Monitoring the distribution of parks and land cover changes along the Tigris River using spatial analysis techniques

Sundus A. Abdullah Albakri[1,*], *Zina* F. Kadhim[2]; *Sura* I. Gburi[2], *Muhend* K.Samer[2], and *Faisel* G. Mohammed[1]

[1]Dept. of Remote Sensing, University of Baghdad, College of Science, Baghdad, Iraq
[2]Dept. of Astronomy and space, University of Baghdad, College of Science, Baghdad, Iraq

Abstract. This study examines the use of GIS and Remote Sensing in monitoring vegetation growth of Baghdad in Al- Risafa limited in the region Abu Nawas that alignment Tigris River. The various land features of land for the adopted area were be analyzed by spatial analysis techniques, Classification the images of land sat 8 will be considered. The techniques of classification that adopted in this work; including supervised with unsupervised techniques that are commonly used to produce land cover features. The results produced from the NDVI images gave a good indication of vegetation degradation through the period (2019 - 2023). For year 2019 the area of Rare plant 269100 m^2, Low plant 603000 m^2, and the medium plant was 344700 m^2 total. Found that plant less area, and low plant area increases through the period (2019–2023) years. That is indicates decrease in vegetation area in the region of Abu Nawas with the decreasing rate of medium plant (12.6-8.3).These results can be due several reasons, including climate change, which causes a rise in temperatures and pollution in the waters of the Tigris River due to water scarcity and lack of interest in plowing the river on a regular basis, as well as due to urban growth represented by the large number of vertical buildings that impede air access to plants and humans alike. The parks proposed in this study, based on spatial analysis techniques depending on the classification methods, were distributed according to the selected sites, and their area ranged along the Tigris River between (172893 m^2 -340006 m^2) for the period.

1 Introduction

Sustainable environment is considered the most important goals that must be achieved for human living and the formation of human settlements. Among the most important environmental components are the presence of clean water and rivers, as the availability of green cover, gardens and parks in all cities are considered suitable conditions for human existence as well as the presence of an environment for animals to live in. Many researchers have now used remote sensing techniques to search for suitable places for the presence of water and the distribution of green cover and to conduct spatial analysis to determine the

[*] Corresponding author: Sundusalbakri70@gmail.com

concentration of water. In Iraq, the Tigris and Euphrates rivers are considered among the most important vital rivers for living.

The Tigris River is Western Asia's second-longest river. The Tigris River, is 1850 km long and rises in eastern Turkey. It flows through densely populated areas, particularly Baghdad, which is home to almost 8 million people. The river enters the city from the north and flows southward as part of the alluvial plain, with an average flow rate of 540 m3/s from 2005 to 2020 [1]. The amount of water in our nation's rivers has drastically decreased in recent years due to the extensive human and economic activities and the great and growing need for water as one of the components of life on water. Increased sewage and the absence of a treatment plant are two major causes of the low river discharge, as is the pollution of the Tigris River water by the transfer of pollutants that are harmful to aquatic and human life and their impact on the vegetation cover as a result of human activities and dead animals in the water, such as: household sewage, hospitals and industrial factories that empty their polluted water directly into the river without any treatment, so it passes through the city of Baghdad and threatens the ecosystem of plants and living organisms and contributes to killing aquatic life and poisoning fish and others [2].

Compared to other Iraqi cities, Baghdad is thought to be the most densely populated city. It is situated on a plain between 31 and 39 meters above sea level [1]. So its aerial extension is unrestricted by any natural boundaries. The Tigris River splits the city in half, with the eastern half being Rusafa and the western half being Karkh. The eastern boundary of the area is formed by the Diyala River, which joins the Tigris River southeast of Baghdad [3].

Study Area

Tigris River located in the northern part of the city serves as the recharge region for the 24 km long Army Canal, which is flows into the southern part of the Diyala River. Figure (1) shows the Tigris river in the geological map of Iraq.

