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Constructed Wetland Parks: A Pathway to Sustainability For Cairo

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ABSTRACT

Cairo is facing a vast number of urban, environmental and social challenges. It is constantly affecting the quality of life in the Egyptian Capital. Water resources are limited and one of the main challenges in Egypt, in addition to the Increasing population, Lack of green spaces, Air and Water pollution rate especially in Cairo. Using untraditional solutions in Egyptian cities now is a critical need, which will help in maximizing the benefits, decreasing projects and operations cost in this developing country.

The Nile is the major water source in Egypt, according to recent studies this source is decreasing. UN and the Egyptian government published that Egypt has reached water poverty. Conservation and developing this resource is the cornerstone of academic researches and on the Egyptian government top priorities. Now in Egypt, the importance of recycling water in different methods increased. It is a basic need to cover water demands. Biological water treatment is one of the eco-friendly techniques for water treatment.

Constructed wetland now is commonly used as an environmental tool in many countries. It achieves many benefits such as increasing biodiversity, habitats, water treatment and reduces air pollution. In the last decade, this technology was used in Egypt as a tool for water treatment in small-scale projects in The Northern lakes.

The multifunction landscape is combining traditional landscape uses with human activities and production. This complexed harmony could achieve a balance between ecosystems with human impacts. Creating a wetland park as multifunction Landscape tool is a new approach in the world. Many countries have success stories in this field.

This research will discuss international experiences in constructed wetland parks and local experiences in wetland areas, monitoring challenges and problems facing this technology and main potential elements that will lead to the success of this experiment in Egypt. Recognizing stakeholder complex needs, Ideas, and official plans for developing wetlands in Egypt. Finally, this research provides a framework and action plan to help in adapting the landscape market with this new approach, gives decision makers tools to achieve sustainability in future projects.

KEYWORDS: Wetland –Multifunction – Landscape – Cairo –Water.

1. INTRODUCTION

Cities worldwide are facing a lot of chronic problems and stresses due to rapid urbanization and population growth. Among which are increased levels of air, water and noise pollution, increasing urban heat island effect, resource scarcity, and environmental degradation. Moreover, as overpopulation, water is being perceived as a precious resource. Governments have been exerting every effort to use water more efficiently and to make use of every drop of water to ensure the wellbeing of future generations. Egypt, among many other countries around the world, is facing water shortages.

The technology of constructed wetlands is generally regarded as a low-cost, easily operated and a viable alternative to conventional wastewater treatment systems. Constructed wetlands are unique as compared to other wastewater treatment options because they use natural vegetation, micro-organisms, and soil as key elements in the treatment process (Ezeah, C. et al. 2015).

Constructed wetlands have been successfully adopted as a natural water purification technique in many cities around the world and have recently been applied in Egypt through the Ministry of Irrigation and The National Institute for Water Research in " Bahr Al-Baqar " drainage as well as " Al-Manzala " lake where agricultural effluents have been treated and reused in the irrigation of productive crops. A similar project of municipal wastewater treatment has also been implemented in "Maryout" lake through Alexandria Coastal Zone Management Project ACZM and the World Bank.

The concept of constructed wetland park sustainably combines landscape features and ecological functions, thus, simultaneously providing reduced water and air pollution, food security, livelihood opportunities, maintenance of species and ecological functions, and fulfilling cultural, aesthetic, recreational needs.

2.CONSTRUCTED WETLANDS – APPROACH

Constructed wetlands are man-made wetlands, simulating the functions of natural wetlands, the primary purpose of which is water purification. The constructed wetland, a typically constructed ecosystem, was initially developed approximately forty years ago in North America and Europe to utilize and recover the biodegradation ability of plants. Possessing the advantages of low construction and operating costs as well as its ability to be used alone or with other systems. Constructed wetlands' systems are especially suitable for small communities in developing countries where potential health benefits from pathogen removal are considerable (W.Yang et al., 2008).

Constructed wetlands for wastewater treatment may be classified according to the life form of the dominating macrophyte, into systems with free-floating, floating-leaved, rooted emergent and submerged macrophytes. They could be classified also according to the hydrology of the wetland and subsurface flow (Vymazal 2010).

