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Planning and Preservation of Natural Areas in Urban Contexts: Application of Biophilic Approach in Kufa City

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ABSTRACT

This paper focuses on sustainable biophilic planning and its application in urban natural spaces. It examines key factors, such as natural green and blue spaces, that contribute to preserving natural areas in biophilic cities. Field surveys, observation, GIS, and mathematical models were used to analyze indicators derived from these factors in Kufa City, Iraq. The study identifies several effective indicators for achieving biophilic planning characteristics in Kufa City, including the urban forest index, urban orchard index, green eco-corridor index, and diversity of uses index. The findings highlight that Kufa City possesses important biophilic city characteristics, primarily due to its natural areas, as indicated by factors such as urban forests, urban pastures, and diverse land uses. These results suggest that Kufa City has the potential to transform into a biophilic city by leveraging its abundant natural areas. This has significant implications for enhancing the city's sustainability and livability.

1. INTRODUCTION

Biophilic cities are characterized by abundant open green and blue spaces that foster interaction and community engagement with nature [1]. These cities prioritize pedestrian-friendly environments, cultural and historical sites related to nature, and a diverse range of land uses that preserve natural areas and habitats [1]. They promote daily contact with and appreciation of nature while aiming to protect and enhance it, making them sustainable and resilient [2].

The term "biophilia" combines the Greek words "bio" meaning life and "philia" meaning love, representing a love for life itself [3]. It stands in contrast to "nicrovilia" (necrophilia), which denotes an attraction to darkness, death, and inanimate objects [4]. The concept of biophilia was first introduced by psychologist Erich Fromm in the 1960s, describing individuals' inherent attraction to all that is alive and vital [5]. Fromm developed a deep psychological model based on Sigmund Freud's theories, emphasizing the human tendency to preserve life and resist death. One of the fundamental aspects of biophilia is the connection between humans and nature [5].

This marked the foundational phase of biophilia, and in 1984, biologist Edward Wilson recognized it as an inherent emotional affiliation in humans towards other organisms, rooted in heredity and constituting an integral part of human nature [6]. The term "biophilia" was introduced in the early 20th century in medical dictionaries, where it was defined as an innate behavior or an innate driving force for survival. "Bio" refers to all things organic, while "filia" represents an excessive or exaggerated love. In other words, biophilia metaphorically represents the strong relationship between humans and nature, which has evolved through different natural environments over time throughout human history [4].

External senses receive stimuli and form initial concepts, which are then conveyed to the first part of the internal senses known as common sense. Common sense collects sensations and transmits them to the imaginative faculty, allowing individuals to develop associations and perceptions. Biophilia represents one of the innate conflicts experienced by humans, as they engage with their surroundings [7]. These interactions between humans and elements of their urban environment reflect their civilization and the vastness of the human mind, where historical concepts are formed and accompanied by emotional experiences [8].

In 1994, the foundation of biophilia in the field of architecture was solidified by Roger Ulrich's research. Ulrich conducted clinical studies on hospital design to test the healing power associated with nature. The results highlighted the importance of incorporating nature into hospital environments, as it was found to accelerate the healing process. Ulrich's research provided empirical evidence that supported the integration of biophilic principles in architectural design, particularly in healthcare settings [9].

This pivotal period marked the entry stage of biophilia into the field of architecture. It was further fueled by a conference held in Rhode Island, United States, in 2006, which brought together participants from academia to explore the practical implementation of biophilia's benefits in urban design. The conference led to the development of a book titled "Biophilic Design: Theory, Science, and the Practice of Building Revival," which laid the multidisciplinary foundations for incorporating biophilic design principles into the built environment [10].

In 2008, Stephen Kellert published a book titled "Biophilic Design: The Theory, Science, and Practice of Bringing Buildings to Life." In this book, Kellert identified over 70 mechanisms for creating biophilic design experiences, outlining universal principles that form the basis for effective biophilic design practice. Biophilic design focuses on human adaptation to nature, promoting physical and mental health, performance, and well-being. It emphasizes interconnectedness and integration, considering the whole setting rather than individual parts. Biophilic design encourages active engagement with nature [11].

This period marked the entry stage of biophilia into urban design. In 2011, Tim Beatley's vision for biophilic cities emerged, extending beyond architecture and urban design to urban planning. The vision encompassed spaces between buildings, urban neighborhoods, cities, and larger regional scales, with a focus on protecting natural systems and biodiversity on a continental and global level [12].