Abu Nawas street area was chosen in Baghdad Governorate for this study. The capital, Baghdad, is considered the first city and the center of Iraq which is located in central of Iraq between (longitude 44˚2157.96E; latitude 33˚1854.72N) as shown in Fig (2) [4]. Geographic information system (GIS) methods are a useful and effective tool for planning and analyzing spatial data. In a digital mapping context, GIS stores geographic information (data) [5]. To visualize spatial information and relationships, data or other layers of information can be superimposed on top of the digital base map. Better viewing and comprehension of physical features and the linkages influencing a specific crucial environmental condition are made possible by GIS. To determine different environmental parameters and effect analysis, factors including vegetation, aspects, and slope steepness can be observed and superimposed. Abu Nawas area is a recent wide, shallow sloped levee extending south to the bend bend eastward to flow around in the form of a large oxbow as shown in Fig. (3) [4].

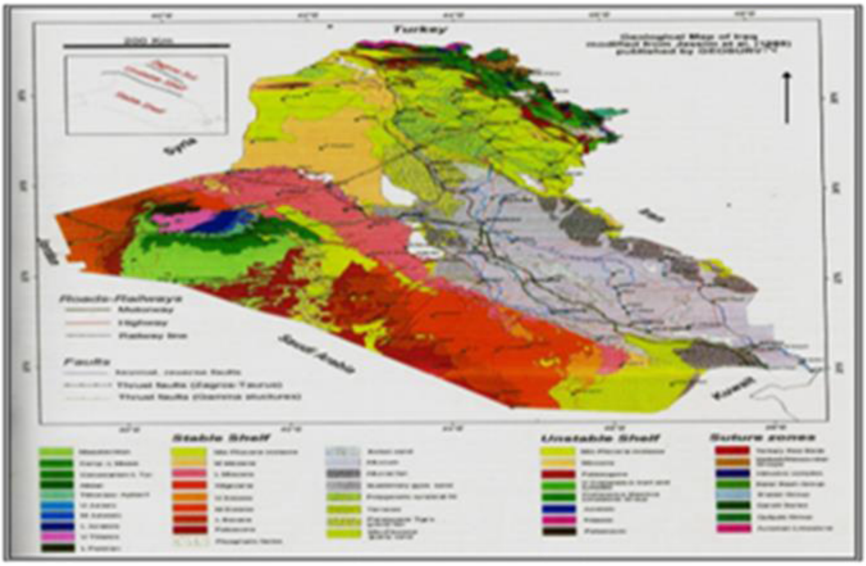

Fig. 1. Represents Geological map of Iraq contains Tigris River [2,3].

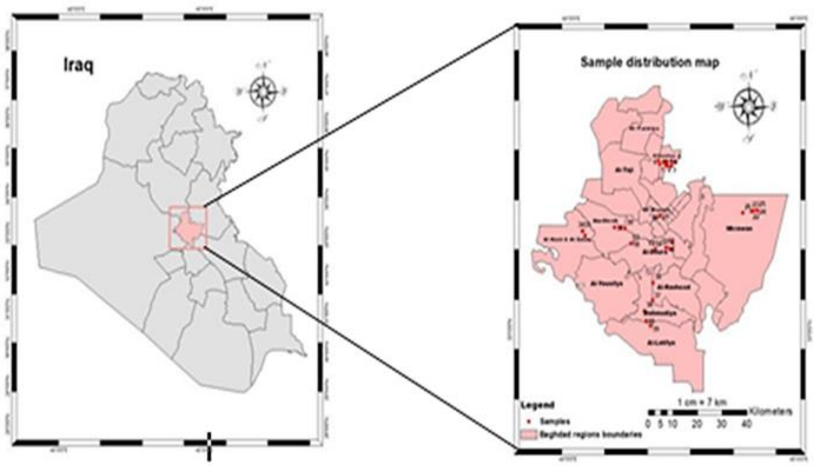

Fig. 2. Shows the location of Study area on the map of Iraq.

