

Sustainable Urban Waterfronts Using Sustainability Assessment Rating System

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Abstract—Sustainable urban waterfront development is one of the most interesting phenomena of urban renewal in the last decades. However, there are still many cities whose visual image is compromised due to the lack of a sustainable urban waterfront development, which consequently affects the place of those cities globally. This paper aims to reimagine the role of waterfront areas in city design, with a particular focus on Egypt, so that they provide attractive, sustainable urban environments while promoting the continued aesthetic development of the city overall. This aim will be achieved by determining the main principles of a sustainable urban waterfront and its applications. This paper concentrates on sustainability assessment rating systems. A number of international case-studies, wherein a city has applied the basic principles for a sustainable urban waterfront and have made use of sustainability assessment rating systems, have been selected as examples which can be applied to the urban waterfronts in Egypt. This paper establishes the importance of developing the design of urban environments in Egypt, as well as identifying the methods of sustainability application for urban waterfronts.

Keywords—Sustainable Urban Waterfront, Green Infrastructure, Energy Efficient, Cairo.

I. INTRODUCTION

SUSTAINABILITY is imperative for cities in the 21st century, and sustainable cities can be distinguished by their strategies for sustainable waterfronts. Each city is experimenting with new ways to tackle a particular challenge in sustainable waterfront development. Most of the waterfronts in Egypt lack the criteria necessary to meet sustainability goals which adversely affect the aesthetic value of the constructed environment, and thus degrade the appearance of most Egyptian cities. Therefore this paper aims to find sustainable solutions to urban waterfront challenges by applying the requirements of sustainability assessment rating systems to the development process of urban waterfronts

II. RESEARCH PROBLEM

Urban waterfronts throughout the world are in deteriorated condition due to a variety of environmental, social and economic factors. This is especially true of Egypt, where most of the urban waterfronts lack the necessary criteria for a sustainable environment which negatively impacts the achievement an overall sustainable urban design. The functional and aesthetic aspects of the constructed environment are also negatively impacted which leads to the deterioration of

the visual image of most Egyptian cities. Given those issues, this paper addresses the following questions:

- What is the definition of sustainable waterfront?
- What are the principles of a sustainable waterfront?
- What are the applications of a sustainable waterfront in sustainable cities?
- How can the waterfront contribute to the sustainable development of the city overall?
- What further improvements can be recommended for the waterfront in Cairo?

III. RESEARCH OBJECTIVES

This paper aims to create a new sustainability framework that will assist cities in creating guidelines for developing sustainable waterfronts. This aim will be achieved through the following combination of sub-objectives:

- Ensuring that sustainability principles are integrated into all operations of urban waterfront development.
- Putting Egypt at the forefront of global cities in the 21st century as an exemplar of waterfront development by transforming the waterfront into sustainable communities.
- Improve the visual image of cities by emphasizing the importance of creating a sustainable waterfront and providing an attractive urban environment.
- Improve waterfront communities and public spaces that offer a high quality of life for residents and visitors alike.
- Identify the main principles that define a sustainable waterfront.
- Formulate a set of recommendations for developing one of the waterfront areas along the main edges of the River Nile in Egypt to fit the criteria for sustainable urban development

IV. RESEARCH METHODOLOGY

The research methodology for this paper is based on three approaches: theoretical, analytical and applied study. The theoretical study identifies the concept of sustainable waterfront, its principles and its applications. It also provides an overview of sustainability assessment rating systems. This is followed by an analytical study of some international examples of cities that applied the sustainability assessment rating system to waterfront improvement. Next, an applied study of one of the waterfronts along the main edges of the River Nile in Egypt is put forth for consideration. The paper then concludes with the most important recommendations for the development of urban waterfronts in this area.

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V. THE SUSTAINABLE WATERFRONT

A waterfront can be defined as a part of a town that is next to an area of water such as a river or the sea" [1], "and it is the natural gem of the city, and offers great potential and opportunity for the future growth of the community" [2]. "Sustainable waterfront development is a process of urban transformation resulting from the present trends and thinking in planning – exploitation of waterfronts and sustainable policies" [1]. "A good waterfront development is that considers diversity, community engagement, safety and security, environment and sustainability. Waterfront development can be a popular destination due to variety of economic, social, and environmental attraction. Awareness of the natural environment and preservation of ecosystem and resources has increased the public demand for sustainability. Outdoor recreation is becoming popular among people and waterfront parks are one of the favorite locations for such activities." [3]

"The popular sign of success of many waterfronts development is bringing citizens and visitors back to the water's edge, and providing tangible evidence of the continuing vitality of the cities" [4]. "And it helped create better places for present and future residents" [5]. So the sustainable design of the waterfront is one of the determining factors in the success of the city. "Sustainable waterfront is a place where people from all backgrounds and ages can live, work, play, visit, and learn in a way that strengthens and celebrates the beauty, the diversity, the economic vitality, the opportunities, the creativity, the heritage, and the natural environment of the city" [6].

