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DETECTION AGRICULTURE DEGRADATION FOR THE SOUTH OF BAGHDAD CITY USING REMOTE SENSING DATA FOR YEARS 2010-2019

Taif Adil DHAMIN [1], Ebtesam F. KHANJER [2] & Fouad K. MASHEE [3]

Abstract

Recently, the develop of the science of remote sensing enabled humanity to achieve the accuracy and wide coverage for different natural phenomena, disasters and applications (such as desertification, rainstorms, floods, fires, sweeping torrents, urban planning, and even in military). The main aim of this study is monitoring, highlighting and assessing maps for the degradation of agriculture in the south areas of Baghdad governorate (Al-Rasheed, Al-Yusufiyah, Al-Mahmudiyah, Al-Latifiyah, and Al-Madaen). Based to several factors, including the economic, social and military operations, the area had suffer the lands degradation which led to agriculture retreating. Remote sensing and Geographic information system (GIS) was applied, using ArcGIS 10.4.1 to process, manage, and analysis datasets, beside field verification to estimate the severity assessment of a computerized land degradation. Two satellites were adapted Landsat5 TM+ and Landsat8 OLI/TIRS imageries to assess the extent of land degradation for the study area during the years (5th May 2010 and 2nd May 2019). Two indices used in this research are: The Normalized Difference Vegetation Index “NDVI”, and The Normalized Differential Water Index “NDWI”. The results showed that there is a clear spatial reduction in both NDVI and NDWI, where the NDVI reduced from 2461082400 m2 to 1552698000 m2, accounting for 89.67 and 56.57 percent, respectively, while the NDWI reduced from 14166000 m2 to 12053700 m2, accounting for 0.52, and 0.44 percent, respectively.

Keywords: Agriculture Degradation, RS and GIS Techniques, Landsat Satellite Imagery, NDVI And NDWI.

[1] Baghdad University, Iraq, taifadil90@gmail.com, https://orcid.org/0000-0002-9757-710X
[2] Baghdad University, Iraq, dr.efk33@yahoo.com
[3] Baghdad University, Iraq, Phdfouad59@gmail.com, https://orcid.org/0000-0002-0519-7346

1. Introduction

Lands of Iraq, inclusive Baghdad areas are actual fertile lands, favorable for agriculture production that can mainly contribute to enriching the national wealth. As the world clearly and rapidly witnesses changes in the climate today as a result of many factors, including human activities of the human being, represented by the industries development and the resulting industrial waste such as acidic fumes and gases which led to excessive oxygen consumption, that led to the expansion of the ozone layer opening, which exposed the Land Cover (LC) to abnormal stresses [1,2], these changes led to widening the phenomenon of deterioration in green spaces (forests, land covered with weeds and farms), desertification, and little water (rain) [2].

As a result, land degradation is cosider one of the most serious problems in the world, where defined as stated in the United Nations Convention to Combat Desertification (UNCCD-1997) as the decreasing or loss of land productivity and the loss of its biological diversity, temporarily or permanently, caused by the natural factors or processes resulting from human activities, includes all types of lands, whether they are agricultural lands, pastures or forests [3].

As it requires two interrelated, complex systems: the natural climate system, including (temperature, rainfall, humidity, wind) and the human social system, causes of land degradation are not only biophysical, but also socio- economic (marketing, income, human health, institutional support, poverty), undermining food production and political stability [4].

The land degradation primary driving factors for are associated with climate variability and anthropogenic factors, Which can be attributed, Extended droughts, caused by shifts in precipitation and increased temperature, influence the distribution of vegetation and constitute the main driver for initiating and exacerbating desertification [5].

Soil erosion caused by water and/or wind and the deterioration of the chemical, physical, and biological properties of the soil [6,7].

Poor use of land practices and human activities such as unsustainable agricultural practices, deforestation, and overgrazing and military operations [8].

Remote sensing has long been recommended for its potential role to detect, map and monitor degradation problems with spatial and spectral resolution and for the detection of degraded areas including their spread effects with time [9,10].

