Integration of Remote Sensing and GIS for Analyzing Green Spaces in Al-Samawah City Center Towards Sustainability

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ABSTRACT

Green areas are considered a major factor in purifying the city's atmosphere from pollution resulting from the joint use of different lands to improve the city environment. This research aims to study green areas in the center of Al- Samawah city for the period from 2004 to 2022, and to explain the real conditions and developments as far as areal recession and expansion are concerned, due to its importance and its reflection on people's lives in terms of environmental, neighborhood and overall impact. The study covered different areas and is located partly on the Euphrates River passing through the center of Al-Samawah to identify green spaces and abandoned spaces based on satellite image data of Landsat-5 TM2000, Landsat-7 ETM, and Landsat-8OLV 2015. Images were analyzed using remote sensing programs such as Arc Map and ERDAS. The analysis results showed that the annual rate of vegetation cover deteriorated during the period from 2004 to 2012 by a percentage of around 12.2%. The yearly rate of vegetation cover decrease was 13.8% from 2004 to 2022. While, NDVI value amounted to 50.02% in 2004, to 38% in 2014, then continued to deteriorate until it reached 36.7% in 2022 to all district areas. Finally, the article explains the absence of an important impact in rural regions, highlighting the necessity of the article to assist decision-makers in developing the essential solutions for protecting green spaces around city centers from urban development and reconsidering urban sustainability.

1. INTRODUCTION

The Euphrates River, which passes through the center of the city of Al-Samawah, is considered one of the important water resources in the areas through which it passes, which has made the governorate's lands agricultural. It is one of the reasons for the expansion of the city and the continuation of life there for humans and animals. Therefore, the subject of studying the green areas in the city of Al-Samawah is related to the availability of water [1, 2].

Therefore, humans have taken the nearby areas on both sides of the Euphrates River as a home for residence to provide plant and animal food. Desertification and drought also push people to migrate and leave their areas of residence in search of a better life, as the availability of water makes people positively respond to nature and gives them incentives to work, give, and rebuild cities [3, 4].

The importance of analyzing the green spaces of Al-Samawah city, which are close to desert regions on one side and marshes on the other. Because many migratory birds use green spaces as resting and transit locations, they are extremely important for preserving ecological balance and increasing biodiversity. Additionally, they contribute to the creation of a suitable environment that is conducive to moderating the city's climate and purifying the air, especially from west dust storms [5].

As a result, analyzing green spaces is considered essential to identify their types and locations as well as to work on their continuity due to their direct influence on cities, sustainability, and reducing the negative effects of urbanization and climate change [6, 7].

In this article, the agricultural regions on both banks of the Euphrates River and close to the city center were the main focus of this study in order to examine, analyze and create solutions. Required to help protect these areas from indiscriminate housing and the growth of cities [8, 9].

The estimated areas for the green area analysis are 364.48 dunums on the left bank of the river and 328.51 dunums on the right bank. In order to compare situations and examine the good or negative development of agricultural areas based on satellite image information, the article's time frame was set for 2004 - 2022.

2. STUDY AREA

The analysis location was situated inside the Al-Muthanna Governorate's administrative boundaries in southern Iraq as this implies, it is located to the east of the governorates of Thi-Qar and Al-Basrah. It is regarded as one of Iraq's most important wetlands, as it provides natural habitats for many animal and plant species [10, 11]. To the north Al-Qadsiyah Governorate, as well as Al-Najaf Governorate and Saudi Arabia to the west and south, where the desert areas represent a part of the Sahara Desert [12]. This particular location was surrounded by a number of desert regions that are a part of desert, which is an extension of Iraq's western desert. The most prominent deserts in the area are [13, 14]:

-The Al-Samawah Desert is a region in southern Iraq that is regarded as a component of the Great Desert.

-The Al-Muthanna Desert is a significant part of the Al-Muthanna Governorate.

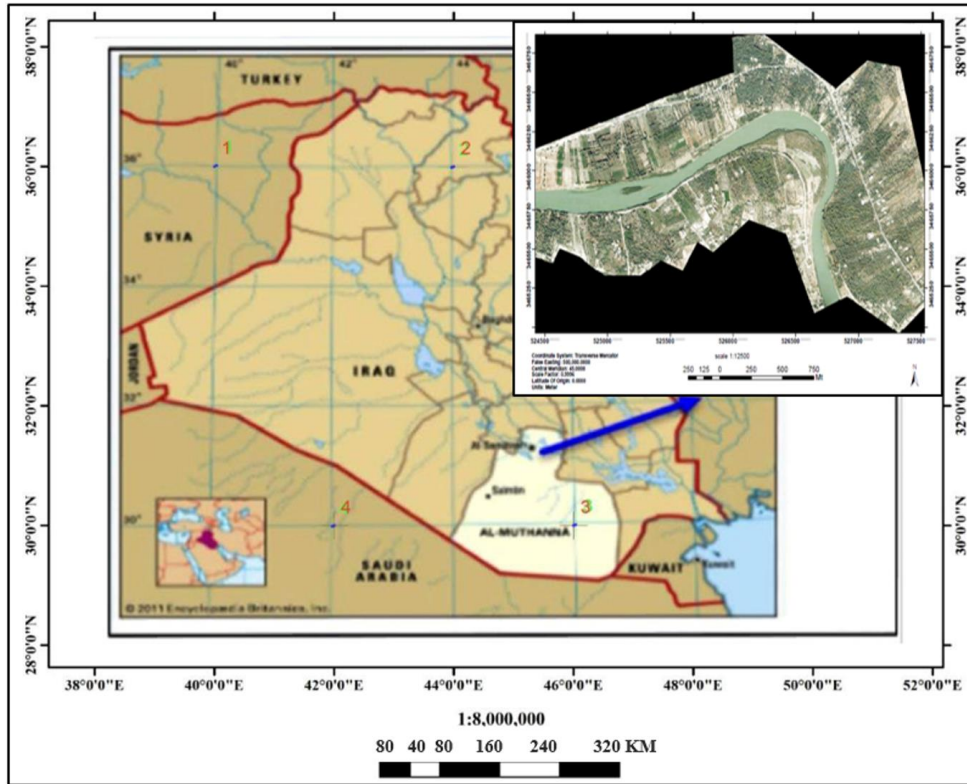-West of Al-Samawah is the Al-Salman Desert, which is home to significant historical and archaeological landmarks.

