Biophilic perceptions in the urban waterfront: analytical study of the Nile waterfront in Central Cairo

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ABSTRACT

With most of the world’s population living in cities and urban areas, cities are currently seeking new strategies to integrate nature into the built environment. Urban waterways, and their adjacent urban areas, have been typically the main concern of these strategies. Urban waterfronts, although often sites of heavy development, are rarely designed to reflect the innate human need for contact with nature, commonly known as ‘Biophilia’. Within this context, the main objective of this paper is to explore biophilic indicators in Central Cairo’s waterfront, under the guidelines of ‘Biophilic Urbanism’ approach, which expands the practice of biophilia on the scale of cities and urban areas. The paper follows an analytical case study approach. Methods of data collection included a literature review, on-site observations, concurrent with semi-structured interviews when possible, and an online survey. An in-depth analysis of data was then carried out to assess the degree of integration of the Nile waterfront within the urban fabric of the city to identify biophilic perceptions in the waterfront. Results demonstrate that users of the Nile waterfront are rarely allowed physical access to the water. Visual access is mostly provided, with minor exceptions. Other cross-cutting findings indicate a lack of longitudinal and lateral social connectivity to the waterfront, lack of continuous appropriate pedestrian trails, and a general lack of green spaces and public amenities.

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Introduction

As it stands, around 54% of the world population lives in cities and mega-cities within largely artificial urban environments dominated by man-made stimuli, a proportion that is expected to increase to 66% by 2050 [1]. According to the
United Nations [2], the process of urbanization is one of the most urgent challenges of the twenty-first century to the implementation of an urban development agenda that seeks to make human settlements resilient, sustainable, inclusive and safe. Consequently, cities are at the forefront of this agenda.

Interest in the role of nature in regulating the built environment of the city has had a steady history since the industrial revolution. First with the rise of the ‘sanitary city’ concept in the nineteenth century in an attempt to alleviate the horrid environmental conditions of the industrial city, and later with the emergence of Ebenezer Howard’s idea of Garden Cities and then Fredrick Law Olmsted’s arguments for the role of urban parks as lungs for the city to counter pollution [3]. According to these visions, planning a city that is in tune with its natural environment will eventually lead to a better urban environment [4].

In line with such trends, ‘Biophilic Urbanism’ is increasingly emerging as a design approach in the retrofit of buildings and urban areas alike. The approach expands the practice of ‘Biophilia’ at the urban scale through the integration of natural elements within the urban fabric of cities [5]. The approach argues for a holistic understanding of the potential benefits of integrating urban nature in the urban realm to foster human experiences of nature in urban areas that provide positive physiological and psychological benefits [6].

In cities founded on river banks or major water-ways, the most obvious places to find explicit nature are the waterfronts, it is exactly in these areas where the city, a purely human product meets the element of water, which is a purely natural element [7]. Historically, waterways played an important role in the evolution of cities and have been the hub of transportation, trade, commerce, and recreation [8,9].

Yet they have been subjected to environmental degradation, exclusive access, and urban segregation from the built environment, consequently solidifying the perception of ‘Cities vs. Nature’ and further widening the gap between people and explicit nature in their communities [5,10]. Within this context, urban waterfronts are gaining more attention and undergoing major urban transformations. However, much of these transformations often result in situating users of the waterfront as passive observers of water; with limited possibilities for active bodily engagement, when water should be the centerpiece of these transformations [11].

The Nile waterfront in Central Cairo is no exception. The Nile River in Cairo, as is the case of many urban rivers around the world, was subjected to severe environmental deterioration as its banks are a prime location for trash, litter, and debris, its lively bridges occupied by informal usages and as alternative sidewalks for pedestrians and it’s waterfront, a manifestation of exclusive access and social segregation [12–14]. Moreover, as the city’s population is underserved by public spaces, this is putting the compelling attraction of the river in a sharp focus as an underutilized natural asset and its waterfront as
a potential public open space, a much-needed space for Cairo’s residents and dwellers [13].

**Theoretical framework**

This section explores the theory of Biophilia as one of many theories that explain human–nature connections, Biophilic Urbanism as the main topic of this research and finally, biophilic perceptions in urban waterfronts as natural elements that exist in a lot of cities around the world and are often sites of heavy development, yet remain mostly underutilized.

**Biophilia**

Throughout most of human history, human cognition was shaped in close contact with the natural physical environment. This first-hand state of knowledge of the natural world helped shape cultural beliefs and perceptions of nature-based on human experiences and adaptation to the natural world [15]. Multiple research fields examined the various direct and indirect ways in which nature affects human health and well-being. Several theories have been put forth to explain the human–nature relationship [16–19].