With the aggravation of these problems in the modern era, there have been many scientific studies of land degradation cases, using the techniques of remote sensing (RS) and geographic information (GIS) systems [11], for its highly advantages effective technology in agricultural studies, in its various fields, where it has become possible to monitor the changes that occur, observe the manifestations of degradation processes [12], locating and define their areas within the visible and infrared spectrum bands [13], and build an integrated geographic database, using applications and software Geographic information systems for preparing digital maps, all of that lead to the ease handling, measuring, managing, and analyzing them [14], and ensuring easy storage and the possibility of viewing it from several different angles in a short time [15].

1- Research Propos

Detecting the processes of agricultural degradation and investigating the extent and magnitude of the deterioration in selected areas in the southern parts of Baghdad for a period from 2010-2019 while identifying the causes of agricultural deterioration

2- Study Area

Baghdad province of the capital of Iraq, it is located almost in the middle with latitude and longitude of (33.452°N → 33.184°N and 44.189°E → 44.576°E) degree minute of the globle coordinate system. It ranks the first in Iraq's, the population of Baghdad is approximately 7,500,140 [16], extended over an area of approximately 205,100 m2, includes 14 administrative units, eight in Rusafa (east of the Tigris River) and six in Karkh (west of the Tigris River). The study area extends between at Universal Transverse Mercator (UTM) of the planet state metric in coordinate system at the top left corner is (406523.257 3677854.421 m) and down right corner is (498088.487 3630828.327 m) [17], as shown in Fig. 1.

