Al-Muthanna J. For Agric Sci Print ISSN: 2226-4086 Online ISSN:2572-5149
Vol. 10 , Issue. 02. 2023

https://muthjas.mu.edu.iq/ http://doi.org/10.52113/mjas04/10.2/30

Temporal and Spatial Analysis of Vegetation Cover Distribution Patterns in Northern Basrah Governorate Using Geomatics Techniques

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Received on 05/10/2023 Accepted on 19/11/2023 Published on 15/12/2023

Abstract:

The study conducted within the administrative boundaries of Basrah Governorate, Iraq extending from the southern borders of Al-Haritha district to the northern borders of Al-Qurna district along the Shatt al-Arab River and its adjacent areas with a total area of approximately 354,450 Km^2. Landsat-8Satellite imagery data were acquired processed and analyzed for the study area for the year 2022 covering four time periods with a temporal interval of three months each. The data were obtained from the Earth-observing sensors, specifically the Operational Land Imager (OLI). Subsequently a vegetation cover index was derived for the purpose of temporal and spatial monitoring and analysis aiding in the acquisition study and interpretation of agricultural activity patterns. The results revealed a clear temporal variation as the vegetation cover index showed an increase in the months of October and April, while the lowest values were recorded in January and July across all study stages. Field of remote sensing and vegetation analysis helps reduce the effort and time required.

Key words: NDVI, Remote Sensing, GIS , Basrah Governorate.

*Part of PhD dissertation of the first author.

Introduction

Remote sensing techniques can be employed to monitor the spatial and temporal trends in vegetation cover changes in drylands. They advocated mapping land degradation using appropriate vegetation cover metrics to analyze the temporal patterns for each pixel(Fensholt et al., 2015). Naji (2018) study three of these vegetation indices techniques that have been adopted (i.e. Difference vegetation index (DVI), Perpendicular Vegetation Index (PVI) and Weighted Difference Vegetation Index (WDVI) for detecting and monitoring vegetation distribution and healthiness, and the separated agriculture regions from the implementation of the DVI-index have proved better than other used indices. Because it showed better coincident approximately with 2D-space plot segmentation.

He emphasized that vegetation monitoring requires the selection of specific spectral bands, including Near Infrared (NIR) and Red wavelengths, as well as the use of infrared ranges for assessing vegetation changes(Galiano , 2012). Statistical analyses focused on the variability of maximum biomass in June. The results revealed a strong positive correlation (0.79, 0.77, and 0.96) between NDVI values derived from Landsat, MODIS, and AVHRR, respectively. The linear slope of NDVI for each pixel indicated a slight negative trend in green biomass over the study area from 2002 to 2018, with slope values ranging from -0.002 to -0.05 (Albarakat & Lakshmi, 2019). The experiments conducted using this module focus on the normalized difference vegetation index (NDVI) based on TOC reflectance data, considering aerosol properties from AERONET Comparisons are made between the NDVI results obtained using this new atmospheric correction module and the dark object subtraction (DOS) scheme a relative atmospheric correction method Significantly different results were observed between NDVI values obtained from TOC reflectance data with or without AERONET data and those obtained from the DOS scheme and Landsat-8 surface reflectance. (Lee et al., 2020). Pałas & Zawadzki (2020) have mentioned that the Soil-Adjusted Vegetation Index (SAVI) is commonly applied in arid regions with low vegetation cover the quantity and magnitude of vegetation cover determine the SAVI values which range between 0.0 and 1.0 value of 1.0 represents areas with no green vegetation cover 0.5 corresponds to areas with moderate vegetation cover and 0.0 signifies areas with dense vegetation cover. Barboza et al. (2023) conducted an assessment of two vegetation cover indices, NDVI (Normalized Difference Vegetation Index) and NDRE (Normalized Difference Red Edge), in estimating green biomass accumulation for bean crops in America. They indicated that NDVI outperformed NDRE with a higher performance.

