*Plant Archives* Vol. 20, Supplement 2, 2020 pp. 554-565 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

# EVALUATION OF DROUGHT IMPACT ON AGRICULTURAL STATUS FOR SOME WAIST'S SOIL USING GEOMATIC TECHNIQUES

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## Abstract

This study was carried out in eastern of Iraq, in Wasit governorate and The geographical coordinates of the study area comprise of Latitude 32°21'04.5699"N to 32°22'48.3305"N and longitude 45°24'323437"E to 45°34'38.9793"E. This study aims to evaluate the impact of drought measured by remote sensing data (NDVI anomaly) on salinity, soil content of organic matter and the soil quality index for sixteen years from 2004 to 2019. Morphology, the soil textures Loam (L), Sandy Loam (SL), Silt Loam (SiL), Silty Clay Loam (SiCL) and Silty Clay (SiC), It occupies 38.42%, 14.17%, 24.24%, 7.38% and 15.79% of the study area, respectively and drainage classes good, moderate and poor, It occupies 24.40%, 40.30% and 35.29% of the study area, respectively. Classification, the soils of the study area were diagnosed to Typic Torrifluvents occupies 64.71% of the study area, series included TW465, TM565 and DM95 It occupies 24.40%, 30.81% and 9.51% of the study area, respectively and Typic Haplosalids occupies 35.29% of the study area, series included 133 FCP, 143 FCP and 153 FCP It occupies 13.30%, 6.30% and 15.79% of the study area, respectively. The drought ranges were not always out of the levels (moderate, Severe and Very severe drought, the moderate drought level area was low at the years (2008 – 2011) compared to the very severe drought level with a large degree, and that this discrepancy appeared in the (2016) and (2018), the area of the severe drought level is remarkably stable throughout the study period (2004-2019) and thus can The area is classified as severely drought. the highest rate of drought occurred in the year 2011, as it achieved a significant increase overall years. A significant increase in the levels of salt concentrations in 2011 compared to the years 2004 and 2019, when they reached 66.67% and 46.29% each of them respectively, At the drier year (2011), the soil content of organic matter was at its lowest rates, as it decreased in 2011 significantly from the year 2004 and 2019 to 32.97% and 20.04%, respectively. The degradation of the soil quality index for the study area at the drought year (2011), which decreased significantly from the years 2004 and 2019 by 44.00% and 36.80% each, respectively.
***Keyword*:** Remote sensing, Soil quality, soil salinization, drought, NDVI anomaly and agricultural extension.

## Introduction

Geomatic techniques contribute effectively to monitoring the phenomenon of drought, which negatively affects the agricultural reality of any region in the world. This monitoring provides researchers with a respectable database better than traditional climatic measures used to assess the state of drought (Ji and Peters, 2003). Remote sensing data enables decision-makers to assess the state of drought by calculating Normalized Difference Vegetation Index (NDVI) by a statistical approach that includes estimating the average of this evidence during the vegetation growing season and then calculating the average of these rates for the drought years under study and thus determining the amount of the standard deviation of the values of this evidence from the general average, which is what It is termed (NDVI anomaly) (Bayarjargal *et al.*, 2006).

Soil surveyors are concerned with observing the years of drought, as it causes manifestations of soil degradation, especially farmers who have to use unknown quality irrigation water, which increases soil salinity or farming near the main sources of irrigation channels, which reduces soil content of organic matter for large areas These characteristics directly affect soil quality index, and as a result, the agricultural situation in that area is deteriorating (Taha *et al.*, 2014). Currently, remote sensing data and vegetable evidence derived from it provide the possibility of integration with soil data and then produce digital maps with accuracy far exceeding the accuracy of traditional soil maps production methods, whereby this method enables Ali and Taha, (2016) to mapping the salinity and soil content of organic matter in Mesopotamia, This integration also allows evaluation spatial relationships between different soil characteristics. In Taha *et al.* (2018) research, it was possible to evaluate the relationship of organic soil carbon to nitrogen availability, in addition to suitability of soils in central Iraq for wheat cultivation, and remote sensing data allow to study the temporal change of soil characteristics and given explanation of this change is related to the agricultural environment to a large extent by climate changes towards severe drought and the consequent immediate decisions that damage the soil characteristics and then allow soil degradation (Al-Waeli *et al.*, 2018). This study aims to evaluate the impact of drought measured by remote sensing data (NDVI anomaly) on salinity, soil content of organic matter and the soil quality index for sixteen years from 2004 to 2019.

## Materials and Methods

### Study Area

The study area located in eastern of Iraq, in Wasit governorate and The geographical coordinates of the study area comprise of Latitude 32°21'04.5699"N to 32°22'48.3305"N and longitude 45°24'323437"E to 45°34'38.9793"E, whereas total area roughly is 14721 ha (Fig. 1).

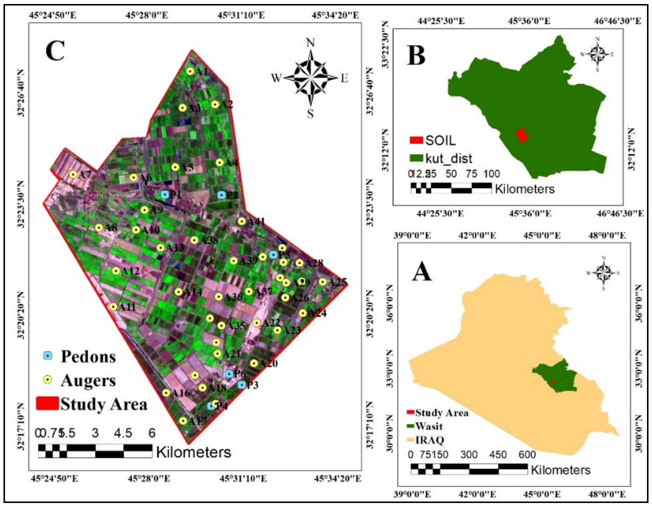


**Fig. 1:** Location of the study area: A (Iraq), B (Wasit) and C soil pedons and auger sites.

This region mimics the reality of farmers in the Mesopotamia region in general, and Wasit governorate in particular, Where this region is characterized by the cultivation of wheat crops, barley, yellow corn, cotton and a class of vegetables, onions and garlic with the presence of halophytes, often at the harvest season the lands are good pastures for cows, buffalo, sheep and goats. The predominant irrigation system is surface irrigation with reliance on well water, especially in the dry season, which extends from the beginning of April to November, and the average precipitation in the best wet years often does not exceed 300 mm (Ali and Taha, 2016).

**Soil survey and morphological description**

The scientific basis for surveying soils is based on revealing their types, locations, areas and distribution in Soilscape with determining their best uses and the pedologist are not always able to know the soil at every point in the Soilscape they deal with and they reveal in their work and separate the soil from each other with the help of specific characteristics in this perspective, and on this basis we relied in this study on the results of chemical analysis of salinity, calcium carbonate, gypsum and Physical analysis of soil texture fractions for the depths of the augers in order to isolate the soil units in the study area, Forty-one locations in the study area were sampling using auger, where soil was sampled at each site at depth (25 cm) (35 cm) (45 cm) (45 cm), That is, the final depth equals 150 cm to meet the requirements for separating the soil series. On this basis, six main pedons were chosen to conduct the morphological description of the soil, all horizons or layers described morphologically in the field according to Soil Survey Division Staff, (1999).

**Laboratory analyzes**

The soil texture fractions were estimated by the pipet method after removing the binders according to Black (1965), and then the soil solution was extracted from the paste saturated with the suction device, as it was used to measure the electrical conductivity of the EC-meter and pH according to Page *et al.* (1982), The total carbonate minerals were also estimated by the gravimetric method and the soil content of gypsum was estimated by precipitation by means of an acetone solution and the measurement of the electrical conductivity of the sediment according to Richards (1954). Soil Organic Matter were estimated according to the Walkely and Black method mentioned by Black (1965).