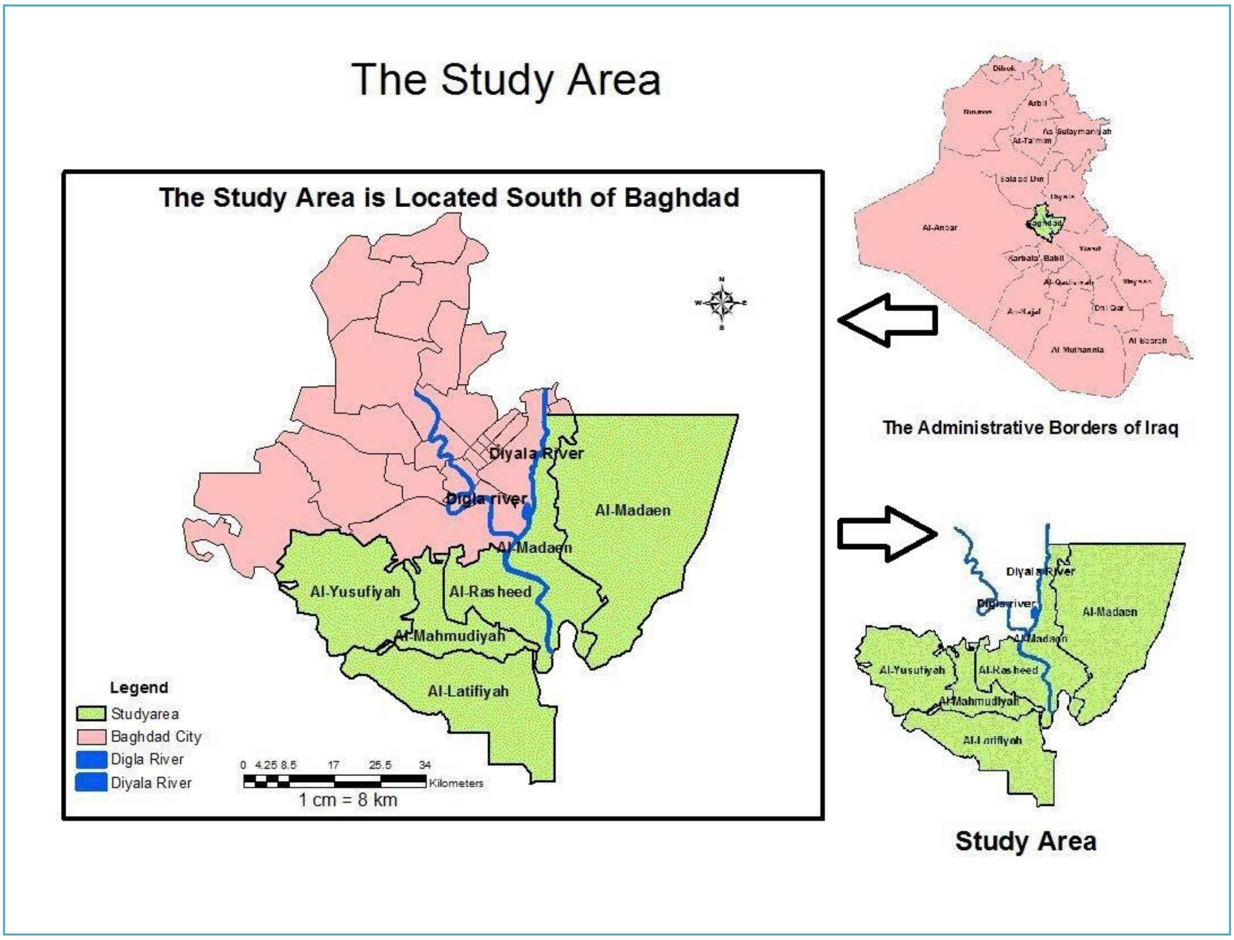

Fig. 1. Illustration the administrative borders of the study area, which are located south of the Iraqi capital, Baghdad, which are, (Al-Rasheed, Al-Yusufiyah, Al-Mahmudiyah, Al-Latifiyah, and Al-Madaen) counties.

3- Data Acquisition

The study area scenes from the LANDSAT 5 Thematic Mapper (TM) sensor, and Landsat 8 OLI / TIRS sensor satellites were used at various times, on May 5, 2010, and May 2, 2019, from the United States Geological Situation (USGS) agency [18], see table 1.

Table 1. Landsat Satellite Sensor Information

Satellite	Date of Lunch	Date of Decommission	Sensors
Landsat-5	1984/3/1	Service	MSS/TM
Landsat-8	2013/2/11	2013/6/5	OLI/TIRS

Table 2. Band ratio process for the appropriate view for the purpose of visual interpretation used in the classification technique

Landsat 5 (TM sensor)	Wavelength (µm)	Resolution (m)
Band 7	2.08 - 2.35	30
Band 4	0.76 - 0.90	30
Band 2	0.52 - 0.60	30

Landsat 8 (OLI and TIRS sensor)	Wavelength (µm)	Resolution (m)
Band 7	2.11-2.29	30
Band 5	0.77-0.90	30
Band 3	0.53-0.59	30

While examining and loading the images they must contain the lowest possible noise in the scene such as (clouds, , water vapor, aerosols weather changes and thick smoke) [19].

4- Methodology:

The research methodology included three basic stages, which are:

4.1. Pre-processing of images: The pre-processing for the dataset included image registration and rectification of TM+ imageries and OLI/TIRS imageries, were based on control points collected from vector files of the e study area, dated on 5th May 2010, and Landsat8 OLI/TIRS in 2nd May 2019.

4.2. Post-processing of images: Two interaction goals followed in this study. In the first stage, remote-sensing techniques are used in evaluation of surface changes and determination of the type of land use classes. In the next stage, the area is evaluated for climate and environmental change by using a prominent land degradation indicator method and GIS tools and then to analyses the impacts of land use/cover class expansion on agriculture degradation. The geometrically rectified and radio-metrically calibrated, TM+ bands 2, 3, 4, 5, and 7 were used to derive the studied indices. Satellite-derived index images were produced to portray surface changes.

4.3. Classification**:**

Classification technology uses two types:

4.3.1. Supervised Classification: This type of classification develops spectral signatures from locations that have been defined by the user. One method is through designating a pixel (the smallest element in the satellite image and is calculated by the neighboring totals at least 2 adjacent pixels and above). Theoretically, this method is the best classifier [20].