VI. OBJECTIVES OF SUSTAINABLE WATERFRONT

Sustainable waterfronts are becoming one of the most celebrated aspects of urban design in sustainable cities. A sustainable waterfront aims to:

1. Promote high quality urban design standards.
2. Rehabilitate and re-use of cultural heritage.
3. Regenerate all environmentally degraded areas overlooking the waterfront.
4. "[Identify] areas of public interest on the waterfront (i.e. parks, open spaces, plazas, public access and view corridors) to sustain social well-being" [2].
5. "Create opportunities for revitalization" [2] by improving the visual image of any city.
6. Reduce energy use.
7. Improve air quality and reduces urban heat island effect.
8. Improve community livability.
9. "Reduce consumption of material resources to sustain economic vitality." [8]

VII. SUSTAINABILITY ASSESSMENT RATING SYSTEMS

"Assessment rating systems are important approaches which became popular worldwide and even obligatory in some places to classify who fulfills the requirements of sustainability and who exceeds it. Examples of these rating systems are the LEED (American system), BREEAM (European system), CASBEE (Japanese system), Green Star (Australian system), Pearl (UAE

system)." [7] In addition to those listed above there is also the Green Pyramid Rating System (GPRS) (Egyptian system).

"The Green Pyramid Rating System in Egypt is a national environmental rating system for buildings. It provides definitive criteria by which the environmental credentials of buildings can be evaluated, and the buildings themselves can be rated. Additionally, the System should assist building designers, constructors and developers to make reasoned choices based upon the environmental impact of their decisions." [9]

GPRS in Egypt is used only for buildings contrary to all of the other assessment rating systems which are used for urban environments as well as buildings. So for the purposes of this study, LEED was selected, as it is the most commonly known rating system, as well as the Pearl system, since it is a rating system used in the Middle East (United Arab Emirates) and is therefore more applicable in the Egyptian context (Table I).

A. LEED Indicators

"LEED stands for Leadership in Energy and Environmental Design which is a green building rating system originally developed in 1998 by the U.S. Green Building Council (USGBC) to provide a recognized standard for the construction industry to assess the environmental sustainability of building designs. LEED for neighborhood development was later developed in 2007 and updated in 2009" [7] (Table I).

B. Pearl Indicators

"The Pearl Rating System for sustainability is the first government initiative released in the Middle East region, by sustainability program of the Abu Dhabi Urban Planning Council in 2010. It aims to create more sustainable communities, cities and global enterprises and to balance the four pillars of sustainability: environmental, economic, cultural and social. And it evaluates the sustainability of all buildings and communities in Abu Dhabi Emirate and awards distinctive projects committed to the principles of sustainability" [10] (Table I).

VIII. SUSTAINABLE WATERFRONT APPLICATIONS

A. Green Infrastructure

"Green Infrastructure is a planned and managed network of natural environmental components." [11] "The main objective of green infrastructure is to establish a healthy green edge to waterfront or riverside area by increasing waterfront access and diversifying transport options, combined with developing a sustainable stormwater management initiative. The integration of soft infrastructure such as shrubbery and trees along the greenway creates a pedestrian-friendly path and an attractive public space whilst also reduce the risk of storm overflow, regulating city temperatures and cleaning the air" [3]. Green infrastructure can play a vital role in achieving sustainability in the following ways:

TABLE I
SUSTAINABILITY ASSESSMENT RATING SYSTEMS, THE (LEED & PEARL) [7], [10]

Category	LEED Indicator		PEARL Indicator	
Community layout	Smart Location & Linkage	- Smart Location - Proximity to water & waste water infrastructure - Brownfields Redevelopment - Open community - Diversity of Uses - Access to Public Spaces - Access to Active Spaces - Universal Accessibility - Community outreach and Involvement	Livable communities & Integrated Development	- Integrated Development Strategy - Sustainable Building Guidelines - Outdoor Thermal Comfort Strategy - Neighborhood Connectivity - Open Space Network - Accessible Community Facilities - Community walkability - Active Urban Environments - Safe and Secure Community - Regionally Responsive Planning
Buildings	Green Construction & Technology	LEED Certified Green Buildings - Energy Efficiency in Buildings - Reduced Water Use - Building Reuse and Adaptive Reuse - Reuse of Historic Buildings	Livable communities	- Minimum Pearl Rated Buildings Within Communities - Housing Diversity
Transportation	Neighborhood pattern & Design	- Reduced Automobile Dependence - Walkable streets - Street Network - Transit facilities - Transportation demand management	Livable communities	- Transit Supportive Practices
Environmental Issues	Ecology	Green Construction & Technology	Natural Systems	- Natural Systems Assessment - Natural Systems Protection - Natural Systems Design & Management Strategy - Reuse of Land - Remediation of Contaminated Land - Ecological Enhancement - Improved Outdoor Thermal Comfort - Construction Environmental Management
	Water	Green Construction & Technology	Precious Water	- Community Water Strategy - Water Monitoring and Leak Detection - Community Water Use Reduction: (Landscaping - Heat Rejection - Water Features) - Storm water Management - Water Efficient Buildings
	Energy	Green Construction & Technology	Resourceful Energy	- On-Site Energy Generation - On-Site Renewable Energy Sources - District Heating & Cooling - Infrastructure Energy Efficiency - Community Energy Strategy - Building Energy Guidelines - Community Strategies for Passive Cooling - Urban Heat Reduction - Efficient Infrastructure: Lighting - Efficient Infrastructure: District Cooling - Efficient Infrastructure: -Smart Grid Technology - Renewable Energy: Onsite - Renewable Energy: Offsite - Energy Efficient Buildings
	Waste	Green Construction & Technology	Stewarding Materials	- Basic Construction Waste Management - Basic Operational Waste Management - Improved Construction Waste Management - Organic Waste Management 2
	Materials	Green Construction & Technology	Stewarding Materials	Modular Pavement & Hardscape Cover - Regional Materials - Recycled Materials - Reused or Certified Timber
	Innovation	Innovation	Innovating Practice	- Showcase of Regional & Cultural Practices - Innovating Practice - Sustainability Awareness