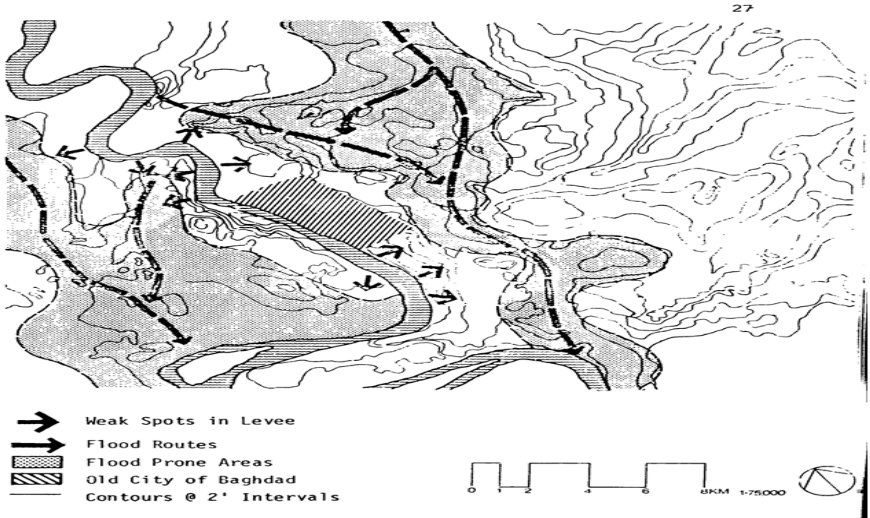

Fig. 3. The area behind the levee, and flood routes [5].

Two or three spots in the Abu Nawas natural levee are weak structurally and show extensive overflows, where the river has deposited large alluvial fans [4].

2 Materials and methods

-In this work, Certain GIS methods can be used based on their significance and the nature of the business. It is possible to estimate, generate, and assess the spatial analysis of land cover distribution using the categorization approaches. According to the facts and information available for the study area, each spectral class is distinct due to the classification being influenced by the urban planning characteristics of the examined area (rural or urban).
- Arc Map 10.8 (GIS) was used to retrieve the authorized maps. Through the intensity of radiation, reflection, and diffusion of the feature chosen for the investigation, the physical qualities influence the characteristics of the phenomenon under study.
-Normalized Difference Vegetation Index (NDVI) is studied widely to describe changes in vegetation index in landscapes around the world [3], [6].
-The source is a satellite video with a resolution of 30 square meters for the year (2019-2020-2021-2022-2023) and processed using the ARC MAP 10.8 (G.I.S) software.

2.1 Remote sensing

In order to identify and classify distant objects or materials, the concepts of remote sensing (RS) entail the detection and measurement of radiations of various wavelengths that are reflected or emitted from their surface [7]. RS is the process of gathering pictures or other information about an item using measurements taken from a distance. Examples of this include satellite imaging and aerial photos [5].
However, only optical pictures obtained by airborne or space-borne sensors are taken into consideration in this context. The scientific community has been using remote sensing technologies more and more in the past few decades to characterize and track a range of systems at the local or global level. Multi-spectral imagery, such as Thematic Mapper, has replaced pure visual imagery, such as aerial images, in this technology.

The spatial properties of the data across different digital layers can be analyzed using GIS [7]. GIS is a rapidly developing information technology that allows the creation of databases

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with geographical data that may be used for both the natural environment (such as population distribution and environmental factors) and human settlements (such as demographic databases). Most significantly, sustainable management can be ensured by combining the two types of databases. In addition to the analytical description of geographical issues, GIS will continue to advance as a crucial acquisition and analysis tool. It will also be used in environmental planning, impact assessment, disaster management, and remote sensing monitoring. Through a number of case studies, Environment, Development, and Sustainability has examined the application of remote sensing and GIS in the sustainable management of tropical coastal ecosystems [8]. Multispectral image classification is the primary technique used in the graphical and spatial analysis of remotely sensed pictures. A multispectral image's pixel (image element) attributes are usually recorded on several spectral channels. Following processing and correction, satellite data analysis entails registration, classification, and change detection utilizing the compared satellite data [3].

2.2 Supervision classification

Supervised classification is a type of machine learning that employs a classification algorithm and predefined training data. In supervised remote sensing, the classification process is frequently employed as the classification algorithm [6]. The most convincing aspect of the Landsat image classification method is the supervised component, which serves as the training sample. To evaluate thick vegetation normalize difference vegetation index (NDVI). The Normalized Difference Vegetation Index (NDVI) is a measure of how much vegetation exists in (NDVI). Low NDVI values (0.1 and below) denote barren rock, sand, environments. Moderate amounts indicate bushes and grassland (0.2 to 0.3), whereas high levels indicate tropical rain-forests and dense forests for a range of values between 0.6 and 0.8 [7].