This research aims to study the temporal and spatial vegetation cover patterns for the year 2022 in northern Basra Governorate. Its primary objectives include calculating the areas of utilized and unutilized agricultural lands that could be of future benefit. Additionally, it aims to identify vegetation distribution patterns and the factors influencing them.

Material and methods

Location and StudyArea

The study area is located within the administrative boundaries of Basra Governorate and extends from the southern borders of Al-Haritha district at coordinates 47^o 46' 54" E - N 30^o 34' 57", 47^o 45' 33" E - N 30^o 33' 38", to the northern borders of Al-Qurna district at coordinates 47^o 27' 16" E - N 31^o 1' 59" and 47^o 22' 46" E - N 30^o 59' 54". It spans along the Shatt al-Arab River and its adjacent areas, with a total area of 354.450 Km^2 (Figure (1)). The study area is located in the alluvial plain of the Tigris and Euphrates rivers on the Arabian tectonic plate. The surface of the land in the southern regions of Iraq is characterized by the deposits of the Quaternary era, primarily from the Tigris and Euphrates rivers, including marshes and wetlands. The alluvial plain in general and specifically the Basra Governorate is divided into several secondary physiographic units based on soil morphology taking into account sedimentary and hydrological processes. These units include ancient river deltas floodplains fluvial terraces delta plains marsh and swamp areas estuarine regions and coastal plains.

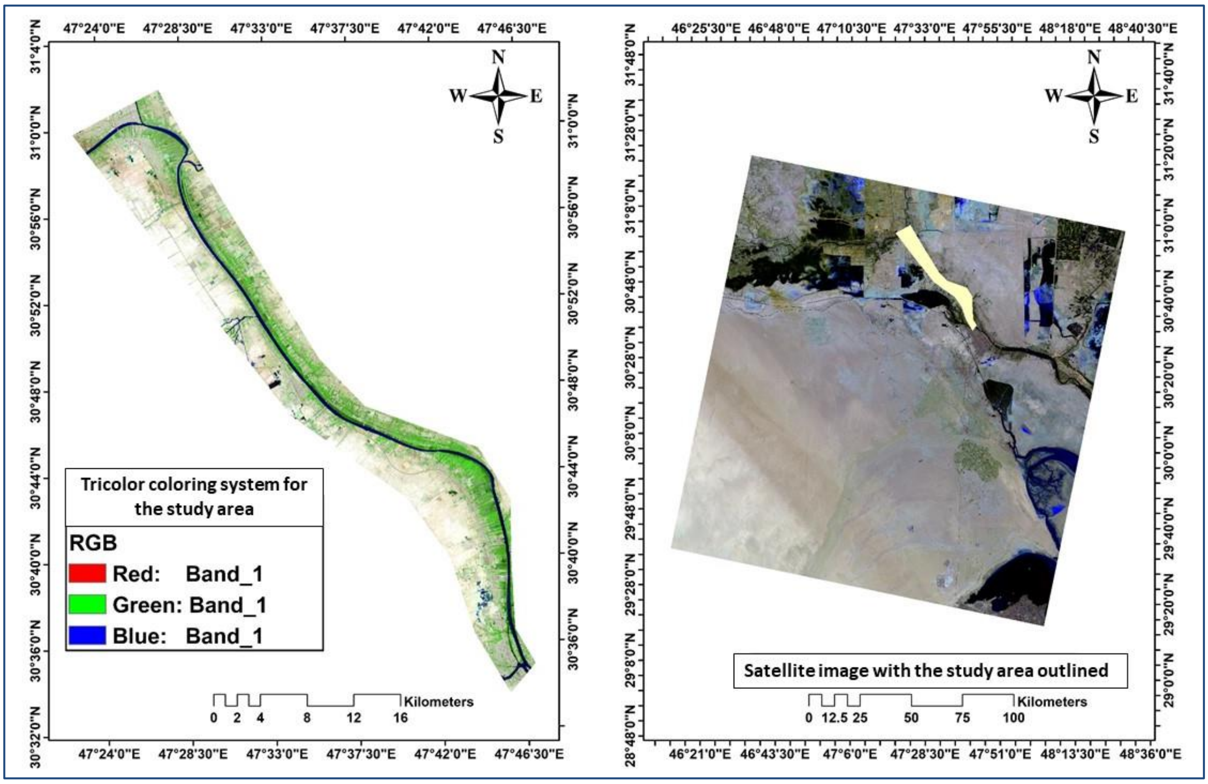

Figure (1) Depicts the study area using the RGB color system.

