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Identifying and Measuring Biophilic Planning Indicators in Riverside Neighborhoods

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Abstract

Biophilic planning is one of the important trends in achieving sustainability and nature conservation, especially in areas that contain natural elements. Since in the case of climate change and urban encroachment on natural habitats, taking care of nature and investing its components properly is a necessity, not a choice. As well as the agreement among many researchers about the social, economic and environmental benefits provided by biophilic planning, which is based mainly on the idea of connecting people with nature. This study aims to provide a guide to planners, urban designers, and decision-makers, including how to deal with residential neighborhoods that contain natural elements such as rivers by depending on a specific methodology based on previous literature and deriving effective indicators in this type of neighborhood. The results of the theoretical framework showed that there are eleven effective indicators, some of which are measured by descriptive methods and some by quantitative methods. These indicators have been applied in one of the neighborhoods of the Iraqi Kufa City overlooking the Euphrates River. The results showed that the study area lacks standards and indicators of biophilic planning.

Keywords: Biophilia; Biophilic Planning; Riverside Neighbourhoods; Urban Planning.

1. Introduction

Humans always need to live in an environment that is healthy, happy, and connected to nature. The environment in which they live affects their life quality and production levels. The connection with nature is one of the main and important issues affecting the quality of contemporary urban life. Therefore, preserving the natural elements that exist in contemporary cities, or trying to find ways to grow them, or recover the lost ones, are among the major challenges facing urban planners and designers.

One of the planning and design approaches that call for the preservation of nature and harmony with it is the biophilic approach. Biophilic is defined as the innately emotional affiliation that humans feel towards other living creatures [1]. Rivers play a major role in determining the locations and development of towns and cities throughout history. In many countries of the world that preserve the natural elements in their cities, rivers have become one of the means of comfort and the practice of recreational activities, as they provide a strong connection with nature [2]. The role of rivers in city planning has been discussed in many works of literature. Some authors have focused on the functional role of the river as part of the urban structure, describing it as a liquid rail-like object. Some authors view

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rivers as an independent urban ecosystem. It also represents a public space, in addition to the fact that some authors believe that the rivers represent part of the visual identity of the city [3].

Some cities around the world (Iraqi cities in particular) contain many neighborhoods overlooking the banks of rivers, which may contain other natural characteristics. These neighborhoods suffer from a lack of interest in the natural elements present in them, especially rivers. In light of the poor environmental and health conditions experienced by the population in many cities around the world, it has become imperative that there be a vigorous pursuit of biophilic planning to preserve the natural elements, to spare the environment from pollution damage, and to preserve human health. Based on the foregoing, this paper aims to identify and measure the indicators of biophilic planning in riverside neighborhoods in an attempt to take advantage of the rivers presence feature in those neighborhoods and use them in a manner that serves to achieve the economic, social, and environmental benefits that this type of planning guarantees.

2. Background of the Research

Many recent studies have looked at biophilic cities from different perspectives. Therefore, this paper attempts to explore the lessons learned from previous studies and to identify the lack of knowledge in this area. Thomson and Newman (2021) found that there is some conflict between compact cities that support energy efficiency and eco-cities, especially concerning density. They suggested that the two previous approaches should be combined through the use of biophilic urbanism tools, by integrating nature with especially dense urban areas. They found that the approach of integrating biophilic urbanism with green infrastructure provides many environmental, social, and economic benefits for cities [4]. Regan et al. (2021) based on the biophilia hypothesis and examined the effect of green spaces on health, social and economic determinants. They found that there is a strong effect of green spaces on the level of health, income, and education. They discussed the important effects of green areas on urban planning and environmental health research and policy [5]. Panlasigui et al. (2021) identified three main ways in which urban biodiversity can be mapped to and support the goals of biophilic cities. These methods are community involvement, setting quantitative goals based on science, and setting priorities for action [6].