**Soil Classification**

One of the most prominent pillars of successful soil management is a survey that leads to distinguishing the types of soils in the study area, and then mapping these classes to show the reality of the difference in the main internal characteristics of these soils, it is a cartographic representation of pedon who has an actual presence in nature organized in a classification system Certainly, it often reaches the chain level because it is the lowest classification level approved by the pedologists in Iraq, as it is one of the most used taxonomic levels in agricultural applications, as it provides abundant information that represents the most prominent inputs to soil management. In Iraq, the American quantitative classification system is used to classify soil levels from order to family (Soil Survey Division Staff, 2014). As for the series, they were classified according to the classification of AL-Agidi (1976) for the classification of fluvents soil series in which Diagnostic Subsurface Horizon (Endopedons) horizons are absent, while soils with salic horizon are classified according to and AL-Agidi (1981).

**Landsat Image Processing**

Landsat ETM$^+$ and OLI images were atmospherically corrected using FLAASH (Fast Line-of-sight Atmospheric Analysis of Spectral Hypercubus) model in ENVI 5.2 It also results in converting DN into reflectivity values and then the vegetation indices, include Normalized Difference Vegetation Index (NDVI) Rouse *et al.* (1973) and Optimized Soil-Adjusted Vegetation Index(OSAVI) Rondeaux *et al.* (1996):

$$\mathrm{NDVI} = \frac{(\mathrm{NIR} - \mathrm{Red})}{(\mathrm{NIR} + \mathrm{Red})} \quad ...(1)$$

$$\mathrm{OSAVI} = \frac{(\mathrm{NIR} - \mathrm{Red})}{(\mathrm{NIR} + \mathrm{Red} + 0.16)} \quad ...(2)$$

**Drought Estimation**

The NDVI anomaly was adopted to estimate the drought in the study area for the years 2004-2019 (Nanzad *et al.*, 2019) according to the following method**:**

1) Because the growing season in central and southern Iraq extends clearly from the January until the middle of May and is often related to the growth of wheat leaves, the NDVI was calculated during this period by applying the following equation in ENVI 5.2:

$$\mathrm{NDVI\ growing\ season} = \frac{\mathrm{NDVI}_{jan} + \mathrm{NDVI}_{Feb.} + \mathrm{NDVI}_{Mar.} + \mathrm{NDVI}_{Apr.} + \mathrm{NDVI}_{May}}{5} \quad ...(3)$$

2) The average of growing season for 16 years (2004-2019) was calculated by applying the following equation in in ENVI 5.2:

$$\overline{\mathrm{NDVI}} = \frac{\sum_{i=1}^{16} \mathrm{NDVI\ growing\ season\ 2004} + ... + \mathrm{NDVI\ growing\ season\ 2019}}{16} \quad ...(4)$$

3) Estimating the drought for each year (i) was based on the deviation of an average for any year from the rate calculated in equation (4) by applying the following equation in ENVI 5.2:

$$NDVI_{anomaly(i)} = \frac{NDVI growing season(i) - \overline{NDVI}}{\overline{NDVI}} \times 100 \quad ...(5)$$

4) The severity of the drought was classified according to the levels shown in Table 1.

**Table 1:** Drought Levels from NDVI anomaly values (%)(Nanzad *et al.*, 2019)

| NDVI anomaly values (%) | Description |
|---|---|
| > 0% | Normal (Non-drought) |
| 0 – (-10%) | Mild drought |
| (-10%)-(-25%) | Moderate drought |
| (-25%)-(-50%) | Severe drought |
| < -50% | Very severe drought |

### Soil Indices Prediction Models

The characteristics of the soil related to the agricultural status in the study area were predicted in terms of the spectral evidence after its numerical values were extracted in ArcGIS10.4.1. where the multiple regression equation was formulated in SPSS25 and then applied in ENVI 5.2 (Wu *et al.*, 2014):

1) Soil Salinity for top soil predicted in equation (6):

$$EC_e = 18.439\text{-}31.139 \ln (NDVI) + 10.746 \ln (OSAVI) \quad R^2 = 0.942^{**} \quad ...(6)$$

2) Soil Organic Matter for top soil predicted in equation (7):

$$S.O.M. = 29.265 + 3.982 \ln(NDVI) - 13.109e^{(OSAVI)} \quad R^2 = 0.942^{**} \quad ...(7)$$

3) Soil Quality for rating soil layers according to Al-Juraysi and Al Rawi (2014) calculated in equation (8):

S.Q.I. = (soil texture 8 soil salinity * organic matter * molting (Drainage) ¼) ...(8)

Then predicted from spectral indices in equation (9):

$$S.Q.I. = 3.108 - 0.142 \ln(NDVI) - 1.645e^{(OSAVI)} \quad R^2 = 0.942^{**} \quad ...(9)$$

**Table 2:** Soil Indices Classification (Al-Juraysi and Al Rawi, 2014)

| Soil Characteristics | Description | Scales | Indictor |
|---|---|---|---|
| Texture | Good | L, SCL, SL, LS, CL | 1.00 |
| | Moderate | SC, SiL, SiCL | 1.20 |
| | Poor | Si, C, SiC | 1.60 |
| | Very Poor | S | 2.00 |
| Drainage | Excessively Well | > 150 cm | 1.00 |
| | Well | 90-150cm | 1.20 |
| | Moderate | 50-90cm | 1.40 |
| | Imperfectly | 25-50cm | 1.60 |
| | Poor | <25 cm | 1.80 |
| | Very Poor | Mottling at soil surface | 2.00 |
| Soil Organic Matter (S.O.M.)% | Very High | > 3% | 1.00 |
| | High | 2-3% | 1.20 |
| | Moderate | 1-2% | 1.50 |
| | Low | 0.5-1% | 1.70 |
| | Very Low | <0.5% | 2.00 |
| Soil Salinity (ECe) $dS.m^{-1}$ | Low | < 4 $dS.m^{-1}$ | 1.00 |
| | Moderate | 4-8 $dS.m^{-1}$ | 1.50 |
| | High | 8-16 $dS.m^{-1}$ | 1.80 |
| | Very High | > 16 $dS.m^{-1}$ | 2.00 |
| Soil Quality Index (S.Q.I.) | High Quality | < 1.13 | |
| | Moderate | 1.13-1.45 | |
| | Low Quality | >1.45 | |

### Analysis of Variance with (L.S.D. $_{0.05}$)

In order to assess the significance of the differences between drought rates during the study years, in addition to assessing its effect on soil indicators, Analysis of variance with a lest significant difference (L.S.D. $_{0.05}$) test was conducted according to Al Waeli (2018), as it was applied in the GenSTAT12 statistical analysis program. Soil indicators were charted in Microsoft Excel 2015 and copied to a template Maps in ArcGIS 10.4.1.

## Results and Discussion

### Soil Morphology and Classification

One of the most prominent physical characteristics that can be perceived morphologically in the study area is the state of sudden discontinuity in the texture of an individual soil unit (Table 3 and 4). Pedological, it is the heterogeneity in the soil fractions, whether sandy or silty or clay, our study concluded that the soil textures Loam (L), Sandy Loam (SL), Silt Loam (SiL), Silty Clay Loam (SiCL) and Silty Clay (SiC), It occupies 38.42%, 14.17%, 24.24%, 7.38% and 15.79% of the study area, respectively(fig.2).

