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Research Article

The Potential of Urban Green Spaces in Achieving Sustainable Urban Alignment for Oil Resources-Based Cities

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ABSTRACT

Cities based on oil resources -which are primarily mining cities- continue to serve as growth hubs that attract workers. This demonstrates the existence of urban relationships at various levels, reciprocal between them and their surrounding region, including environmental relationships, And social and economic relations, which impose challenges on its reality, and urban problems that must be paid attention to, as a result of urban and human expansion on the one hand, and the expansion in the exploitation of the city's resources with all its challenges and urban problems on the other hand, which highlights the necessity of finding sustainable urban solutions for the reality of cities based on oil resources, especially the Iraqi ones, However, these sustainable solutions often clash with the economic power of these resources, which makes many of the ideas of sustainability and urban sustainability idealistic visions if they are to be achieved in their current perspective to address the urban and environmental challenges and problems resulting from them, due to the restrictions and obstacles they impose from the perspective of employers, In view of the above, the importance of the research that seeks to achieve sustainable urban alignment between the exploitation of these oil and gas resources associated with them, and the challenges and problems resulting from them, and the realistic green potential of the city based on the oil resources themselves, as an adaptation of the city's potential to address some of its problems, and with a standardized analytical approach based on the GIS-ArcMap 10.8 program in the analysis of a selected Iraqi city based on oil resources, is clearly evident.

Keywords: GIS-ArcMap, Sustainable alignment, Smart growth, Green urban development, Oil-based cities.

INTRODUCTION

Oil resources-based cities are cities that rely on the development of natural resources (such as oil, gas, and other minerals), the export of energy or raw materials, or the development of resource-based industries [1]. The developed countries of the world have turned to developing their cities with oil resources, aiming primarily to diversify their economic base, by increasing the added value of the extracted oil, while activating the exploitation of the revenues of this oil in developing any other inexhaustible energies of these oil cities, and it is possible to turn towards the sustainable energies of the city such as agriculture and activating local tourism and others [2], In an attempt to make optimal use of the oil resources of its cities in the face of the excessive consumption of these resources, so that the cities become growth poles that attract workers to them, industry has been nominated by some research to be the most important function and economic basis for them, due to its proximity to the nature of the origin of the emergence of these cities on the one hand, and because on the other hand it achieves the goal of increasing the added value of oil through the process of its manufacture [3], From here, and between the expansion of the urban and human growth pole, and the expansion of industry, extractive or transformational, other challenges emerged, which were studied by some research,

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towards environmental problems, or the curse of resources, or even the social problems resulting from that [4], Or negative urban expansion as a result of the expansion of the growth pole, and the urban power resulting from this expansion [5], and what is associated with this expansion of an increase in population density, and what is associated with it of major urban challenges [6], Or climate problems such as rising temperatures and the associated climate changes, which may be associated with rising levels of carbon in the atmosphere, and the associated global warming phenomena and others [7], and some studies have turned to finding some solutions to these challenges, such as striving to achieve environmentally sustainable, low-carbon cities, especially with the rising levels of carbon in these cities [8], Some studies have investigated the role of green urban spaces in the carbon balance of cities [9], or the activation of the ecological nature of cities, as a sustainable treatment for them [10], especially studies that document the relationship between the shift towards green growth and ecological urban planning in cities based on petroleum resources [1] [11], This matter requires planners, designers, and developers of resource-based cities to adopt a rational, realistic approach with a new approach that aligns the city's industrial oil reality and resources, with all its challenges and problems, with the visions of urban sustainability, with its planning and design strategies and standards, These visions should be realistic, not idealistic, and stem from the city's own potential, making the Iraqi city, based on resources, a sustainable urban fit, the optimal, realistic, and adaptable solution to all these challenges. This is the goal of this research.