1. Reduction of Energy Use:

- When properly placed, trees provide shade, which can help cool the air and reduce the amount of heat reaching and being absorbed by buildings. In warm weather, this can reduce the energy needed to cool buildings.
- Trees also reduce wind speeds which, especially in areas with cold winters, can have a significant effect on the energy needed for heating.
- Trees release water into the atmosphere, resulting in cooler air temperatures and reduced building energy consumption.

2. Improves Air Quality and Reduces Urban Heat Island Effect:

- Trees absorb air pollutants.
- Trees reduce energy consumption, which improves air quality and reduces the amount of greenhouse gases including N₂O.
- The various cooling functions of trees help to reduce the urban heat island effect.

3. Improves Community Livability:

- Trees provide beauty and privacy, which improves the aesthetic appeal of a community.

- Planting trees increases recreational opportunities for communities by improving pathways, creating places to gather and providing shade during warm weather.
- Trees provide a sense of place and promote feelings of well-being, which can strengthen community cohesion.
- "Trees help to reduce sound transmission, reducing local noise pollution levels" [3].

B. Planning for Community Involvement

"Successful waterfront development happens when the community realizes that the waterfront belongs to them. It happens when they recognize the significance and potential of their waterfront. Community participation can take many forms; generate a community consensus about the vision for the future of the waterfront and develop a strategy to address the community's most critical waterfront issues" [12]. "Waterfront provides an opportunity to develop community awareness and understanding around the importance of sustainable water resource management." [3] As indicated by the LEED and Pearl systems there are many applications of the sustainable waterfront, such as;

1. Sustainable Green Areas and Public Spaces

"Urban landscape design can increase the amount of public recreational space, sustainable green areas and public spaces, by;

- Creating high quality public spaces, with both practical and symbolic value, in terms of integrating waterfront into the wider urban fabric" [13].
- "Making the Waterfront a place of learning" [14].
- Enabling better use of parkland, with green wall fencing interspersed with signage, and water fountain channeling water to planting (Fig. 1).
- Enhancing public use of the parkland by increasing recreation opportunities.
- "The waterfront culture and heritage infrastructure plan identifies the waterfront as a cultural opportunity; this classification is based on the waterfront's unique sense of place and embedded history as part of urban waterfront" [14].

2. Sustainable Buildings

"Sustainable building systems are ones that meet sustainability objectives for reducing use of natural resources during construction and during operation" [6].

- Design buildings with high levels of energy efficiency.
- "Preservation of different aspects of heritage can contribute to the success of sustainable strategies: linking new and old structures in an urban design framework, providing an exciting basis for citizen participation, fostering the waterfront as a cultural heritage destination.
- "Architectural competitions for new buildings of international stature can help to ensure that new build equals the quality, character and identity of the architectural heritage" [13].

3. Sustainable Transport

"Sustainable transport modes, such as walking, cycling and public transport" [12] "include providing publicly accessible water's edge throughout the entirety of the waterfront." [13]

"Achieving sustainable transport requires create an expert panel on transport to ensure a reduction in negative impacts such as CO2 emissions, air pollution and noise, redesign the street to become more pedestrian and bicyclist friendly, and improve pedestrian, cycling and transit infrastructure" [12].

4. Environmental Issues

Environmental issues include (water, energy, materials, waste, and ecology). To create a sustainable waterfront the city should "plant trees to provide more tree cover and meet city tree canopy policy objectives, reuse runoff for irrigation, improve the current stormwater management facilities and where possible, promote the implementation of green design practices" [13], and "reduce the use of nonrenewal natural resources" [6].



Fig. 1 Green wall fencing interspersed with signage, Tokyo and water fountain channeling water to planting, WXY [15].