Plants, that are solid and have a long near IR (NIR) reflectivity, around 0.7-1.3 µm. Chlorophyll is a substance found in greenery that powerfully reflects green (0.5-0.6 µm), red (0.4-0.5 µm), and blue (0.4-0.5 µm) . High Ruddy retention and long NIR reflectance are the two criteria used to determine the NDVI.

NDVI can be calculated by using the formula in equation (1) [10]:

$$NDVI = \frac{(NIR-R)}{(NIR+R)} \quad (1)$$

Where NIR: near infrared, R: red color spectrum,the NDVI value is in the range of -1 to 1. Higher NDVI readings represent greater NIR levels, which suggest thick vegetation [3]. NDVI classification was used to extract the total area of vegetation in the Abu Nawas area adjacent to the study area located in Baghdad. It was revealed through this technique that there was a difference in the distribution of vegetation cover through the period (2019– 2023) years in terms of Plant less, Rare plant, Low plant, Medium plant, and the total plants as illustrated in the following: tables (1), (2), (3), (4), and (5).

Table 1. The area of vegetation types for the year 2019.

Class	Area (m^2)	(%)
Plant less	1814400	59.86
Rare plant	269100	8.88
Low plant	603000	19.89
Medium plant	344700	11.37
The total	3031200	100

Table 2. The area of vegetation types for the year 2020.

Class	Area (m^2)	(%)
Plant less	1812600	59.80
Rare plant	291600	9.62
Low plant	567000	18.71
Medium plant	360000	11.88
The total	3031200	100

Table 3. The area of vegetation types for the year 2021.

Class	Area (m^2)	(%)
Plant less	1766700	58.28
Rare plant	373500	12.32
Low plant	548100	18.08
Medium plant	342900	11.31
The total	3031200	100

Table 4. The area of vegetation types for the year 2022.

Class	Area (m^2)	(%)
Plant less	1595700	52.64
Rare plant	379800	12.53
Low plant	673200	22.21
Medium plant	382500	12.62
The total	3031200	100

Table 5. The area of vegetation types for the year 2023.

Class	Area (m^2)	(%)
Plant less	1566000	51.66
Rare plant	522900	17.25
Low plant	689400	22.74
Medium plant	252900	8.34
The total	3031200	100

3 Results and discussion

Through satellite images of the Abu Nawas area that alignment Tigris River in the city of Baghdad and using the NDVI program, the following results were obtained as shown in figures below. Figure (4) shows the rates of vegetation areas with rate of plants for year 2019. The areas of Plant less was1814400 m^2, Rare plant 269100 m^2, Low plant 603000 m^2, and the medium plant was 344700 m^2. The data analysis from GIS system helps planner in Planning and Managing the environmental hazards and risks. In order to plan and monitor the environmental problems, the assessment of hazards and risks becomes the foundation for planning decisions and for mitigation activities [6]. Horologic Properties of the Tigris River shows that the annual flow of the River for the period (2005–2020) ranged between (15.96 and 98.02) (m^3/s) with a mean annual flow (46.71) (m^3/s) for the Tharthar -Tigris Canal [6]. While for the Baghdad site, the range was between (399.84 and 711) m^3/s with a mean annual flow (525.50) m^3/s.