McDonald and Beatley (2020) found that the solution to contemporary cities problems is to adopt biophilic planning and design, and biophilic cities offer a new vision for global urbanization. This study found a set of planning principles to help guide cities [7]. In his study published in 2020, Beatley pointed out the possibility of applying biophilic design and planning principles at all planning levels, from buildings to regions. He discussed the idea that biophilic design extends deeper than creating urban gardens and thinking about providing people with comfort and relaxation. He stressed the need to put nature at the center of planning and design, and to explore the ethical foundations of biophilic cities [8]. Maleki et al. (2019) presented an analytical model to evaluate the characteristics of the biophilic city in five cities. This study used descriptive and analytical methods and followed quantitative and qualitative approaches. This study found that there are internal and external factors that affect the characteristics of the biophilic city. One of the most prominent external factors is the concern for environmental development and giving it priority over physical development. The most prominent internal factor is the interest in gardens and urban agriculture [9]. Beatley (2017) linked the biophilic city and social justice, by discussing social disparities in access to nature, especially the blue nature. This study found that access to the blue nature will contribute to overcoming many social and health inequalities. As well as a moral commitment towards future human generations and concern for other living creatures [10].

Previous studies dealt with a number of important and fundamental issues in biophilic planning, some of which examined the health, economic and social effects of the presence of biophilic planning elements, and some of them dealt with green infrastructure that supports biophilic planning. Another part of these studies dealt with the possibility of building analytical models to study the characteristics of biophilic cities. In this paper, the authors try to focus on the neighborhoods overlooking the rivers and take into account their natural characteristics, especially the presence of the river, to find a number of effective indicators in planning these neighborhoods in a manner consistent with the presence of the river and other natural characteristics associated with it. Taking into account the natural characteristics in the planning of cities and neighborhoods will contribute directly to alleviating the epidemics and environmental problems that afflict the planet and its inhabitants.

3. Theoretical Approaches

3.1. The Biophilia and Biophilic Planning

The word “Biophilia” was first used by psychoanalyst Erich Fromm. He defined biophilia as the affection love towards life and living organisms, and he considered biophilia as a natural biological instinct [11]. After Fromm, the term has been used by many researchers, most notably Edward O. Wilson in his published book 1984. Wilson defined biophilia as “the innate tendency to focus on life and lifelike processes”. Wilson claimed that the connection with nature goes beyond physiological issues, as it has genetic bases [12]. The biophilia hypothesis is based on the idea that

humans have an intergenerational need that invites them to connect with nature because humans depend on nature for their survival and continuity [11]. It is an attempt to find out the inherent human affinity for belonging to processes and systems in nature (love of nature) in designing a built environment [13]. It was used in recognition of the need to communicate with nature again, adding, "The life around us excels in The complexity and beauty of anything else humanity faces" [12] that positive impact of design or what is preferred to be called a design that loves nature reflects the construction of landscapes that enhance the human body and mental health through correct contact with nature characterized by environmental, cultural familiarity and being meaningful [14].

The first goal is to reduce stress, as many questions have been asked to people to find out where they prefer to be after periods of stress and anxiety where the majority and by 95% indicated external environments as a solution to escape stress and anxiety [15]. The building's harmony with its natural surroundings, green areas, waterways, or sea views nearby, will generate a set of sensations that can stimulate other mental activities [16]. It was also found that inspiration from nature is one of the indicators of beauty in planning and urban design [17]. In this sense, and according to literary reviews, the Hanging Gardens of Babylon may be the first and oldest biophilic model in the world, which meets all the principles and patterns of Biophilic design [18].

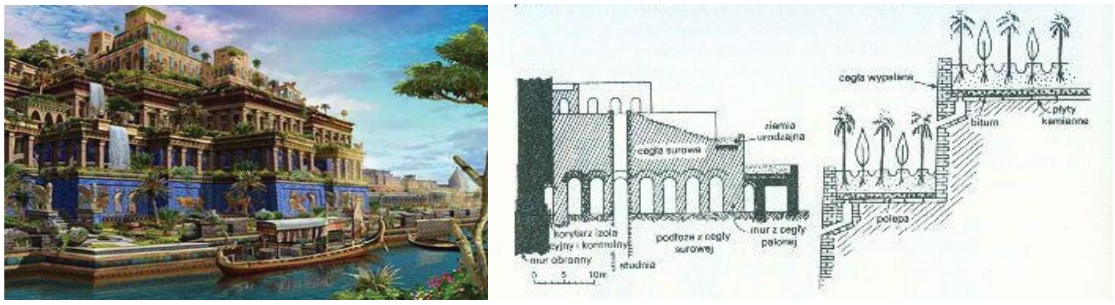

Figure 1. Hanging Gardens of Babylon [18]