IX.CASE STUDIES OF SUSTAINABLE URBAN WATERFRONT

Each city in the following case studies has experimented with new ways of tackling a particular challenge of waterfront development. This section will focus on two cities, Toronto and Sherman Creek, which have applied sustainability criteria to waterfront areas.

A. Toronto Waterfront Revitalization Corporation

Toronto was selected as a case study given its application of waterfront sustainability indicators, which complied with the LEED rating system in all categories.

"The Toronto waterfront revitalization corporation is committed to making the city's waterfront both a national and global model for sustainability, this sustainability framework aims to ensure that sustainability principles are integrated into all facets of waterfront" [6].

"The sustainability benefits afforded by waterfront revitalization are numerous and include:

- Remediating Brownfield and developing new communities in the city.
- Reducing air pollution associated with commuting.
- Reusing or improving existing infrastructure.
- Requiring the development of high efficiency, green buildings.

- Making public transit, cycling and walking the primary modes of transportation.
- Increasing opportunities for economic development.
- Increasing the amount of parks and other public spaces.
- Engaging the community as an active partner in revitalization.
- Improving access to the waterfront.
- Increasing cultural vibrancy and beautiful public spaces” [14].

1. Energy:

“The goal was to significantly reduce levels of per capita energy consumption coupled with a greater use of low-impact renewable energy to meet energy demands, and increase the percentage of energy consumption from renewable sources. Renewable sources of energy include offshore wind, solar photo voltaic, small-scale building-size wind turbines, small hydro, biomass, landfill gas, wave/tidal power and geothermal. To achieve energy conservation goals, energy efficiency measures must be taken into account from the very beginning of infrastructure and building design (Fig. 2). In the Toronto waterfront revitalization project, buildings were designed with high levels of energy efficiency (in accordance with LEED Gold and Platinum standards).

Sustainable land use optimizes street layout and building placement to ensure energy savings, access to lake and community interaction, in the following ways:

- Street layout that is welcoming and encourages walking and community interaction year-round are essential to the sustainability of waterfront communities.
- Mixed land use and compact urban development are essential to community sustainability.
- Balancing residential, commercial and industrial areas, parkland, open space and compact urban development with excellent access to the lake, to public transit, and to community and recreational features.
- To maximize opportunities for using renewable energy, buildings and streets were arranged so as to optimize access to natural lighting and heat from the sun in the winter.
- Use of renewable energy resources, with priority given to passive and active solar systems.

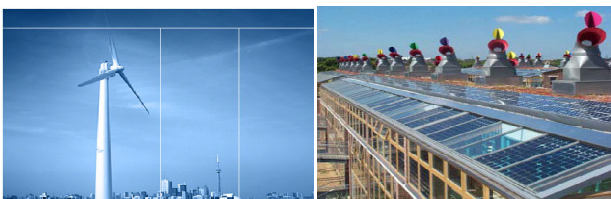


Fig. 2 Renewable sources of energy examples; wind turbines and solar photo voltaic [6]

2. Transportation:

The objective was to make alternative transportation options such as walking, cycling and public transit the natural choice for residents and visitors to the waterfront area by.

- Encouraging transit-friendly compact urban form by increasing the relative cost of automobile use through increased fuel taxes, road tolls, and parking costs.
- Minimizing car use and increase walking, cycling and public transit use.
- Situating basic shopping needs and personal services within walking distance of residential units.
- Creating bike paths and pedestrian friendly links between waterfront neighborhoods and the rest of the city.
- Increasing use of sustainable transportation options such as walking, cycling, and public transit to maximize reductions in pollutant emissions.

3. Sustainable Buildings:

Elegant architectural building systems that reduce negative environmental impacts and provide high indoor air quality and exceptional comfort were promoted by.

- Focusing on durability of materials and systems and flexibility of building use.
- Integrating design process to implement appropriate energy efficiency measures, recycle materials, use materials from sustainable sources and local sources, and reduce the generation of construction” [6].

4. Air Quality:

“Minimize pollutant emissions on the Toronto waterfront to help improve air quality in the city and throughout the region. A sustainability response to air quality is strongly linked to energy use along with land use, urban design and infrastructure planning. And building a reasonable tree canopy to improve air quality and enhance biodiversity and community livability.

5. Human Communities:

- Create vibrant welcoming healthy and inclusive waterfront communities.
- Create and maintain green and open space that is suitable for a wide range of recreational activities and park land.
- Strengthen native biodiversity by identifying native plants most suitable for waterfront revitalization.

6. Water:

- Improve water quality along the Toronto waterfront and reduce per capita consumption of fresh water.
- Implement measures to help absorb rainwater such green roofs.
- Increase the use of rainwater and greywater.
- Capture stormwater and reuse on-site.
- Create and maintain a plan that relies on the use of clean storm water.
- Design and install distinctive pieces of water art along the waterfront.

7. Materials & Waste:

- Use recycled materials over new ones and re-use building components.
- Obtain 75% of lumber from sustainable plantations or recycled sources.

- Obtain 25% of building materials from recycled or renewable sources.
- Use recycled materials in infrastructure.