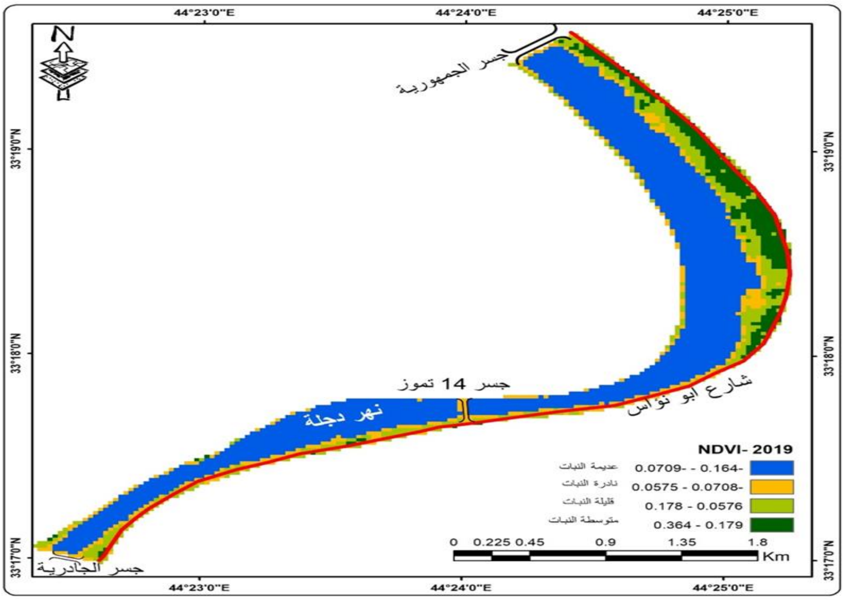

Fig. 4. The rates of vegetation areas with rate of plants that found in the study area that adopted (2019).

The results showed that the rates of vegetation areas with rate of plants for year 2020 as shown in Figure (5), the areas of Plant less was 181440 m^2, Rare plant 269100 m^2, Low plant 548100 m^2, and the medium plant was 360000 m^2.

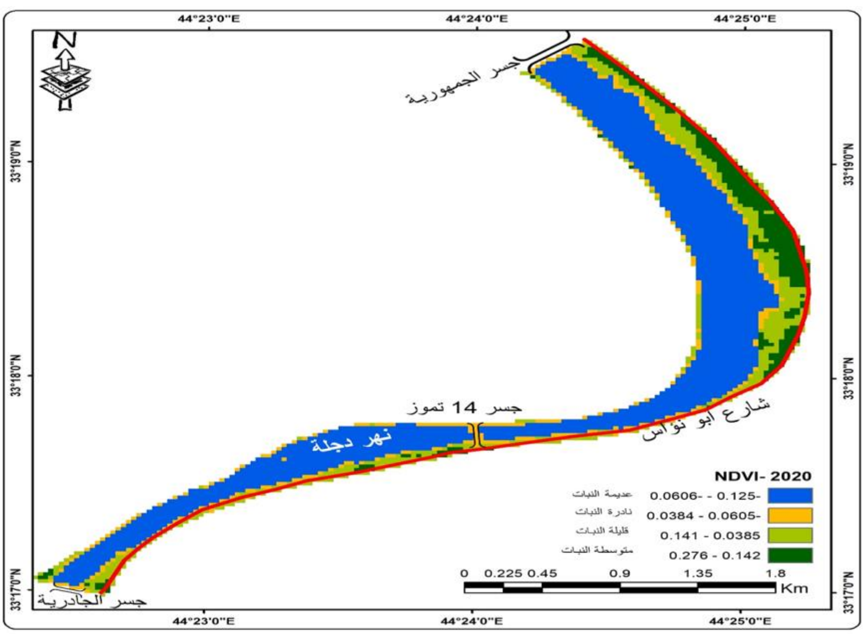

Fig. 5. Illustrated the rates of vegetation areas with rate of plants that found in the study area that adopted (2020).

Figure (6) shows the rates of vegetation areas with rate of plants for year 2021. The areas of Plant less was1814400 m^2, Rare plant 269100 m^2, Low plant 548100 m2, and the medium plant 342900 m^2 .