Remote Sensing Data Sources and Office Work

The study relied on satellite imagery data sources , particularly multispectral imagery, which provide extensive spatial information about the study area. This multispectral imagery consists of eleven spectral bands with a spatial resolution ranging from 30 to 15 meters. Satellite imagery data were obtained, processed, and derived for the study area for the year 2022, covering four time periods with a three-month temporal interval. This data was acquired from Earth-observing sensors including the Operational Land Imager (OLI) on the American satellite Landsat-8 It includes eleven spectral bands, of which the fourth band (Red) and fifth band (NIR) were used which are intended in Path 166 and raw 39 . Recent images for the year 2022 were downloaded from the United States Geological Survey (USGS) website(Pivato et al., 2020).These images were used to determine the Vegetation Cover Index was derived to monitor changes and conduct temporal and spatial analysis assisting in the acquisition, study, and interpretation of agricultural activity.

Digital Classification

Process involved a series of statistical procedures that segmented the satellite imagery into Visual false classification. This segmentation was achieved by merging seven spectral bands into a single visual image and using the spectral bands 7, 5, and 3 in the RGB color system successively as a color combinatio(Azad

Calculation of Vegetation Cover Index

The study period was divided into four stages with a three-month temporal interval, based on the acquisition time of satellite imagery for the study area, as follows: 10/1, 16/4, 5/7, and 14/10 for the first, second, third, and fourth time periods of the year 2022 respectively. Then, the Vegetation Cover Index (NDVI) was calculated using the following equation (Attafi *et al.*, 2021), which was divided

Vishwakarma *et al.*, 2021). TIdentification of the visual variation in vegetation cover in the study area (Figure 1). into five categories, each representing a specific land cover type.

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

NDVI: Vegetation Cover Index, which ranges (1 , –1).

B4: The fourth spectral band of red wavelengths.

B5: The fifth spectral band of near-infrared wavelengths**.**

Results and Discussion

Vegetation Cover Index

Temporal Variation

The results in Table (3) and Figures (2, 3) show clear variation in the Vegetation Cover Index values for the months of January, April, July, and October in the study area. This variation is considered a characteristic influenced by climate changes during seasons and agricultural activities in the region. The values of the Vegetation Cover Index generally range from -1 to 1. The range from -1 to 0 indicates water and bare land, while positive values approaching zero represent bare land. Values approaching 1 represent

vegetation cover. The results indicate a clear temporal variation, with the Vegetation Cover Index showing an increase in the months of January and April, while the lowest values were recorded in the months of January and July across all study intervals. This variation can be attributed to the activity of winter crops such as wheat and barley from October to April when the cultivation of maize and other forage crops begins Additionally there is an increase in natural vegetation activity during the spring seasons, increasing chlorophyll in plant cells, while plant activity decreases during the autumn and summer seasons (Kadhim, 2021).

Spatial Variation

Regarding spatial variation in each phase of the study, the Vegetation Cover Index was divided into five categories with values ranging from -1 to 0, 0.001 to 0.125, 0.126 to 0.250, 0.251 to 0.375, and 0.376 to 0.500 for the first, second, third, fourth, and fifth categories, respectively, for each of the months of January, April, July, and October. The results presented in Table (1) and Figures (2, 3) show that the

second category, representing bare land, accounted for a percentage of the study area of 55.903%, 53.218%, 58.140%, and 56.281%. Meanwhile, the third category, representing cultivated agricultural land, recorded percentages of 22.208%, 23.039%, 19.247%, and 19.198%. Sparse vegetation cover was represented by the fourth category, covering area of 12.821%, 14.942%, 12.874%, and 13.613%, respectively. The fifth category, representing dense vegetation cover, covered an area of 3.636%, 4.249%, 4.388%, and 5.592% for each of the four study phases, respectively.