**Table 3 :** Soil series morphology description in study area.

| Horizon | Depth(cm) | Description | Soil Series | Soil Sub Great Group |
|---|---|---|---|---|
| $A_p$ | 0-31 | Yellowish brown (10 YR 5/4 d), brown (10 YR m); Silt Loam; moderate, coarse, subangular blocky structure; slightly hard, friable, sticky, slightly plastic; common, fine tubular pores; common, fibrous roots; common black spot of O.M; abrupt, wavy boundary. | TW465 | Typic Torrifluvents |
| $C_1$ | 31-65 | Light yellowish brown (10YR 6/4 d), brownish yellow (10YR 6/6 m); Loam; moderate, medium, subangular blocky structure; hard, friable, sticky, slightly plastic; common, fine tubular pores; common, fine roots; many black spot of O.M; clear, smooth boundary. | | |
| $C_2$ | 65-109 | Dark grayish brown (10YR 4/2 m); Sandy Clay Loam; moderate, medium, subangular blocky structure; hard, friable, sticky, plastic; common, fine tubular pores; many, fine roots; common black spot of O.M; clear, smooth boundary. | | |
| $C_3$ | 109-150 | Dark yellowish brown (10 YR4/4 m) and common fine distinct Olive gray (5 Y 5/2) mottles of node lime accumulation; Loam; moderate, medium, subangular blocky structure; slightly hard, friable, sticky, slightly plastic; common, fine tubular pores; common, fine roots; common black spot of O.M. | | |
| $A_p$ | 0-26 | Light yellowish brown (10YR 6/4 d), dark yellowish brown (10 YR4/4 m); Silt Loam; strong, very coarse, subangular blocky structure; hard, firm, sticky, plastic; many, fine tubular pores; common, fine roots; common black spot of O.M; abrupt, wavy boundary. | TM565 | |
| $C_1$ | 26-60 | Brownish yellow 10YR 6/6 (m); Silt Loam; strong, coarse, subangular blocky structure; very hard, firm, sticky, plastic; common, fine vesicular pores; few, coarse roots; few black spot of O.M; wavy gradual boundary. | | |
| $C_2$ | 60-103 | Very dark brown (10YR 2/2 m) and common Olive gray (5 Y 5/2) mottles of node lime accumulation; Silty Clay Loam; moderate, coarse, subangular blocky structure; hard, friable, sticky, plastic; common, fine tubular pores; few, fibrous roots; common; clear, smooth boundary. | | |
| $C_3$ | 103-150 | Dark grayish brown (10YR 4/2 m) and common fine distinct Light gray (5 YR 7/1) mottles of node lime accumulation; Loam; strong, very coarse, subangular blocky structure; hard, friable, sticky, plastic; common, fine tubular pores; few, fine roots. | | |
| $A_p$ | 0-25 | Light yellowish brown (10YR 6/4 d), brownish yellow (10YR 6/6 m); Loam; moderate, medium, subangular blocky structure; hard, firm, sticky, plastic; many, fine tubular pores; many, fibrous roots; common black spot of O.M; clear, smooth boundary. | DM95 | |
| $C_1$ | 25-63 | Grayish Brown (10 YR 5/2 m); Silty Clay Loam; moderate, coarse, subangular blocky structure; hard, friable, sticky, plastic; many, fine vesicular pores; few, fine roots; common; clear, smooth boundary. | | |
| $C_2$ | 63-101 | Dark brown (10YR 3/3 m) and common fine distinct reddish gray (5 YR 5/2) mottles of spot lime accumulation; Silty Clay Loam; moderate, medium, subangular blocky structure; hard, friable, sticky, plastic; common, fine tubular pores; many, fine roots; common black spot of O.M; clear, smooth boundary. | | |
| $C_3$ | 101-150 | Dark yellowish brown (10YR 4/4 m) and pinkish gray (7.5 YR 6/2) mottles of common lime accumulation; Silt Loam; ; strong, coarse, subangular blocky structure; hard, firm, sticky, plastic; common, fine vesicular pores; common, coarse roots. | | |
| A | 0-17 | Pale brown (10 YR 6/3 d); Silt Loam; strong, coarse, subangular blocky structure; hard, friable, sticky, plastic; very fine, vesicular pores; common, fibrous roots; common salt accumulation; abrupt, wavy boundary. | 133FCP | Typic Haplosalids |
| $Br_1$ | 34-51 | Dark brown (10 YR 3/3 m) and brown (2.5 Y 4/4) mottles of common lime with salt accumulation; Silt Loam; strong, coarse, subangular blocky structure; hard, frim, sticky, plastic; fine, vesicular pores; common, fibrous roots; clear, smooth boundary. | | |
| $Br_2$ | 51-99 | Olive gray (5 Y 5/2 m) and pale red (2.5 YR 7/2) common fine distinct of lime with salt mottles; Silt Loam; strong, coarse, subangular blocky structure; very hard, frim, sticky, plastic; fine, vesicular pores; few, coarse roots; clear, smooth boundary. | | |

| | | | | |
|---|---|---|---|---|
| $C_r$ | 99-150 | Dark brown (10YR 3/3 m) and light gray(10 YR 7/2) common fine distinct of lime with salt mottles; Silt Loam; strong, medium, subangular blocky structure; very hard, frim, sticky, plastic; common, fine tubular pores; few, coarse roots; common salt accumulation. | | |
| A | 0-13 | Very dark grayish brown (10 YR 3/2 m); Silty Clay Loam; moderate, medium, subangular blocky structure; hard, frim, sticky, very plastic; many, fine tubular pores; few, fibrous roots; common salt accumulation; clear, smooth boundary. | 143FCP | |
| $Br_1$ | 13-48 | Very dark grayish brown (10 YR 3/2 m); Silty Clay Loam; moderate, medium, subangular blocky structure; hard, frim, sticky, very plastic; many, fine tubular pores; few, fibrous roots; common salt accumulation; clear, smooth boundary. | | |
| $Br_2$ | 48-95 | Very dark brown (10YR 2/2 m) and common fine distinct pinkish gray (7.5 YR 6/2) mottles of lime and salt accumulation; Silty Clay Loam; very strong, coarse, subangular blocky structure; very hard, frim, sticky, plastic; common, fine tubular pores; few, medium roots; common salt accumulation; clear, smooth boundary. | | |
| $C_r$ | 95-150 | Olive gray (5 Y 5/2 m) and common fine distinct pinkish gray (7.5 YR 6/2) mottles of lime and salt accumulation; Silty Clay Loam; very strong, coarse, subangular blocky structure; very hard, frim, sticky, plastic; common, medium tubular pores; few, coarse roots; common salt accumulation. | | |
| $A_z$ | 0-15 | Very dark brown (10YR 2/2 m); Silty Clay; very strong, coarse, subangular blocky structure; hard, frim, sticky, plastic; common, fine vesicular pores; few, fibrous roots; common salt accumulation; clear, smooth boundary. | 153FCP | |
| $Bz_1$ | 15-53 | Dark brown (10 YR 4/3m) and common fine distinct light gray (5 YR 7/1) mottles of lime and salt accumulation; Silty Clay; very strong, coarse, subangular blocky structure; very hard, frim, sticky, plastic; many, fine vesicular pores; few, medium roots; common salt accumulation; clear, smooth boundary. | | |
| $Bz_2$ | 53-97 | Olive gray (5 Y 5/2 m) and light gray (10 YR 7/2) common fine distinct of lime with salt mottles; Silty Clay; very strong, coarse, subangular blocky structure; very hard, frim, sticky, plastic; many, fine vesicular pores; few, medium roots; common salt accumulation; abrupt, wavy boundary. | | |
| Cz | 97-150 | Dark brown (10 YR 4/3m) and common fine distinct light gray (5 YR 7/1) mottles of lime and salt accumulation; Silty Clay; very strong, coarse, subangular blocky structure; hard, frim, sticky, plastic; common, fine vesicular pores; few, coarse roots; common salt accumulation. | | |

The soil of the study area is affected by the activity of the salinization process that leads to saline accumulation in the soil to the level that affects the health of the plant. It is the most common process in this part of Iraq (Wu *et al.*, 2014). The ground water near the soil surface is a source of accumulation of sodium, calcium and magnesium salts in the form of chlorides or sulfates in the rhizosphere of the plant, which are generally more soluble than gypsum and may collect in the soil layers, forming the Salic horizon (Bockheim and Gennadiyev, 2000), salinization process also causes poor internal drainage of the soil, and mottling is a morphological function in this capacity, When an appropriate amount of water is available, especially in the loamy soils (Table 3 and 4), the salt and carbon compounds will accumulation to the lower horizons of the soil, Our study found that drainage classes good, moderate and poor, It occupies 24.40%, 40.30% and 35.29% of the study area, respectively (Fig. 2).