Smart Growth Strategies are among the most famous sustainable urban strategies that work to mature the potential of cities and develop them towards sustainable development. They are urban strategies that use highly efficient urban patterns, managed effectively by using natural resources and respecting the environment, according to a limited financial budget, and with new standards that evaluate the urban form according to the dimensions of environmental, social and economic sustainable development [12], these strategies have taken the goal of improving the quality of social life and ensuring sustainable urban development at the residential, commercial and industrial levels as their general strategies. Urban developers have agreed to unify the general frameworks for these strategies into several strategies that include: (Development strategies: they are based on spatial organization strategies (integrated, ecological, and biological), with an emphasis on integration and high population and housing densities in their strategies, and mixed development uses [13] [14]. Design strategies: They include everything related to design principles such as diversity in building designs, smart buildings, investment in renewable energy, sustainable urban designs, open space designs, and the urban landscape, and include the integration of local characteristics of architecture with its traditional sustainable vision [15] [16]. Transportation strategies: These include everything related to road networks and transportation systems, such as transportation-oriented development (TOD) designs, which adopt the idea of mixed land uses directed near major and secondary transportation nodes linked to an environment that encourages walking and interest in public transportation [15]. Open & Natural Space Protection Strategy: This concerns everything related to the designs of open green spaces, the urban landscape, and the interest in ensuring biodiversity, forests, and the exploitation of public spaces, while restoring previously built spaces as open spaces and parks (Brownfields), in order to reduce the depletion of natural land [17]. The strategy of creating open green areas, sense of place and site interaction: This includes everything related to site interaction, from preserving nature during development, and community participation in protecting the natural environment [17]. Urban community strategies: These are concerned with ensuring the rights of the community through agreements and laws related to the aforementioned strategies, in addition to the community's contribution to the development process and engagement in collective action [13]). The strategies followed in the sustainable development of the city must also be characterised by adaptation and flexibility so that they can be adapted to the urban reality of the city [18].

The research aims to achieve sustainable urban alignment between the reality of the Iraqi city based on oil resources, with its urban and environmental problems resulting from the expansion of resource exploitation, and the green natural potential of this city itself, in order to address these problems, by

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maturing these potentials according to the visions of urban sustainability represented by the strategies of (Open & Natural space protection) and (Open space creation, Sense of place and Site interaction)) within the smart growth strategies that seek to develop the Iraqi city based on resources towards sustainable development, according to an analysis of the city's current situation using the GIS-ArcMap 10.8 program, with the development of planning and design scenarios to develop the city's green reality potential, as a solution to these environmental problems, and testing these scenarios according to their analysis using the aforementioned program.

Materials and Methods

In this research, the selected study area is analysed and tested with regard to the elements related to its main problems, the axes of green cover and its changes, in light of an analytical approach that relies on field studies in the two on-site survey processes (Observation) and study of the data of the region, as well as a standardized testing process with a program GIS-ArcMap 10.8 to data related with the natural and urban contexts of the study area were collected to determine their reliability and validate them for testing the causes of shortcomings in planning and designing sustainable urban alignment for Iraqi resource cities. This data was then used as input for subsequent steps of the research methodology, where planning and design scenarios were developed for developing the study area towards sustainable urban development.

2-1 Study area

The city of "Al-Madina" was chosen as the center of Al-Madina district, located in the northwestern part of Basra Governorate, south of Iraq, at a distance of (65) kilometers from the center of the governorate, between latitudes (30˚42΄52.11΄΄ 31˚16΄1.33) north, and within a longitude arc (47˚5΄32.16΄΄ 47˚24΄43.39) east, (Figure 1).