A biophilic city is defined as a city that puts nature first in its planning, design, and administrative considerations. As it focuses on the basic need of humans in daily communication with nature, as well as the presence of many economic and social values and benefits provided by natural systems [19]. The concept of biophilic cities is built on the well-established fact that humans have an innate connection with nature and are drawn to it [20]. The biophilic city is also known as a city rich in nature, it is a city that is constantly looking for opportunities to repair and restore what has been damaged from its nature. It is a place that simulates natural systems and learns from them [21]. Many studies indicate the great benefits caused by the presence of nature, for example, the health and mental benefits caused by walking in green spaces, as it reduces stress hormone levels and enhances the immune system [22]. The presence of nature improves the cognitive performance of a personal nature experience reduces rumination and subgenual prefrontal cortex activation. It also helps reduce fatigue and exhaustion felt by city dwellers [23]. Biophilic urbanization can provide a wide range of ecosystem services, which include air quality, carbon dioxide reduction, microclimate benefits, flood control, and water quality, food production, and economic benefits [24].

3.2. The Biophilic Planning Indicators

Biophilic planning indicators have been classified according to several levels: building, street, block, neighborhood, city, and region. Each of these levels has a set of sub-indicators on which it is based [25]. Indicators of biophilic planning were also categorized into 14 types, categorized into three main groups: nature in space, natural analogy, and nature of space [26]. In order to derive effective indicators in the biophilic planning of neighborhoods on the banks of rivers, the paper will review two successful experiences of biophilic cities are: Portland and Berlin , as well as be guided by a number of literature on this subject.

Portland is known as the largest city in the state of Oregon, it contains the Willamette River as well as the presence of the Columbia River, it is one of the world's most natural cities. This city is characterized by its high walkability as well as very large numbers of cyclists and is characterized by the presence of large areas of green spaces, as well as large numbers of trees on both sides of residential streets and on the banks of the river [27]. This city is also characterized by the presence of urban agriculture, which directly contributes to obtaining healthy food. This city has properly handled rainwater through the Green Streets initiative, and it has implemented the limits of urban growth through increased density and compactness within the city [28] (See Figure 2).

Figure 2. Portland City

Berlin has a number of rivers within it, has a long history of integrating natural elements with the built environment, and is one of the densest cities in Europe. The city has used a number of the world's most successful and developed urban greening policies and programmes, which are strongly supported by the community and stakeholders as a result of their understanding of the economic, social, environmental and personal benefits that biophilic planning provides [29]. Gardens and green spaces were used for recreation, picnics and agricultural crops, until about a third of Berlin became a natural habitat and green space. Berlin is also characterized by easy access to facilities and services, while giving distinction to the city's identity by dealing with buildings overlooking the banks of the rivers to give a sense of well-being to the residents [28] (See Figure 3).

Figure 3. Berlin City

There are many indicators for how to deal with urban rivers according to biophilic planning. The most prominent of these indicators is the use of urban agriculture on the rivers' edges and the preservation of biological diversity within and around the river. Pollutants and wastes must be removed from the riverbed and its banks, and sewage water should not be discharged into urban rivers [30]. Diversity in land uses is one of the important indicators in achieving

biophilic planning, by including all land uses within the framework of environmental development that achieves ecological balance and integration. That is not limited to residential and commercial uses [31]. It measured by Simpsons Index according to the equation:

$$D_i = 1 - \sum(n/N)^2 \quad (1)$$

Where n represents the area of each type of land use (For example: residential, commercial, and civil) in a hectare within a locality, N represents the total area of a locality. D_i represents the resulting mixing index [32].

