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# SPATIAL DISTRIBUTION OF VEGETATIVE COVERS IN BAQUBA DISTRICT, DIYALA GOVERNORATE USING THE MEANS OF REMOTE SENSING

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## Abstract

Al-Abara area is located on a tributary of the Tigris River within Diyala governorate. The area covered by the study reached 919.4 hectares between longitudes (44º 36º 31.795 - 443 38 28.093 east) and two latitudes (33º 45 11.987 33º 46 51.496 North). Ten soil pedon sites were selected for three paths of movement and soil material samples were obtained from every horizon of pedon for the purpose of laboratory analysis. The satellite image of Sentinel-2 European satellite was used and the vegetative spectral indices SAVI and MSAVI2 were calculated to determine the land cover and soil chains prevailing in the study area. The results showed that the soils of the area are considered from the newly formed, undeveloped soils belonging to the rank of Entisols, due to the nature of the environmental conditions prevailing in the study area. The results of the directed classification showed that there are seven types of soil series in the study area. The results of the spectral vegetative evidence used in the study SAVI, MSAVI2 confirmed the predominance of the dense plant variety, which represents the lands cultivated with palm groves as well as citrus trees that were not affected by salinity due to the low salt content in them.

***Key words:*** Vegetative covers, Baquba District, remote sensitivity

## Introduction

Remote sensing and geographic information systems are among the main means for surveying and monitoring land resources, identifying their distribution and characteristics and preparing plans and programs to achieve development. It is an important source of data that provides information in an efficient and effective way that traditional methods cannot provide and what we are witnessing today in the information age of the vast amount of data needs effective devices to deal with it. Correct and accurate information based on scientific analysis leads to the optimal and sustainable use of land resources. The soils of Iraq vary spatially according to the nature of soil formation factors, including Diyala Governorate, which are modern deposits dating back to the Quaternary era and are part of the sedimentary plain sediments. Diyala province is famous for its palm and citrus orchards, as it was the first governorate to specialize in citrus cultivation and it preserved this specificity. Citrus cultivation was clearly linked to palm groves except rarely and this is an inherited phenomenon as multi-species fruit trees are grown in palm groves and in light of the above and in continuity with progress Remote Sensing Techniques and Geographic Information Systems This study aimed to test the efficiency of some spectral evidences of vegetation covers in isolating and diagnosing soil units by using remote sensing technology (Qi *et al.,* 1994).

## Materials and Methods

Al-Abara district is located on one of the tributaries of the Tigris River within Diyala governorate, about 90 km to the northeast of Baghdad and 40 km northeast of Baqubah. The ferry area extends over fertile agricultural land of more than 50 thousand hectares. As for the area of the studied area, it amounted to 919.4 hectares between longitudes (44º36 31.795 - 44º 38 28.093 east) and two widths (33º 45 11.987 - 33º 46) 51.496 3 N) Fig. 1.

### Field side

A pilot area was chosen as the Pilot area and three transect paths were taken in a vertical direction across the Diyala River, so that each of them passes the largest

number of larger and more frequent soil units, using all available previous survey maps completed by the National Center for Water Resources Management and with accreditation On field investigation and observing local variations in the soil tissue of the surface horizon and the level of spotting and through studying the type and density of vegetation cover as well as the nature of agricultural exploitation. In light of the information obtained, ten sites were selected with soil paddocks for each of the selected tracks, as follows: The first track (2.9 km) was distributed in the seventh, eighth and ninth soils, while the second track (3.16 km) was included with the paddocks of the fourth, fifth, sixth and tenth soils. The third (3.07 km) included the pedons of the first, second and third soils Fig. 2. The description of soil pedons with their central concept and a basic morphological description was carried out according to the Soil Science Division Staff (1993) guide. Soil material samples were taken from every horizon of pedon horizons for the purpose of conducting the required laboratory analyzes. Then the soils were classified into a sub-group level based on the American Soil Survey Staff (2014) classification system and to the series level suggested by AL-agidi (1976).

**Laboratory side**

Estimate the proportional distribution of soil separators by the hydrometer method mentioned in Bouyoucos (1962). Also, the electrical conductivity and soil reaction (pH) were measured in the saturated soil paste extract according to the method described in (Page *et al.,* 1982). Calcium carbonate, calcium sulfate and organic matter were estimated in soil material samples as described in Jackson (1958).