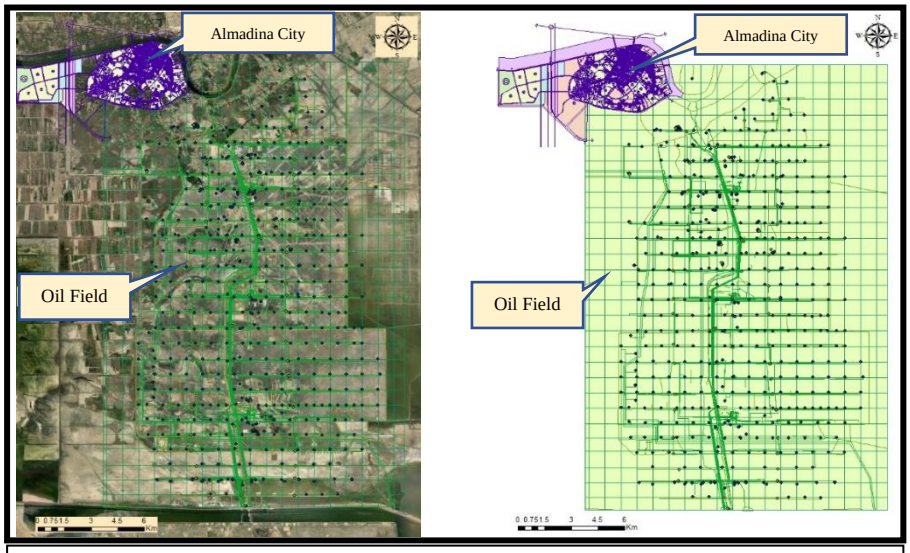

Figure (1)- The region of the study area, (Drawing by rresearcher, using GIS-ArcMap 10.8)

The study area consists of two main parts that differ in their environment and ecology, namely the urban part represented by the city of (Al-Madina), the center of Al-Madina district, and the industrial, productive part represented by the super-giant West Qurna-1 oil field. However, the borders between these two parts are porous and imperceptible, due to the city being located above the oil reservoir of the field, in addition to the presence of residential villages outside the city borders and within the lands of the oil field as well, within an urban environment that combines the characteristics of the natural marshes in southern Iraq, industry and oil fields, the total area of the study area is (45,082) hectares,

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of which (1644.9) is the area of the city of Medina, which represents the study area, which overlaps with the area of the oil field, which is (44,200) hectares, as shown in (Figure 1) (the researcher, based on the GIS program).

2-2 Analysis of urban problems and environmental challenges of the study area

The most prominent sustainable urban problems that can be addressed in the study area are the problem of drying up the study area with its plants, and the erosion of its vegetation cover, in addition to the erosion of agricultural lands, for the purposes of expanding oil production operations on the one hand, or urban expansion resulting from the city of Medina attracting workers in the oil field and living in it at the expense of agricultural lands on the other hand, these problems were accompanied by increases in air pollution rates in the study area, as well as the rise in temperatures and other effects resulting from them, which causes increased urban pressure on the city's urban environment, as a third axis. To prove this, the following was done:

First: The research analyzed the proportions of (land cover/land use) for the study area during a period of (10) years, by classifying them into five categories, which are (the built environment of residential or oil buildings, green vegetation cover, lands that were bulldozed again and can be revived and greened, open lands that were completely dried up, water bodies), and studying the differences between their proportions during (10) years, The analysis was done for the year 2014, when the expansion of oil production in the field began through its investment, and also the analysis for the year 2024, and the comparison between them, and the process of analysis and obtaining the ratios was from the analysis of the Landsat optical spectrum images for each year separately, amounting to (11) images for each year separately as well and with different optical spectra to increase the accuracy of the results, which were obtained from the official website of the US Geological Survey (USGS) [19], then it was merged, analyzed and tested by means of the GIS-ArcMap 10.8 program, Figure (2), then converted to Polygin (Vector) by means of the Dissolve tools. After that, the research also conducted (the supervised classification) of land uses in the study area, the following was shown:

- The results of the analysis of the study area for the year 2014 showed that the percentage of the built environment reached (10.03)% of it, including city buildings and oil field area buildings, and open areas reached the highest percentage of land cover (43.87)%, which are mostly marsh or dried agricultural lands, followed by open lands suitable for greening and agriculture because they were not completely destroyed (23.65)%, then green areas with a percentage of (13.25)%, while rivers and water bodies came with the lowest percentage (9.2)%, Figure (3). - As for the year 2024, the analysis results showed that the percentage of the built environment reached (12.1)% of it, including city buildings and the oil field, and open areas reached the highest percentage of land cover (59.7)%, which are mostly marsh or dried agricultural lands, followed by open lands suitable for greening and agriculture because they were not completely destroyed (14.9)%, then rivers and water bodies (8.8)%, while the percentage of green areas came in at the lowest percentage (4.5)%, Figure (4).