**Table 4 :** Soil series physical and chemical properties in study area.

| Horizon | Depth(cm) | gm.kg$^{-1}$ | | | Texture Class | ECe (dS.m$^{-1}$) | $CaCO_3$ gm.kg$^{-1}$ | $CaSO_4.2H_2O$ gm.kg$^{-1}$ | Mottling depth (cm) | Soil Series | Sub Soil Great Group |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sand | Silt | Clay | | | | | | | |
| $A_p$ | 31 | 293 | 517 | 191 | SiL | 3.13 | 250.94 | 0.99 | 115 | TW465 | Typic Torrifluvents |
| $C_1$ | 34 | 461 | 392 | 148 | L | 3.19 | 251.01 | 1.10 | | | |
| $C_2$ | 44 | 520 | 176 | 305 | SCL | 3.24 | 251.07 | 1.10 | | | |
| $C_3$ | 41 | 448 | 463 | 90 | L | 3.22 | 251.04 | 1.10 | | | |
| $A_p$ | 26 | 256 | 509 | 235 | SiL | 4.86 | 252.95 | 1.21 | 77 | TM565 | |
| $C_1$ | 34 | 344 | 526 | 131 | SiL | 4.26 | 252.25 | 1.17 | | | |
| $C_2$ | 43 | 130 | 535 | 336 | SiCL | 5.33 | 253.49 | 1.24 | | | |
| $C_3$ | 47 | 426 | 465 | 110 | L | 4.63 | 252.68 | 1.20 | | | |
| $A_p$ | 25 | 416 | 459 | 126 | L | 9.90 | 258.77 | 1.55 | 71 | DM95 | |
| $C_1$ | 38 | 173 | 498 | 330 | SiCL | 16.38 | 266.27 | 1.99 | | | |
| $C_2$ | 38 | 144 | 490 | 366 | SiCL | 17.14 | 268.35 | 2.09 | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $C_3$ | 49 | 293 | 540 | 168 | SiL | 14.40 | 263.98 | 1.86 | | | |
| A | 17 | 242 | 569 | 190 | SiL | 32.09 | 284.46 | 3.05 | 20 | 133FCP | Typic Haplosalids |
| $Br_1$ | 34 | 394 | 544 | 63 | SiL | 40.73 | 286.07 | 2.93 | | | |
| $Br_2$ | 48 | 280 | 520 | 200 | SiL | 39.44 | 278.68 | 2.31 | | | |
| $C_r$ | 51 | 387 | 537 | 76 | SiL | 37.57 | 291.18 | 2.93 | | | |
| A | 13 | 159 | 497 | 345 | SiCL | 41.97 | 295.89 | 3.72 | 23 | 143FCP | |
| $Br_1$ | 35 | 158 | 476 | 367 | SiCL | 44.82 | 299.23 | 3.92 | | | |
| $Br_2$ | 47 | 160 | 479 | 362 | SiCL | 44.40 | 298.70 | 3.89 | | | |
| $C_r$ | 55 | 189 | 474 | 338 | SiCL | 44.14 | 298.40 | 3.87 | | | |
| $A_z$ | 15 | 42 | 528 | 431 | SiC | 60.08 | 316.84 | 4.95 | 18 | 153FCP | |
| $Bz_1$ | 38 | 52 | 519 | 429 | SiC | 52.84 | 308.46 | 4.46 | | | |
| $Bz_2$ | 44 | 57 | 529 | 414 | SiC | 50.89 | 306.21 | 4.32 | | | |
| Cz | 53 | 30 | 535 | 436 | SiC | 55.01 | 310.98 | 4.61 | | | |

Based on the results of table (3 & 4) classes, the soils of the study area were diagnosed to Typic Torrifluvents occupies 64.71% of the study area, Series included TW465, TM565 and DM95 It occupies 24.40%, 30.81% and 9.51% of the study area, respectively (Fig. 2), While Typic Haplosalids occupies 35.29% of the study area, Series included 133 FCP, 143 FCP and 153 FCP It occupies 13.30%, 6.30% and 15.79% of the study area, respectively (Fig. 2), In this study, we believe that the calcareous alluvium as (parent material) deposited on the sediments of the Gulf waters that receded with the formation of the Mesopotamian Plain, in addition to the traditional management of the soil by the absence of a homogeneous distribution of irrigation water and the decline of effective drainage networks and their neglect and the adoption of open dirt channels in the management of water distribution And mixing with drainage water, or leaving the agricultural activity in it completely, are all factors that lead to transformation a class Sub Great Group of Typic Torrifluvents into a category Typic Haplosalids.

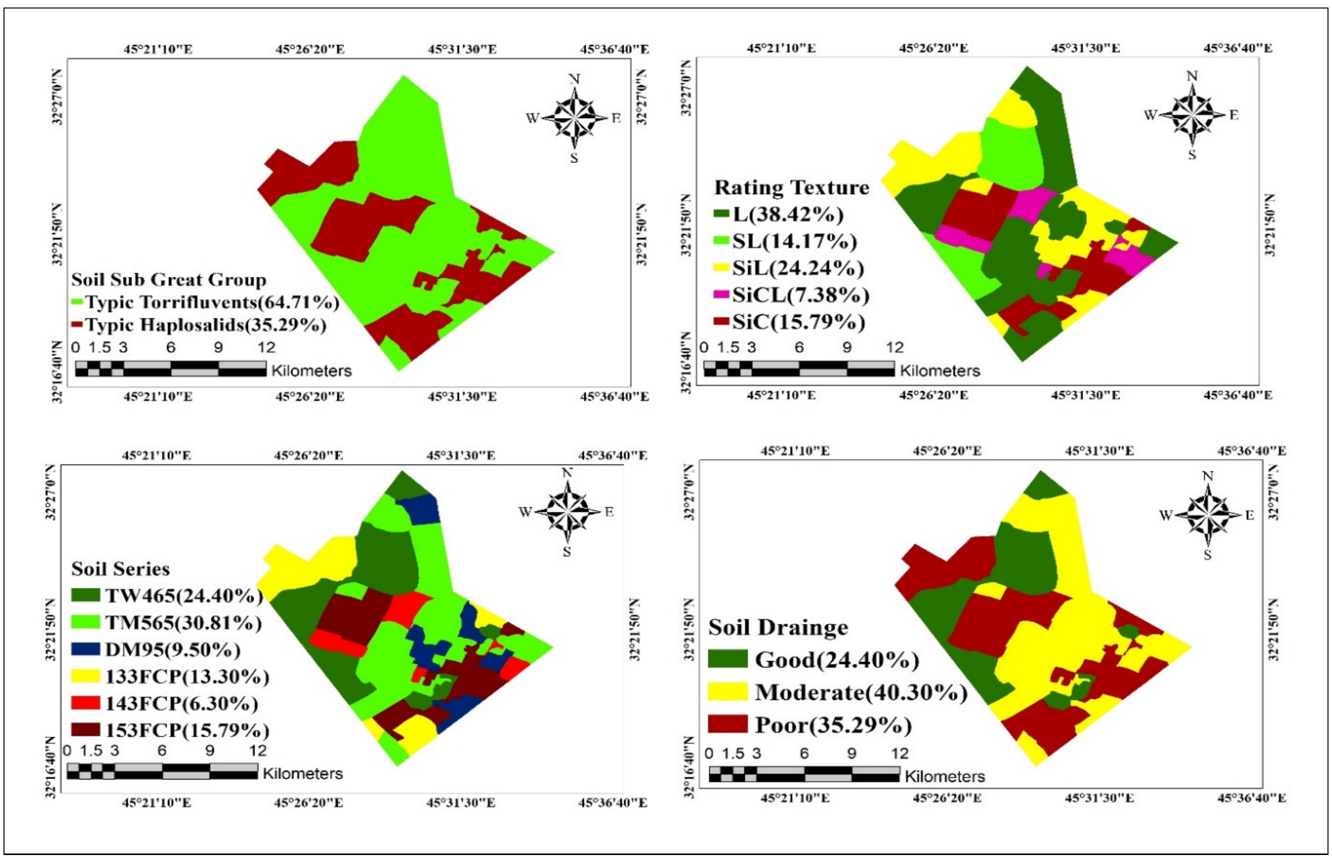


**Fig. 2:** Soil morphological a classification maps.

## Drought Status

Figure (3) shows the fluctuation of the drought state during (2004-2019) by the fluctuation of the density of vegetation, which responds substantially to climatic changes in this region. It is also noticed that the years 2008 to 2011 were the most severe and that the vegetation cover was virtually non-existent in the region and the drought ranges were not always out of the levels (moderate, Severe and Very severe drought). Figure (4) also shows that the moderate drought level area was low at the years (2008 – 2011) compared to the very severe drought level with a large degree, and that this discrepancy appeared in the (2016) and (2018), that it was less than the previous, except that the area of the severe drought level is remarkably stable throughout the study period (2004-2019) and thus can The area is classified as severely drought. Figure 5 shows that the highest rate of drought occurred in the year 2011, as it achieved a significant increase overall years in this study, where the increase reached -46.14%, Nanzad *et al.* (2019) study justifies the severity of drought in one year and not the other to the sharp decline in the annual rain rate and the inability of vegetation to withstand the stresses of drought. We believe that in addition to these factors, poor environmental management and the absence of logical planning contributed to a significant decline in vegetation, especially in 2011, as shown in Figure (3).