It can be observed that there was a slight increase in the fourth category during the months of April and October, while the lowest values were recorded in the months of January and July. The fifth category, representing dense vegetation cover, showed a different pattern, with higher values in October compared to the other months, followed by July, compared to January and April, respectively. This variation can be attributed to agricultural practices in the study area, as the cultivation of winter crops begins in the early growth stages in October, coinciding with satellite imagery capture (Attafi *et al.*, 2021). Additionally, the increase in the values of the fourth category in July may be due to the cultivation of forage crops and irrigation practices that support some plants' growth during this time (Jaradat, 2003).

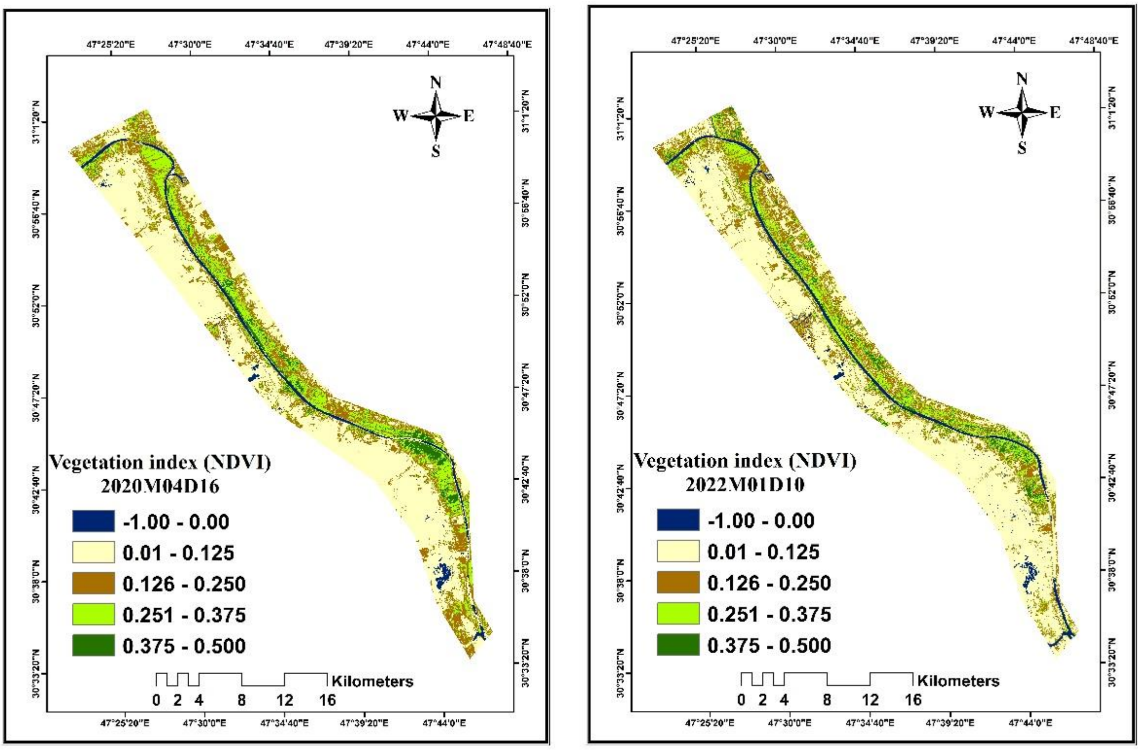

Figure (2): A map illustrating the values of the Vegetation Cover Index in the study area for the months of January and April in the year 2022.

