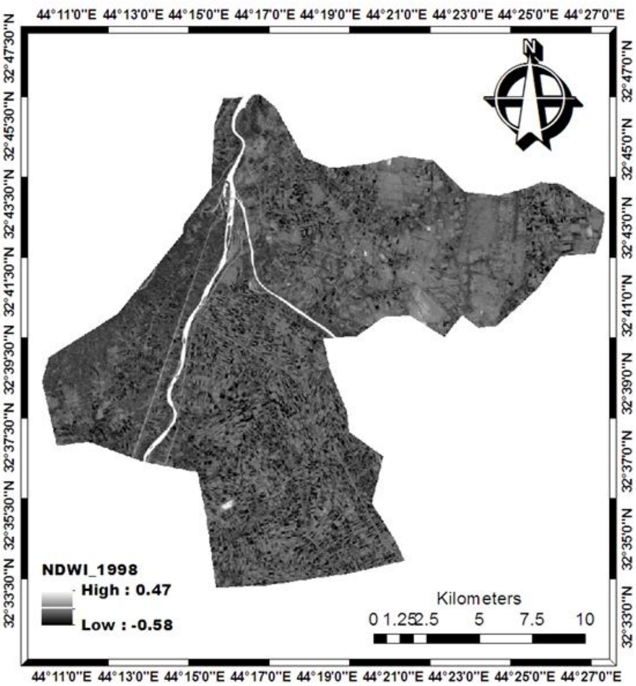

Fig. 14: Spatial Variation of NDWI index Values for 1998.

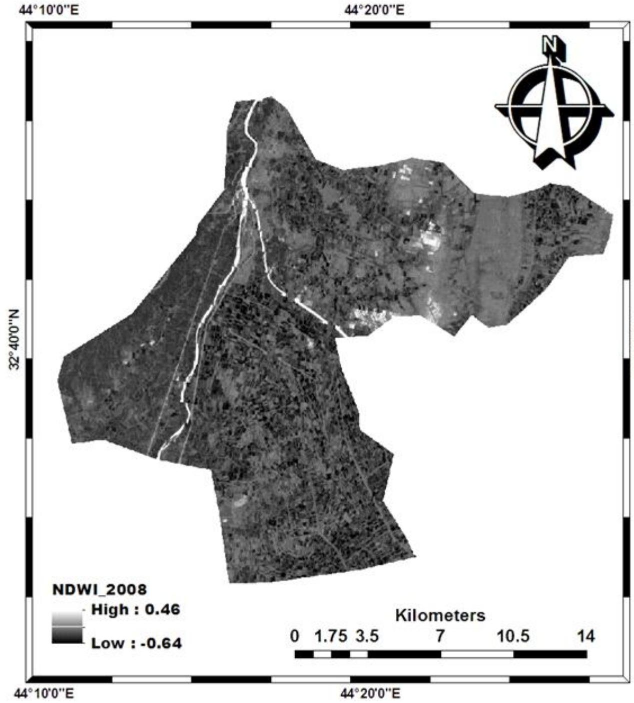

Fig. 15: Spatial Variation of NDWI index Values for 2008.

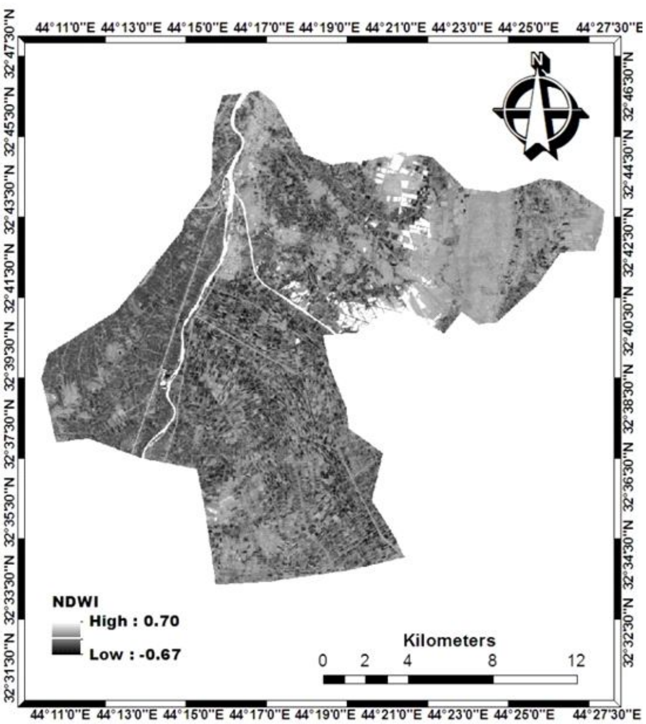

Fig. 16: Spatial Variation of NDWI index Values for 2018.

Table 9: Temporal variation of NDWI values during the study years.

Year	Max	Min
1998	0.47	-0.58
2008	0.46	-0.64
2018	0.70	-0.67

and the rate of increase in water bodies was 108.7 km^2 annually for the year 1998 - 2008 while the percentage of decline for 2018 was due to the policy of neighboring countries as well as High temperatures for the year 2008-2018.

Conclusions

The presence of a spatial and temporal variability of all the prevailing land coverings in the study area as a result of the influence of locational and human and economic factors, and that the human factor has a significant impact on land degradation activity, represented by an increase in population and misuse of land as well as the economic factor of farms.

Table 10: Temporal variation of water cover during the study years.

Type of Change in area	1998-2008) Relative Changes %	Relative Changes for area km2	2008		1998		Land cover class
			%	Area km2	%	Area km2	
Increase	38.7	108.7	40.5	113.9	1.85	5.20	Water
Decrease	-38.6	-108.5	59.6	167.5	98	276	Other

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