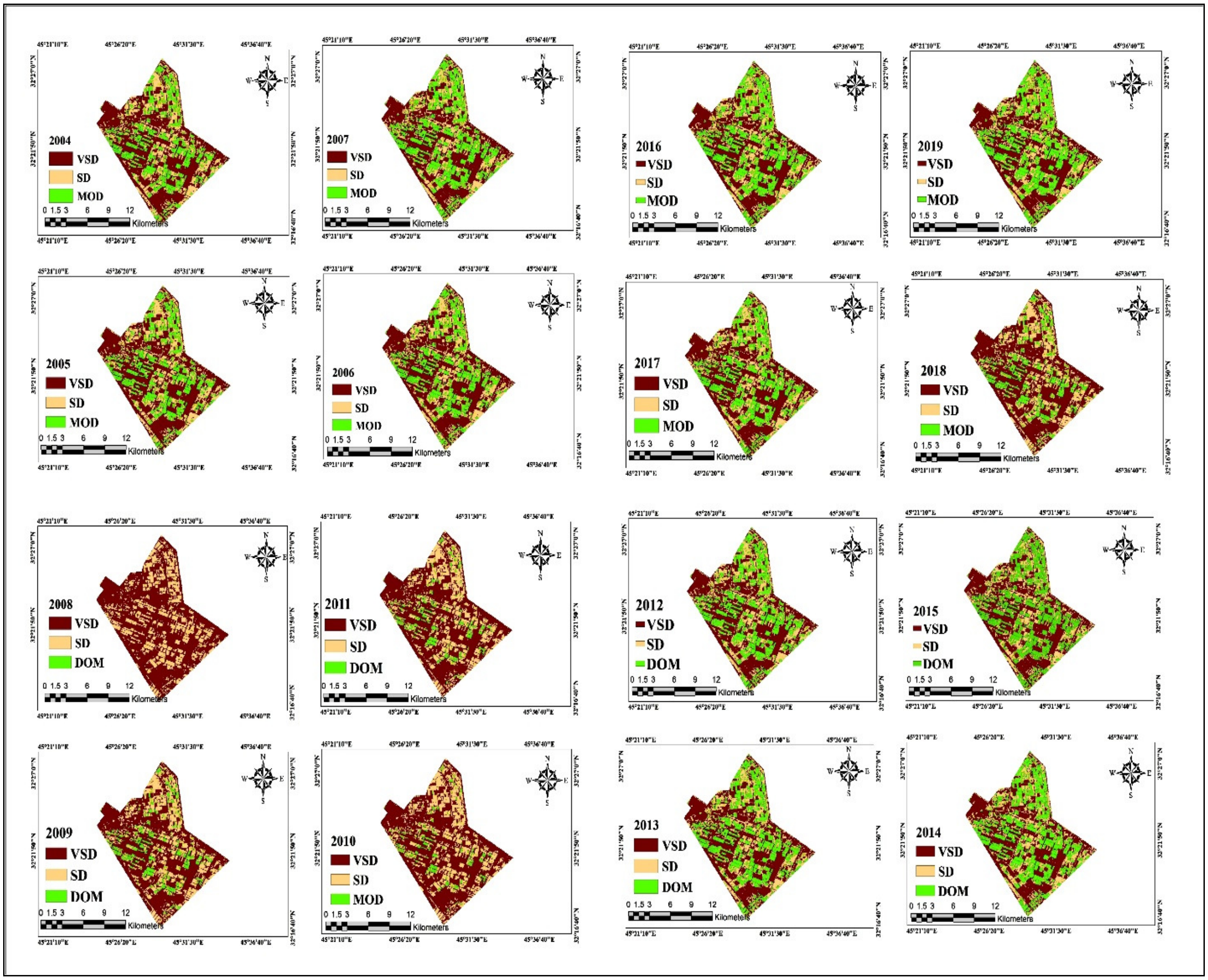


**Fig. 3:** Drought status in study area (2004-2019) by NDVI anomaly.

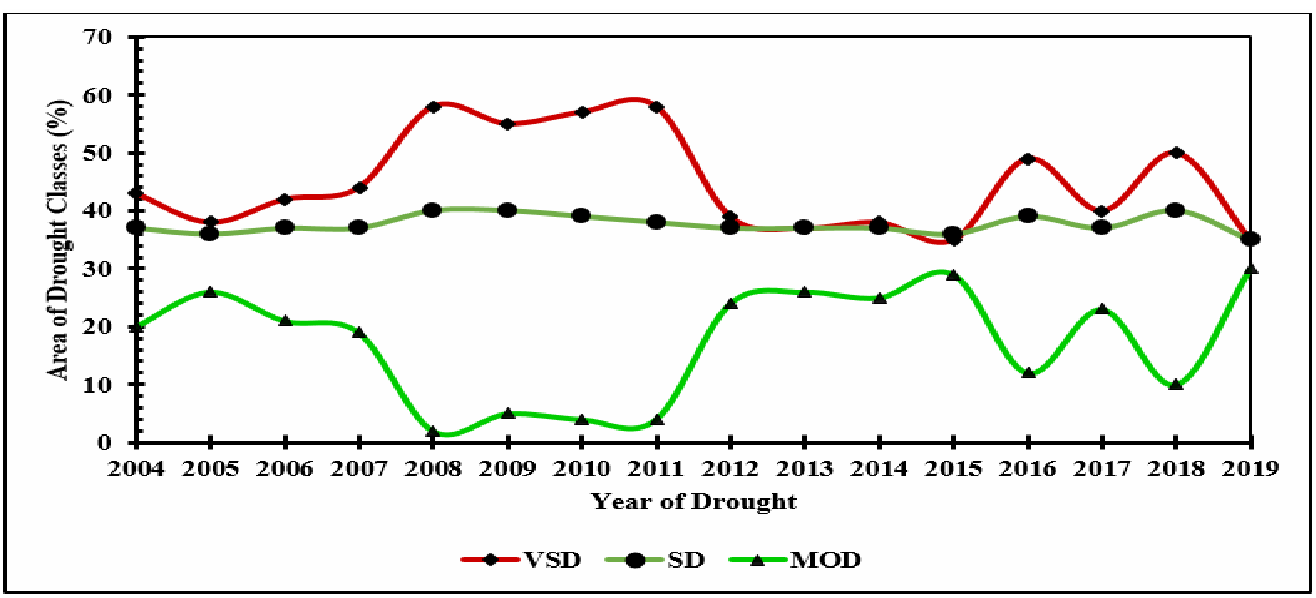


**Fig. 4 :** Area of Drought Classes (%)

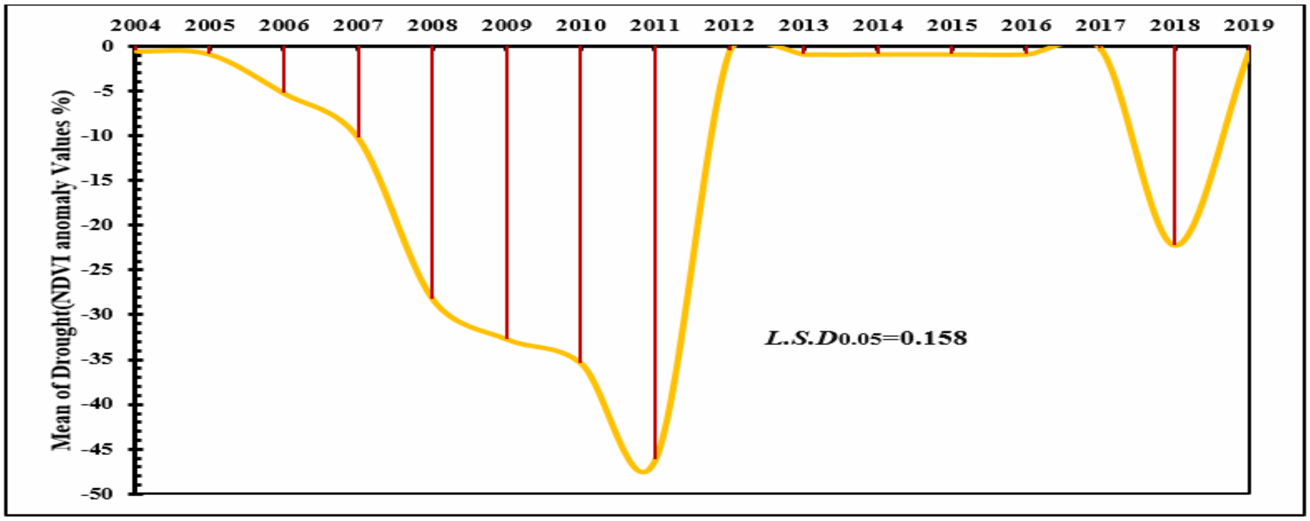


**Fig. 5 :** Analysis of Variance among Mean of Drought (NDVI anomaly Values %)

**Drought Impact on Agricultural Status**

The indicators on the agricultural status are numerous, and they are mostly dialectically related to the ability of the soil to support the growth of economic plants and in a manner that achieves the highest productivity and quality that covers the requirements of the local market, We believe that the high salt concentrations in the soil and the decrease in their content of organic matter will lead to a degradation of the soil quality and consequently a breakdown of the agricultural environment., In our study, we found a significant increase in the levels of salt concentrations in 2011 compared to the years 2004 and 2019, when they reached 66.67% and 46.29% each of them respectively (fig.6), That is, drought activated the salinization process in the study area, and therefore, according Taha *et al.* (2014) study, the increase in salinization directly causes the decline of the cultivated area and the transformation of agricultural lands into a desert, which is difficult to reclaim in the future. Figure 6 also shows the clear effect of drought on the cultivated area, which is represented by the low class, where it was at its lowest expansion 6.24% compared to the year 2004 and 2019, which amounted to 10.36% and 8.89% each, respectively, On the other hand, it is noted that the very high class was at its widest extent in 2011, when it reached 75.14% compared to the year 2004 and 2011, when it reached the 60.82% and 