In his seminal work titled ‘Biophilia’ [20], Wilson argued for the innate human affiliation to other forms of life and which is explained through the process of human survival and evolution [21,22]. Wilson argued that humans have a hereditary psychological affiliation to other beings that evolved to react to certain natural settings or situations as part of their evolutionary process and because these settings were essential for survival, which still applies to modern-day societies. Recent scientific research based on the ‘Biophilia’ hypothesis has found that people tend to exhibit positive feelings and emotions toward domestic animals, being near environments or settings with natural elements [6,23,24].

**Biophilic urbanism**

Biophilic urbanism expands to practice the concept of biophilia at the urban scale through the integration of natural elements throughout cities [25]. As a design principle, biophilic urbanism suggests that nature must be incorporated into the urban fabric of cities and other urban areas [26]. In this regard, the main focus of biophilic urbanism is to provide experiences of nature in urban areas that invoke positive physiological and psychological responses, which can be achieved through incorporating nature into the built environment to maximize opportunities for human exposure to nature [5,25]. Humans experience contact with nature through three strategies that involve direct, indirect contact with nature, and the experience of space and place in ways
that elicit their inherent and evolved affinities to the natural environment [20,21,25]. These experiences translate into the human cognitive process through three components (Figure 1).

The first component is ‘Sense perception’ which means the initial perception of the environment, natural or urban because the impact of the environment on the senses is caused by stimuli that either draw users to a certain place or keep them away. Thus, designing places that evoke positive emotions toward a certain place is very important. Sense perception is the result of physical senses [27–29].

Second is an experiential reception, which means the direct or indirect experience of being present in nature. This, in turn, influence human behaviors and actions toward the environment [29], which calls attention for the need to design built environments that enhance the human experience of nature as a form of raising their environmental awareness through fostering certain valuations of nature. The third component, cognitive recognition refers to mental processes to recognize and interpret surrounding environments. This analysis is affected by the influence of personal experiences, personality factors and psychological determinants and consequently influenced by personal values and meanings of places as well as the cultural and societal perception of the environments [27–29].

To sum up, human direct and indirect experience of nature is based on human recognition of surrounding environments, natural and built alike, which consequently affect the degree to which people give meanings and values to these places; therefore, there is a need to shift attention to designing the built environment that evokes positive human–nature interactions.

Figure 1. Components of Realizing Biophilia in Urban Environments. Source [29].
[25,28,29]. Needless to say, not all nature is positive or appreciated as some natural elements might be associated with negative experiences. Similarly, not all forms of urban Nature can improve human well-being (e.g. isolated non-maintained green areas, pot plants in buildings). Therefore, for the effective application of Biophilic urbanism [25], a number of principles/conditions that must be met to provide a positive experience of nature for urban residents and dwellers have been developed. These are the following:

- Focusing on evolved human adaptations to the natural world that has advanced human health and well-being over time.
- Fostering Attachments to particular ecological, geographical and cultural places and settings.
- Promote positive interactions between people and nature.
- The experience of nature should be ongoing, repeated and sustained.
- Connected and integrated architectural solutions should be considered in the process.

Materials and methods

The paper follows an analytical case study approach. For purposes of data collection, the study area for this research is the CBD in Central Cairo, selected for its significant location and distinctive character. Data were collected from various sources including selected literature work related to biophilic design, biophilic urbanism and the valuations of urban waterways as urban nature in the planning and design process, particularly recent literature work that provided results related to the topics of the study. Site visits were conducted to gather more detailed information regarding the physical and functional aspects of the study area. When possible, site visits were concurrent with semi-structured interviews and questionnaires to prompt discussion. An online survey was conducted to obtain data about social aspects in relation to users’ experiences on the waterfront within the boundaries of the study area. The paper then provides a set of biophilic indicators using biophilic parameters and indices of human well-being in urban waterfronts to guide analysis of the selected study area to identify biophilic perceptions of the Nile waterfront in the selected study area and to assess the degree of integration of the Nile waterfront within the city fabric.

Conceptual framework

From the initial review of the literature and existing Biophilic Design and Urbanism Frameworks, the research identified a broad scope model for urban waterfronts. The selection of the final study indicators was based on the feasibility of measurement, and relevance within the waterfront context. For
example, some items were excluded due to their focus on building and interior spaces scale more than city scale or because they were variations on other more suitable items within the research’s context. While other items that apply across scales were included with the description of each indicator and it’s relevance to the research’s context.

**Biophilic perceptions, attributes, and indicators in urban waterfronts**

First, it is important to emphasize that natural, open spaces close to water are among the most valued places that are often recognized as people’s person-scapes [30–32]. As species, humans are drawn to water environments much like our ancestors [33]. In discussing the relationship between urban waterfronts and human perceptions, meanings, and values of them, the most important concepts to be emphasized are the feelings people associate with these types of urban/natural spaces [34].