In 2021, McDonald and Beatley [12] published the book "Biophilic Cities for an Urban Century: Why Nature is Essential for the Success of Cities." The book proposes a new approach to urban planning that emphasizes the integration of nature into cities. It advocates for a shift in perception, considering cities and natural elements as interconnected and mutually beneficial. Biophilic cities are seen as resilient and sustainable, providing a wide range of environmental and adaptive services while promoting mental and physical health. The book also discusses the measurement of biophilic design and its components at various scales, from individual buildings to neighborhoods and entire cities. It explores how cities can incorporate biophilic plans to enhance their overall quality [13].

This period marked the entry stage of biophilia into the field of urban planning, with numerous studies focusing on biophilia in urban planning. The concept of biophilia has gained recognition as an essential consideration for creating livable and sustainable cities.

In a study conducted by Asadzadeh and Ahmadchali [14] in 2018, the focus was on exploring the principles of biophilic elements for sustainability in neighborhoods. The study analyzed five criteria: biodiversity, biotechnology, probability, sense of fun, and mystery. The research took place in Mashhad, the capital city of Iran, which is expected to experience rapid urbanization in the coming decades, leading to various environmental challenges, including pollution, waste management issues, and biodiversity depletion.

The goal of the study was to create a city that integrates with urban nature, often referred to as urban greening and green infrastructure. This approach has gained increasing attention as a means to address challenges such as population pressures, climate change, and resource scarcity. The study aimed to highlight the strategies for creating a biophilic city that complements or promotes urban greening, emphasizing the importance of integrating nature into urban environments [14].

In a study conducted by Asadzadeh and Ahmadchali [14] in 2020, the focus was on the potential of biophilic streets to serve as the gateway to biophilic urbanization. The study explored how integrating nature into the design of new streets could yield a range of economic, environmental, and social benefits. The findings indicated that incorporating biophilic design elements in traditional streets could enhance economic, social, and environmental outcomes within cities.

The study proposed the inclusion of biophilic elements such as green walls, green roofs, and green balconies, as well as the integration of trees, pocket parks, essential buildings, rain gardens, and street furniture in urban areas. These biophilic elements, when integrated with street furniture, can enhance the value of these vital features by providing educational and active functions that can be experienced and appreciated by individuals on the street [14].

Previous studies have not extensively examined the natural factors and indicators that are essential characteristics of biophilic cities. Therefore, this paper aims to fill this gap by focusing on studying the natural area factor, extracting relevant indicators, discussing measurement methods, and establishing criteria for achieving a biophilic city. The research will specifically concentrate on measuring the extracted indicators in Kufa City, a city located in the Najaf Governorate of Iraq. Kufa City boasts a rich historical heritage and abundant natural areas, including the Kufa River (a branch of the Euphrates River), orchards along its banks, and palm forests that span the river's shores, along with significant urban agricultural areas.

2. BIOPHILIC CITIES

Sustainability is a comprehensive framework encompassing the economic, social, and environmental dimensions, guiding the development of cities and promoting the reduction of environmental impacts and resource consumption. By deepening the connection with nature and space, sustainable cities enhance the well-being and quality of life for their residents while expanding economic opportunities, especially for marginalized populations. Biophilic planning is one approach to achieving sustainable cities, emphasizing the integration of nature into city design, planning, and management, and recognizing the importance of daily interaction with nature for citizens [13].

The United Nations Environment Programme (UNEP) emphasizes the role of green spaces within cities in regulating natural processes and mitigating issues such as high local temperatures. Numerous studies have explored the relationship between urban green spaces, parks, trees, and green landmarks, and the environmental sustainability of cities [15].

The use of Biophilia in urban planning and design, enables us to get as many benefits as the economic benefits (increase employee welfare, prevent boredom and increase shopping times, creating mixed-use areas, improving health and increasing healing rates, improving mood, improve behavior) and the environmental benefits of (promoting more green and blue spaces and habitats, easy access to nature) social benefits (promotion of walking and cycling, conservation of natural areas, work or volunteering for habitat care, building of social capital).

The incorporation of biophilia in urban planning and design yields numerous benefits across economic, environmental, and social dimensions. Economically, it enhances employee well-being, prevents boredom, and increases shopping times. It also fosters the creation of mixed-use areas and improves health outcomes, including increased healing rates and improved mood and behavior. Environmentally, biophilia promotes the presence of green and blue spaces, habitats, and easy access to nature. Socially, it encourages walking and cycling, the conservation of natural areas, and the development of social capital through community engagement [16].