Constructed wetlands have proved to be an attractive and stable alternative because of their low cost, and energy savings. Also, there is the advantage of multi-purpose re-use of the high-quality effluent, self-remediation, and self-adaptation to the surrounding conditions and environment. (D. Zhang et al.,2009). Other functions and added values for human welfare include but are not limited to: greenhouse gases

regulations, reduced heat island effect, habitat for diverse species, recreational services, socio-economic benefits, as well as scientific and educational values.

The use of constructed wetlands for wastewater purification and detoxification is a simple concept aimed at simulating natural wetlands and their processes, such as sedimentation, filtration, chemical deposition, microbial interaction, plant absorption adsorption of soil particles give wetlands the ability to remove many nutrients, including nitrogen, sulphur, carbon, phosphorus and potassium, and lead to an increase in water quality (Kadlec & Knight, 1996). These processes are accomplished by changing water depth, flow rates, oxygen levels and plant cultivation within systems, increasing biological productivity, degradation and removal rates (EPA, 2000).

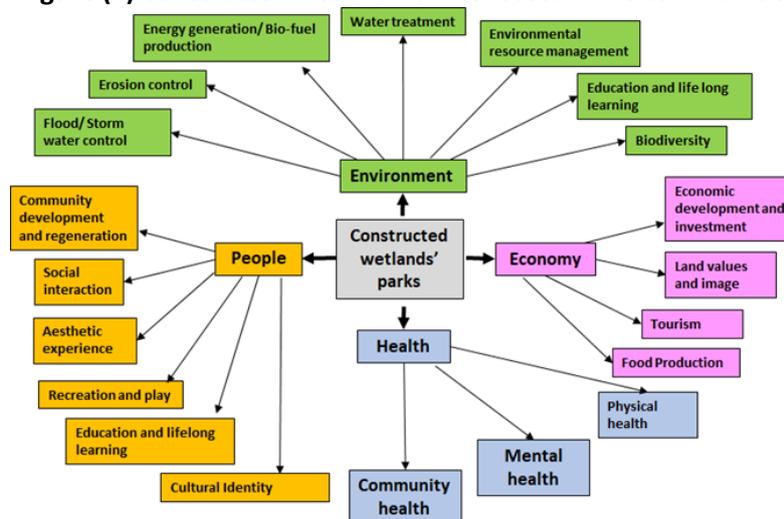
The size of the wetlands is determined by the pollutant that requires the largest area of land to be removed. This is the bottom area of wetland cells, for this area to be 100% effective, the flow of wastewater should be uniformly distributed across the entire surface. This is possible with wetlands built by carefully grading the bottom surface and using appropriate entry and exit structures. It is also essential to take into account the hydraulic aspects of system design because there is considerable friction resistance to the flow through the wetlands (EPA, 2000).

3. CONSTRUCTED WETLAND PARKS FOR SUSTAINABILITY

Constructed wetlands are more and more known as rather low-cost, energy-efficient, natural methods of treating sewage, industrial and agricultural wastes, and storm water runoff while simultaneously offering the possibility for several benefits.

Constructed Wetland Park offers the potential for integration of constructed wetlands into park and recreational systems, the wildlife habitat they offer, their aesthetic values, and the greater quality effluent that they deliver, which can be recycled for landscape irrigation or impounded in an attractive and educational pond of value in attracting wildlife while also conveying information on wetlands procedures.

Figure (1) Constructed wetland Park for sustainable communities



Source: (Feisal Z., 2017) with editing

Constructed wetland parks can be placed in the sustainable landscape category, mainly due to their ability to deliver multiple functions and benefits at low cost and with low environmental impact (Wu H, 2015). Constructed wetland parks can offer different ecological, environmental, economic and sociocultural benefits which help in achieving sustainability in cities.

4. INTERNATIONAL CASE STUDIES

The research in this section analyses a group of similar projects around the world that have succeeded in various fields of development and have positively impacted the sustainability of the community. A local experience from Egypt is also presented and compared with the international experiences to reach the strengths and weaknesses and how to develop the experiment and maximize the benefit of these types of projects.

4.1. Sydney Park water reuse project:

This project is currently one of Sydney's largest environmental projects and is part of Sydney's Sustainable Development Strategy 2030. The project's idea is to connect water, people, topography, urban life, and plant and natural life.