In urban waterfronts, many biophilic qualities can be identified. For example, the surface of the water, when calm, has an extraordinary reflective capacity, this mirror effect of water gives life to not only the buildings reflected on its surface but also to the whole space. On the other hand, the vibrancy effect of moving water gives a sense of motion, animism, and ultimately life. Other biophilic qualities include sensory stimulation of the five senses, people can directly see the water, be able to touch it, if direct physical access is allowed, hear the sounds of moving water, smell it, or just breathe in the cool air over the water surface [10,35,36] Figure 2.

River topography and river width also play a significant role in biophilic perceptions of urban waterfronts. Spatial perceptions of urban rivers depend on the scale of the river, its scale in comparison to the scale of the city itself, and the river’s width. In turn, it strongly influences the river’s social role within the city, the degree of physical and social integration, and the degree to which it influences the city form. Moreover, perceptions of ‘closeness and connectedness’ are strongly influenced by river width in relation to buildings’ height [14]. In narrow streams, the proximity of the opposite bank makes it relatively easy for people to communicate across the river. In dense urban settings, this sense of intimacy often produces vibrant public spaces on both sides of the river [14].

As the width of the river increases, typologies of social interactions between people on opposite banks also change; up to 15 m, one can still be able to recognize other people or activities on the other bank of the river. In rivers that are 50 to 200 m wide, people can still be clearly visible, but not distinguishable, the banks of the Chicago River are a good example of this case. Yet, being able to observe activities occurring on the other side still gives a sense of vibrancy to the waterfront space. At greater distances, from
about 200 m and up, such as the Thames Riverfront in London, people blur, but the motion of vehicles can still be recognizable [14]Figure 3.

In urban waterfronts, aspects of lateral, longitudinal and vertical connectivity of urban waterways in social interactions are indicators of the degree of integration of these places within the urban fabric (Figure 4). Certain urban activities may require a combination of lateral, vertical, and longitudinal connectivity [14,37]. Longitudinal connectivity refers to connectivity along the course of the river. Historically, the most important longitudinal connectivity aspect of urban rivers was their role in navigation and transportation of people and goods, which diminished with the industrial revolution. Lateral connectivity refers to direct physical and visual access between cities and watercourses, which might be hindered by highways, railroads, and bridges while vertical connectivity refers to the vertical dimension of human connectivity with rivers. Many uses occur on the top of the bank, such as contemplation, strolling, or cycling along a riverside trail, while others depend on contact with the water itself, such as swimming, diving, or kayaking, all of which presupposes good water quality [14].

Within this context, [Table 1] provides a set of biophilic attributes and indicators relative to the context of urban waterfronts and waterways, based on metrics and parameters of biophilic urbanism.

**Biophilic perceptions in the Nile waterfront in Central Cairo**

Throughout its long history, Egypt has been centered around the Nile, dependent upon the river for communication, navigation, and upon its periodic floods to bring water to its agricultural lands [39]. Cairo, the capital city, is one of the densest cities in the world with a population of over nine million [40]. Cairo has a strategic location as it is situated at the point...
where the Nile Delta fans out to the north [41], yet the city is struggling with many challenges including increasing population, persistent traffic problems, a large sector of informal housing and a general lack of open public spaces [42]. For Cairo, the Nile serves as the mainline of communication with the
Historically, the river banks were lively and most of the city’s life occurred along and around it. However, by the end of the twentieth century, the river’s waterfront was largely cut off from public access and its banks were subjected to severe environmental degradation [12].

Within this context and as mentioned previously, the purpose of the study is to assess the degree of integration of the Nile waterfront as a natural asset within the city fabric through identifying indicators of Biophilia, or human connectedness to nature, in this case, the Nile river. This is based on the

Table 1. Biophilic Attributes and Indicators in Urban Waterfronts. Source: Authors based on [29,38].