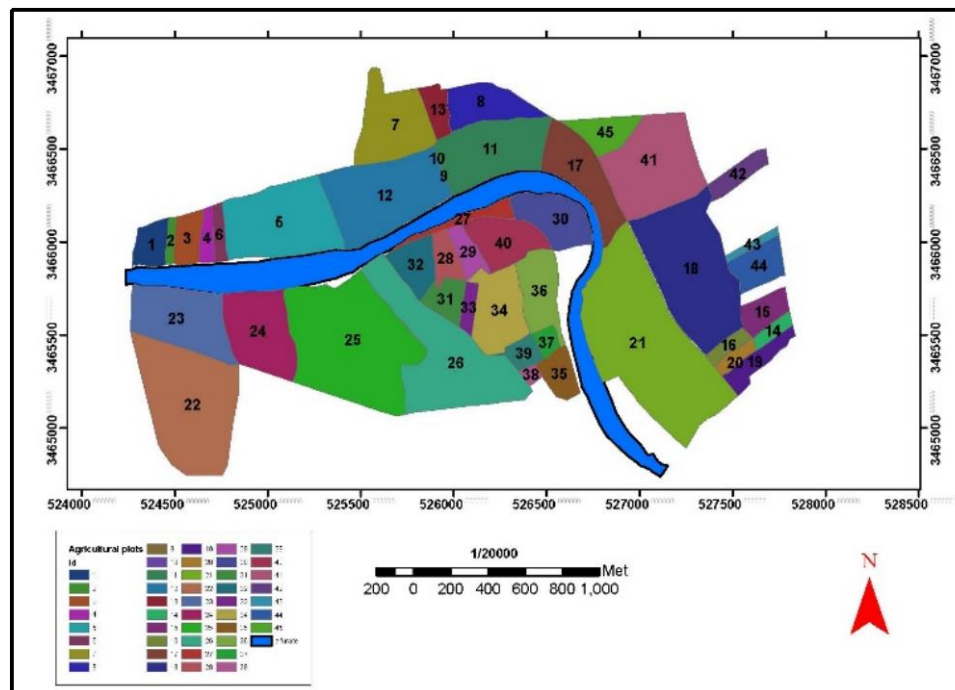**Figure 1.** Location of the study area: Al-Samawah city center in Al-Muthanna Governorate of Iraq

Figure 2. The districts from (1 to 45) in study area to NDVI analysis

Although Al-Samawah is not directly within the marsh's areas, which are famous for their unique ecosystem and historical importance, but it is relatively closely to. This makes it a significant city for maintaining historical and natural diversity [15].