Local gardens are one of the important elements in biophilic cities, as the majority of buildings in neighborhoods must overlook green open spaces [33]. References indicate the need for diversity in green spaces. As there must be recreational spaces in which the recruitment and simulation of natural elements are taking place. With the existence of educational spaces in which there are spaces for teaching and practicing various scientific activities. As well as the presence of therapeutic spaces that are often associated with health institutions to provide physical and psychological treatment [34]. It is worth noting that the presence of ecological corridors near or within urban areas, is one of the important things in biophilic cities. These corridors must contain what encourages effective human use of them, as they must contain pedestrian paths and areas for sitting and watching nature. These corridors may be green or blue [35]. Researchers point out the need to preserve aspects of the original natural environment within urban areas to enhance the population's attachment to their original environment [36]. Some references also point to the importance of people's ability to move comfortably and safely among spaces, even if the paths are complex. This provides a sense of security and safety for the residents, and this ability can be ensured by clarifying the entry and exit points of the spaces [11]. The percentage of the population living near green spaces and ecological spaces is an important factor in achieving biophilic planning. The percentage of the area covered by trees or other types of vegetation to the total area of the city [37]. It is necessary to avoid high-rise buildings in neighborhoods that contain natural elements such as rivers. It is necessary to take into account the natural phenomena that can occur in it, such as the migration of birds that follow specific paths [38].

Table 1. Biophilic Planning Indicators

Indicators	Measurement method	Standards
Use of urban agriculture	Quantitative: The ratio of the number of produced green spaces to the total number of green spaces [39].	It is better to have a large number of produced green spaces.
Preservation of biological diversity	Quantitative: Count all kinds of living things in the area.	All living things must be preserved.
Correct handling of pollutants and waste	Descriptive: Note the presence of waste and pollutants in the riverbed and its banks.	Pollutants and wastes must be removed from the riverbed and its banks [30].
Diversity in land uses	Quantitative: Measured by the Simpsons index.	The value ranges from 0-1, where the values closer to 0 mean less diversity and values closer to 1 mean high diversity. Lands designated for public streets are usually excluded [40].
Presence of local gardens	Descriptive: Note the presence of appropriate local gardens in the local communities.	All local communities must have a local garden.
Diversity in green spaces	Quantitative: Count the types of green spaces in the area.	There should be a wide variety of green spaces.
Presence of ecological corridors	Descriptive: Note the presence of green and blue corridors in the area.	It should have fountains, pedestrian paths, and seating areas. These corridors must achieve a visual connection among the spaces.
People's ability to move comfortably and safely among spaces	Quantitative: Through a questionnaire form in which people are asked about their comfort and feeling of safety while moving among spaces.	There must be paths for pedestrians, and these paths must be safe with ease of movement, and the use of environmentally friendly materials and for walking. These paths should provide an easy transition between spaces.
Percentage of the population living near green spaces and ecological spaces	Quantitative: It is calculated by knowing the number of people who live at a distance of 400 meters as maximum from their nearest green space [41].	100% of the population should be close to green spaces.
The percentage of the area covered by trees or other types of vegetation	Quantitative: Calculate the area planted with trees or other plants to the total area.	The percentage of areas planted with trees or other plants is 10% as a minimum of the total area [42].
Suitable building heights	Quantitative: Calculation of building heights using meters as a unit of measurement.	The height of buildings in areas containing natural elements shall be a maximum of 18.75 meters [31].

4. Research Methodology

In this research, the authors relied on a clear and specific methodology. This methodology is generally based on previous literature in determining the knowledge gap, then several relevant studies were adopted to extract effective indicators for biophilic planning of neighborhoods overlooking the rivers banks. Some descriptive measurement methods and quantitative measurement methods were used to measure the indicators in the study area represented in one of the neighborhoods overlooking the Euphrates River in the Iraqi Kufa city (See Figure 4).