4.3.2. Unsupervised Classification: This classification type categorizes pixels into a pre specified number of statistical clusters. Usually, it is done when little knowledge of the study area is possessed [20].

5- Discussions:

The Supervised Classification Results:

As shown in Figure (2) and table (3) the statistical analysis for supervised classification technique for the study area , the total area of the arable land is (906733800 m2) and the percentage is 33.04% of the total survey area of (2744541900 m2) for the fifth month of the year (2010), but for the fifth month of year (2019) the ratio was 24.84% and the area extracted (681684300 m2) and this means an decrease in the green area.

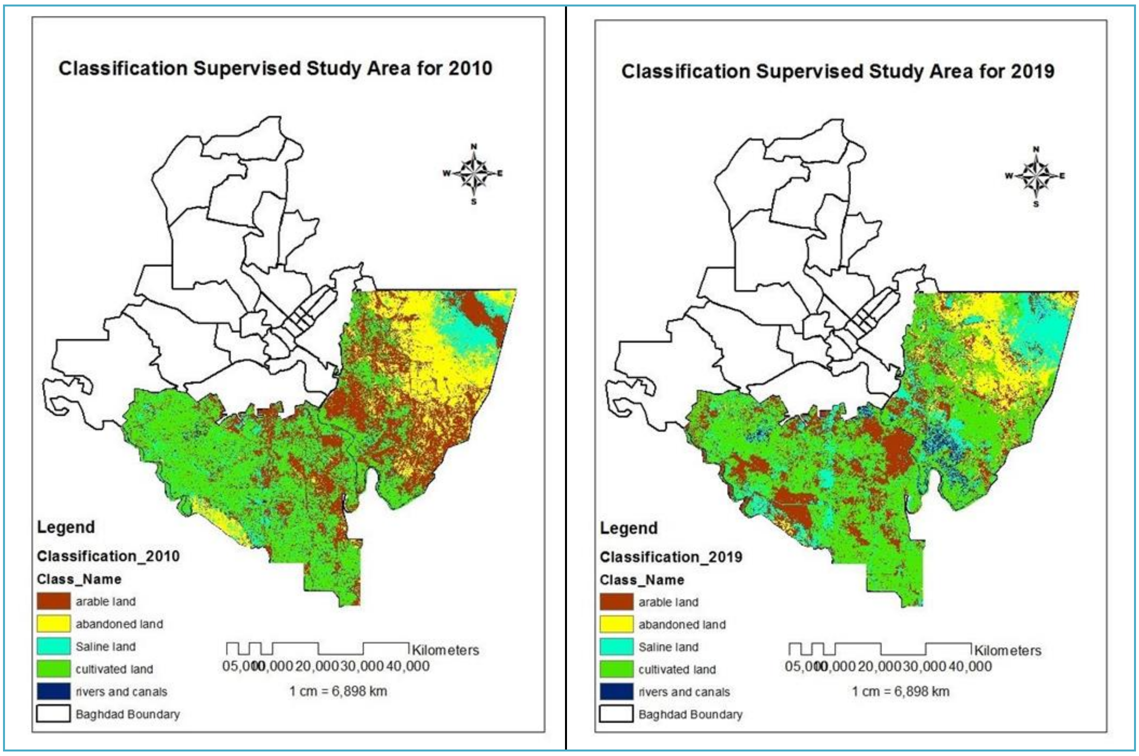

Fig. 2. Supervised Classification of composite (visible images) for 2010 and 2019 years periodic respectively. The statistic was calculated for the features (Arable, Abandoned, Saline, Cultivated and Rivers and canals Types)

Table 3. Calculating statistical pixel content each features classification.