**The desk side**

The satellite image of the European industrial satellite Sentinel-2 was used, as the image was captured on October 19, 2019, which is within the study area and with thirteen spectral beams. And the series of soils prevailing in the study area. The study area was deducted from the satellite visual to increase the accuracy of the work used in geographic information systems. The locations of the pedons selected during the field survey process were dropped on the satellite visual through the use of the software ArcGIS 10.6.1 and ERDAS IMAGINEv14.1 for the year 2014, as well as the GPS locator, then the interpretation and classification process was carried out as follows:

1. Classification of visual space The digital interpretation of the satellite visual process was carried out using the application of directed classification by testing

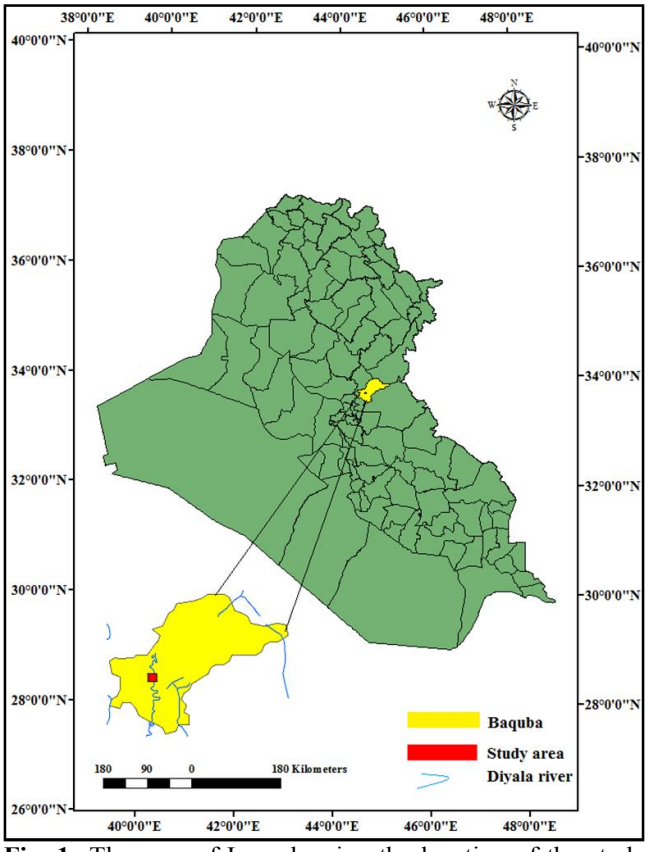


**Fig. 1:** The map of Iraq showing the location of the study area.

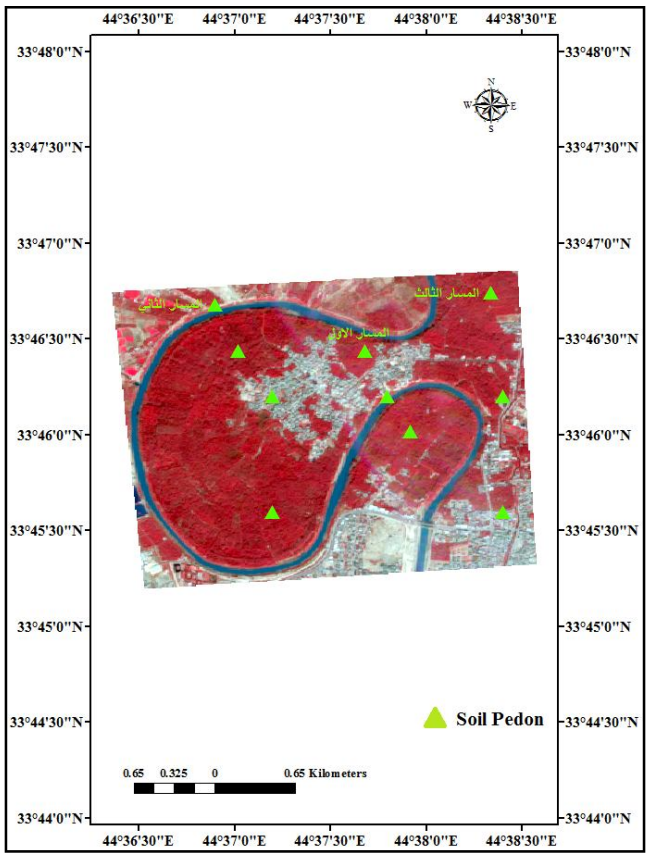


**Fig. 2:** Soil pedon sites for the selected paths within the study area.

a number of training areas that included all cases of heterogeneity in the study area depending on the state of heterogeneity in the characteristics of the study soil and in line with the results of the field survey work that determined the number of soil units prevailing in the area.