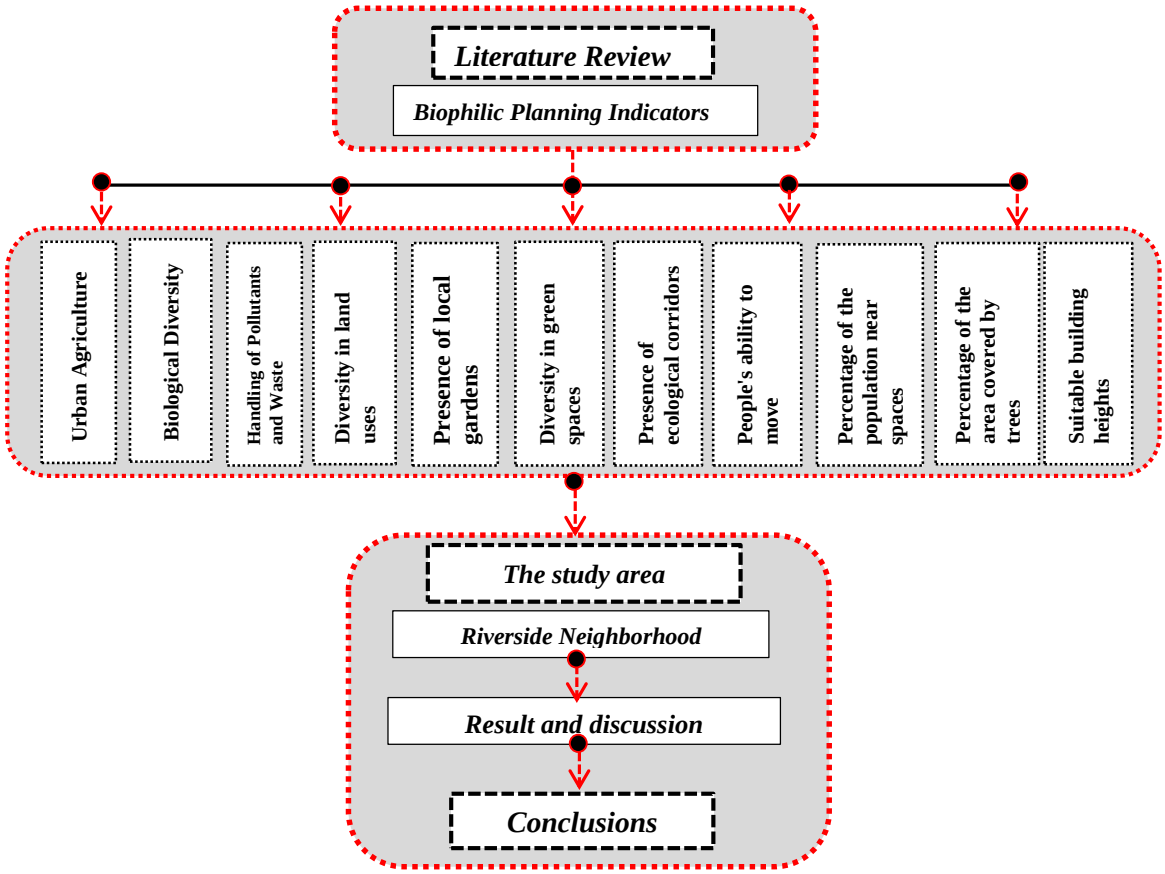

Figure 4. Research Methodology

5. Case Study

The Kufa city is an Iraqi city located in the An-Najaf province, to the south of the capital, Baghdad, about 156 km away from it. Global coordinates of 44˚ 23' 55" latitude and 32˚ 02' 11" longitude [32]. The Kufa city is located on the banks of the River of Kufa, which is one of the branches of the Euphrates River. The annual average discharge into the River of Kufa at the Dam of Kufa station was 93.6 m^3/sec [43]. The population uses the River of Kufa for many economic activities, such as fishing and the use of its waters to irrigate crops. The river also stimulates some recreational activities such as water sports, swimming, and walking on its bank. The Kufa city consists of several neighborhoods, one of these neighborhoods overlooking the river is the Euphrates neighborhood (Al-Furat neighborhood), which was chosen as the study area. The study area was previously agricultural, but it gradually turned into a residential neighborhood. The northern part of the study area is a built-up area at present, while the southern part is a residential complex under construction. It covers an area of 134.4 hectares and has a population of about 14,000. It contains many land uses such as residential, commercial, service, and administrative. This neighborhood was chosen as a case study due to its proximity to the River of Kufa and a large agricultural area known as the Island of Kufa [44, 45]. (See Figure 5).