Supervised Classification							
		2010\5\5			2019\5\2		
No	Class	Area m2	%Area	Sum of Pixels	Area m2	%Area	Sum of Pixels
1	Arable land	906733800	33.04	1007482	681684300	24.84	757427
2	Abandoned land	466678800	17.00	518532	313468200	11.42	348298
3	Saline land	393303600	14.33	437004	545274900	19.87	605861
4	Cultivated land	952685100	34.71	1058539	1134562500	41.34	1260625
5	Rivers and canals	25140600	0.92	27934	69552000	2.53	77280
Total		2744541900	%100	3049491	2744541900	%100	3049491

The total area of the abandoned land is (466678800 m2) and the percentage is 17.00% of the total area of the year (2010), but in 2019 the ratio was 11.42% and the area extracted (313468200 m2) and this means a decrease in the area.
The total area of the saline land is (393303600 m2) and the percentage is 14.33% of the total area of the year (2010), but in (2019) the ratio was 19.87% and the area extracted (545274900 m2) and this means an increase in the area with saline lands.
The total area of the cultivated land is (952685100 m2) and the percentage is 34.71% of the total area of the year (2010), but in (2019) the ratio was 41.34% and the area extracted (1134562500 m2) and this means an increase in the green area.

The total area of the rivers and canals is (25140600 m2) and the percentage is 0.92% for the fifth month of the year (2010), but in (2019) the proportion was 2.53% and the extracted area was (69552000 m2), and this means there is an increase in water, shown in figure (3).

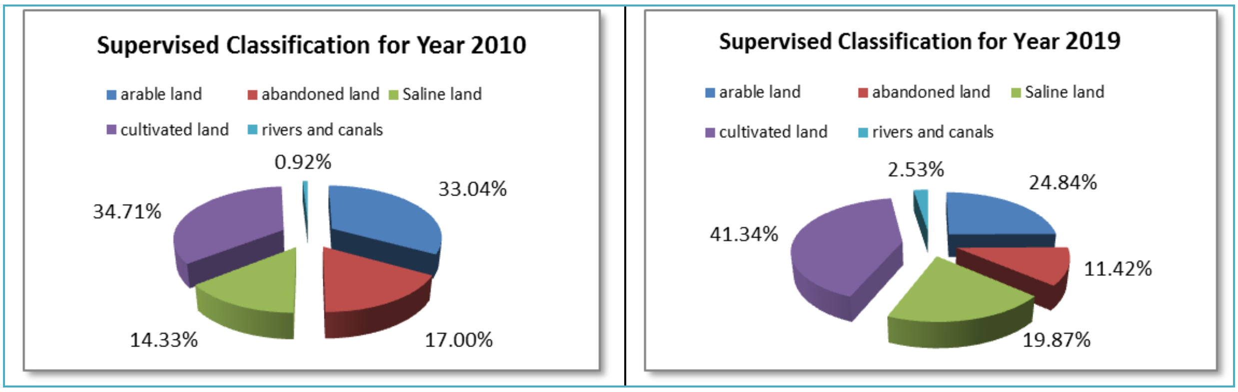

Fig. 3. Chart of Supervised Classification techniques for years 2010-2019.

The two indices covered in this study were tested for vegetation changes; Normalized Difference Vegetation Index (NDVI), Normalized Difference Water Index (NDWI), were calculated on basis of the following equations, respectively:

- **Normalized Difference Vegetation Index (NDVI)**

The NDVI is a calculation used to identify vegetation and its health through the levels of chlorophyll detected in the leaves. It has been widely used for remote sensing of vegetation, uses radiances or reflectance from a red channel around (0.66 μm) and a near-IR channel around (0.86 μm) . The red channel is located in the strong chlorophyll absorption region, while the near-IR channel is located in the high reflectance plateau of vegetation [21].

NDVI is calculated from the visible and near-infrared light reflected by vegetation [22].

To apply the NDVI the following formula is used [23];

NDVI = (NIR–R Visible) / (NIR+ R Visible) ...., (1).