| Element | Attribute | Indicator |
|---------|-----------|-----------|
| Biophilia Ratio, Biophilic Performances and Settings | Biophilic Infrastructure and Management. | Percentage of Green spaces, with consideration to its quality, conditions, and public access to these spaces. Vegetation along riparian areas. Water quality, configurations, and water appearances. |
| | Biomorphic shapes and patterns. | Biomorphic shapes and forms inspired by nature. |
| | Natural materials and colors. Performances that celebrate nature. | Using Natural Materials and settings. Activities that celebrate proximity to water such as festivals, water-based sports, fishing. |
| Waterfront Sensory Experience | Planning and design for built environments that invoke sensory stimuli based on human evolutionary adaptations to the natural environment. | Prospect and Refuge: offering a secure and protected setting and the capacity to discern distant objects and habitats and horizons. Enticement and Mystery: Enticement fosters curiosity which reflects the human need for exploration, discovery, and creativity. Mental peace and security: personal safety within the waterfront. Thermal comfort and shelter from elements. |
| Connectivity and Accessibility | Experience of nature. Environmental, Historical, and Cultural Literacy on the waterfront. Social (Logitudinal, lateral, and vertical connectivity). | Traffic and Pedestrian volumes on waterfronts. Inclusive access to diverse user groups. Physical, visual and material access to water. |
| | Navigation and wayfinding. | Signages and wayfinding infrastructure. |
| | Accessibility. | Number of transportation modes available in the |
| Physical Character and Place Identity | Land uses and Physical Character. | The number of water-dependent and related activities compared to non-dependent water activities. |
| | Emotional, cultural, ecological and historical attachments to place. | The Number of Cultural and historical facilities on the waterfront. Unique place identity |
premise that human valuations and actions toward natural environments are highly tied and sometimes dependent on their perceptions and experiences of nature. Therefore, identifying biophilic perceptions in the Nile waterfront will help assess the degree to which people feel connected to the river and its waterfront and identify the core problems of the waterfront related to users’ experience of the waterfront to guide future development decisions of the Nile waterfront. Moreover, the main principle for the effective application of ‘Biophilic urbanism’ as a development approach is promoting positive human–nature interactions through improving users’ experience of nature. Therefore, improving the experience of users and dwellers of the waterfront will help improve their experience and ensure positive interactions between people and the river.

Central Cairo area is home to the city’s downtown, functions as the social, economic, and political heart of the city, and is home to many affluent urban areas. To assess indicators of Biophilia in the waterfront, the CBD area was selected as the study area. The study area consists of a very densely built-up area with embassies, cultural centers, government administrative buildings, and commercial high-rise buildings, 15th May Bridge forms the northern border of the study area, while Al-Gamaa Bridge forms the southern border. For purposes of data collection and analysis, the 2.7 Km study reach is further divided into three sectors with a 100 m width offset from east and west banks to include the first row of urban functions; Sector 1 extends from Al-Gamaa Bridge in the south to Qasr El-Nile Bridge in the north, Garden city area to the east, and the eastern bank of Roda Island to the west. It is the largest and longest sector within the study area. Sector 2 extends from Qasr El-Nile Bridge as the southern border to 6th October Bridge as the northern border and Sector 3 extends from 6th of October Bridge in the south to 15th of May Bridge in the north, bordering Maspero area in the east bank and Zamalek Island in the west bank.

It is noteworthy to mention that two sectors (Sectors 2 & 3) have undergone recent development as part of ‘Ahl Masr’ Promenade Project, a national project seeking to connect Egyptian cities to the river banks and provide outdoor public spaces for recreation while preserving the river and improving the city’s image [43]. Rivatization of both sectors were completed in 2016–2017 [44]. Another sector was undergoing development, at the time of conducting the field-survey, extending from 15th May Bridge in the south to Imbaba Bridge in the north Figure 5.

Results and discussion

Each indicator might include a group of sub-indicators. As the research follows a qualitative analytical approach, each sector was then evaluated using values from Low to High that represents the score of its indicator and
sub-indicator, respectively. The results are showcased in [Table 2]. Each sector might score a high value in one sub-indicator but a low value in another; hence, highlighted cells represent the relative score of each indicator. Cells highlighted in Red represent points of weaknesses while those highlighted in Blue represent strengths.

**Biophilia ratio, Biophilic performances and settings**

Generally, the area suffers from a lack of open green spaces. Green spaces within the study area are categorized under three main categories; public, semi-public, and private/prohibited green spaces. These that are allowed for public access are usually not well maintained and are not completely free, thus rendered inaccessible to some user groups. Going toward the Garden city area, a change can be noticed, with its more maintained green spaces and tree-lined upper-level pedestrian promenade. Semi-private green spaces are mainly located in front of large floating restaurants and fixed barges and are mostly not accessible. Private green spaces are mostly in the form of private nurseries in Garden City area and Roda Island. Vegetation is very limited, on both upper and ground levels of the Nile banks. On-site observations revealed that most user groups prefer sitting by the river banks rather than engaging in different activities such as walking, jogging, and in very few cases of cycling Figure 6.