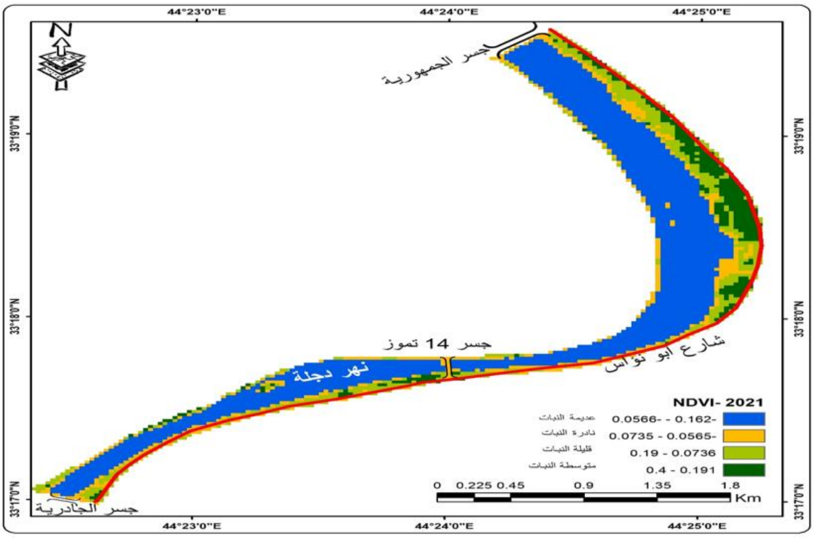

Fig. 6. Illustrated the rates of vegetation areas with rate of plants that found in the study area that adopted (2021).

The rates of vegetation areas with rate of plants for year 2022 discussed in Figure (7), the areas of Plant less was1814400 m^2, Rare plant 269100 m^2 (12.5%), Low plant 548100 m^2 (22.21), and the medium plant was 382500 m^2 (12.62).

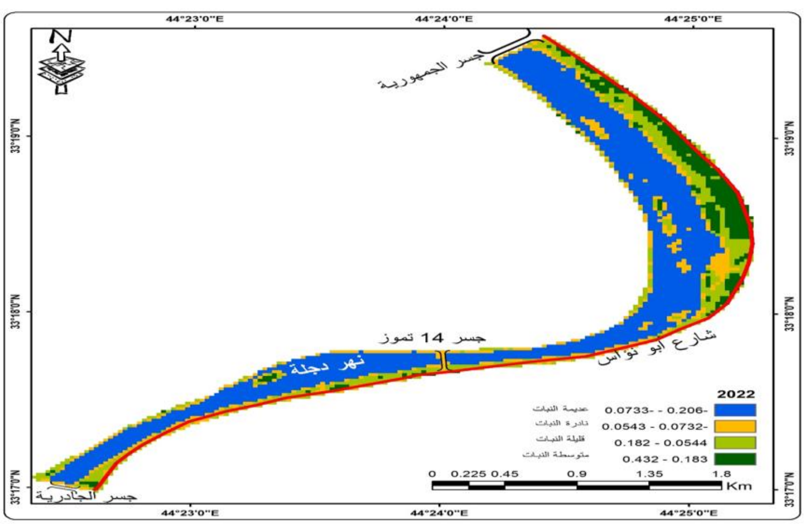

Fig. 7. Illustrated the rates of vegetation areas with rate of plants that found in the study area that adopted (2022).

Finally, the rates of vegetation areas with rate of plants for year 2023 was illustrated in figure (8). The rate of Rare plant 269100 m^2 (17.25 %) with NDVI value (0.0543-0.0732), Low plant 548100 m^2 (22.74%) With NDVI value (0.182-0.0544), and the medium plant was

252900 m^2 (8.34 %) with NDVI value (0.432-0.183). Also the results estimated that plant less area, and low plant area increases through the period (2019 – 2023) years as shown in Figure (9) and (10).

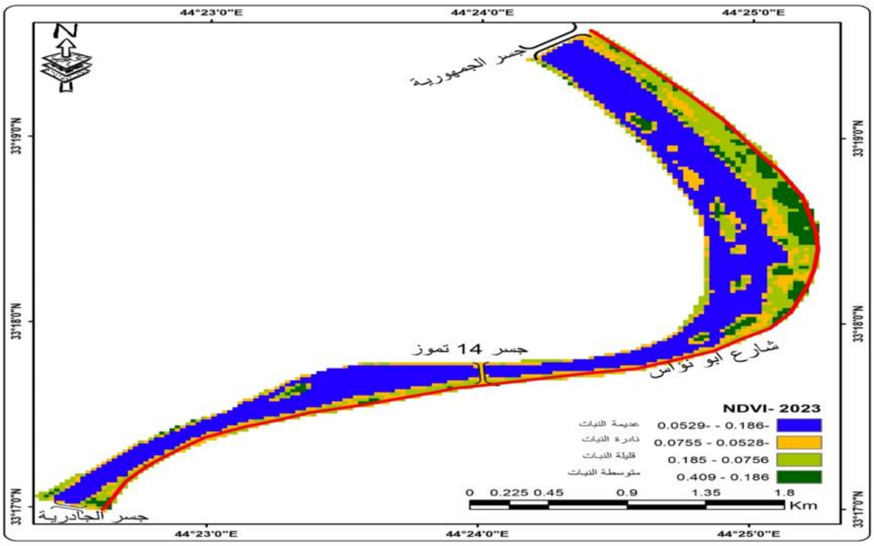

Fig. 8. Illustrated the rates of vegetation areas with rate of plants that found in the study area that adopted (2023).