Second: the research analysed the amount of changes in (land cover/land use) over the ten years mentioned above (2014-2024) based on the plans that were drawn and analysed by crossing the plans of the different time periods mentioned above using the (Intersect) tool to test the changes that occurred in land use/land cover by analysing the table of the layer components that resulted from the intersection of the two layers (Field Calculator) with the equations for analysis in the program, Table (1) & Figure (5) show the most prominent changes in (land cover/land use) during the ten years studied, which shows the extent of the encroachment on the ecological zones in the study area.

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Table (1) shows the amount of change in land cover/land use for the study area during the years 2014–2024, (Prepared by the researcher, using GIS-ArcMAp 10.8)	
The most prominent changes	Amount of change (Hectares)
Rivers and water areas – Open areas	1016.24
Rivers and water areas – Built environment	92.73
Areas suitable for greening – Open areas	5183.58
Areas suitable for greening – Built environment	1245.6
Green areas – Open areas	2112.9
Green Areas - Areas suitable for greening	1459.77
Green Areas – Built environment	154.02
Open areas – Built environment	2622.34

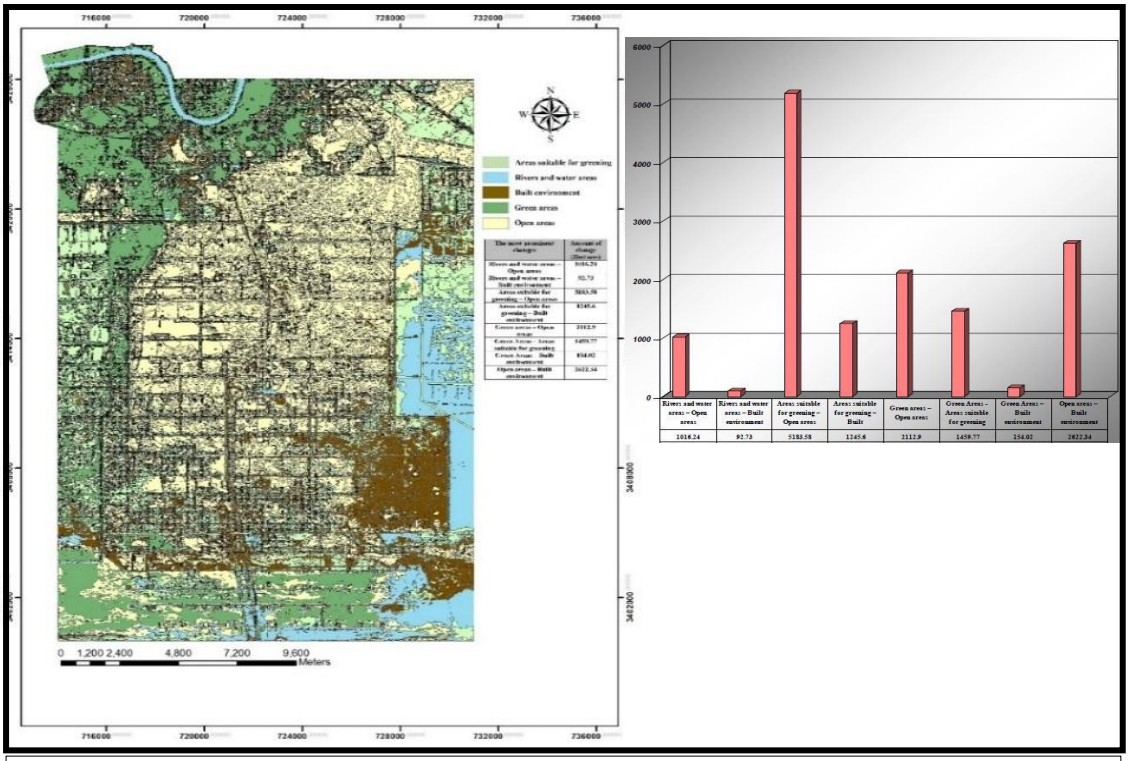

Figure (5): Analysis of changes in land cover/land use during the years 2014–2024, (Prepared by the researcher, using GIS-ArcMap 10.8)

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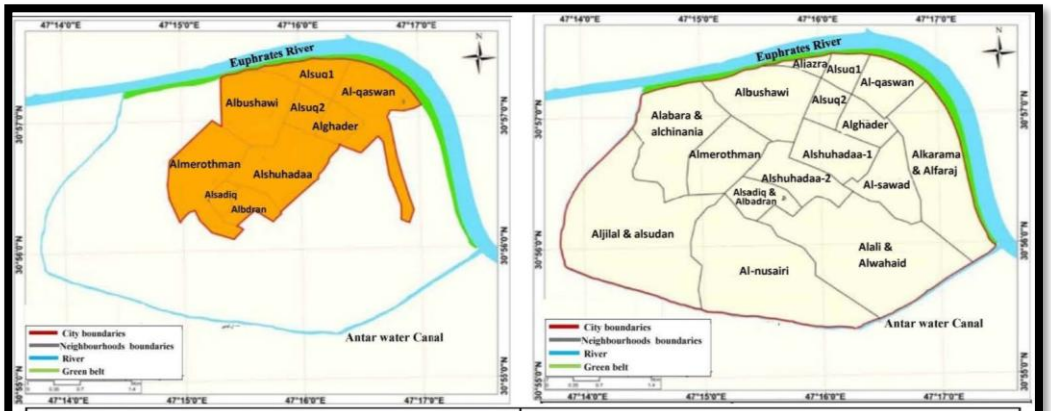
Figure (6): Encroachment on green areas in the study area, (The researcher).