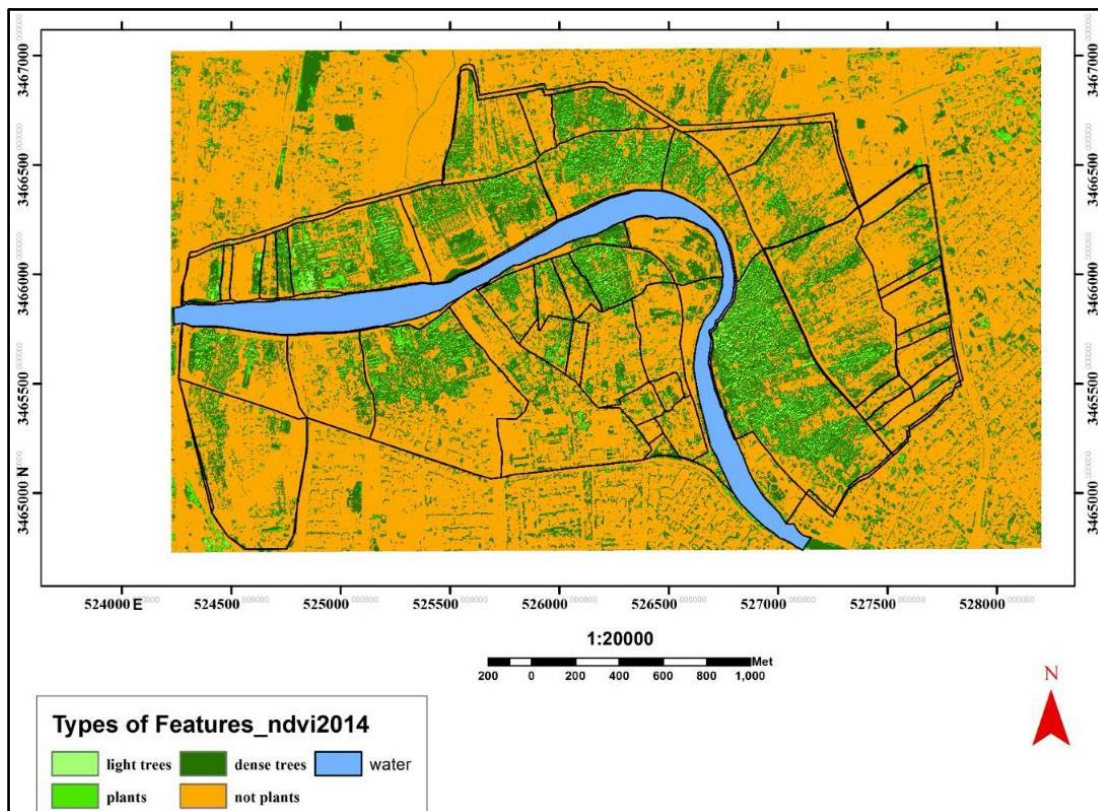In this study, the area which is enclosed by two latitude lines (3465000N – 3467000N) and two longitude lines (528000E – 524000E) was analyzed [16], as shown in Figures 1 and 2.
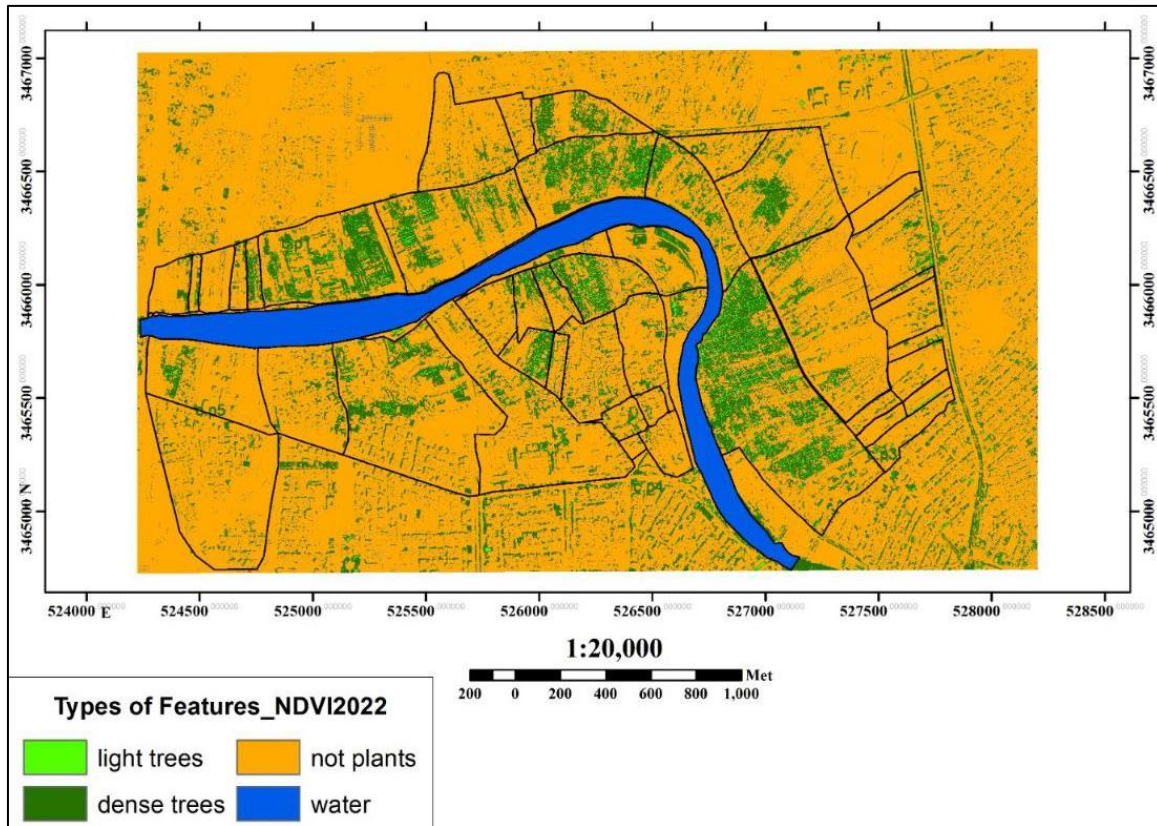
3. RESEARCH METHODOLOGY
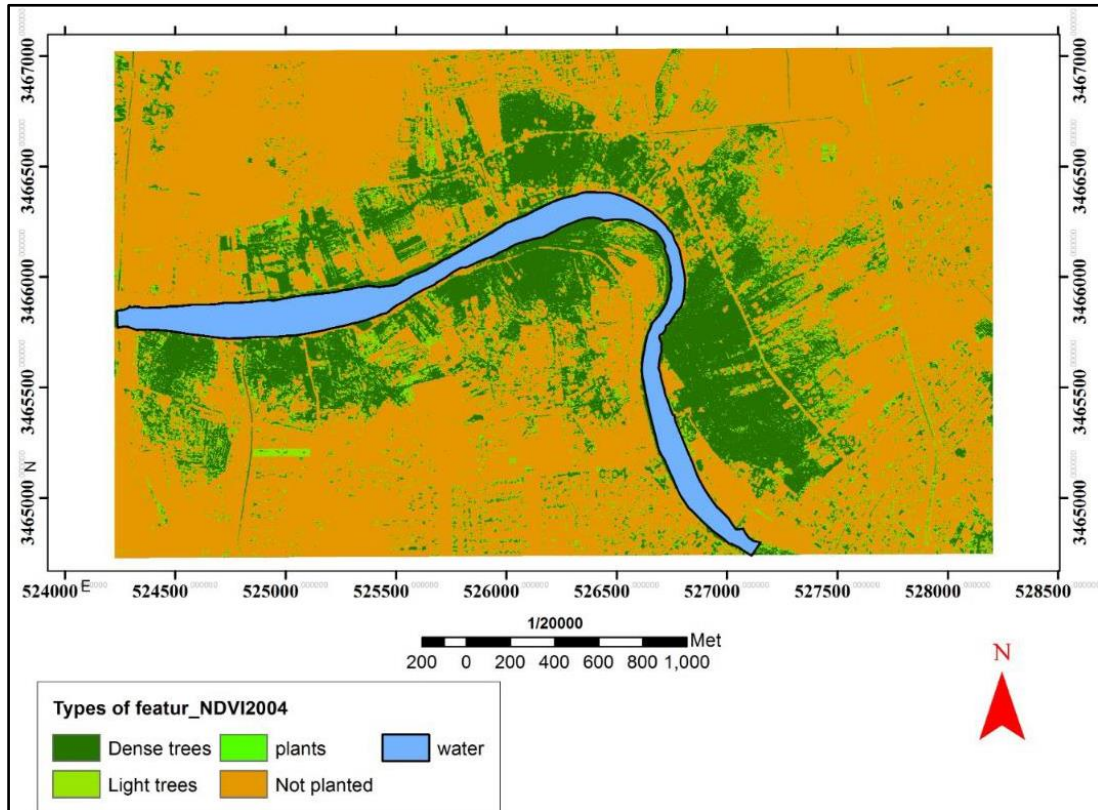
(a) 2004 (NDVI) analysis index
NASA Type 5 TM visual analysis, 2004 Landsat 5(a) Temperature field