These biophilic benefits align with Sustainable Development Goal 11 (SDG 11) - making cities and human settlements inclusive, safe, resilient, and sustainable. SDG 11 aims to establish sustainable transport systems, create green and public spaces, protect cultural and natural heritage, and strengthen rural-urban linkages [16]. Biophilic cities provide abundant opportunities for the creative integration and restoration of nature. They enable environments that mimic natural settings and offer various activities such as gardening, hiking, bird-watching, and other nature-related pursuits. In biophilic cities, citizens have ample opportunities to engage in the restoration and care of their surrounding natural environment, fostering a sense of ownership and connection [17]. Based on these principles, the following paragraph will delve into the discussion of the natural area factor as a means to realize biophilia in cities.

3. NATURAL GREEN SPACE FACTOR

Urban landscapes in biophilic cities act as basic parks and open spaces in the city. Natural areas are different from typical parks in that they return to a pre-developed state. These areas are preserved as they are formed to provide maximum habitat for plants and animals. These areas are more effective when associated with some forms of the corridor that are necessary for many wild species because they are often required for hunting, migration, safety, and reproduction [18]. This factor contains two sub-indicators, the urban forest index and the urban orchards index, which can be explained as follows:

3.1 Urban forest index

The urban forest is a mosaic of trees and other plants, some of which are intensely managed by different agencies or persons and others, where there are climatic factors indirectly affected by urban identification and regeneration of species. The urban forest consists of street trees, residual and emerging forest patches, plantations, and plants in parks, squares, highway edges, and the metropolitan campus [19]. The urban forest index can be measured by the following measures and criteria:

(1) The highest average value of forest tree cover in high-income cities is 33.4%.

(2) The highest average value for forest tree cover in low-income cities is 11.8%.

This difference in tree coverage between high and low-income areas is due to the lack of adequate financial support as the population is often unable to Plant trees for a variety of reasons including financial constraints, land ownership, and Lack of space for agriculture. This criterion represents the proportion of tree coverage within the forest's own area [19] (see Figure1).

Figure 1. Urban forest at Munich's Nimvenburg

3.2 Urban orchard index

Urban orchards are an extension of the natural areas of the city. They are particularly creative expressions when grown in public and semi-public places where orchards give value to sustainable communities. It also works to protect resources, protect fruitful trees for future generations, preserve fruitful trees, recognize the heritage and important varieties, connect older people in society, and share their horticulture leading to increased participation in the local environment, promoting awareness and education [19].

(1) Residual/inherited orchards: are most problematic because they are more likely to be private lands prone to changing their sex to residential, commercial, or industrial.

(2) Informal orchards/decorations: the landscape is represented in private spaces and parks or in the center along the streets where fruit trees and fruit trees of all kinds exist.

(3) They are explicitly designed to produce food and products ranging from fresh fruits and nuts to nannies and juices. Some are also designed to display food Orchards give value to society's sustainable resources, protecting fruitful trees for future generations, developing and sustaining the health and preservation of fruit trees, recognizing heritage and important varieties, connecting older people in society and sharing their own horticulture, thereby increasing participation in the local environment, promoting awareness and environmental education, creating conditions that can, directly and indirectly, improve health, one of the most important pillars of biophilic cities [20].

4. BLUE AREA FACTOR

Blue spaces (also referred to as blue infrastructure) include all areas dominated by surface water bodies or waterways in conjunction with green spaces (gardens, parks, etc.,) identifies blue spaces as exterior environments that are either natural or man-made and have blue origins and are accessible to people [21] where "blue assets" refer to water bodies including ports, rivers, streams and conservation-related water spaces (such as wetlands, marine parks, and marine reserves), water sports centers, beaches, reservoirs, artificial lakes, fountains, artificial waterfalls [21] (see Figure 2). This indicator includes sub-indicators, environmental corridor index, multifunction index, biodiversity index and can be explained as follows:

Figure 2. Integrating the city with natural water areas

4.1 Environmental corridor index

These blue areas are connected to green spaces through private environmental trails and corridors. These corridors form a network so that spaces in the form of parks, street trees, and waterfronts are physically and visually connected to facilitate community access thereby enhancing biodiversity and thus providing environmental, cultural, and recreational benefits to the community [22]. The environmental corridor index can be measured by the following measures:

(1) They are in the form of biodiversity conservation corridors: that range in width (200 m-10 m) depending on the biodiversity that is likely to exist in the environmental corridor. The corridor that he offered from 10-12 m contributes to the preservation of the biological prognosis of invertebrates. The corridor from 150-200 m can be built through a waterway and protect more biological diversity, and more wild and amphibious animals [23] (see Figure 3).