- The city of Madina has witnessed a large encroachment on the green areas as a result of the urban expansion that has occurred due to settlement in it for the expansion of job opportunities related to the oil field, or as a result of the migration of some residents from the villages surrounding it due to the erosion of the agricultural lands in which they live due to the expansion of oil field operations, or the drying up of the marsh areas of water, The city tends to expand to (16) residential neighbourhoods according to the plans obtained from the municipality of the city of "Al-Madina", which did not recommend preserving more than an area of (164.2) hectares of green areas and existing orchards, and kept open and green areas within the urban area with an area of (15.1) hectares, and thus the total area of open and green areas together is about (179.3) hectares out of the total area of the city, which is (1644.9) hectares, That is, at a rate of (10.9)% of the total area of the city, while in 2004 the city had only (9) residential neighbourhoods, its urban area with an area of (631.16) hectares, of which (172.7) hectares were open areas, and green areas and orchards with a limit of (800) hectares, and the total open and green areas (972.2) hectares, that is, about (59.1)% of the total area, and this clearly shows the percentages of encroachments on the green spaces and the ecological nature of the city, Figures (6) & (7).



2004	2024
Total Area of the urban Area = 631.16 hectares	Total Area of the urban Area = 1644.9 hectares
Number of residential neighborhoods = 9	Number of residential neighborhoods = 16
Total Area & percentage of green and open areas = 972.2 hectares, (59.1%).	Total Area & percentage of green and open areas = 179.3 hectares, (10.9 %).

Figure (7): Urban expansion in the face of green spaces between 2004 & 2024, (The researcher, based on the Directorate of Municipality of the city of Madina).