64.91% for each respectively, And that this fluctuation included all classes and all years of study, and accordingly we believe that drought influences effectively the salinization of the soil and the failure to take scientific measures to face it causes an environmental degradation in the agricultural system in the region.

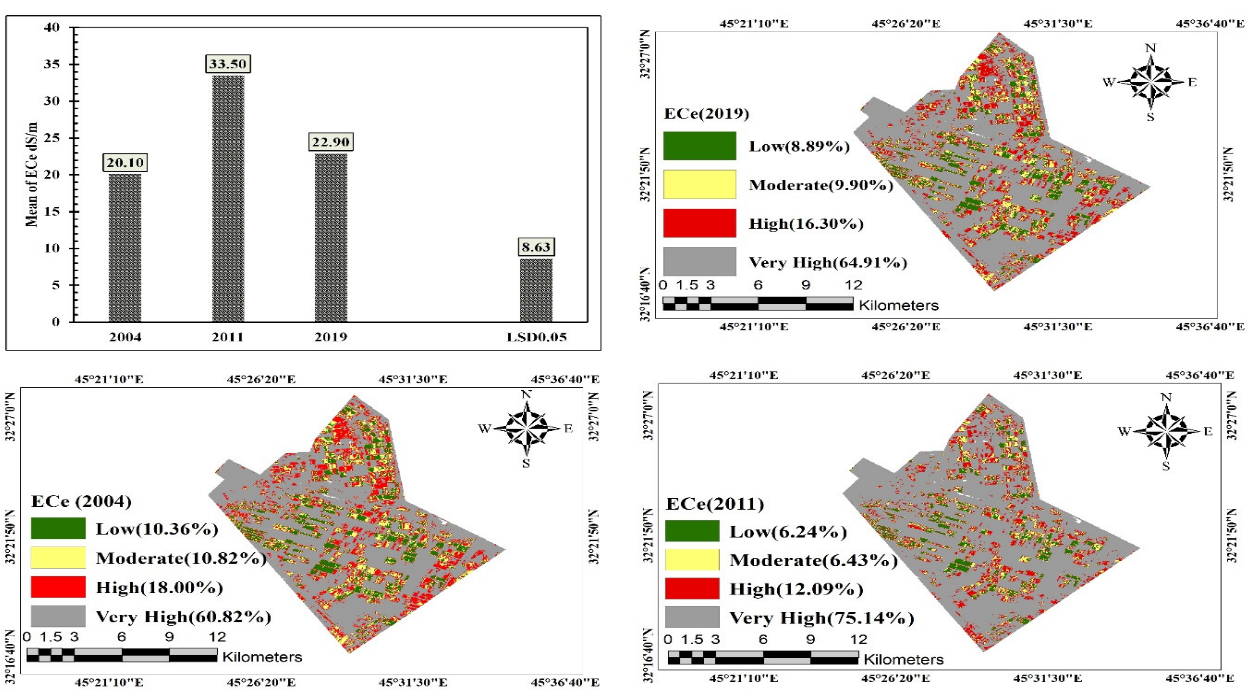


**Fig. 6 :** Analysis of Variance among Mean of ECe (2004, 2011 and 2019).

Where the Mubarakah and Al Waeli (2019) study found that increasing the soil content of organic matter in arid regions improves the suitability of the soil for field crops, improves its fertility by raises the nitrogen availability in it. In our study, we found that drought negatively affected the soil content of organic matter, therefore, drought destroys all these advantages of agricultural soils, since it causes directly and indirectly to reduce the soil content of organic matter. In our study, we found significant differences in the soil content of organic matter within the study years (Fig.7). At the drier year (2011), the soil content of organic matter was at its lowest rates, as it decreased in 2011 significantly from the year 2004 and 2019 to 32.97% and 20.04%, respectively. It is also noted from Figure (7) that drought in the region did not give the environment in the region that the soil content of organic matter exceeded the moderate class to the higher classes, However, we find that the moderate class varied in its breadth, reaching its highest 72.74% in 2004, followed by 56.40% in 2019, but in the year of drought it did not exceed about 25.42%, On the other hand, we notice that the very low class expanded in the 2011 drought year to reach 4.88%, while it decreased in 2004 and 2019 to reach 0.08% and 0.24%, respectively.