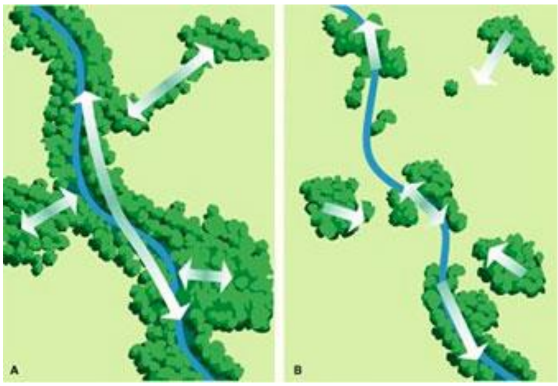

Figure 3. (A) Green corridors connected to the Blue Zone, (B) There is no green corridor connected to the Blue Zone

(2) It is connected with the blue area physically and visually: the range of visual contact is at a distance of 300-500 m when the distance is reduced to about 100 m the details for users are becoming increasingly clearer either for physical contact either by green space or open space [24].

4.2 Diversity of uses indicator

Mixed-use is horizontal and vertical. The land uses are classified as commercial, residential, recreational, institutional, and industrial the mixed-use with high density has an important role in achieving urban sustainability. The land uses must be homogeneous, thus reducing the distance of access to services and activities [25]. These uses are a mixture of commercial, and service uses, as well as residential use. This land uses diversity made the city characterized by vitality and activity throughout the long hours of the day [26] recreational use, amenities and commercial uses along riverfronts [27] can be measured by an indicator called the entropy index which is a measure of the land use mix as in the equation $ENT = -\frac{\sum_{j=1}^{n} Pj \ln (pj)}{\ln (n)}$. The value of this indicator ranges from (0-1) value (1) expresses a large mix and equal distribution of land uses which is the optimal value of diversity. However, when this value approaches zero, it expresses the dominance of one use over other uses and its equivalence as coming Pj represents the percentage of each land use type j in the region, N is the total number of land use/services found in the area concerned [28].

4.3 Aquatic biodiversity index

Aquatic biodiversity can be defined as the diversity of life and ecosystems that make up freshwater and the world's marine areas and their interactions. Aquatic biodiversity includes freshwater ecosystems, including lakes, ponds, reservoirs, rivers, streams, groundwater, and wetlands, and also consists of marine ecosystems including oceans, estuaries and salt marshes, Seaweed basins, coral reefs, kelp layers [29]. Encompasses all unique species, their habitats, and interactions, consisting of phytoplankton, zooplankton, aquatic plants, insects, fish, birds, and mammals. As well as aquatic biodiversity of economic and aesthetic value and is largely responsible for maintaining, and supporting general environmental health through the equation Biodiversity = N/T as N represents the total number of species in each species in the river area, therefore biodiversity represents a value (0.09) Where the closer the figure to the (1) the greater the biodiversity in the ecosystem [30].

In Punggol City - Singapore, local biodiversity in the Blue Zone has been strengthened by selecting native plants to create habitats and food sources and preserving birds and butterflies through trees and bushes produced in selected green corridors adjacent to the waterway. This matter supports the waterway as an urban environmental corridor (Land Use Plan to Support Singapore's Future Population,2013, p11).

5. METHODOLOGY

The article is based on theoretical and practical literature and many previous literature dealing with sustainability factors and their relationship to biophilic city factors. By presenting this literature, the knowledge gap was identified and the research problem was formulated with the lack of clarity of the role of indicators of the green and natural areas factor in achieving the biophilic city. The study hypothesized that these indicators have a crucial role in making a biophilic city. The research aims to define the criteria for these indicators and the methods of measuring them for application in the study area (see Figure 4).