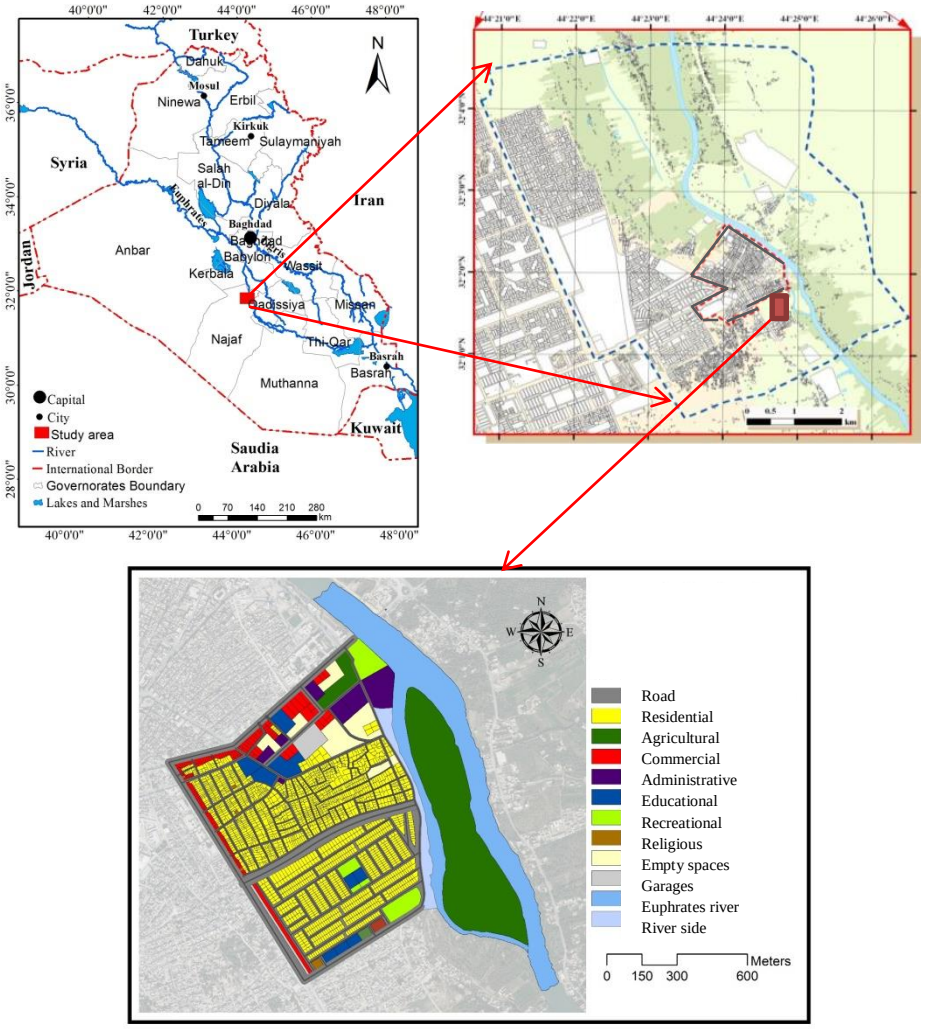

Figure 5. The location of the study area

6. Results and Discussion

Through the field survey and the use of GIS maps and pictures of the study area, the following was found:

Use of urban agriculture: The area of productive agricultural spaces constitutes a very small area in the study area, as there is only one productive agricultural space. However, the study area overlooks what is known as the Island of Kufa, which is a large agricultural land. The lack of productive spaces in the study area constitutes a weakness factor in achieving biophilic planning indicators because many productive agricultural spaces have been converted to residential or commercial uses (See Figure 6).