(b) 2014 (NDVI) analysis index
ETM satellite visual analysis,NASA 2014, using Landsat 7

(c) 2022 (NDVI) analysis index

OUL satellite visual analysis, NASA, 2014 using the space shuttle Landsat 8

Figure 3. 2004, 2014 and 2022 (NDVI) analysis index

The article's objectives are to integrate GIS and RS to identify green spaces and compare them over the years to show the extent of changes and positive and negative impacts on these green spaces. The financial effect of this problem on human life in the city of Al-Samawah in particular, as well as the environmental impact on city safety generally.

At the beginning, by ERDAS program cut visuals by using for different periods (2004, 2014, 2022) with the same coordinates, using (PATH=167, RAW=38) and then georeferencing process was performed. For the satellite images, ArcMap program was used, then lateral and spatial improvements were made to these images. Then we began to calculate the meaning of the change in vegetation cover (NDVI) using the ERDAS program as in Eq. (1), shown in Figure 3(a-c) as the NDVI value is calculated through the following equation (which is the value range between -1.0 to +1.0):

$$NDVI = \frac{NIR - RED}{NIR + RED} \qquad (1)$$

As the large values represent a high density of green plants, provided that the reflectivity and absorption of rays are taken into consideration. Small, is negative values represent areas in which there is no vegetation cover and are barren lands.

Through the colour gradient, where the green colour represents the vegetation cover, the value is represented by the positive, while the light orange gradient represents areas devoid of plants [10], or it represents other uses, and the value is negative.

4. RESULTS AND DISCUSSION

The study area is restricted to the agricultural districts that are situated within the center of Al-Samawah District on both banks of the Euphrates River. That represents the agricultural areas in the city center [17-21]. These areas vary greatly in terms of total and green areas. This discrepancy is a natural matter, and its causes are primarily human. These human elements are driven by a variety of causes, the most notable of which is the passion for agricultural ownership.

The financial capacity of individuals, general culture, economic orientation, the number of family members owning the land, the level of commercial market prices, and the volume of consumption of agricultural materials, etc. While natural elements are frequently marginal, there are additional variables that either encourage or inhibit the growth of green spaces. They either support and interact with the plant that creates the green area or they completely prevent it.