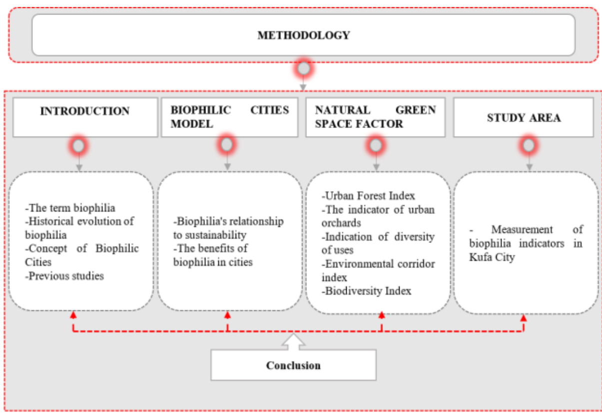

Figure 4. Research methodology

6. STUDY AREA

Kufa City is one of the oldest Islamic religious cities [31]. Al-Kufa is an Iraqi city and the administrative district centre of Najaf governorate in the central Euphrates area south of the capital Baghdad, some 156 km and 10 km northeast of Najaf with world coordinates 44° 23 '55. Latitude 55 inches and longitude 32 degrees 32 minutes 11 inches [26]. Kufa City is located within the city's administrative boundaries of 4914.04 hectares and consists of five sectors, which in turn consist of 21 residential neighbourhoods. A branch of the Euphrates River passes through the city, called the Kufa River, which creates open green spaces of palm forests, orchards and farms. (Kufa Municipality Directorate 2022) Kufa City has a high percentage of green spaces [26]. In this research, we will explore and analyze the green and blue biophilic area factor and measure its indicators in the study area by drawing on a field survey of the area and mapping it using the GIS programme. Data and maps from the Directorate of Urban Planning in Najaf and interviews with employees in the municipality of Kufa, the Najaf Census Service, the Directorate of Health and Environment in Najaf, the Directorate of Urban Planning in Najaf and the Directorate of Agriculture in Najaf are presented below. The results of the interviews resulted in obtaining statistical data for the preparation of animals and obtaining the date and age of palm trees. In addition, to obtain data on the master plan of the city and the level of per capita income.

The main reasons for choosing the city of Kufa as an area of study can be explained by:

-Natural green spaces in the city: Kufa City enjoys large natural green spaces surrounded by palm forests and natural green corridors as well as large agricultural land and orchards. The city is situated on plain land and is one of the most suitable lands for agricultural use in addition to the presence of river shoulder soil located on the banks of the Kufa River which is one of the finest arable soils.

-Blue Spaces: The Kufa River is the most important blue element in the city as it is considered a natural wealth as well as a great biodiversity and reflects life in the city as well as one of the recreational areas of the community.

-Biodiversity in the region: Kufa City has a wide range of different species in sex and species plant ", originally found naturally and represented by plants of various types, sizes, and forms. It also includes vertebrate animal organisms such as birds, fish, amphibians, and reptiles as well as aquatic and terrestrial plants and biodiversity that have an important role and function to preserve life forms in the city and thereby preserve the city's environment and economic and social status.

7. APPLICATION OF BIOPHILIA INDICATORS TO THE STUDY AREA

Green and blue spaces are a network of nature-based features located in built-up areas that form part of the urban landscape. These specifications depend either on vegetation (Green), water (blue), or both [21], where natural greenery can take the form of urban forests, urban orchards, green corridors, and the like that provide a variety of environmental services to the urban environment. Blue spaces include water bodies in all their natural forms [1]. The following will address the natural area factor and its indicators.

7.1 Natural green space factor

Urban Forest Index: The study area has a palm tree forest located on the two banks of the river in the northern part of the city of Koufa with a total area according to the basic plan of the city of Koufa of approximately 224.68 hectares Palm trees cover approximately 100 hectares of the total forest area and when the urban forest index criterion is applied to the study area, 44.5% of the forest's total forest area has been found to be tree coverage, which is high compared with 35% of the total forest area. (Researcher based on the GIS program and the Directorate of the Municipality of Kufa) This forest contains palm trees some of which are more than 50 years old and represent the history and heritage of the region. However, these trees need to be preserved from the processes of changing the Earth's sex and from the dredging of these lands for other uses. These trees are the economic, environmental, and social wealth of the city. These trees have decreased over the past 10 years with the area of tree coverage being 118.2 hectares, equivalent to 52.6% of the total forest area. In addition, the fact that this area is not eligible for use for recreation or hiking activities in terms of roads, pedestrian paths, rest, and recreation spaces as illustrated in Figures 5 and 6.