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- If this clear and significant decrease in the percentages of vegetation cover and green areas in the study area is compared with the temporal changes in temperature increases in the study area, we will find a clear and obvious relationship, especially with the presence of a characteristic in the study area represented by oil production and the resulting pollutants to the air and soil, all of which contribute to the rise in the temperature of the region during the past two decades during the years of increasing oil investment and the accompanying increase in the erosion of water and green areas, in which the temperatures of the study area recorded unprecedented leaps compared to other Iraqi cities, while, for example, its rates in 2012 were an annual average of maximum and minimum temperatures respectively (34.0-20.7)°C, it rose in 2022, as the annual average of maximum and minimum temperatures respectively reached (35.6-21.3)°C [20], These are very high elevations, indicating a significant increase in temperature rates over the years, which usually accompany the increase in CO2 levels in the air of the study area for one reason or another.

- The research found that there is a large and clear increase in the concentrations of CO2 in the air. While its concentrations were within the normal level at the beginning of the expansion of oil investment in the study area in 2014 (424.033 ppm), it rose significantly to (1029 ppm) in 2024 [21], while the natural rates of carbon concentration in the air are (420 ppm) after it was (280 ppm) before the industrial revolution. However, if the rates range (500-550 ppm) in urban areas, this is considered an indication of a high level of emissions, which requires reducing them [22], This is an indication of the need to adopt green cover standards equivalent to carbon quantities within the green cover standards of this city.

- The large and ill-considered urban expansion that the city witnessed towards its rapid growth leaps came for several reasons, the most important of which is the economic situation of the city towards attracting job opportunities as a result of the investment expansion in the oil field to exploit oil resources, and the resulting settlement of some due to work, Or the return of its children who had previously emigrated from it for various reasons. There is also another factor in this increase due to the migration of farmers who had previously inhabited its agricultural surroundings to live there after leaving their lands, whether due to the drying of the marshes, or the expansion of oil production on agricultural lands and their confiscation and compensation of their inhabitants.

2-3 Green planning and design scenarios

In this step of the practical study, the planning and design strategies to be followed are developed as proposals and scenarios for the sustainable urban development of the city. The goal is to identify important green areas for preservation and ensuring their continuity, after identifying the main environmental and ecological problems and seeking to solve them. The proposals and scenarios are practical and realistic, studied and tested through standardization using the GIS-ArcMap 10.8 program.

The problem of encroachment on the city's green cover, with its canals and waterways running through it, is one of the city's most prominent sustainable urban problems. Other sustainable urban problems related to the green cover include the climate problem, with the increasing rise in temperatures, as mentioned above, and the subsequent environmental problem of global warming and rising levels of carbon dioxide (CO2), a pollutant in the city's air, as was also explained.

The research finds that in resource-based cities, and for this urban climate-environmental specificity, and for the purpose of achieving sustainable urban alignment for the city, and also preserving the health of the residents, it will not be sufficient to use the usual green cover standards to achieve the percentage of green cover for the city between (30-15)% of the city's area, but rather the green carbon equivalent standard must also be activated (one green acre for every 40 tons of carbon, i.e. it stores 40 tons of carbon), (hectare = 2.47 acres) [23], The above criteria are calculated and vary from one city to another, and whichever is greater depends on ensuring the local privacy of each city, as the greening equivalent to carbon has an economic benefit as well as an environmental one, as (15,000) trees retain the

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equivalent of (1500) tons of carbon, thus achieving an economic benefit that studies have determined at (1.5) dollars per tree [24].

As for the city of Madinah, the average amount of carbon produced by the three oil stations in the air is (25,621) tons [25] (Basra Oil Company, Health, Safety and Environment Authority, unpublished data), meaning that the city needs a green area equivalent to carbon of (259) green hectares, which is approximately (15.74)% of the total area of the city, which is (1644.9) hectares, While the total green areas of the city are currently (164.2) hectares, which is equivalent to (9.92)% of the city's area, that is, it is also below the standard of the percentage of green cover for the city (30-15)%, which should range between (493.47-246.73) hectares, and for the purpose of raising the value of the green cover area of the city, the research developed, analyzed and tested the following scenarios by means of the program (GIS-ArcMap 10.8), Figure (8):