2. The spectral evidence used in the study The values of some Spectral Indices standards were calculated for the purpose of diagnosing and determining the nature of the vegetative covers prevailing in the study area table 1.

3. Production of vegetation cover maps Spatial distribution maps for the varieties of vegetation cover were prepared in light of the obtained results of the vegetative spectral indices used in the study and by using the geographic information systems program.

## Results and Discussion

### Classification of threshing soils

The results of the physical, chemical and morphological characteristics of the study pedons table 2 and 3 indicated that the soils of the area are considered from the newly formed undeveloped soils belonging to the rank of Entisols. This is due to the nature of the environmental conditions prevailing in the study area that do not help the activity of the pedogenous processes responsible for the formation of Soil and its development at a sufficient level as well as the short life span of the source material for these soils as it is represented by the modern sedimentary state. Therefore, these soils are characterized by a horizontal sequence of their A-C primates. And that the predominant diagnostic horizons in it are of the primitive form, represented in a major degree by the Ukrainian horizon, with the absence of the subsurface horizons of all kinds and because the source materials of the study typhoons are the result of river sediments, so these pedons return to the rank of fluvents. The largest group belongs to the great group Torrifluvents and under the group TypicTorrifluvent.In general, the chemical and physical characteristics did not show a specific pattern of distribution with depth in all pedons and this reflects the sedimentary state and the non-development of those soils except for the relative decrease of organic matter with depth.

### Satellite Visibility Guided Classification

The spectral signature of each type of soil series and other land uses of the study area was determined with the help of special applications in the ERDAS.V.11.02 program. The results of the directed classification indicated the existence of seven types of soil series and

**Table 2:** Some of the physical characteristics of pedons in the study area.

| Pe-don | Soil Series | Hori-zone | Depth (cm) | Sandg kg$^{-1}$ | Siltg kg$^{-1}$ | Clayg kg$^{-1}$ | Tex. |
|---|---|---|---|---|---|---|---|
| $P_1$ | MW9 | Ap | 0-32 | 308 | 358 | 334 | C L |
| | | C1 | 32-67 | 91 | 603 | 306 | Si C L |
| | | C2 | 67-125 | 124 | 587 | 289 | Si C L |
| $P_2$ | DW86 | Ap | 0-32 | 455 | 290 | 255 | L |
| | | C1 | 32-64 | 309 | 407 | 284 | C L |
| | | C2 | 64-120 | 192 | 504 | 304 | Si C L |
| $P_3$ | DW97 | Ap | 0-33 | 131 | 574 | 295 | Si C L |
| | | C1 | 33-80 | 91 | 554 | 355 | Si C L |
| | | C2 | 80-125 | 52 | 497 | 451 | Si C |
| $P_4$ | DW93 | A | 0-35 | 95 | 504 | 401 | Si C L |
| | | C1 | 35-70 | 68 | 607 | 325 | Si C L |
| | | C2 | 70-125 | 855 | 62 | 83 | L S |
| $P_5$ | MW5 | A | 0-44 | 189 | 455 | 356 | Si C L |
| | | C1 | 44-75 | 265 | 603 | 132 | Si L |
| | | C2 | 75-125 | 149 | 598 | 253 | Si L |
| $P_6$ | DW97 | Ap | 0-36 | 165 | 476 | 359 | Si C L |
| | | C1 | 36-75 | 182 | 442 | 376 | Si C L |
| | | C2 | 75-123 | 42 | 541 | 417 | Si C |
| $P_7$ | MW45 | Ap | 0-25 | 297 | 502 | 201 | L |
| | | C1 | 25-52 | 312 | 453 | 235 | L |
| | | C2 | 52-110 | 253 | 641 | 106 | Si L |
| $P_8$ | DW97 | Ap | 0-30 | 133 | 503 | 364 | Si C L |
| | | C1 | 30-55 | 113 | 516 | 371 | Si C L |
| | | C2 | 55-105 | 81 | 485 | 434 | Si C |
| | | C3 | 105-130 | 23 | 528 | 449 | Si C |
| $P_9$ | DW117 | Ap | 0-29 | 483 | 388 | 129 | L |
| | | C1 | 29-60 | 71 | 507 | 422 | Si C |
| | | C2 | 60-120 | 280 | 309 | 411 | C |
| $P_{10}$ | DW93 | A | 0-35 | 123 | 508 | 369 | Si C L |
| | | C1 | 35-75 | 101 | 541 | 354 | Si C L |
| | | C2 | 75-120 | 823 | 104 | 73 | L S |