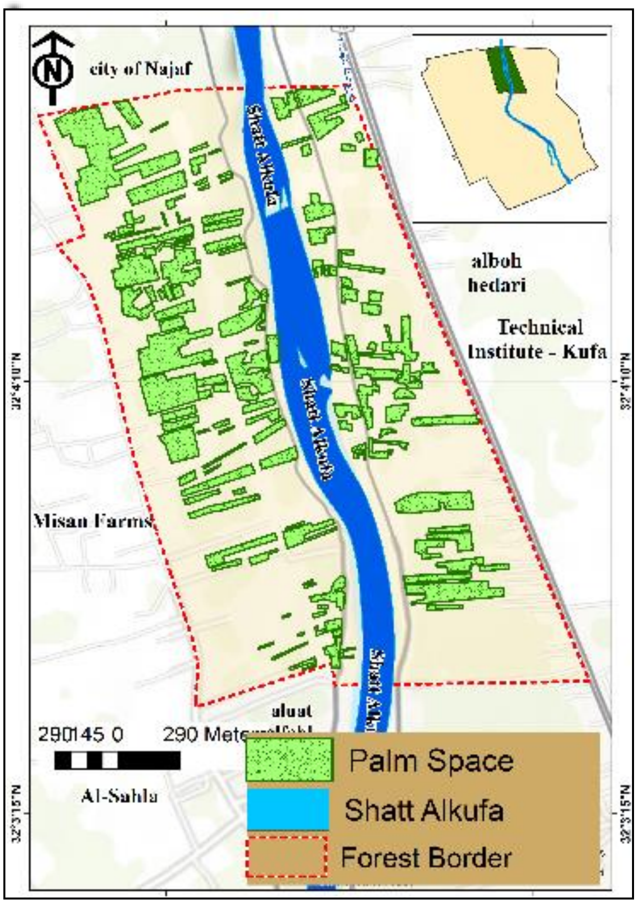

Figure 5. Palm Forest in Kufa

Forests are important natural areas in biophilic cities where they invest as basic parks and open spaces in the city that connect people to nature and make them more sense of place and drive towards the preservation and increase of nature in the city. They are considered the starting point for greater greening, conservation of biodiversity, and sustainability of the region. In the area of study, the decrease in tree coverage in the palm forest in the future leads to the city's loss of these important natural areas, as previously explained, as the tree coverage decreased from 52.6% to 44.5% in just 10 years.

Figure 6. Palm areas in the forest in 2022

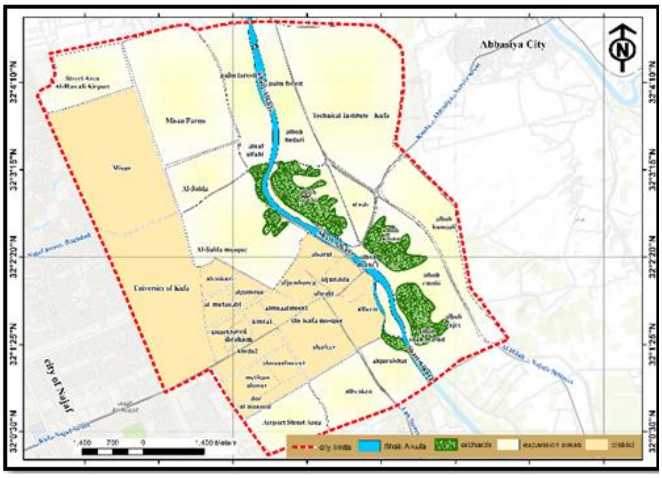

Figure 7. Urban orchards in Kufa City

Figure 8. Natural blue spaces (Kufa River)

Urban orchard index: In the study area, there are urban orchards with an area of approximately 80 hectares overlooking the Kufa River, which are orchards (functional inheritance) containers on many fruit and palm trees as well as being a suitable place for biodiversity in them. It is important to shift towards Biophilia where orchards give value to sustainable community resources, protect fruitful trees for future generations, and develop and sustain fruit trees' health and preservation. Recognition of important heritage and varieties and connecting older people to society can directly enhance environmental participation. Table 1 is a showing the criteria and measures adopted in measuring and analyzing the factor of natural green space in Kufa City (see Figure 7).