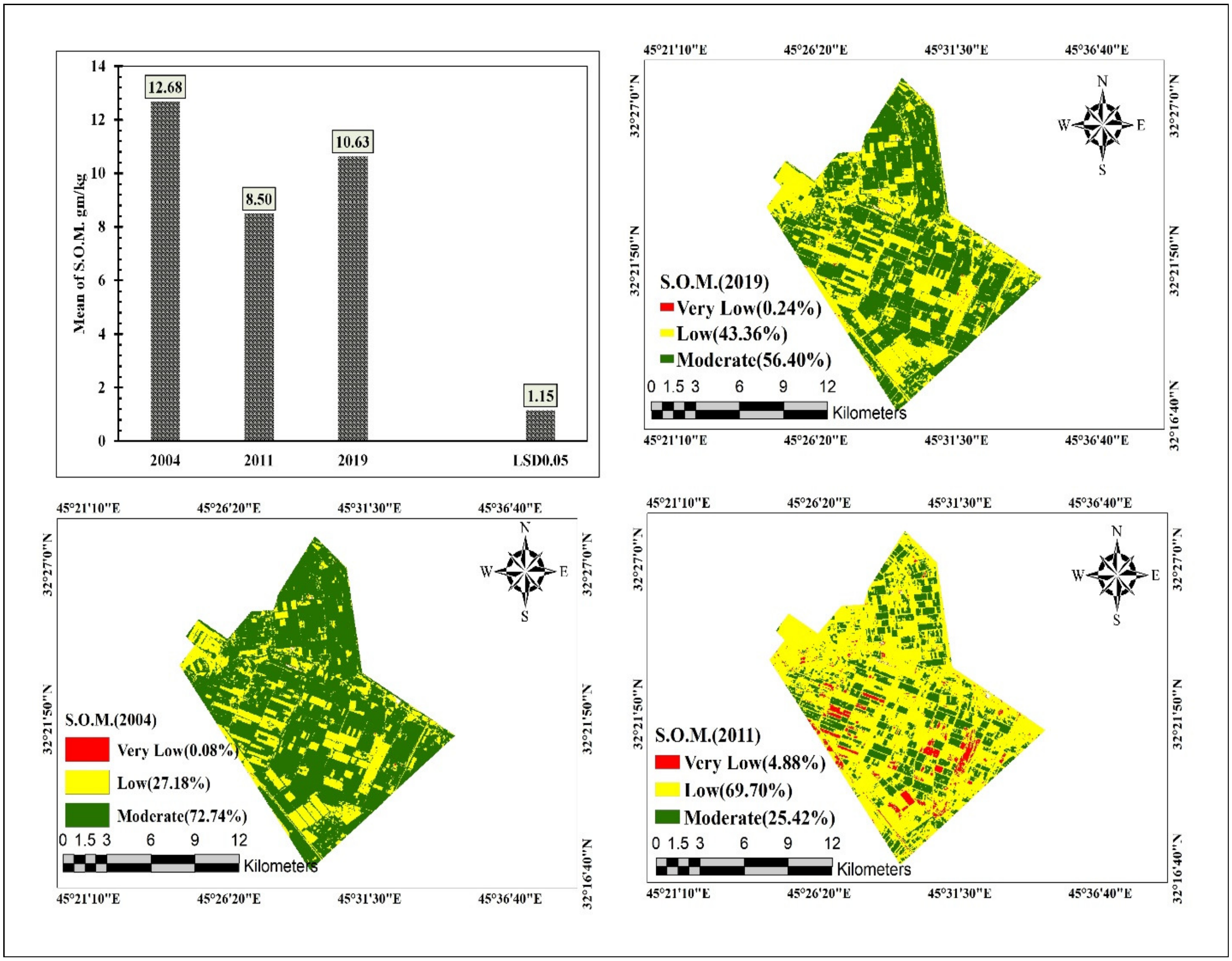


**Fig. 7 :** Analysis of Variance among Mean of S.O.M. (2004, 2011 and 2019).

The soil quality index expresses its ability to perform its economic role in a balanced manner with its environment, in terms of attributing plant growth and increasing productivity and limiting the emission of toxic gases to the atmosphere and other important natural functions, as the soil quality indicates the state of its system in nature if it is Balanced or degraded, and this case is determined by the nature of soil characteristics, the pattern of their uses and their type within the approved classification structure and most importantly the nature of their management (Marvin *et al.*, 2004), In our study, we found that the most important characteristics affecting the soil quality index are soil salinity, soil content from organic matter, mottling (Drainage) and soil texture. For the same reason, the equation (8) from (Al-Juraysi and Al Rawi, 2014) was adopted because it realistically reflects the soil quality of the study area and was estimated from the data of Table (5):

**Table 5 :** Soil laboratory analysis as rating in study area.

| Position | gm.kg$^{-1}$ | | | Soil Texture | dS.m$^{-1}$ | gm.kg$^{-1}$ | Drainage | S.Q.I. | | Soil Series |
|---|---|---|---|---|---|---|---|---|---|---|
| | Sand | Silt | Clay | | ECe | S.O.M. | | Value | Class | |
| P1 | 440 | 374 | 187 | L | 3.20 | 13.00 | Good | 1.11 | High | TW465 |
| P2 | 293 | 507 | 201 | SiL | 4.79 | 9.12 | Moderate | 1.38 | Moderate | TM565 |
| P3 | 245 | 503 | 252 | SiL | 14.85 | 7.98 | Moderate | 1.45 | Moderate | DM95 |
| P4 | 338 | 537 | 126 | SiL | 38.26 | 5.28 | Poor | 1.65 | LOW | 133FCP |
| P5 | 170 | 478 | 353 | SiCL | 44.19 | 4.54 | Poor | 1.71 | LOW | 143FCP |
| P6 | 45 | 528 | 427 | SiC | 53.76 | 3.61 | Poor | 1.84 | LOW | 153FCP |
| A1 | 486 | 350 | 164 | L | 3.11 | 12.97 | Good | 1.11 | High | TW465 |
| A2 | 332 | 518 | 150 | SiL | 4.16 | 9.22 | Moderate | 1.38 | Moderate | TM565 |
| A3 | 291 | 431 | 278 | L | 12.46 | 8.34 | Moderate | 1.38 | Moderate | DM95 |
| A4 | 515 | 321 | 164 | L | 7.88 | 8.82 | Moderate | 1.32 | Moderate | TM565 |
| A5 | 559 | 276 | 165 | SL | 3.08 | 12.93 | Good | 1.11 | High | TW465 |
| A6 | 274 | 535 | 191 | SiL | 39.33 | 5.41 | Poor | 1.65 | LOW | 133FCP |
| A7 | 393 | 479 | 128 | SiL | 40.29 | 5.30 | Poor | 1.65 | LOW | 133FCP |
| A8 | 456 | 391 | 153 | L | 3.45 | 12.93 | Good | 1.11 | High | TW465 |
| A9 | 564 | 266 | 170 | SL | 3.84 | 12.91 | Good | 1.11 | High | TW465 |
| A10 | 181 | 444 | 375 | SiCL | 43.67 | 4.93 | Poor | 1.71 | LOW | 143FCP |
| A11 | 68 | 519 | 413 | SiC | 50.19 | 4.21 | Poor | 1.84 | LOW | 153FCP |
| A12 | 324 | 504 | 172 | SiL | 5.49 | 9.09 | Moderate | 1.53 | LOW | TM565 |
| A13 | 58 | 511 | 431 | SiC | 53.74 | 3.81 | Poor | 1.84 | LOW | 153FCP |
| A14 | 399 | 369 | 232 | L | 8.00 | 8.82 | Moderate | 1.32 | Moderate | TM565 |
| A15 | 178 | 419 | 403 | SiC | 270.81 | 4.17 | Poor | 1.84 | LOW | 153FCP |
| A16 | 327 | 500 | 173 | SiL | 26.29 | 6.84 | Poor | 1.65 | LOW | 133FCP |
| A17 | 420 | 326 | 254 | L | 8.54 | 8.76 | Moderate | 1.38 | Moderate | TM565 |
| A18 | 283 | 455 | 262 | L | 40.68 | 5.26 | Poor | 1.57 | LOW | 133FCP |
| A19 | 375 | 435 | 190 | L | 30.32 | 6.40 | Poor | 1.57 | LOW | 133FCP |
| A20 | 190 | 572 | 238 | SiL | 17.40 | 7.74 | Moderate | 1.49 | LOW | DM95 |
| A21 | 407 | 388 | 205 | L | 3.29 | 12.91 | Good | 1.11 | High | TW465 |
| A22 | 30 | 544 | 426 | SiC | 55.91 | 3.57 | Poor | 1.84 | LOW | 153FCP |
| A23 | 444 | 322 | 234 | L | 6.61 | 8.96 | Moderate | 1.32 | Moderate | TM565 |
| A24 | 26 | 542 | 432 | SiC | 53.87 | 3.79 | Poor | 1.84 | LOW | 153FCP |
| A25 | 105 | 527 | 368 | SiCL | 48.50 | 4.39 | Poor | 1.71 | LOW | 143FCP |
| A26 | 179 | 498 | 323 | SiCL | 11.97 | 8.39 | Moderate | 1.45 | Moderate | DM95 |
| A27 | 246 | 534 | 220 | SiL | 4.30 | 9.21 | Moderate | 1.38 | Moderate | TM565 |
| A28 | 33 | 545 | 422 | SiC | 54.48 | 3.73 | Poor | 1.84 | LOW | 153FCP |
| A29 | 390 | 543 | 67 | SiL | 36.57 | 5.71 | Poor | 1.65 | LOW | 133FCP |
| A30 | 477 | 356 | 167 | L | 3.76 | 12.91 | Good | 1.11 | High | TW465 |
| A31 | 138 | 490 | 372 | SiCL | 44.25 | 4.87 | Poor | 1.71 | LOW | 143FCP |
| A32 | 263 | 559 | 178 | SiL | 4.96 | 9.14 | Moderate | 1.38 | Moderate | TM565 |
| A33 | 155 | 514 | 331 | SiCL | 44.35 | 4.86 | Poor | 1.71 | LOW | 143FCP |
| A34 | 358 | 422 | 220 | L | 8.93 | 8.72 | Moderate | 1.38 | Moderate | TM565 |
| A35 | 298 | 491 | 211 | SiL | 12.81 | 8.30 | Moderate | 1.45 | Moderate | DM95 |
| A36 | 169 | 431 | 400 | SiC | 50.55 | 4.17 | Poor | 1.84 | LOW | 153FCP |
| A37 | 255 | 511 | 234 | SiL | 4.09 | 9.23 | Moderate | 1.38 | Moderate | TM565 |
| A38 | 177 | 456 | 367 | SiCL | 43.53 | 4.94 | Poor | 1.71 | LOW | 143FCP |
| A39 | 466 | 344 | 190 | L | 5.91 | 9.04 | Moderate | 1.32 | Moderate | TM565 |
| A40 | 281 | 537 | 182 | SiL | 4.40 | 9.20 | Moderate | 1.38 | Moderate | TM565 |
| A41 | 241 | 516 | 243 | SiL | 17.18 | 7.82 | Moderate | 1.45 | Moderate | DM95 |