8. Innovation:

The Toronto waterfront revitalization corporation strove to encourage innovation as a means to make the Toronto waterfront the foremost example of sustainability and a center for creativity and knowledge.

The waterfront “innovation in sustainability” recognition program recognizes:

- Design that contains original and innovative technology
- Design that uses existing technology in an original way
- Design that can be replicated and marketed elsewhere
- Design that uses recognized sustainable design specialists in design process” [6].

The framework developed in the Toronto waterfront revitalization project presented a comprehensive vision of sustainability, a thorough analysis of the sustainability challenge and a concrete action plan with important guidelines for the Toronto Waterfront Area.

B. Sherman Creek Waterfront:

The Sherman Creek Waterfront was selected because it took a different approach to achieving sustainability in waterfront development; one that actively engaged the community in the decision making process.

“The Sherman Creek Waterfront Esplanade master plan establishes a planning and design framework for an open space amenity to revitalize a section for the Harlem River waterfront that has been derelict and inaccessible to the public for decades” [15].

1. Aspects of Sustainability:

The Esplanade should function as a well-maintained asset that improves the natural environment and the water quality. Thus, in addition to the design features implemented to restore ecological continuity, the master plan proposes a strategy to ensure that the Esplanade is adequately maintained over the long term.

2. Community Engagement:

“The design team held several small-format meetings with community members and elected officials to present and gather preliminary feedback on the planning process.

The meetings were followed by a public workshop where more than 70 people discussed their needs, desires, and concerns regarding a Sherman Creek waterfront esplanade. At the meeting, the team presented a set of initial design options for the waterfront. Depending on the Advisory Committee's valuable feedback, the team began to develop a preferred design direction for the waterfront. And the team presented the final design direction to the Advisory Committee, more than 60 people attended the meeting, and provided valuable feedback on the final design and the overall planning process” [15].

3. Ecological Continuity:

“The design also features the following “green” elements: porous shoreline edges, native and marine organism plantings, infrastructure measures that divert stormwater away from the conventional system and into the freshwater wetlands, and fences that integrate plants with security fences (Fig. 3).

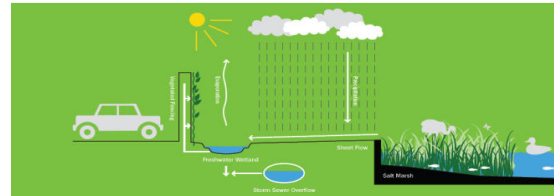


Fig. 3 Sherman Creek Waterfront; schematic representation of on-site water management [15]

4. Historical Continuity:

The design included several water-based recreation features such as a pebble beach, a fishing pier, a floating dock to launch row boats, and a community facility that can be used for boating activities.

5. Continuity of Access:

The high volume of car and truck traffic along the avenue limits pedestrian access to the Esplanade Site, so the design includes safe, meaningful pedestrian connections throughout the entire Esplanade Site, and recommendations to create safe, inviting links to the uplands. At the water's edge, The Esplanade Site offers great opportunities to restore and enjoy the natural habitat and also touch the water.” [15]

6. Conceptual Design:

“Academy Street: Part of the Academy Street will become a natural area, with freshwater wetlands, restored salt marshes, and green infrastructure to collect, treat and recirculation stormwater run-off. A walkway will wind amidst these amenities and there will be look-out points to enjoy views of the river. A substantial portion of the Academy Street will become a waterfront promenade, with lawns and other areas for recreation. It will have shade structures, a space for community gatherings and group activities, and a fishing deck Fig. 4.

The Pebble Beach: where people will be able to touch the water and launch their row boats and kayaks, and new fishing pier will extend into the river. The Pebble Beach Park will be connected by a public place that people of all ages can enjoy. The place will include seating, shade structures, a play area and a water feature for children and fitness equipment for adults Fig. 5.

River walk: A ten-foot wide riverside walkway will create a safe pedestrian path Fig. 5.

The North Cove: It will become an improved natural haven” [15]