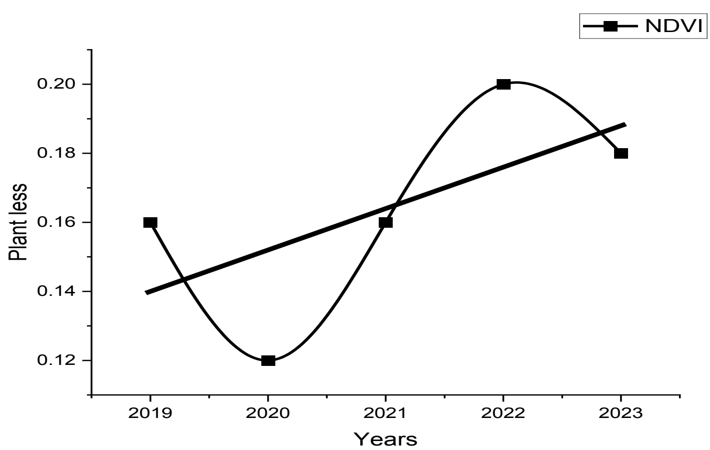

Fig. 9. Illustrated the plant less rates of vegetation areas with variation through the period (2019– 2023) years, found in the study area that adopted. Abu Nwas that alignment Tigris river.

Based on the spatial analysis and classification of NDVI of vegetated areas using supervised classification techniques, a proposed map was prepared for the distribution of parks according to the available areas, data as the results showed that proposed parks can be distributed between area (1728931 m^2) (340006m^2) for the periods (2019-2023) as shown the Figures (10) and (11).

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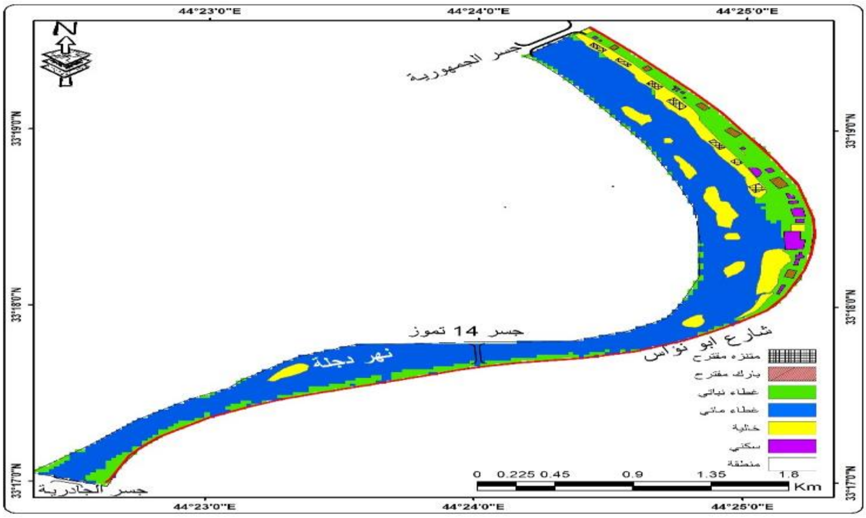

Fig. 10. Illustrated Locations of parks and parks proposed for the best year, which is 2023.Park area = 22,609 square meters, garden area = 29,405 square meters.