Green spaces include all types of plants and trees, regardless of their type, class, and purpose of cultivation. The agricultural plant activity is the active human element in creating the agricultural environment with its green space, regardless of the type of plant and its class in that activity. Table 1 shows the agricultural provinces included in the study, in number and area in comparison, with the number of green spaces and uncultivated areas and the amount of residential expansion on green spaces over periods for the years (2004, 2014, and 2022). Table 1 is the basis for the research to determine the level of positive or negative development of these areas.

In Figure 4, the red area represents 2004, the green area represents 2014, and the yellow area represents 2022.

1- The green area amounted to 50.2% of total area of

agricultural districts in 2004.

2- The districts (21, 27, 28, 29, 40) stand out with the highest green area, exceeding 90%. Meanwhile, the districts (1, 2, 3, 9, 10, 11, 13, 14, 15, 33, 42, 44, 45) had the lowest green spaces, making them the least affluent in terms of greenery during the year 2004.

3- The percentage of green spaces that were lost in 2014 due to urban growth exploitation at the expense of green spaces increased from 38% to 62% for other uses, resulting in a 12.2% decline in green spaces and a 24% shortfall.
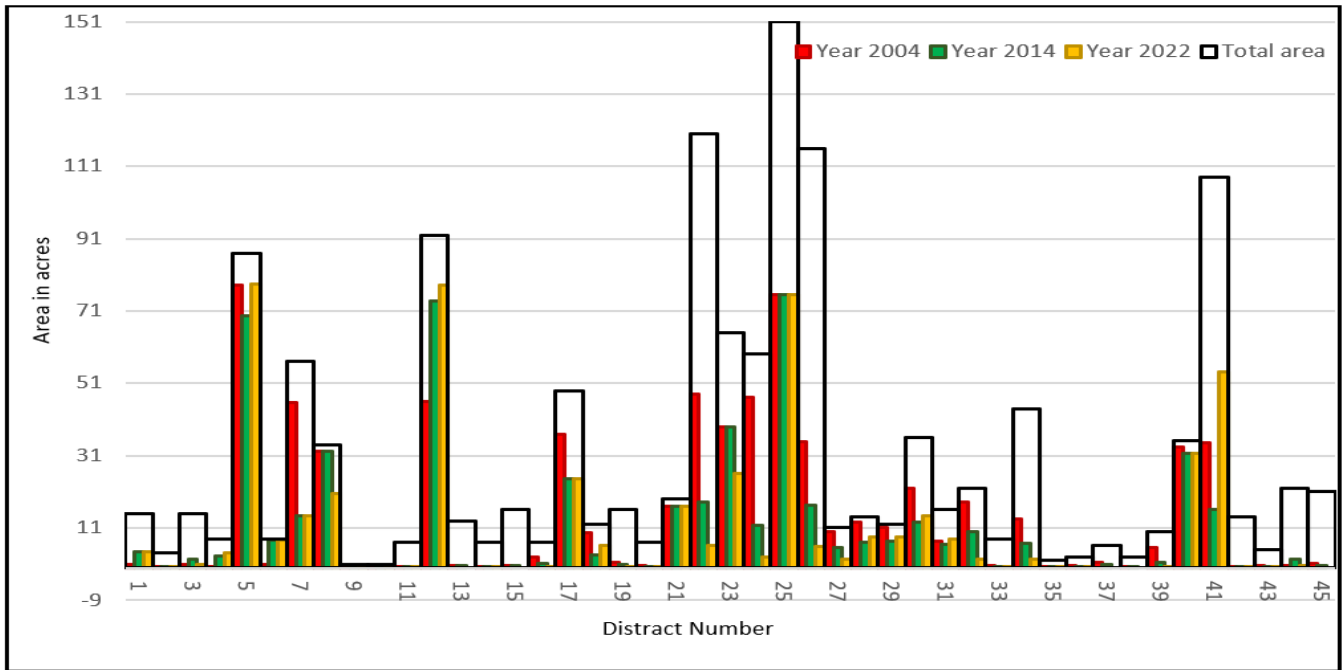