**Waterfront sensory experience**

The Nile promenade is designed to have two levels; the lower levels of the Nile banks, especially in the east bank in Sectors 2 and 3, lack basic amenities with bare granite or concrete steps and designed in a monotonous repeated pattern that offers few opportunities for people to explore, no shaded areas to offer thermal comfort with exception to few wooden Gazebos on the upper levels of the Nile banks, no trees canopies insight, and with dilapidated upper terraces overlooking the river banks. Trash and litter in the river is a consistent sight along the Nile Corniche which affects users’ visual experience in the waterfront. Informal uses of river banks also represent a challenge as visitors complain about street vendors harassing them, which in turn negatively affect people’s experience of place. Another major challenge is reflected in the heavy noise levels generated by traffic volumes in the area, which also affects people’s sensory experience in the waterfront. Banks’ conditions also decrease potentials of biophilic experiences as in most areas they consist of armored or concrete steep slopes that extend to the water level which make physical public access difficult or even dangerous.

However, despite the general lack of amenities provided in the area, when asked about their reasons to come to the waterfront, participants’ answers varied from ‘Contemplating’, ‘taking a break from their daily routine’ to
Figure 5. Satellite Image of (Highlighted) Study Area in Central Cairo and major iconic landmarks within its boundaries. From Top left; A) Cairo Tower, B) Egyptian opera House, C) Sofitel El-Jazeera Hotel. From Top Right; D) Maspero Building, E) The Egyptian Museum, F) Ramses Hilton Hotel, G) Intercontinental Semiramis Hotel. Source: Authors based on Google Earth.
preferring to be close to the water as much as they can’. One interesting response from a participant when asked about why they like to come to the waterfront, was ‘I can trust the water to keep my secrets more than anyone else’. Moreover, many participants expressed satisfaction over safety measures in recent developments in relation to adequate sufficient lighting.

Table 2. Biophilic Urbanism Indicators in the study area in Central Cairo and its Three sectors. Source: Authors.

| Biophilic Urbanism Indicators | Sector 1 | Sector 2 | Sector 3 | Aggregation |
|------------------------------|----------|----------|----------|-------------|
| Percentage of Green spaces   | High     | Moderate | Low      |             |
| Riparian vegetation          |          |          |          |             |
| Water quality and appearance |          |          |          |             |
| Biomorphic shapes and forms  |          |          |          |             |
| Natural Materials and settings |        |          |          |             |
| Activities that celebrate proximity to water | | | |   |
| Prospect and Refuge          |          |          |          |             |
| Enticement and Mystery       |          |          |          |             |
| Mental peace, security, and safety | | | | |
| Thermal comfort              |          |          |          |             |
| Traffic and Pedestrian volumes |      |          |          |             |
| Signages and wayfinding infrastructure | | | | |
| Number of transportation modes |        |          |          |             |
| Access to diverse user groups |        |          |          |             |
| Physical and visual access   |          |          |          |             |
| Number of water-dependent, and related activities | | | | |
| Number of cultural and Historical Facilities | | | | |
| Unique place identity        |          |          |          |             |
However, some user groups were observed disregarding safety measures in favor of seeking contact with the water. 

**Connectivity and accessibility**

In terms of connectivity and accessibility, there is a lack of lateral connectivity with surrounding communities because the river banks are occupied by uses that preclude public access such as many of the embassies in Garden City, police clubs, and private installations that decrease the potentials of the utilization of river banks for leisure or recreation, and due to the fact that nearby neighborhoods are mostly cut off from the river by busy roads, bridges and other physical barriers. Moreover, longitudinal connectivity almost does not exist because there is a lack of continuous pedestrian trails on both upper and lower levels of the banks, this is partially due to bridge structures that intercept pedestrian routes along the Corniche, an issue that persisted since before the recent development of Sectors 2 and 3. However, these same bridges offer panoramic views of the river, which is highly utilized by different user groups specifically for this purpose.
It is evident that the area is highly diverse in terms of land uses. For example, Sector 1, with Garden City area in the east, the southern part of Zamalek

**Figure 7.** Pictures showing current conditions of the river promenade/banks in the study area. A) Dilapidated upper-level terraces overlooking lower levels of the promenade in Sector 2, B) Rubbish and debris in the water along the lower level of the promenade in Sector 3, C) Seating areas lined in a very repetitive pattern along the promenade in Sectors 2&3, D), E) Barren landscape and seating areas with very limited shading trees and vegetation, F) Illegal/Informal Seating areas lined down the steep armored slope of river banks to provide direct physical and visual access to the river with. Source: Authors.
island and the northern tip of Roda Island to the west is mostly dominated by hotels, embassies, and upper-class residential buildings in Garden City. The northern part of Roda island houses the Grand Hyatt Hotel and the teaching hospital of Cairo University, while the west bank of the island is dominated by private residences or areas of restricted access. Sector 2 mainly contains governmental, commercial, cultural and tourists areas and is home to Tahrir, Abdel-Moneim Riad squares and the Egyptian Museum in the east and Cairo Tower and the Egyptian Opera House in the west situated on Zamalek island, while Sector 3 is dominated by open spaces and private, recreational club facilities.