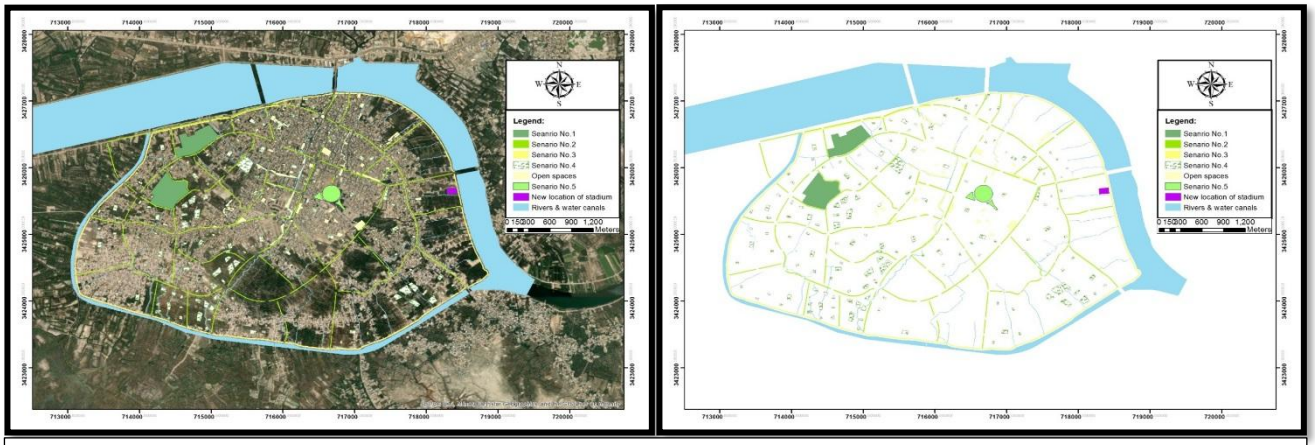

Figure (8): Proposed green planning & design scenarios for sustainable development of the city.

1- Preserving the green areas that are in the process of being razed and which the analysis and testing of the research sensed as being green areas suitable for green investment, by testing the information available about the vegetation cover through the GIS-ArcMap 10.8 program as in Figure (4) during the analysis and testing of the vegetation cover, and its area within the city of Madinah is (32) hectares.

2- Designing green medians with a width of (4) meters in the main streets with dimensions of (20-30) meters, according to the visions of green infrastructure and its water networks that work as rainwater catchments and are recycled to irrigate crops, in addition to recycling the quantities of water leaking from the irrigation itself, as part of preserving the city's water resources, within the components of sustainable urban design, and specifically what is called water-sensitive urban design, based on the density of greening that he referred to in the road axes and public squares to support the treatment of the environmental impact of the city, reaching the vital rainwater preservation system (Bioretention facilities) within the sustainable stormwater management, especially with what the study area and its larger region (the city of Basra) are going through in terms of a fresh water crisis with the passage of years, Figure (9), and these green median islands will achieve a total of (53.78) hectares.

3- Greening the sloping side of the dam that surrounds the city and separates it from the Dyer River that surrounds the city, where the street space above it is currently about (7) meters, and the basic design of the city has expanded it to (15) meters, which is what will be worked on, while the sloping side of the dam towards the city is about (15) meters long as a (Side Slope) of the dam towards the city, It is an area that can be utilized by turning it into a green belt surrounding the city, giving it a great aesthetic

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feature and contributing to shaping its image and green identity by sloping from top to bottom, Figure (10), and it will achieve a green area of (22.09) hectares.

Figure (9): The central median and its treatments for green infrastructure for rainwater and irrigation

Figure (10): Greening on the sloped side of the city embankment.

4- Greening the abandoned and neglected open areas in the city, which total an area of (2.65) hectares, in addition to greening the neglected waste left between the houses and residential complexes, which amounts to about (52.3) hectares according to the research analysis in Figure (8), which will add it to the green cover in the city.