**Table 1:** Calculation of the evidence for vegetative covers.

| Index | Formulation | Name | Reference |
|---|---|---|---|
| SAVI | $SAVI = \frac{(NIR - RED) * (1 + L)}{(NIR + RED + L)}$ | Soil-adjusted Vegetation Index | Huete (1988) |
| MSAVI2 | $MSAVI2 = \frac{[2NIR + 1 - \sqrt{(2NIR + 1)^2 - 8(NIR - RED)}]}{2}$ | Modified Soil-adjusted Vegetation Index | Qi *et al.*, (1994) |

the rest of the land cover of water bodies and urban areas as shown in Fig. 3.

The areas of soil series in the study area were calculated in hectares, estimated in hectares with their percentages, as they totaled 866.62 hectares, or 94.26% of the total surface area of 919.4 hectares. The soil series MW5 has the lowest area of 33.44 hectares, or 3.64%, in addition to the water bodies, which amounted to 36.95 hectares, or 4.02%, while the urban areas amounted to 15.83 hectares, 1.72% of the total area, as shown in table 4.

## Measured spectral indices

### Soil Adjusted and Vegetation Index (SAVI)

Fig. 4 shows the spatial distribution of the SAVI index values in the study area for the spatial data for the year 2019, as it is noticed that there is a discrepancy in the values, ranging between (-1.4 _ 1) and this reflects the state of variation in the type of vegetative covers prevailing in the study area. Depending on the state of discrepancy in the values of the SAVI index, four types of land cover were identified in the study area represented by water bodies, which showed the lowest values, ranging between 0.2 and 0.4- and they used to occupy an area estimated at 239.67 hectares and by 26.07% of the total area of the study area table 5. Whereas, the index values of the weak plant variety ranged between (0.4-0.2) and had an area of 127.45 hectares, representing 13.86% of the total area. As for the medium density plant variety, the values of this index ranged between 0.6-0.4 and it had an area of 179.16 hectares and a percentage of 19.49% of the total area of the study area. The results also indicate that the SAVI index values for the dense plant variety ranged between (1-0.6) and it used to occupy an area estimated at 373.12 hectares, representing 40.58% of the total area. For the visible red and near infrared spectral beams, which in turn helped change the values of the modified vegetative index.