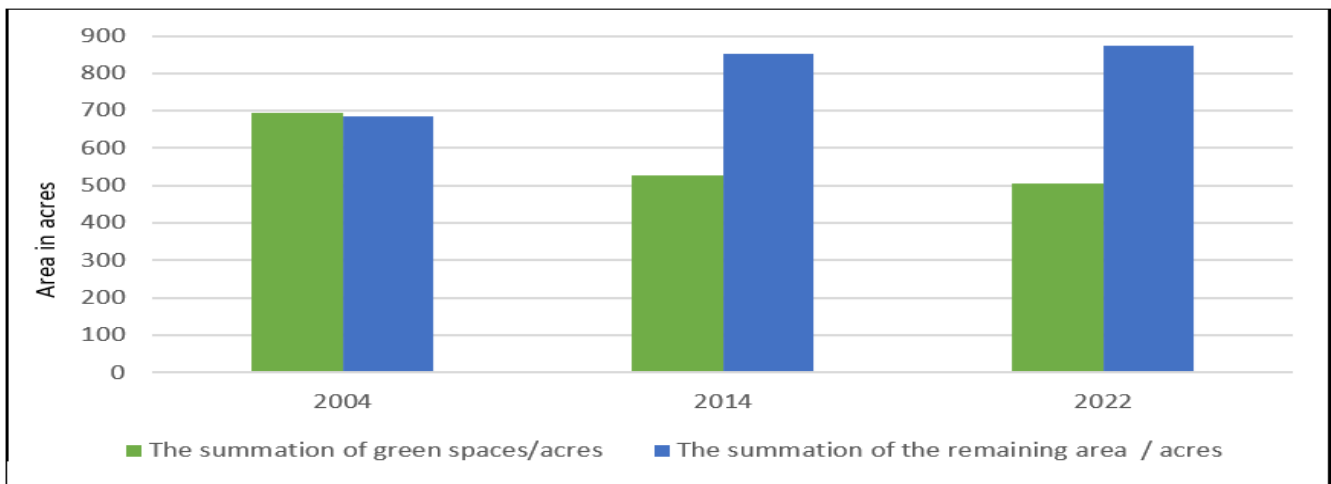**Figure 4.** The green area by acres in 2004, 2014 and 2022

Figure 5. The summation of green area and remaining area in acres

When comparing the districts in 2014 to those in 2004, the percentages of green spaces declined. In general, the largest damage occurred in the examined area close to the urban development of the city.

4- In 2022, the analysis of the green area revealed that the proportion going to other uses increased from 36.7% to 63.3%, resulting in a loss of overall green space.

5- While the districts (13, 15, 37, 38, and 45) became around zero acres in area, the areas had an increase in (6, 7, and 12) districts.

In contrast, the areas of districts 13, 15, 37, 38, and 45 shrank to about zero acres. But there were more distractions in regions 6, 7, and 12 have increase.

Figure 5 explains the green area by green colour and the remaining area of distracts in blue colour.

Table 1 shows the extent of variation in areas between agricultural districts as in number of Figure 3(a-c). Ratio refers to the green area from total distract. as in chart in Figure 4.

In Table 2, the green area was estimated to be 692.99 acres in 2004, but reached 527.2 acres in 2014, and is expected to reach 505.35 acres by 2022. In other words, the average annual decline in green area was 12.02% from 2004 to 2014. By 2022, the average annual decline in green area will be 13.32%.

Table 1. Ratio of green area to total distracts area

Dist. No.	Total Area	The Year 2004			The Year 2014			The Year 2022		
		Green Area Acres	Ratio %	Total Area Acres	Green Area Acres	Ratio %	Total Area acres	Green Area Acres	Ratio %	Other Area Acres
1	15	0.75	5	15	4.5	30	15	4.5	30	15
2	4	0.2	5	4	0.2	5	4	0.2	5	4
3	15	0.75	5	15	2.25	15	15	0.75	5	15
4	8	0.4	5	8	3.2	40	8	4	50	8
5	87	78	90	87	69.6	80	87	78.3	90	87
6	8	0.8	10	8	7.6	95	8	7.6	95	8
7	57	45.6	80	57	14.25	25	57	14.25	25	57
8	34	32.3	95	34	32.3	95	34	20.4	60	34
9	1	0.01	1	1	0.01	1	1	0.01	1	1
10	1	0.01	1	1	0.01	1	1	0.01	1	1
11	7	0.01	1	7	0.01	1	7	0.01	1	1
12	92	46	50	92	73.6	80	92	78.2	85	92
13	13	0.65	5	13	0.52	4	13	0	0	13
14	7	0.28	4	7	0.21	3	7	0.07	1	7
15	16	0.64	4	16	0.48	3	16	0	0	16
16	7	2.8	40	7	1.05	15	7	0.14	2	7
17	49	36.75	75	49	24.5	50	49	24.5	50	49
18	12	9.6	80	12	3.6	30	12	6	50	12
19	16	1.6	10	16	0.8	5	16	0.16	1	16
20	7	0.7	10	7	0.35	5	7	0.14	2	7
21	19	17.1	90	19	17.1	90	19	17.1	90	19
22	120	48	40	120	18	15	120	6	5	120
23	65	39	60	65	39	60	65	26	40	65
24	59	47.2	80	59	11.8	20	59	2.95	5	59
25	151	75.5	50	151	75.5	50	151	75.5	50	151
26	116	34.8	30	116	17.4	15	116	5.8	5	116
27	11	9.9	90	11	5.5	50	11	2.2	20	11
28	14	12.7	91	14	7	50	14	8.4	60	14
29	12	11	93	12	7.2	60	12	8.4	70	12
30	36	22	62	36	12.6	35	36	14.4	40	36
31	16	7.2	45	16	6.4	40	16	8	50	16
32	22	18	82	22	9.9	45	22	2.2	10	22
33	8	0.48	6	8	0.24	3	8	0.16	2	84.16
34	44	13.6	31	44	6.6	15	44	2.2	5	44
35	2	0.22	11	2	0.16	8	2	0.06	3	2
36	3	0.66	22	3	0.3	10	1	0.09	3	3
37	6	1.5	25	6	0.9	15	6	0	0	6
38	3	0.12	4	3	0.03	1	3	0	0	3
39	10	5.5	55	10	1.5	15	10	0.3	3	10
40	35	33.3	95	35	31.5	90	35	31.5	90	35
41	108	34.6	32	108	16.2	15	108	54	50	108
42	14	0.42	3	14	0.42	3	14	0.14	1	14
43	5	0.6	12	5	0.15	3	5	0.05	1	5
44	22	0.44	2	22	2.2	10	22	0.66	3	22
45	21	1.3	6	21	0.63	3	21	0	0	21
Sum.	1378	692.99	50.2	1378	527.27	38	1378	505.35	36.7	1377.82

Table 2. The contrast between the green area in the city center of Al-Samawah district in 2004, 2014 and 2022.