The area houses a number of historical buildings and iconic landmarks such as Cairo Tower, Mogamaa Al-Tahrir, the Egyptian Museum, Egyptian Television and Radio Building (Maspero), Egyptian Opera House, and many Hotels. These landmarks provide a significant opportunity to connect urban revitalization and economic development as well as the opportunity to act as orientation points that people associate with the waterfront in Central Cairo. However, with many of these buildings being Hotels and entertainment facilities, they are places that are inaccessible to the majority of people, which might act as a disadvantage. Moreover, most of these High-rise Hotels and administration buildings hinder visual access to the river Figure 8.

**Conclusion and recommendations**

As the study sought to identify biophilic indicators in the Nile waterfront in Central Cairo, the most significant finding from the analysis of the selected case study area is that despite the lack of public amenities, public open spaces and limited activities, the Nile waterfront is already a popular place of recreation and leisure for Cairenes. Moreover, based on on-site observations and land use analysis of the study area, it is evident that economic factors remain as the main drivers for development decisions along the waterfront. Moreover, exclusive access to certain user groups is a persistent issue within the study area manifested in the number of restricted areas in front of fixed barges and floating restaurants.

There are overwhelming opportunities for the waterfront to be fully realized if looked at beyond being an economic engine or a mere scenic view. Most development projects along the Nile focused mainly on the beautification of the riverbanks, with little attention given to the river’s ecology, public preference for certain design interventions and human–nature interactions, which represent the main dimensions of biophilic urbanism as a development approach. Most participants in the research expressed concern over deterioration in the esthetics of the river banks where litter and debris are first noticed
when people are close to the water edge. On-site observations and interviews revealed that most users flock to the Nile waterfront to find refuge from their daily life, contemplate, or just enjoy a breath of air on the Nile and observe the movement of its water. This indicates an already emotional connection to the Nile, which presents a great opportunity if the river waterfront to be fully utilized as a natural-cultural asset.

Within this context, the main identified core problems within the selected study area are as follows:

- Poor environmental conditions of the river reflected in trash and debris along with the water level and limited riparian vegetation along the river banks.

Figure 8. Top: View from Cairo Tower looking downstream toward the northern part of Zamalek Island. Bottom: View from Cairo Tower looking upstream toward Garden City and Roda Island. Source: Authors.
Lack of connected and well-maintained open green spaces and lack of public amenities.

High traffic volumes which increase noise levels generated within the area, increase air-particulate matter levels and air temperatures.

Limited activities provided for the public that offers proximity to water.

Exclusive and restricted access in most areas of the Nile waterfront, specifically in the west bank in Zamalek and Roda Islands because of floating restaurants, fixed barges and structures that hinder public access.

Lack of lateral connectivity along the river banks because most surrounding neighborhoods are cut off from the waterfront by high-rise commercial, administrative buildings and heavy traffic roads.

Lack of longitudinal connectivity along the river banks and lack of continuous pedestrian trail because of physical barriers such as highways and bridge structures.

As shown in the study, biophilic perceptions of urban waterfronts are highly dependent on users’ experience of the waterfront and the user’s individual and collective values and meanings of such spaces as natural areas. Therefore, the design and development of urban waterfronts, as places of sensitive ecological nature, should reflect the human need for contact with nature to help foster positive human–nature interactions and ultimately raise environmental awareness and promote environmental stewardship. Therefore, to tackle the key issues outlined above, the research suggests a number of recommendations as follows:

1. Create a continuous trail of riparian vegetation along the river banks and remove concrete edges. Private nurseries along the river banks could be utilized for this purpose by being relocated to a higher level, or allocated smaller plot areas to allow a continuous pedestrian promenade along the river banks.

2. Activate enacted laws and regulations to protect the river and its tributaries from pollution and to preserve its ecological nature and restore natural habitat.

3. Establish a connected network of open green spaces along the river with consideration of its quality, maintenance and public access.

4. Decrease traffic access to the waterfront.

5. Increase the number of ferry stops and water taxi stations by placing them at strategic locations.

6. Support activities that celebrate proximity to water such as national festivals, shows, art performances, and provide efficient public amenities to support intense use of the river banks.

7. Relocate water-independent/non-related uses such as police and administrative structures and limit private ownership of the river banks.
(8) Create a continuous pedestrian promenade along the Nile Corniche, preferably on the lower level of the river banks.

Finally, the development of the evaluation criterion for Biophilic indicators in urban waterfronts was based on global practices. Therefore, adapting it to local contexts requires more investigation into the role of cultural perceptions of the Nile and its waterfront as a natural resource and asset as it is crucial for any future development of the Nile waterfront.