**Table 3:** Some chemical properties of pedons in the study area.

| Pedon | Soil Series | Horizone | Depth (cm) | pH (1:1) | ECe $dSm^{-1}$ | Calcium Carbonate $g.kg^{-1}$ | Gypsum $gkg^{-1}$ | O.M. $gkg^{-1}$ |
|---|---|---|---|---|---|---|---|---|
| $P_1$ | MW9 | $A_p$ | 0-32 | 7.02 | 3.04 | 275 | 1.50 | 39.67 |
| | | $C_1$ | 32-67 | 7.16 | 1.68 | 310 | 1.60 | 14.83 |
| | | $C_2$ | 67-125 | 7.54 | 0.55 | 330 | 0.20 | 0.69 |
| $P_2$ | DW86 | $A_p$ | 0-32 | 7.06 | 6.66 | 325 | 1.90 | 6.55 |
| | | $C_1$ | 32-64 | 7.81 | 0.64 | 345 | 0.10 | 1.72 |
| | | $C_2$ | 64-120 | 7.45 | 1.10 | 315 | 0.20 | 5.17 |
| $P_3$ | DW97 | $A_p$ | 0-33 | 7.30 | 4.85 | 350 | 1.90 | 13.79 |
| | | $C_1$ | 33-80 | 7.70 | 0.50 | 320 | 0.20 | 2.41 |
| | | $C_2$ | 80-125 | 7.41 | 1.15 | 325 | 0.10 | 6.20 |
| $P_4$ | DW93 | A | 0-35 | 7.35 | 1.22 | 305 | 0.50 | 1.72 |
| | | $C_1$ | 35-70 | 7.40 | 1.13 | 300 | 0.10 | 0.69 |
| | | $C_2$ | 70-125 | 7.69 | 0.43 | 225 | 0.20 | 0.34 |
| $P_5$ | MW5 | $A_p$ | 0-44 | 7.08 | 5.71 | 325 | 1.70 | 4.82 |
| | | $C_1$ | 44-75 | 7.64 | 0.70 | 310 | 0.90 | 0.69 |
| | | $C_2$ | 75-125 | 7.57 | 0.88 | 315 | 0.10 | 0.34 |
| $P_6$ | DW97 | $A_p$ | 0-36 | 6.74 | 5.39 | 325 | 1.60 | 12.16 |
| | | $C_1$ | 36-75 | 7.61 | 0.51 | 340 | 0.30 | 1.72 |
| | | $C_2$ | 75-123 | 7.49 | 0.85 | 345 | 0.10 | 2.78 |
| $P_7$ | MW45 | $A_p$ | 0-33 | 7.30 | 2.15 | 350 | 0.50 | 13.79 |
| | | $C_1$ | 33-52 | 7.16 | 4.08 | 360 | 1.60 | 0.68 |
| | | $C_2$ | 52-110 | 7.17 | 3.34 | 325 | 1.70 | 0.34 |
| $P_8$ | DW97 | $A_p$ | 0-30 | 7.20 | 1.18 | 330 | 0.30 | 24.83 |
| | | $C_1$ | 30-55 | 7.40 | 0.55 | 325 | 0.10 | 20.33 |
| | | $C_2$ | 55-105 | 7.50 | 0.52 | 310 | 0.40 | 27.80 |
| | | $C_3$ | 105-130 | 7.44 | 1.20 | 295 | 0.20 | 25.87 |
| $P_9$ | DW117 | $A_p$ | 0-29 | 7.22 | 9.50 | 200 | 2.70 | 43.12 |
| | | $C_1$ | 29-60 | 7.50 | 1.66 | 305 | 0.50 | 6.89 |
| | | $C_2$ | 60-120 | 7.35 | 3.36 | 325 | 1.60 | 10.43 |
| $P_{10}$ | DW93 | $A_p$ | 0-35 | 7.54 | 1.54 | 305 | 0.10 | 1.72 |
| | | $C_1$ | 35-75 | 7.50 | 1.79 | 270 | 0.10 | 1.37 |
| | | $C_2$ | 75-120 | 7.30 | 0.47 | 280 | 0.20 | 1.03 |

The Modified Soil Adjusted Vegetation Index (MSAVI2)

Use the MSAVI to delineate vegetation covers more accurately and more closely to real life. The results indicated in Fig. 5 that there is a clear variation in the areas and percentages of the varieties of vegetation covers prevailing in the study area. The values of the MSAVI2 index ranged between .0.8 and -0.8, calculated from the space data for the year 2019. Five classes of land cover were identified in the study area. It is noticed that the negative values of this index reflect the existence of water bodies and they occupy an area estimated at 118.12 hectares, or 12.85%. From the total area of the study area table 6. Whereas, the index values of the non-agricultural land category ranged between (0.1-0.8), as this item occupied an area estimated at 0.13 hectares, representing 0.01% of the total area.

The results also indicate that the index values of the low-density plant variety ranged between (0.2 - 0.1). This variety had an area of 83.88 hectares and that of 9.12% of the total area of the study area. As for the index values of medium density plants, they ranged between (0.5 - 0.2) and it had occupied an area estimated at 186.86

hectares, representing 20.32% of the total area.