Where:
NDVI, Normalized difference vegetation index
NIR, Near Infra-Red channel and R: Red band visible

- **NDVI Normalized Difference Water Index (NDWI)**

The water index is usually calculated in order to monitor the water condition in the study site, it is a satellite-derived index from the Near-Infrared (NIR) and Short Wave Infrared (SWIR) channels. The SWIR reflectance reflects changes in both the vegetation water content and the spongy mesophyll structure in vegetation canopies, while the NIR reflectance is affected by leaf internal structure and leaf dry matter content but not by the water content. The combination of the NIR with the SWIR removes variations induced by leaf internal structure and leaf dry matter content, improves the accuracy in retrieving the vegetation water content. The amount of water available in the internal leaf structure largely controls the spectral reflectance in the SWIR interval of the electromagnetic spectrum. SWIR reflectance is therefore negatively related to leaf water content [24].

The change in land cover is estimated using the water standard difference indicator NDWI by the equation:

NDWI = (SWIR-NIR) / (SWIR+ NIR) ...., (2).

Where:
NDWI, Normalized Difference Water Index
NIR, Near Infra-Red Band
SWIR, Short Wave Infrared Band
Both (NDVI) and (NDWI) range between value (+1.0, -1.0)

- **(NDVI) Results and Discussions :**

The statistical analysis of the supervised classification technique for south Baghdad area was illustrated in table 4, and the change was measured using the NDVI indicator. The total area of south Baghdad is

(2744541900 m2). From this area, the quantities of the vegetation cover were calculated, and its area (2461082400 m2) about 89.67% in 2010. On the other hand in 2019, the area of vegetation cover (1552698000 m2) was 56.57%. The area of land without vegetation was also measured in 2010 and it is estimated (283459500 m2), 10.33% of the total area. In 2019, the total area without vegetation cover is estimated at (1191843900 m2) with a percentage of 43.43%, shown in figure 4 and 5. That is leading to the fact of decreasing in the area of vegetation, which is the highest recorded in the controlled classification process for the study area. This shows that the NDVI process is accurate.

Table 4. Calculating statistical pixel content features classification of Change Vegetation (NDVI).

Change Vegetation (NDVI)							
		2010\5\5			2019\5\2		
No	Class	Area m2	%Area	Sum of Pixels	Area m2	%Area	Sum of Pixels
1	Water Body	2461082400	89.67	2734536	1552698000	56.57	1725220
2	Without Water	283459500	10.33	314955	1191843900	43.43	1324271
Total		2744541900	%100	3049491	2744541900	%100	3049491

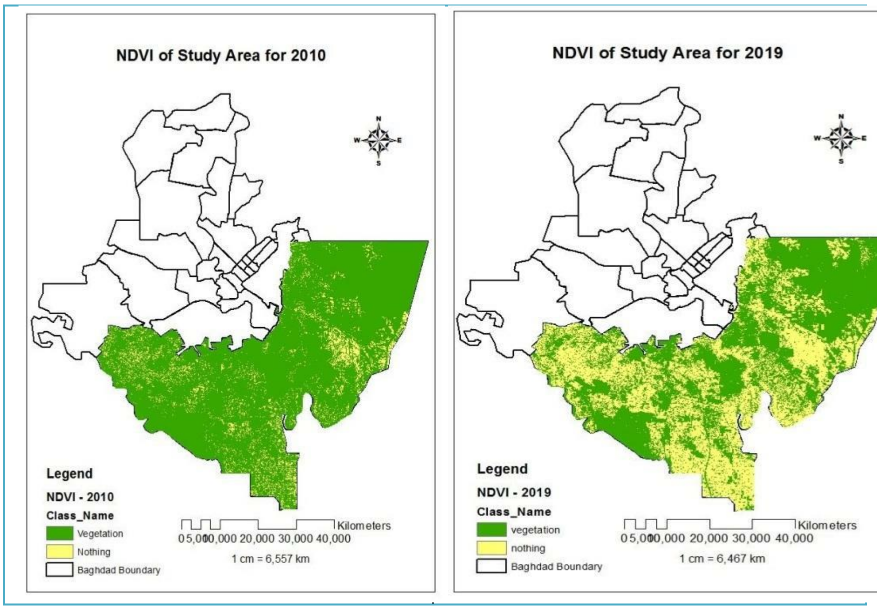

Fig. 4. The Band Ratio process for calculating the Normalized Difference Vegetation Index (NDVI) for the study area for years (2010-2019) respectively.