**Disclosure statement**

The authors declare that there is no conflict of interest.

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**References**

1. United Nations. (2017). *The world population Prospects: the 2017 revision.*
2. United Nations. (2015). *Transforming our world: the 2030 agenda for sustainable development.*
3. Kaika M. *City of flows: modernity, nature and the City.* London & New York: Routledge; 2005. [https://doi.org/10.4324/9780203826928](https://doi.org/10.4324/9780203826928)
4. Ebrahimpour M, Majedi H, Zabihi H. “Biophilic” planning, a new approach in achieving liveable cities in Iranian new towns – hashtagged case study. Stads-En Streeksbeplanning = Town Reg Plann. 2017;70:1–13.
5. Beatley T. *Biophilic Cities: integrating nature into urban design and planning.* Washington, D.C: Island Press; 2011.
6. Reeve A (2014). *Mainstreaming biophilic urbanism in Australian cities: A response to climate change, resource shortages and population pressures* [A Doctoral Dissertation]. Queensland University of Technology.
7. Samant S, Brears R. Urban waterfront revivals of the future. In: Jim C, Tan P-Y, editors. Greening Cities: advances in 21st Century human settlements. Singapore: Springer; 2017. p. 331–356.
8. Hae M, Jackson-smith D, Buchert M, et al. Accessing blue spaces: social and geographic factors structuring familiarity with, use of, and appreciation of urban waterways. Landscape Urban Plann. 2017;167:136–146.
9. Mačiukėnaitė J, Povilaitienė I. The role of the River in the City Centre and its identity. J Sustainable Archit Civil Eng. 2013;4(5):33–41. [https://doi.org/10.5755/j01.sace.4.5.4820](https://doi.org/10.5755/j01.sace.4.5.4820)
10. Timur UP. Urban waterfront regenerations. In: Ozyavuz M, editor. Advances in landscape architecture. Cankiri, Turkey: IntechOpen; 2013. p. 169–206. [https://doi.org/10.5772/55759](https://doi.org/10.5772/55759)
11. Mikkelsen JB, Stevens Q, Hills C, et al. Exploring how urban waterways can encourage visitors’ active engagement with water through a temporary design
installation. Archnet-IJAR. 2018;12(1):91–111. https://doi.org/10.26687/archnet-ijar.v12i1.1444.

12. Gabr HS. Perception of urban waterfront aesthetics along the Nile in Cairo, Egypt. Coastal Manage. 2004;32(2):155–171. https://doi.org/10.1080/08920490276191-1452.

13. Kondolf GM, Gohar A, Marizon R, et al. Connecting Cairo to the Nile: renewing life and heritage on the River. University of California, Berkeley; 2011. (WP-2011-06).

14. Kondolf GM, Pinto PJ. The social connectivity of urban rivers. Geomorphology. 2016;277:182–196. https://doi.org/10.1016/j.geomorph.2016.09.028.

15. Hartig T, Van-den-Berg AE, Hagerhall CM, et al. Health benefits and nature experiences: psychological, social and cultural processes. In: K. Nilsson, M. Sangster, C. Gallis, T. Hartig, S. Vries, K. Seeland, & J. Schipperijn, editors. Forests, trees and human health. Dordrecht: Springer; 2011. p. 127–168.

16. Hough RL. Biodiversity and human health: evidence for causality? Biodiversity Conser. 2014;23(2):267–288. https://doi.org/10.1007/s10531-013-0614-1.

17. Keniger LE, Gaston KJ, Irvine KN, et al. What are the benefits of Interacting with Nature? Int J Environ Res Public Health. 2013;10(3):913–935. https://doi.org/10.3390/ijerph10030913.

18. Sandifer PA, Sutton-grier AE, Ward BP. Exploring connections among nature, biodiversity, ecosystem services, and human health and well-being: opportunities to enhance health and biodiversity conservation $$. Ecosyst Serv. 2015;12:1–15. https://doi.org/10.1016/j.ecoser.2014.12.007.

19. Turner WR, Nakamura T, Dinetti M. Global urbanization and the separation of humans from nature. BioScience. 2004;54(6):585–590.

20. Wilson EO. Biophilia. Cambridge, Massachusetts: Harvard University Press; 1984.

21. Heerwagen J, Kellert S, Mador ML. Biophilic design: the theory, science, and practice of bringing buildings to life. New Jersey: John Wiley & Sons; 2008.

22. Kellert S, Wilson EO Biophilia and the conservation ethic. In: S. Kellert & E. O. Wilson, editors, The Biophilia hypothesis. Washington, D.C: Shearwater Books; 1993. p. 31–40. https://doi.org/10.15713/ins.mmj.3.