The Total Area of Agricultural Counties	Green Areas by Year			The Extent of Deterioration of Green Spaces Compared to the Base Year 2004	
Study Years	2004	2014	2022	2014	2022
The summation of green spaces/acres	692.99	527.27	505.35	- 165.72	- 187.64
The summation of the remaining area of distracts / acres	685.01	850.73	872.47	+165.72	+ 187.46
The ratio of the total green areas to the total areas of the districts	50.2%	38%	36.7%	- 12.02	- 13.32

The total green area in the city center decreased from 2004 to 2014 as well as in 2022. As a result, analysis of Tables 1 and 2 and Figures 4 and 5 shows that:

1- While the study years, the districts' overall area stayed constant, but the green spaces continually decreased, as the other places kept on expanding.

2- In comparison to the base year of 2004, the amount of green space lost in 2014 was 165.72 acres, and in 2022, it was 187.64 acres. Future reductions in this detrimental environmental degradation are not assured. The green space's

degradation provided benefits to other land uses.

3- Compared to the previous year, the percentage of green areas fell from 50.02% in 2004 to 38% in 2014, then continued to deteriorate until it reached 36.7% in 2022. That was regarded as damage to environmental and to achieve sustainability.

4- This means the annual rate of green cover deterioration during the period from 2004 to 2012 amounted to 12.2%, and indicates that from 2004 and 2022, the yearly rate of decrease was 13.8%.

5. CONCLUSIONS

The following briefly describes the main results of the current study:

1-The reasons for decline of green space, particularly in rural regions and near urban areas, include the increase of informal areas, a shift from agricultural to residential or other uses, and the spread of urban growth.

This explains the lack of a major factor in rural regions, notably the shifting usage of agricultural lands, particularly food-producing areas, which began after 2002 that became noticeable after 2004.

2- The decline of green cover and the spread of barren spaces result in significant environmental risks that have negative repercussions on health and the economy in general, and the joints of human life and activity are not spared. Rather, this affects the future of the coming generations who have the legitimate right to a decent life, supported to achieve sustainability. The year 2022 is a statistical measure whose indicator exceeds the red line, warning and danger to decision-makers, and represents a distress call and an environmental call to avoid the situation before it is too late.

6. RECOMMENDATIONS

Based on what was stated in the research, the following recommendations can be obtained:
1- Preventing residential encroachment on agricultural fields, raising cultural consciousness, and reducing illiteracy in agricultural regions.
2- Increasing public awareness of the environmental, society and economic benefits of green areas through authorized media channels.
3- Promoting the slogan "Wherever you find a green environment, life will be good for you, and wherever you find trees, the environment will be safe from destruction" and educating people on the value of green space.
4- Activate Al-Muthanna Agriculture Directorate to promote agricultural development and environmental preservation.
5- Combating unfair campaigns by removing plants and trees specially on river banks and around the countryside, which plays a crucial role in soil stabilization and reducing dust storms.
6- Implementing detailed plans for reclamation and agriculture in desert areas and city borders, as well as water and green space management.
Introducing the topics of desertification and sustainability into the curricula of scho0ols, institutes, and universities to teach students about its actuality and risks, and determine the degree of causes, consequences, and treatment approaches.

REFERENCES

[1] Abed, F., Al-Khafaji, S., Hasan, M. (2022). Study of hydrology and geomorphology of the Lake Sawa, Al-Muthanna Province, Iraq. Dirasat, Human and Social Sciences, 49(3): 290-303. https://doi.org/10.35516/hum.v49i3.1357

[2] Al-Timimy, S.R.A. (2023). Spatial modelling for enhanced disaster preparedness by mapping evacuation routes in Al-Hillah city. International Journal of Sustainable Development and Planning, 18(10): 3077-3084. https://doi.org/10.18280/ijsdp.181010

[3] Al-Timimy, S.R.A., Bedewy, B.A.H. (2023). Enhancing urban sustainability by integrating MCDM and model of GIS spatial analysis in Al-Nasiriyah Heritage Center Development. International Journal of Sustainable Development and Planning, 18(11): 3429-3438. https://doi.org/10.18280/ijsdp.181108

[4] Alhadedy, S.G., Alomary, A.Y. (2024). The impact of green-blue infrastructure on enhancing cities happiness indicators - A comparative study. International Journal of Sustainable Development & Planning, 19(5): 1655-1661. https://doi.org/10.18280/ijsdp.190503