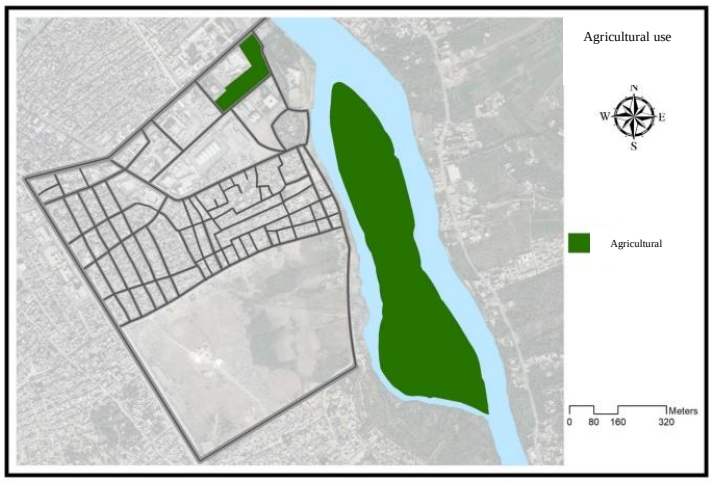

Figure 6. Productive agricultural spaces in the study area

Preservation of biological diversity: The biodiversity in the study area has been lost as a result of various human activities in it and its transformation from an agricultural area to a residential area, only a few are left. In the River of Kufa and Island of Kufa, which are close to the study area, there is good biodiversity of different types of animals and plants, which must be preserved and used to restore the biodiversity in the study area (See Figure 7).

Figure 7. Biological diversity in the study area

Correct handling of pollutants and waste: There is improper handling of pollutants and waste, as waste is dumped in the river or on its edges, and some sewage pipes flow into the river. The study area suffers from clear neglect in the treatment of pollutants and waste, and this neglect has several reasons, some of which are related to the failure of the local government and others related to the behavior of some members of society that do not take into account the need to preserve nature. This will cause major environmental pollution and will lead to serious consequences that affect the health of humans and other living organisms present in the study area. Failure to properly deal with pollutants and waste is a bad indicator in achieving biophilic planning indicators (See Figure 8).

Figure 8. Incorrect handling of pollutants and waste

Diversity in land uses: The value of the Simpson index was 0.37, which is a low value indicating the weak diversity of land uses in the study area. The reason for this is the dominance of residential use, whose area constitutes 67% of the total area. The weak diversity of land uses in the study area indicates an imbalance between those uses, which indicates a defect in the organization that leads to a major environmental defect in how the land is used, which leads to weak indicators of biophilic planning.

Presence of local gardens: There are no local gardens in the northern part of the study area to serve the residents of local communities. This is due to the poor organization and coordination of land uses in the study area and the dominance of residential use over all other uses. In the southern part, there are two local gardens, but they are under construction.

Diversity in green spaces: There is no diversity in the green spaces of the study area, due to the lack of enough green spaces and local parks. The study area contains only one green space overlooking the river called the "Flowers Garden", containing some different types of plants and flowers. This space can be used for some educational issues for children, but it is used most often for recreational purposes (See Figure 9).

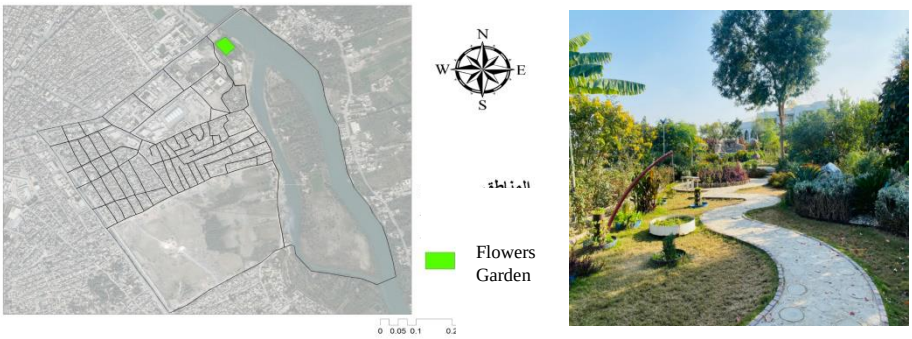

Figure 9. Flowers garden in the study area

Presence of ecological corridors: Despite the importance of this indicator in planning biophilic neighborhoods, the study area is devoid of it. The lack of green and blue corridors, the lack of well-furnished pedestrian walkways, the absence of fountains and seating areas, have negatively affected the quality of the neighborhood environment and the visual connection between the spaces.

People's ability to move comfortably and safely among spaces: It became clear through the field survey of the study area that there are paths designated for pedestrians, but they were not used properly. A questionnaire was distributed to a random sample of 200 people living in the study area. The results of the survey showed that 70% of the respondents were not satisfied with the pedestrian paths in their area, due to the presence of many violations, especially by shop owners, who use them as places to display their goods, as well as the lack of paving with materials friendly for walking, and the absence of trees and furniture. Therefore, the residents could not move comfortably and safely between the spaces (See Figure 10).