23. Dustin DL, Bricker KS, Schwab KA. People and nature: toward an ecological model of health promotion. Leisure Sci. 2009;32(1):3–14. https://doi.org/10.1080/01490400903430772.

24. Gullone E. The Biophilia hypothesis and life in the 21st Century: increasing mental health or increasing pathology? J Happiness Stud. 2000;1(3):293–322. http://link.springer.com/10.1023/A:1010043827986.

25. Kellert S. Biophilic urbanism: the potential to transform. Smart Sustainable Built Environ. 2016;5(1):4–8. https://doi.org/10.1108/SASBE-10-2015-0035.

26. Littke H. Becoming biophilic: challenges and opportunities for biophilic urbanism in urban planning policy. Smart Sustainable Built Environ. 2016;5(1):15–24. https://doi.org/10.1108/SASBE-10-2015-0036.

27. Berto R, Barbiero G, Barbiero P, et al. An individual’s connection to nature can affect perceived restorative nature of natural environments. some observations about biophilia. Behav Sci. 2018;8:3. https://doi.org/10.3390/b8030034.

28. Chen Y (2017). The impact of biophilic design on health and wellbeing of residents through raising environmental awareness and nature connectedness. University of Georgia.

29. Tokhmechchian A, Gharehbaglou M. Biophilic perception in urban green spaces (Case study: el Gölp Park, Tabriz) Biophilic perception in urban green spaces
(Case study: el. Int J Urban Sci. 2019; 1–18. https://doi.org/10.1080/12265934.2019.1568284
30. Lasiewicz S. Urban waterfronts’ wilderness as a space of engagement. Tech Trans. 2019;2(2):41–56. https://doi.org/10.4467/2353737xct.19.020.10156
31. Pitt H. Muddying the waters: what urban waterways reveal about bluespaces and wellbeing. Geoforum. 2018;92:161–170. [November2017]. https://doi.org/10.1016/j.geoforum.2018.04.014
32. White M, Smith A, Humphryes K, et al. Blue space: the importance of water for preference, affect, and restorativeness ratings of natural and built scenes. J Environ Psychol. 2010;30(4):482–493. https://doi.org/10.1016/j.jenvp.2010.04.004
33. Beatley T. Blue Biophilic Cities- nature and resilience along the urban coast. Acuto M, Rapoport E, Setzer J, editors. London, UK: Springer Nature: 2018.
34. Faggi A, Breuste J, Madanes N, et al. Water as an appreciated feature in the landscape: A comparison of residents’ and visitors’ preferences in buenos aires. J Clean Prod. 2013;60:182–187. https://doi.org/10.1016/j.jclepro.2011.09.009.
35. Völker S, Kistemann T. The impact of blue space on human health and well-being - Salutogenetic health effects of inland surface waters: A review. Int J Hyg Environ Health. 2011;214(6):449–460. https://doi.org/10.1016/j.ijheh.2011.05.001.
36. Völker S, Kistemann T. “I’m always entirely happy when I’m here!” Urban blue enhancing human health and well-being in Cologne and Düsseldorf, Germany. Soc Sci Med. 2013;78(1):113–124. https://doi.org/10.1016/j.soscimed.2012.09.047.
37. May R. “Connectivity” in urban rivers: conflict and convergence between ecology and design. Technol Soc. 2006;28(4):477–488. https://doi.org/10.1016/j.techsoc.2006.09.004.
38. Xue F, Gou Z, Lau SS, et al. From biophilic design to biophilic urbanism: stakeholders’ perspectives. Cleaner Prod. 2019;211:1444–1452.
39. Wohl E. A world of rivers: environmental change on ten of the world’s great rivers. Chicago, US: The University of Chicago Press; 2011.
40. CAPMAS. Population numbers. 2020 [cited 2020 Aug 04]. https://www.capmas.gov.eg/Pages/populationClock.aspx
41. Sims D. Understanding Cairo: the Logic of A City out of Control. Cairo, Egypt: The American University in Cairo Press; 2012.
42. Kondolf GM, Gohar A, Mozingo L, et al. Connecting Cairo to the Nile: opportunities for public access and alternative transportation. Nadim W, editor. German University in Cairo. Democratic transition and sustainable communities- overcoming challenges innovative practical solutions. Shaker Verlag;2013. p. 320–329.
43. Abd-al-Aziz NA. Nile River: A Fitness Trail Promoting Physical Activity In Cairo City. Int J Eng Res Dev. 2017;13(5):59–69.
44. Aly DG. Multifunctional landscape design: an analytical framework for urban waterfronts in Cairo. Aachen, Germany: Ain Shams University; 2017.