It is noticed from Figure (8) the degradation of the soil quality index for the study area at the drought year (2011), which decreased significantly from the years 2004 and 2019 by 44.00% and 36.80% each, respectively, It is also noticed that the high class was in its best breadth at 2004 and 2019 compared to the year 2011, when it reached 60.27%, 52.14% and 34.51% for each of them, respectively, and that the low class was at its highest breadth at the drought year (2011), when it reached 58.58% compared to the 2004 and 2019, where it reached 7.34% and 27.22% for each, respectively. The failure of the soil administrator to adopt modern approach and technologies makes the soil quality index always threatened with degradation whenever the severity of drought increases, the neglect of agricultural extension and the absence of its role indicates the failure of soil management and the weakness of sustainable development in central and southern Iraq in general (Taha *et al.*, 2019).

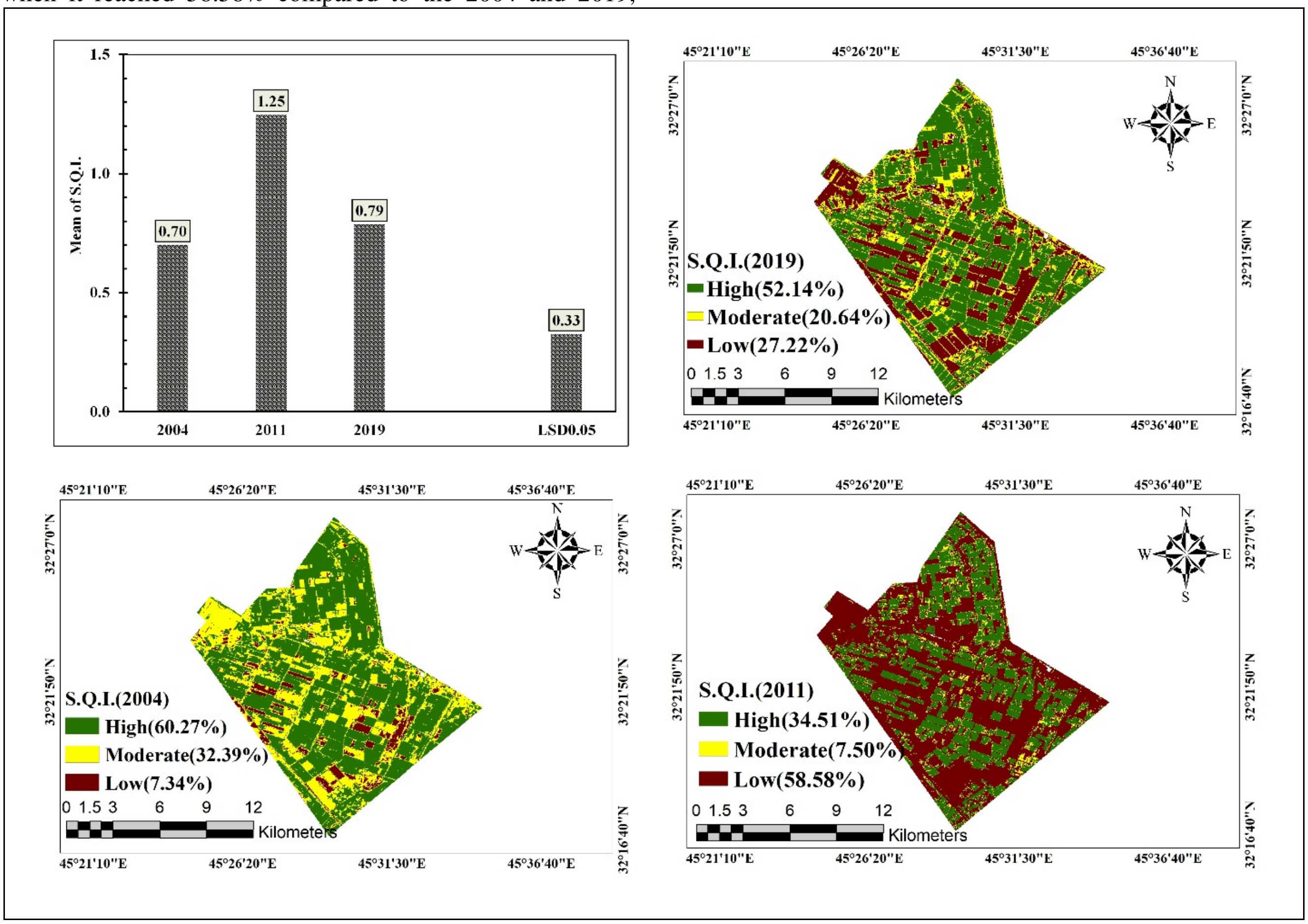


**Fig. 8 :** Analysis of Variance among Mean of S.Q.I. (2004, 2011 and 2019).

## Conclusion

Drought causes degradation in the agricultural status by increasing soil salinization, which leads to chemical degradation of the soil and reducing the soil content of organic matter, which causes poor fertility and unsuitable to economic plants, and thus the degradation of the soil quality index. Adopting geomatic techniques and the data it provides (NDVI anomaly) will allow pedologists to assess the severity of drought and thus provide clear and understandable maps for agricultural extension specialists to educate stakeholders and avoid environmental disasters that accompany the drought years, which serves sustainable development goals.

**Acknowledgements**

This study support from remote sensing and GIS laboratories in remote sensing and Geophysics College in Al-Karkh University for Science in Iraq - Baghdad and soil laboratory in soil and water resources in Agriculture College in Al-Qasim Green University in Babylon province in Iraq.

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