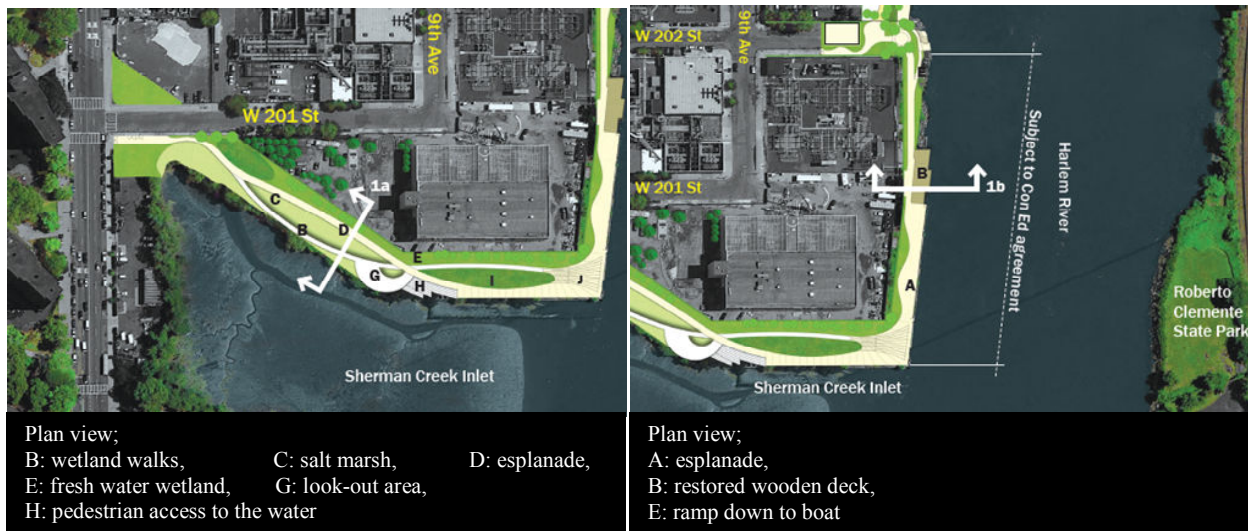


Fig. 4 Sherman Creek Waterfront; conceptual design (phase1) [15]



Fig. 5 Sherman Creek Waterfront; conceptual design, esplanade [15]

X. BASIC CRITERIA OF SUSTAINABLE WATERFRONT

“There are many criteria for sustainable development of urban waterfront areas; that we learned from the previous analytical study;

- “Secure the quality of water and the environment: The quality of water in the system of streams, rivers, canals, lakes, bays and the sea is a prerequisite for all waterfront developments. The municipalities are responsible for the sustainable recovery of derelict banks and contaminated water.
- Waterfronts are part of the existing urban fabric: New waterfronts should be conceived as an integral part of the existing city and contribute to its vitality. Water is a part of the urban landscape and should be utilized for specific functions such as waterborne transport, entertainment and culture.
- The historic identity gives character: Collective heritage of water and city, of events, landmarks and nature should be utilized to give the waterfront redevelopment character and meaning. The preservation of the past is an integral element of sustainable redevelopment
- Mixed use is a priority: Waterfronts should celebrate water by offering a diversity of cultural, commercial and housing uses. Those that require access to water should have priority. Housing neighborhoods should be mixed both functionally and socially.
- Public access is a prerequisite: Waterfronts should be both physically and visually accessible for locals and tourists of all ages and income. Public spaces should construct in high quality to allow intensive use.
- Planning in public private partnerships speeds the process: New waterfront developments should be planned in public private partnerships. Public authorities must guarantee the quality of the design, supply infrastructure and generate social equilibrium. Private developers should be involved from the start to insure knowledge of the markets and to speed the development.
- Public participation is an element of sustainability: Cities should benefit from sustainable waterfront development not only in ecological and economical terms but also socially. The community should be informed and involved in discussions continuously from the start.
- Waterfronts are long term projects: Waterfronts need to be redeveloped step by step so the entire city can benefit from their potentials. They are a challenge for more than one generation and need a variety of characters both in architecture, public space and art. Public administration must give impulses on a political level to ensure that the objectives are realized independently of economic cycles or short-term interests.
- Re-vitalization is an ongoing process: All master planning must be based on the detailed analysis of the principle functions and meanings the waterfront is concerned. Plans should be flexible, adapt to change and incorporate all relevant disciplines. To encourage a system of sustainable growth, the management and operation of waterfronts during the day and at night must have equal priority to building them.
- Waterfronts profit from international networking: The re-development of waterfronts is a highly complex task that involves professionals of many disciplines” [8].

XI.CASE STUDY OF NILE WATERFRONT OF CAIRO DOWNTOWN, EGYPT

This section contains an applied study of the Nile Waterfront of downtown Cairo, Egypt. The objective of the study is to focus on the most important issues degrading the Cairo waterfront that can be eradicated through the application of sustainability on the urban waterfront.

A. The importance of Nile Waterfront of Cairo Downtown, Egypt

Downtown Cairo is one of the most important areas for tourists from both an administrative and economic perspective. Nile Waterfront in downtown Cairo is in a strategic location as it is one of the most important gateways to Tahrir Square, which is now one of the universally squares where the Egyptian revolution was witnessed on January 25/2011. Waterfront in downtown Cairo suffers from deterioration of the urban design and physical character.

B. Documentation of Nile Waterfront of Cairo Downtown

There are some weaknesses which need to be overcome in order to improve the waterfront sustainability in Cairo. This section of the paper will focus on those issues which include;

1. Problems Related to Community Layout & Integration with the Waterfront

- Poor pedestrian access within the area and along the waterfront (Fig. 6).
- The presence of unplanned areas and many scattered slums (Fig. 7).
- The absence of connected open spaces on the waterfront and green area.
- Lack of community participation in urban design development processes.