5- Greening the central area of the city, which the basic design proposes to be a city stadium, as the location is more suitable for green activity as it is located almost in the city center, and in a dense residential complex that lacks green areas. Therefore, this area can be used as a green, tree-lined area and may contain a sign representing the city, due to the area's distinguished location, with the stadium being moved to a more suitable location near the shore of the Euphrates River, with an open environment that accommodates the public and the number of cars that might accompany them, the site has the characteristics that qualify it to be the nucleus of a sports complex for the city that achieves sustainable (social-economic) returns, noting that greening this area adds (8.35) hectares to the green cover.

* The five scenarios mentioned above will achieve an additional green area for the city amounting to a total of (171.17) hectares, i.e. they will work to raise the value of the green cover within the city limits from (164.2) hectares to (335.37) hectares, Figure (8), and thus the city will achieve the required amount of green cover equivalent to carbon (259) hectares, and it also raised the percentage of green cover for the entire city land from (9.92)% to (20.38)%, i.e. within the high rates which are (15-30)%.

It should be noted that agriculture in the aforementioned scenarios takes place within the urban spaces of the city, meaning that agriculture cannot be open to the land indefinitely in order to sequester carbon. Rather, it must be carefully considered in what is currently being cultivated to achieve the highest levels of efficiency in sequestering carbon, in addition to the other important function of agriculture in being attractive to the population, therefore, it is not limited to the presence of trees only, but it also needs the presence of shrubs and herbs, especially since the carbon sequestration efficiency of large trees slows down over time, therefore, when designing green spaces in cities, it must be known that carbon sequestration resulting from planting medium-sized plants is of equal importance in the long term, and this is also linked to factors related to the characteristics of plant communities in urban green spaces, as it was found that carbon sequestration in plants is positively and significantly related to the diameter of the trunks, the density of the tree canopy, and the density of the plant community. It is also positively related to the type of plants [26]. The most famous trees with high carbon sequestration capacity are palms, Platanus orientalism, Salix babylonica, Koelreuteria paniculata, and Melia azedarach. Shrubs with high carbon sequestration capacity include Lonicera maackii, Nandina domestica, Rosa (Floribundas Group), and Rosa xanthine. Grasses with high carbon sequestration capacity include Iris pseudacorus, Zephyranthes candida, and Stipa lessingiana [27].

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3- Conclusion

The research concluded that there are multiple potentials in the city within the study of the current situation, represented by many sustainable urban resources and potentials, which rise to the level of creating planning and design components based on the resources of the vegetation cover and the green environment, Enables sustainable urban alignment between the problems resulting from the expansion of resource use, especially environmental ones, and natural assets, in a manner that is sustainable for economic, social, environmental and political purposes.

The most important thing that must be stopped at through the analysis of the study area is the high deterioration of the green cover, especially the agricultural cover of the city, this sustainable resource of the city must be taken care of, activated, not exceeded, and global oil policies and strategies should be followed to invest in oil within this type of land without causing any harm. The region's oil resources should also be utilized to activate other economies to maximize resources, such as the crude oil-based processing industry, the petroleum derivatives industry, and the Food industry for the specificity of the study area.

It was also found that there is a sustainable urban disconnect between the area of the productive oil field and the urban residential surroundings, despite the fact that entire cities and villages are located on the field's land, where the invisible porous borders do not prevent physical, spatial and environmental interference, as the Iraqi field sites possess most of the potential and components necessary to develop or rehabilitate them towards growth to achieve the sustainable urban concept based on measured planning and design foundations, which requires following a strategic action plan that ensures the creation of sustainable urban alignment between the area of the production field and the urban environment associated with it, through social and political synergy, and in a manner that achieves the equitable distribution of resources within the spatio-temporal environment, and ensures the continuity of the urban system despite its different political, social, cultural, economic, and environmental orientations, the principles of this plan are included among the primary and fundamental principles that are always set for the development of resource-based cities.

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