[5] Al-Timimy, S.R., Al-Rawe, M. (2020). Evaluate education in the marshes of southern Dhi-Qar toward a new paradigm of sustainability. IOP Conference Series: Materials Science and Engineering, 737(1): 012199. https://doi.org/10.1088/1757-899X/737/1/012199

[6] Abass, K.A., Salman, K.J., Farman, M.S. (2023). Topography study of Uruk monuments using remote sensing techniques. AIP Conference Proceedings 2776(1): 060012. https://doi.org/10.1063/5.0138243

[7] Altimimy, S.R.A. (2024). Detecting indicators of futurity urban planning by comparing them with analyzing ancient Ur city to fulfillment sustainable new city. AIP Conference Proceedings, 3105(1): 050110. https://doi.org/10.1063/5.0212598

[8] Zhang, H., Abed, F.H. (2013). Dynamics of land use/cover change in Iraqi Marshlands using remote sensing techniques. Environmental Engineering & Management Journal (EEMJ), 12(9): 1825-1828. https://doi.org/10.30638/eemj.2013.222

[9] Olgun, R., Cheng, C., Coseo, P. (2024). Nature-based solutions scenario planning for climate change adaptation in arid and semi-arid regions. Land, 13(9): 1464. https://doi.org/10.3390/land13091464

[10] Ouzir, M. (2023). Green infrastructure, a thermal regulator for the arid city. Case study of the city of Bou-saada. Glasnik Srpskog Geografskog Društva, 103(1): 419-432. https://doi.org/10.2298/gsgd2301419o

[11] Al-Abas, K.A.A., Al-timimy, S.R., Husain, K.Y., Ethaib, S., Njeban, H.S., Rahil, F.H., Ziboon, A.R.T. (2022). Building geo-database for geotechnical properties of Thi-Qar Governorate area using modern digital techniques. In 2nd International Multi-Disciplinary Conference Theme: Integrated Sciences and Technologies, IMDC-IST 2021, Sakarya, Turkey. https://doi.org/10.4108/eai.7-9-2021.2314917

[12] Salman, K.J., Alhadi, M.A., Wattan, S. (2024). Remote sensing technology to study and monitor the land cover in North-Eastern Al-Muthanna, South-Iraq. In 3rd International Conference on Engineering and Science, Al-Samawa, Iraq. https://doi.org/10.1063/5.0191835

[13] Salman, K.J., Salah, M.A., Al-Hussain, Y.A. (2021). Adopting geographical information systems (GIS) for investigation the reality of health care centers in Samawa city, Iraq. In 2nd International Conference on Engineering & Science, Al-Samawa, Iraq. https://doi.org/10.1063/5.0069685

[14] Hussin, A.A., Ghazal, K.A. (2020). The quality of groundwater in the Samawah desert (Iraq) and its impact on increasing the likelihood of severe desertification in the cultivated pasture lands. International Journal of Psychosocial Rehabilitation, 24(9). https://doi.org/10.37200/IJPR/V24I9/PR290519

[15] Ali, N.M., Ebraheem, A.K., Ebraheem, M.A., Laffta, S.J. (2020). Environmental assessment of land use in the city of Samawah using spatial techniques. IOP Conference Series: Materials Science and Engineering, 737(1): 012240. https://doi.org/10.1088/1757-99X/737/1/012240

[16] Salman, K.J., Saleh, M.A., Farman, M.S. (2021). Development of renewable energy projects using geographic information systems: An applied study to calculate solar irradiance in Samawah Desert, Iraq. In 2nd International Conference on Engineering & Science, Al-Samawa, Iraq. https://doi.org/10.1063/5.0069690

[17] Salman, K.J., Hammed, Y.A.H.A., Hussein, K.H. (2018). Hydrological analysis of Al-Samawa Desert using GIS. International Journal of Advancements in Technology, 9(1): 1000199. https://doi.org/10.4172/0976-4860.1000199

[18] Wattan, S., Salman, K.J. (2024). Using modern survey techniques and 3D software for establishing and correcting control points in area west of Al-Qurna city. In 3rd International Conference on Engineering and Science, Al-Samawa, Iraq. https://doi.org/10.1063/5.0191655

[19] Khattab, S.I., Abid, R.S., Abdulla, B.M. (2013). The spatial analysis for some geotechnical properties in the left side of Mosul city by GIS. Tikrit Journal of Engineering Sciences, 20(2): 12-17. https://doi.org/10.25130/tjes.20.2.10

[20] Saber, M.J., Suleimany, J.M.S. (2022). Application of RS and GIS techniques for estimating the rainfall erosivity (R) of Harir River Basin in Kurdistan Region of Iraq KRI. Tikrit Journal of Engineering Sciences, 29(3): 24-32. https://doi.org/10.25130/tjes.29.3.3

[21] Arzu, M.H., Akram, K.M., Huda, J.J., Mohammed, H.A.; Bahareh, K., Hossein, M.R., Zainab, T.A. (2022). GIS-based rainfall analysis using remotely sensed data in Kirkuk Province, Iraq. Tikrit Journal of Engineering Sciences, 29(4): 48-55. https://doi.org/10.25130/tjes.29.4.6