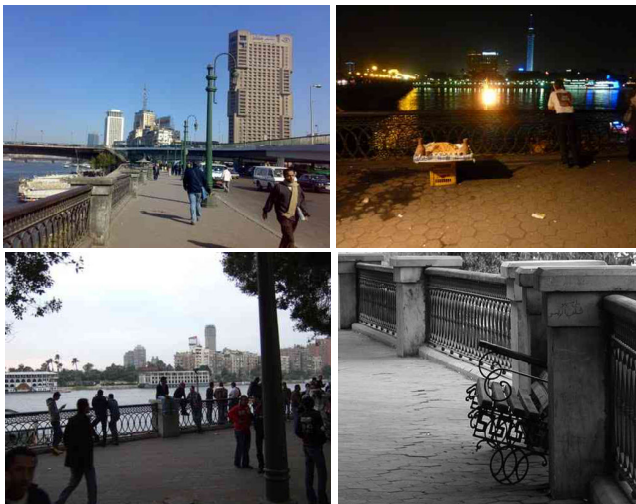


Fig. 6 Poor pedestrian access lack (Trees and landscape strips-recreation opportunities-Benches [16])



Fig. 7 Unplanned area lake (pedestrian crossing-access to water) Traffic congestion [16]

2. Problems Related to Transportation

- Population growth leads to an increase in traffic jams (Fig. 8).
- A greater focus on people walking and cycling is needed in order to reach sustainable transport goals.
- Lack of street furniture, lighting and general ambiance in the area.
- Poor maintenance of buildings resulting in a dilapidated streetscape.

3. Problems Related to Buildings

- Absence of sustainability applications on urban waterfront such as using nonrenewable materials.
- Presence of slums in scattered areas with dilapidated buildings, generally poor conditions and very narrow streets which cannot supply many areas with efficient infrastructure (waste management, water supply and electricity) (Fig. 9).
- Illegal buildings which do not consider the architectural character of place.

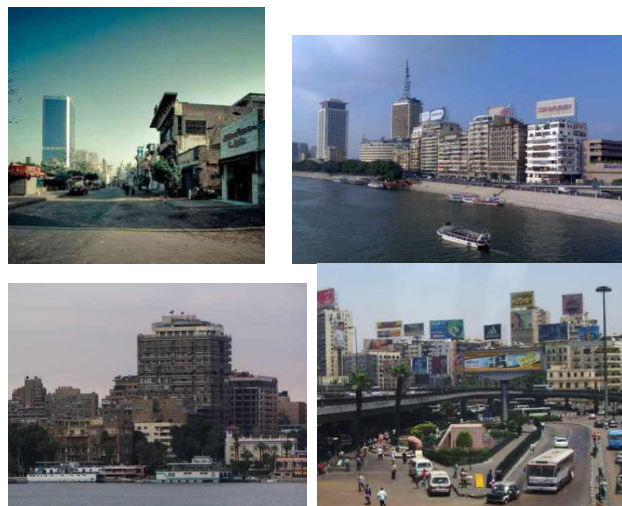


Fig. 8 Urban character pollution-large number of signage-narrow streets-lake brand projects [16]

4. Problems Related to Waste

- Discharging polluted industrial waste from different sources into the Nile River which causes pollution.
- No waste collection which causes accumulation of waste in front of buildings.

5. Problems Related to Environment

- Air pollution due to transportation congestion and the lack of trees and green areas.
- Water pollution due to wastes (Fig. 8).
- Urban character pollution due to the large amount of signage.

6. Problems Related to Energy

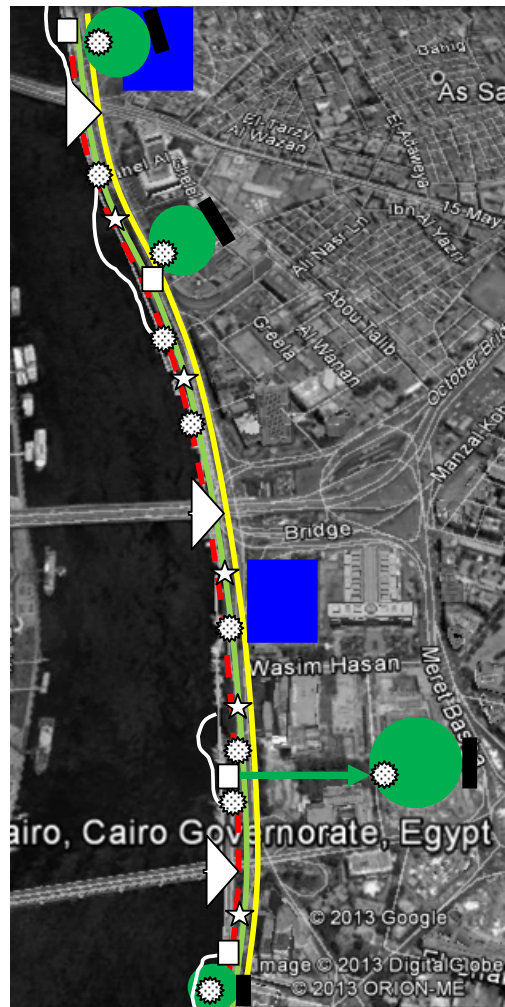
- Absence of sustainability applications on urban waterfront.
- The absence of any means of energy saving in buildings or in the community.
- No channeling of the renewable energy available from the sun despite Cairo's sunny climate.