Natural blue spaces in the study area are as shredded as in the photo Kufa River, after branching south of Kafel City, penetrates the Kufa and Aboussakh districts long (75.25km), and enters the province after (10km) from the Hindi River branch point (Al-Farat Main Stream in Babylon Governorate), running 40 km In addition, the Kufa Corniche is located on one of its two banks and extends to a length of 700 m with an annual Kufa shell discharge rate of up to 700 m (118.7 m^3/tha), with the highest monthly rate in July (196.5 m^3/tha) and lower annual discharge rate in January (77.3 m^3/tha), and its annual import rate is (3.745 billion/m^3). The total area of agricultural land benefiting from the mainstream of the River of Kufa and its branches is about (150,000 dunums) (Directorate of Health and Environment in Najaf, Directorate of Water Resources in Najaf Governorate) (see Figure 8).

Blue area factor indicators can be applied to the study area as follows:

- Environmental Green Corridor Index: When measuring this indicator in the study area, it was found that the number of Green Eco Corridors geared towards the Kufa Strip is 12 green corridors. According to the observation form and fieldwork, these corridors are agricultural areas where there are no habitats. This indicator can be measured in the study area by the following:

- The display of green corridors: According to the standard, the display of green corridors ranges from (10-100m). In applying this criterion to green corridors geared towards the shatter of the cuff, 4 green corridors were found to range in width (50-60m) 4 of these corridors range in width (60-70m) and width corridor (70-80m), corridor (90-100m) and two corridors (150m), all of these corridors within the required standard (see Figure 9).

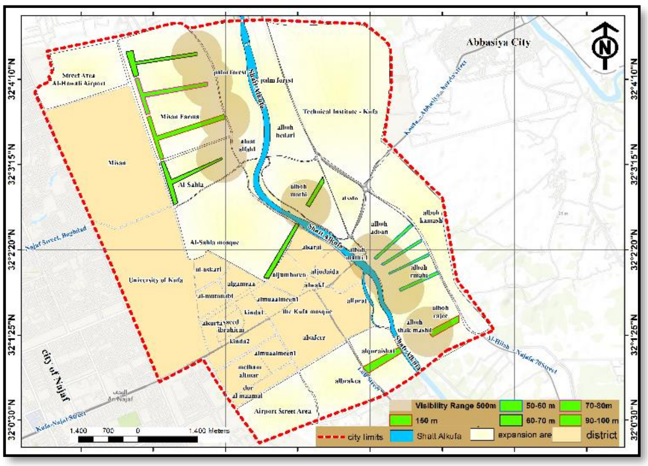

Figure 9. Green corridors in Kufa City

- Physical and visual connectivity: When applying the optical communication standard for green times geared towards the River of Kufa, which represents the range of vision below 500 m, it was found that 6 out of 12 corridors provide visual connectivity, within the range of less than 500 m and two corridors provide direct contact with the river as in the images. The rest are out of visual contact, so their delivery needs to be physically and visually with the river area, so as to maintain their connectivity with nature and make it an incubator of habitat that the river can provide an environment suitable for its existence, as some species of birds and wild animals as well as its recreational and aesthetic function in the city.

As for physical communication only the observation form and fieldwork there is no physical contact of those corridors, with the river area only the standard must be the existence of private spaces or parks linking the blue zone with the green environmental corridors directed towards it.

Green environmental corridors are important elements and environmental connectors in biophilic cities. They provide a suitable incubator for habitats that can be found in the city and thus strengthen the urban ecosystem, help monitor the city's biosystem, enhance the natural value of the place, and stimulate the increase, preservation, and interaction with the natural areas of the city through the use of these corridors for hiking and community participation in habitat.

Diversity of Uses Index: This indicator is measured in the speech of the study through the varied land uses found along the water facade river of Kufa, by applying the entropy index $ENT = -\frac{\sum_{j=1}^{n} Pj \ln{(pj)}}{\ln{(n)}}$ to measure the diversity of uses in the pony facade of the cuff shaft.

In applying the entropy equation $ENT = -\frac{-1.17}{1.7}$. The output of the entropy is 0.65. This figure represents the diversity of uses on the riverfront of Kufa River where the degree of diversity is good and there is no dominance of one use over the other in biophilic cities. The degree of diversity of uses is high on waterfronts, where they are places of high activity and continuous movement in order to invest and integrate nature with land uses on waterfronts, helping to encourage pedestrian movement, reduce cars and increase social interaction in the region (see Figure10).