It is noted that the values of the MSAVI2 index of the dense plant variety ranged between (0.8 - 0.5) and it had an area of 530.41 hectares and that of 57.70% of the total area of the study area. These results reflect the

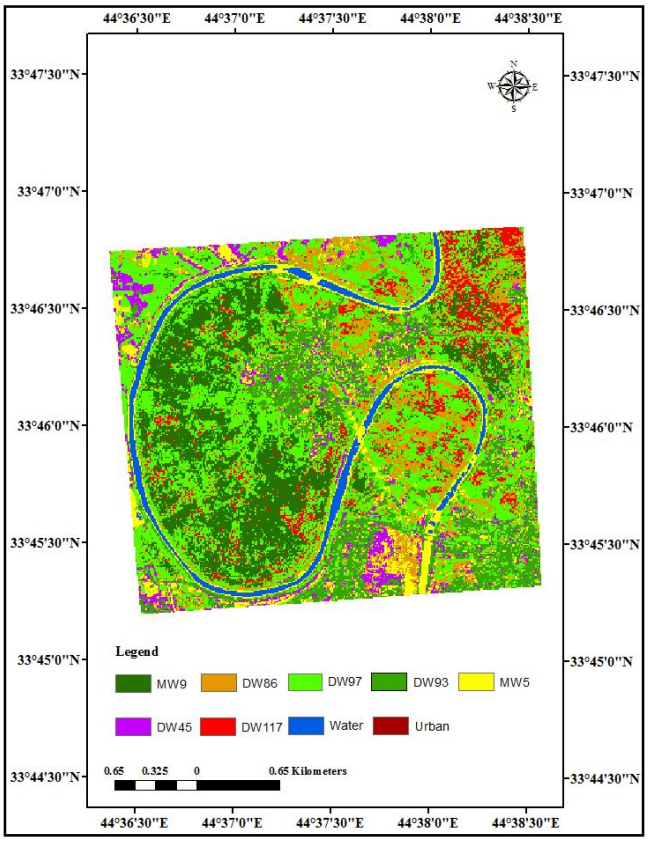


**Fig. 3:** Spatial distribution of soil series in the study area.

**Table 4:** The areas of soil series in the study area.

| Land Cover_Soil Series | Area_ha | Area % |
|---|---|---|
| Water | 36.95 | 4.02 |
| Urban | 15.83 | 1.72 |
| MW9 | 147.55 | 16.05 |
| DW86 | 64.53 | 7.02 |
| DW97 | 337.34 | 36.69 |
| DW93 | 134.78 | 14.66 |
| MW5 | 33.44 | 3.64 |
| DW45 | 68.25 | 7.42 |
| DW117 | 80.73 | 8.78 |
| Total Area of Soil Series | 866.62 | 94.26 |
| Total of the Study Area | 919.40 | ---- |

**Table 5:** Areas of the SAVI index of amended vegetation cover categories.

| Class | SAVI Range | Area_ha | Area% |
|---|---|---|---|
| Water | -0.4-0.2 | 239.67 | 26.07 |
| Low Vegetation | 0.2-0.4 | 127.45 | 13.86 |
| Moderate Vegetation | 0.4-0.6 | 179.16 | 19.49 |
| Dense Vegetation | 0.6-1 | 373.12 | 40.58 |
| Total Area | 919.40 | ---- | |