XII. SUSTAINABILITY GUIDELINES IN DEVELOPMENT OF WATERFRONT OF CAIRO DOWNTOWN

In order to achieve sustainability in the waterfront areas of Cairo, it will be necessary to apply the guidelines for a sustainable waterfront as concluded from the analytical study of the Toronto and Sherman Creek waterfronts in defining a framework for a sustainable urban waterfront in downtown Cairo. The following Table II and Fig. 9 give a set of guidelines to achieve sustainable waterfront in downtown Cairo based upon the problems discussed above.

TABLE II
SUSTAINABLE URBAN WATERFRONT GUIDELINES

Category	Sustainability Guidelines
Community Layout	<ul style="list-style-type: none"> - Design pedestrian access to water. - Create public spaces with opportunities for recreation activities, other water-based activities, and walking. - Brownfield redevelopment. - Create a safe pedestrian path along water (riverside walkway). - The exploitation of the Nile River as an entertainment axis - Engage the community as an active partner in the development process by holding workshops, design festivals and community design centers.
Transportation	<ul style="list-style-type: none"> - Open up the view of the Nile view by removing the structures that obscure it. - Increase the use of sustainable transportation options (bicycling and walking spine) along the main streets of the waterfront areas. - Improve streetscape to be more sustainable (use of sustainable materials, lighting and dark skies, landscaping and reduction in the urban heat island effect). - Design green roofs for bus shelters and plan areas of shade in order to improve the impact on the environment, and construct them out of recycled materials.
Buildings	<ul style="list-style-type: none"> - Use materials from sustainable and local sources. - Improve existing infrastructure, thus reducing the use of natural resources. - Energy efficiency in buildings. - Create new waterfront projects that fit the urban character of the place. - Create branded projects to strengthen the economic value of the waterfront urban image. - Create an entertainment park on the Nile by establishing tourist, service and administrative towers. - Convert Islamic, Coptic and Kdloi Cairo to open museums and tourist centers
Waste	<ul style="list-style-type: none"> - Waste management. - Materials that are utilized in building trash receptacles should be sustainable or recycled materials to achieve sustainability.
Environment	<ul style="list-style-type: none"> - Improve air quality by planting trees along the waterfront. - Reduce carbon dioxide emissions by using sustainable transportation. - Improve water quality. - Water resources management. - Increase the use of greywater.
Energy	<ul style="list-style-type: none"> - Design and install distinctive pieces of water art along the waterfront - Energy efficient buildings. - Infrastructure energy efficiency. - Use of renewable energy sources. - Solar orientation. - Urban integrated photovoltaic (UIPV) can play an important role in the process of developing the waterfront.



- ▶ Potential entrances to Cairo Downtown
- The proposed green way
- The proposed bike path
- Public spaces/Green area
- ➔ Pedestrian access to the water
- ☼ Shades with solar photo voltaic
- Recreation opportunities
- ☆ Distinctive pieces of water art
- ~ River walk
- Green wall
- New brand projects with energy efficient in buildings
- ▨ Look-out area
- Elements of streetscape from renewable /local sources

Fig. 9 Conceptual Plan for sustainable of waterfront of Cairo Downtown

XIII.RECOMMENDATIONS

Many requirements and design considerations must be taken into account when creating a sustainable urban waterfront including:

- In the context of the city, integration of land use and transportation options to and from the waterfront is critical to achieving sustainable development.
- Linking the waterfront to the city is crucial. This can be done by developing new transportation and movement patterns in and out of the waterfront area, and planning strategically located new urban spaces.
- Using urban spaces to reconnect the city with the water.
- Using sustainable transportation options to move between the city and the waterfront.
- Achieving social integration through community participation to benefit all aspects of waterfront development.
- Reducing the use of nonrenewal natural resources.
- Increasing the amount of public recreational space.
- Using sustainable infrastructure along the waterfront.
- Improving air quality.
- Using best available technologies for meeting energy efficiency goals.
- Using innovative technology to produce street furniture.
- Creating brand waterfront projects to improve the sustainability of the city's waterfront.

XIV.CONCLUSION

The city's identity can be improved by means of the sustainable waterfront, and it can help make the city an internationally renowned region. Plan the sustainable waterfront area as Whole – an appraisal of urban design concept dictates that the optimal use of the sustainability principles in many aspects such as (sustainable green areas and public spaces, sustainable buildings, sustainable transport, community involvement and environmental issues).

As shown in the applied study the paper concludes the proposal for developing the waterfront of Cairo Downtown to become sustainable urban waterfront.

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