Figure 10. Inadequate pedestrian paths for movement

Percentage of the population living near green spaces and ecological spaces: Because of the study area's lack of green spaces and ecological corridors, the percentage of the population living at a distance of 400 meters from the nearest green space was very small, especially in the northern part of the neighborhood, if it was only 15%. As for the southern part of the neighborhood, about 80% of the population will be close to the green spaces if they are completed.

The percentage of the area covered by trees or other types of vegetation: Through the field survey and maps of the study area, it was found that the percentage of the land area covered with trees and other types of plants is 3.12% of the total area of the neighborhood. Although the area was originally agricultural, it gradually turned into residential, commercial, and administrative lands, which contributed to the lack of vegetation cover in the study area, as well as the absence of local gardens.

Suitable building heights: It became clear through the field survey of the study area, that the buildings with a height of one floor, which is in the range of 3-3.5 m, are dominant over the rest of the buildings with a percentage of 88 %. As for the buildings whose height was 2-3 floors, which are 6-10 meters high as average, their percentage was 12%, as shown in Table 2. The reason for the low building height is that the study area is newly established and that the majority of the buildings in it are residential buildings established by families with low to medium incomes.

Table 2. The height ratios of the buildings in the study area

Building heights	Percentage
single-story buildings	88%
Two-story buildings	10%
3 story buildings	2%

6. Conclusions

In this article, we try to shed light on the neighborhoods that are located on the banks of rivers, to exploit the location advantage of these neighborhoods in the creation of biophilic urban planned environments. The biophilic planning approach is characterized by its many benefits and sustainable characteristics, therefore, it can be said that it is possible to present biophilic planning as an integrated approach to sustainable planning that offers many economic, social, and environmental benefits. The biophilic planning approach provides a state of harmony and balance between the planning and architectural products on the one hand, and nature on the other, in a way that meets the dimensions of sustainability and enhances human well-being. Neighborhoods overlooking the banks of rivers need special treatment in which the highest degree of balance is achieved between the requirements of daily life needed by the residents and the requirements of preserving the natural environment that characterizes these neighborhoods. For that, in this study, many biophilic planning indicators that are appropriate for this type of residential neighborhood were derived. The study area suffers from many planning problems, as the environmental aspects and the protection of nature that characterize it were not taken into account, so there is a gap between the standards and the reality of the study area.

This paper attempted to clarify the gaps in the study area to address them in line with the modern trends of nature-loving urbanization and to be an example and guide for planners, urban designers, and decision-makers to address the problems of other residential neighborhoods that exist in many Iraqi cities that have the same natural characteristics. Future studies may pay more attention to studying the most appropriate urban form to achieve indicators of biophilic planning and the relationship between biophilic planning and the prosperity of communities. Local governments must legislate and activate laws related to protecting the river from pollution and protecting and restoring natural habitats. As well as the need to pay attention to the provision of green spaces along the waterway and the provision of pedestrian paths, and the use of water transport as a means to reduce pollution resulting from the use of the car, as well as its use for entertainment. In light of the environmental and health conditions and the water crisis that human societies suffer in general, efforts must be intensified to support and encourage urban agriculture, given its economic and environmental benefits.

7. Declarations

7.1. Author Contributions

Conceptualization, A.A.A. and T.R.A.; methodology, T.R.A.; software, A.A.A.; validation, A.A.A. and T.R.A.; formal analysis, A.A.A.; investigation, A.A.A.; resources, A.A.A.; data curation, T.R.A.; writing—original draft preparation, A.A.A.; writing—review and editing, T.R.A.; visualization, T.R.A.; supervision, T.R.A.; project administration, A.A.A.; funding acquisition, A.A.A. All authors have read and agreed to the published version of the manuscript.

7.2. Data Availability Statement

Data sharing is not applicable to this article.

7.3. Funding

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7.4. Acknowledgements

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7.5. Conflicts of Interest

The authors declare no conflict of interest.

8. References

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