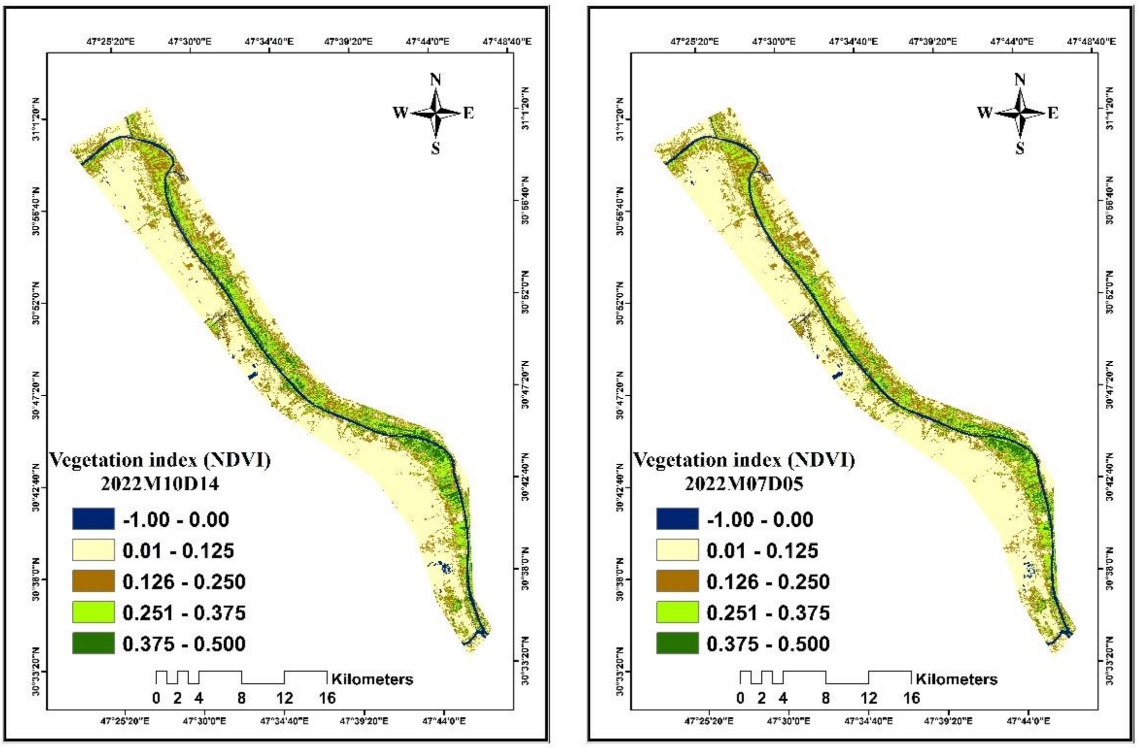

Figure (3): A map displaying the values of the Vegetation Cover Index in the study area for the months of July and October in the year 2022.

Table (3): Shows some of the geostatistical characteristics of the Vegetation Cover Index values in the study area.

Date	Class	Minimum limit	Maximum limit	Area km ^{2}	Percentage (%)
2022M01D10	1	-1.00	0.00	19.26	5.43
	2	0.00	0.13	198.15	55.9
	3	0.13	0.25	78.71	22.21
	4	0.25	0.38	45.44	12.82
	5	0.38	0.50	12.89	3.64
2022M04D16	1	-1.00	0.00	16.14	4.55
	2	0.00	0.13	188.63	53.22
	3	0.13	0.25	81.66	23.04
	4	0.25	0.38	52.96	14.94
	5	0.38	0.50	15.06	4.25
2022M07D05	1	-1.00	0.00	18.96	5.35
	2	0.00	0.13	206.08	58.14
	3	0.13	0.25	68.22	19.25
	4	0.25	0.38	45.63	12.87
	5	0.38	0.50	15.55	4.39
2022M10D10	1	-1.00	0.00	18.85	5.32
	2	0.00	0.13	199.49	56.28
	3	0.13	0.25	68.05	19.2
	4	0.25	0.38	48.25	13.61
	5	0.38	0.50	19.82	5.59

Conclusion

- There is a clear variation in the Vegetation Cover Index values for the months of January, April, July, and October in the study area for the year 2022. This variation is influenced by seasonal climate changes and agricultural activities in the region.
- Remote sensing techniques have provided a high-precision detection of the vegetation cover distribution pattern and land cover percentages in the northern region of Basra province.

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