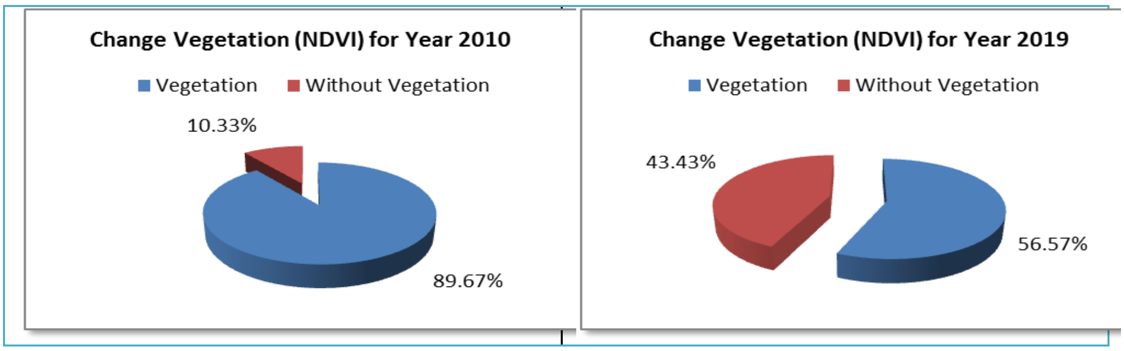

Fig. 5. Chart of Supervised Classification techniques of Change Vegetation (NDVI) for years (2010-2019).

(NDWI) Results and discussion

Water content area was illustrated in table 5, where the total area for 2010 is (2744541900 m2), which constitutes of 0.52% of water body with area of (14166000 m2), and the remaining area without water is (2730375900 m2)with 99.48% percentage. The total area of water in 2019 is (2744541900 m2), which constitutes 0.44% of water body with area of (12053700 m2), and the remaining area without water is (2732488200 m2) with a percentage of 99.56%. We conclude that the quantities of water in south Baghdad during 2010 were more than 2019, and this indicates that the rainy season was better. The decreasing in water will affect the spread of natural vegetation and the result of human activity, as shown in figure 6 and 7.

Table (5): Calculating statistical pixel content each features classification of Change Water Body (NDWI)

Change Water (NDWI)							
		2010\5\25			2019\5\2		
No	Class	Area m2	%Area	Sum of Pixels	Area m2	%Area	Sum of Pixels
1	Water Body	14166000	0.52	15740	12053700	0.44	13393
2	Without Water	2730375900	99.48	3033751	2732488200	99.56	3036098
Total		2744541900	%100	3049491	2744541900	%100	3049491