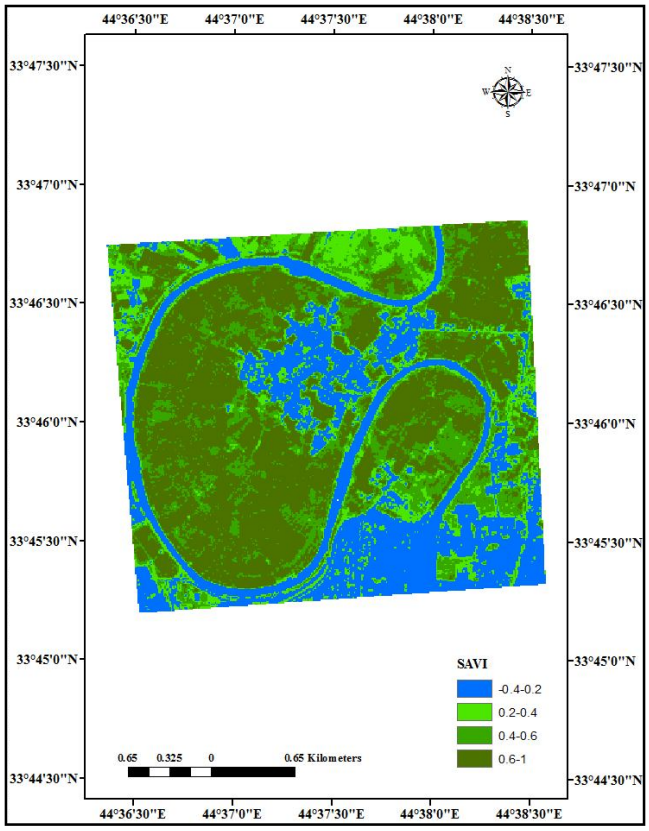


**Fig. 4:** Spatial distribution of SAVI in the study area.

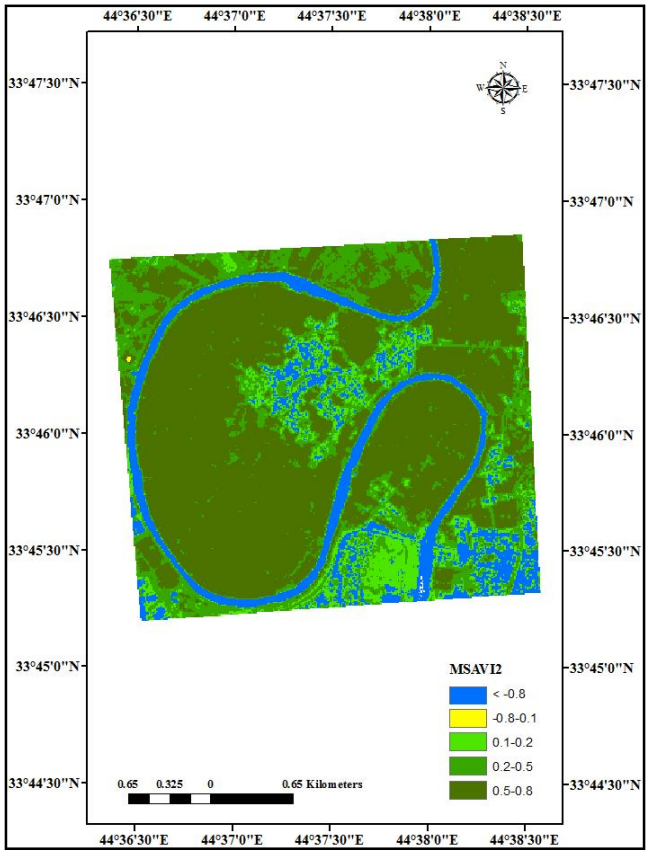


**Fig. 5:** The spatial distribution of MSAVI2 in the study area.

**Table 6:** Areas of the MSAVI 2 categories of vegetative cover index.

| Class | MSAVI2 Range | Area_ha | Area% |
|---|---|---|---|
| Water | <-0.8 | 118.12 | 12.85 |
| No Vegetation | -0.8-0.1 | 0.13 | 0.01 |
| Low Vegetation | 0.1-0.2 | 83.88 | 9.12 |
| Moderate Vegetation | 0.2-0.5 | 186.86 | 20.32 |
| Dense Vegetation | 0.5-0.8 | 530.41 | 57.70 |
| Total Area | 919.40 | ---- | |

predominance of the intensive plant variety and it is noted that they accompany river courses and wetter areas in the region, such as irrigated lands and cultivated with different crops. Waked (2013) *et al.,* Narayanan Efficiency of using MSAVI2 compared to NDVI. The spectral reflectance values of infrared and red visible rays directly influence the determination of the values of this index with the simplification and ease of calculating the *Brightness factor* L.

## Conclusions

1. The results of the directed classification indicated the existence of seven types of soil series totaling 866.62 hectares, or 94.26% of the total cover area of 919.4 hectares and the dominance was for the DW97 series, with an area of 337.34 hectares, or 36.69% of the total areas of the soil series.

2. The results of the spectral vegetative evidence used in the study SAVI and MSAVI confirmed the predominance of the dense plant variety, which represents the lands cultivated with palm groves as well as citrus trees that were not affected by salinity due to the low salt content in them.

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