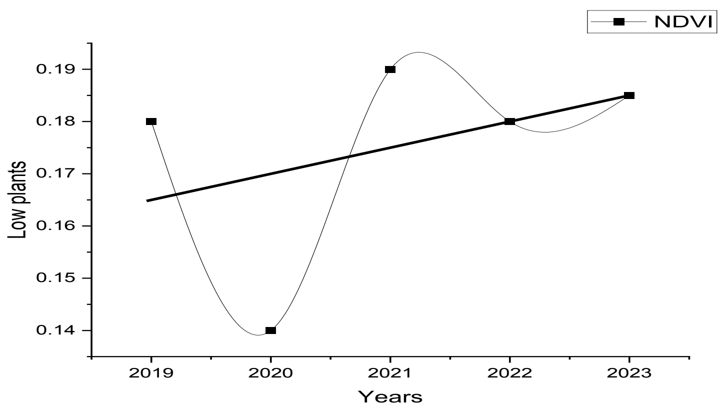

Fig. 11. Illustrated the low plant rates of vegetation areas variation through the period (2019 – 2023) years found in the study area that adopted. Abu Nawas that alignment Tigris river.

4 Conclusions

In this study, the focus was on using the spatial analysis and classification technique for the available data in order to create a proposed map for the future and current distribution of parks along the study area of the Tigris River (Abu Nawas is the case study).

The following conclusions were reached:

1.From this study by reviewing the pictures of NDVI images, conclude that the total area of vegetation plant, through the period (2019 – 2023) years was 3031200m^2.

2. The plant less, and the low plant in increasly, it indicates decrease in vegetation area in the region of Abu Nawas. Perhaps for several reasons, including climate change, which causes a rise in temperatures and pollution in the waters of the Tigris River due to water scarcity and lack of interest in plowing the river on a regular basis, as well as due to urban growth represented by the large number of vertical buildings that impede air access to plants and humans alike.

Using remote sensing techniques and spatial analysis, some of the proposed parks were distributed along the Tigris River from the Abu Nawas side, at a distance ranging between (1728931 m^2) and (340006m^2) for the adopted periods as shown in the area images ..

References

1. S. Oleiwi, M. Al-Dabbas, "Assessment of contamination along the Tigris River from Tharthar-Tigris Canal to Azizziyah, Middle of Iraq," Water **14**, 1194 (2022)
2. GIS, Al-Mostansiriyah J. Arab Int. Stud. **68**, 77 (2024)
3. S. A. Abdullah, K. H. A. Abbas, A. Alaa H. Harif, A. Alaa R. F., H. S. S., "Sustainable urban distribution of educational institutions and population density in Baghdad City using remote sensing techniques," in IOP Conf. Ser.: Earth Environ. Sci. **1202**, 012015 (2023)
4. E. A. Mohammed, Z. Y. Hani, G. Q. Kadhim, "Assessing land cover/use changes in Karbala city (Iraq) using GIS techniques and remote sensing data," J. Phys. Conf. Ser. **1032(1)**, 012047 (2018), DOI: 10.1088/1742-6596/1032/1/012047
5. Al-Hussein Nabeel Hussein, "Monitoring vegetation degradation in Baghdad," Al-Kut Univ. Coll. J. **7(2)**, 182–184 (2022)
6. S. A. Abdullah, T. R. Aziz, "Detect environment pollution by GIS for some regions in Baghdad City," J. Phys. Conf. Ser. **2114**, 012024 (2021)
7. F. K. Mashee Al Ramahi, Z. K. I. A. B., "Estimation of Suaeda aegyptiaca plant distribution regions at Iraq using RS & GIS applications," Iraqi J. Sci. **58(2a)**, 767–777 (2017)
8. T. A. Dhamin, E. F. Khanjer, F. K. Mashee, "The effect of temporal resolution of climatic factors on agriculture degradation in southern Baghdad by applying remote sensing data," Iraqi J. Sci. **64(2)**, 994–1006 (2023)
9. E. S. Hassan, A. F. Hasson, E. F. Khanjer, "Monitoring changes in the spectral reflectivity of Baghdad City and the impact of the atmospheric elements on it using R.S and GIS," in IOP Conf. Ser.: Earth Environ. Sci. **1223**, 012023 (2023)
10. G. A. Al-Edhar, A. Ab. Al-Sadoon, E. F. Khanjer, "Monitoring the land surface temperature LST with different seasons for Babylon City using GIS and R.S techniques," in IOP Conf. Ser.: Earth Environ. Sci. **1202**, 012018 (2023)