Biological Diversity Index: This indicator represents the diversity of biodiversity in the Blue Zone and its surroundings. In the study area, the River of Kufa contains many terrestrial, aquatic, and amphibious organisms, which constitute the biodiversity of this area. As well as the local wealth of the city. The area contains 21 birds, 14 species of fish, and 10 species of aquatic plants, as well as the presence of amphibians and reptiles, as the river provides a suitable environment for all these species. As N represents the total number of species in each species in river area and therefore biodiversity represents a value (0.09). As the figure approaches 1, the greater the biodiversity of the ecosystem. Thus, the river area in Kufa City has a weak biodiversity and in biophilic cities, the biodiversity leads to an important indicator of biodiversity.

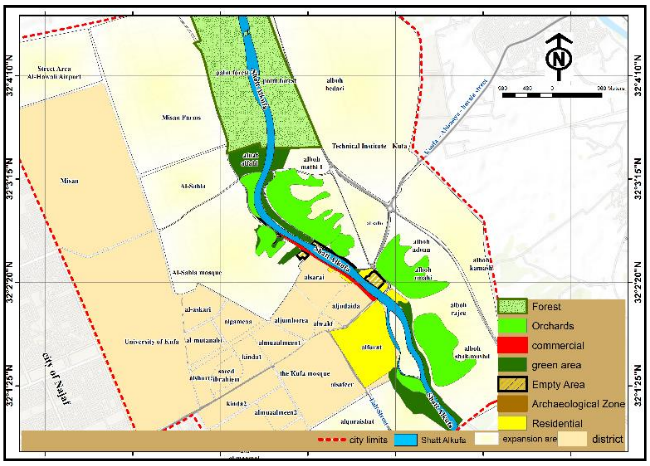

Figure 10. Diversity of Uses on waterfronts

8. CONCLUSION

The various forms of natural areas in urban areas represent the natural heritage of the city and its inhabitants, and their investment in an appropriate manner increases the sustainability of the city. The neighborhood-loving planning approach is an important approach that helps to deal with the natural areas of the city in a more sustainable and effective manner. Bio-planning integrates nature into the city by creating a green network of natural areas in the city that are interconnected through private green environmental corridors thereby ensuring natural access to all city joints. Residents can be in constant direct and indirect contact with nature. The practical results of this paper in the study area showed that the city of Koufa has abundant natural characteristics of palm forests, orchards, green corridors, and the Koufa River, which is the most important blue area. The city of Koufa achieved forest and orchard index, green corridor index, and usage diversity index.

Table 1. Showing the factor of natural green and blue spaces, their indicators, measurement methods and criteria used in measurement, with an analysis of the reality of the situation in Kufa City

Indicator	Measurement Method	Standard	Reality	Analysis
Forests	Average tree coverage	-33.4% average forest tree coverage for high to medium income areas -11.8% average forest tree coverage for low-income areas	The tree coverage ratio is 44.5% for the palm forest area	This proportion is considered high compared to the standard. However, these trees need to be preserved from the processes of changing the Earth's sex and from the dredging of these lands to other uses. These trees are an economic, environmental and social wealth of the city
Orchards	Property type	- Legacy orchards - Informal orchards - Functional orchards	Functional inherited orchards	In the study area there are urban orchards overlooking the shore of the cuff with an area of about 80 hectares, which are orchards (functional inherited) containing many fruit and palm trees as well as being a suitable place for biodiversity
Eco-corridors are in the form of gardens and street trees	Green corridor width	200m-10m	In the study area there are 12 corridors geared towards the Euphrates River	4 green corridors range in width (50-60 m) and 4 of these corridors range in width (60-70 m), width corridor (70-80 m), width corridor (90-100 m) and 2 150 m corridors all within the required standard

and are connected with each other physically and visually	Visual connection	100m-500m	There is no physical connection between the Euphrates River and the green corridors	According to the observation and fieldwork form, there is no physical connection to these corridors with the river area only. The criterion is that there must be private spaces or gardens linking the blue zone with green environmental corridors directed towards it
Integration of multiple functions	Entropy scale to measure the mix of uses and its value ranges from (0-1)	Value (1) expresses a large mix and equal distribution of land uses, which is the optimal value. When approaching zero, it means the dominance of use over other uses	The output of Alantropia 0.65 represents the diversity of uses on the riverfront of the Euphrates River	The degree of diversity of uses on the riverfront in the study area was good and there was no dominance of one use over the other
Biodiversity	Biodiversity = N/T	and therefore biodiversity represents a value (0.09) Where the closer the figure to the (1) the greater the biodiversity in the ecosystem	Biodiversity represents value (0.09)	and therefore biodiversity represents a value (0.09) Where the closer the figure to the (1) the greater the biodiversity in the ecosystem

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