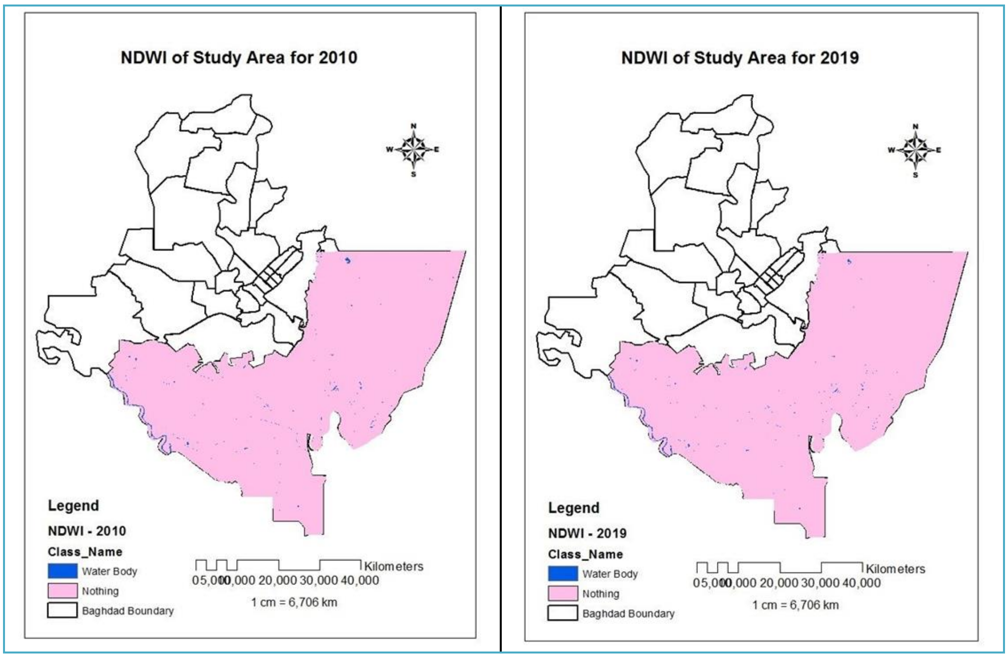

Fig. 6. The Band Ratio process for calculating the Normalized Difference Water Index (NDWI) for the study area for years (2010-2019) respectively.

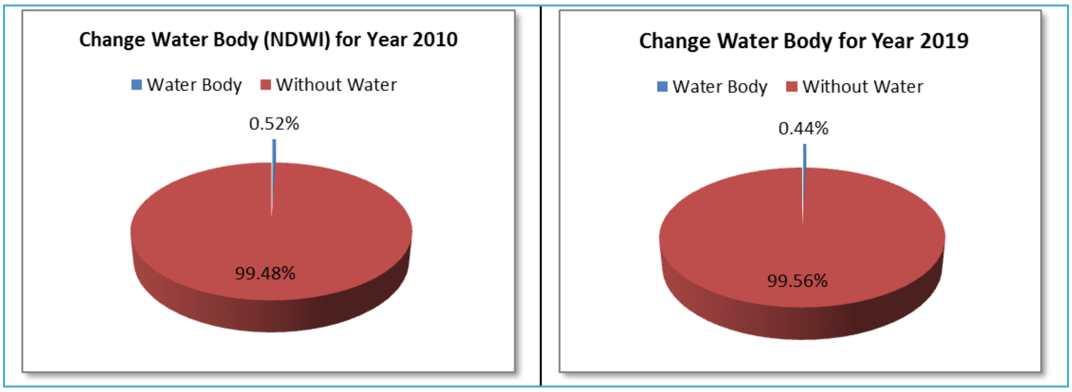

Fig. 7. Chart of Supervised Classification techniques of Water Body (NDWI) for years (2010-2019)

6.Conclusions

The study highlighted that land use dynamics is a useful indicator for areas threatened by agriculture degradation, which is closely related to anthropic activities, where increasing land degradation lead to the acceleration of the land surface sensitivity, which has negatively serious impact on the agriculture ,environment and public health.

1. The study showed that the processes of land degradation that were rich in agriculture contributed to the gradual loss of vegetation cover, due to wars and military operations, which led to the displacement of the labor force in agriculture, plowing, random watering, urban encroachment and excessive exploitation of available resources without the introduction of engineering and agricultural mechanization.
2. Overall results of the study indicated a general vegetation deterioration of 33.1 %.
3. The findings of this study showed a decrease of arable land with 8.2%, a decrease of abandoned land with 5.58 %, an increase of saline land with 5.54%, an increase of cultivated land with 6.63%, an increase of rivers and canals areas with 1.61% of the total area.
4. The distribution of (NDVI) for the period (2010-2019) showed negative pattern of (high vegetation density and moderate vegetation density) and positive pattern of (low vegetation density).
5. Application of (NDWI) during the period (2010-2019), showed a negative change in surface area of the water body of the study area represented by south of Baghdad areas, with area of (14166000 m2) with water body in 2010 to (12053700 m2) in 2019, while (2730375900 m2) in 2010 to (273248820 m2) in 2019 without water body.

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