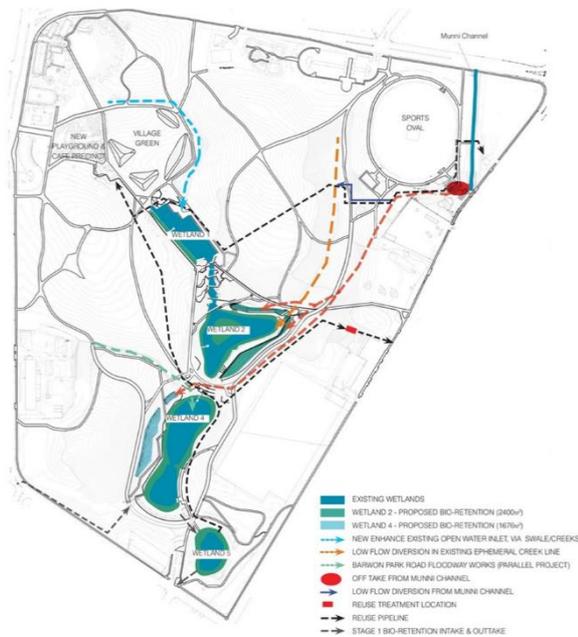
The importance of the project:

Water purification: Urban wastewater is harvested from the urban areas into the wetlands of the project and processed and cleared for reuse within and outside Sydney Park and nearby industry

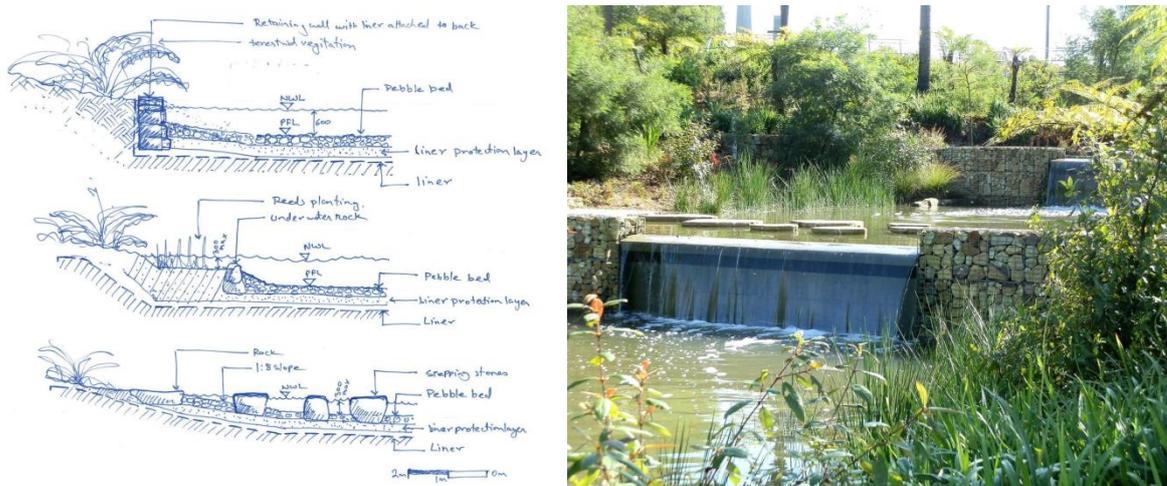
The cost of this system is \$ 11.3 million. It collects rainwater and cleans enough water to fill an Olympic-size swimming pool every day, providing a sustainable supply to the park and its wetlands and restoring any remaining water to the Alexandria Canal.

Biodiversity: Wetlands with waterfalls and green areas attract new wildlife to the park, which has the highest number of native bird species in the local area, including 22 wetland species

Figure (2) Sydney Park Layout



www.cityofsydney.nsw.gov.au

Figure (3) Water treatment through Sydney Constructed wetland Park

Source: Sydney-Park-POM-adopted-May-2014

Raising awareness of the importance of water: Water reuse is carried out in front of people, that educates them the importance of water management and how improving water quality and reducing the use of drinking water can be linked mainly to the urban ecology.

Social Effect: The project reinforces the vision of the park's landscape by creating dialogue when park users explore and discover "moments" in the landscape that can be playful, exciting and sometimes quiet and peaceful, but at all times linked to water narrative of capture, movement, and cleansing.

The Artworks "Waterfalls" in Turpin Crawford produce water from wetlands into the ponds. Playing on the water spirit and its interactions with topography, shape, surfaces, flora, and recreational areas are intertwined with the new landscaping of the park; enhanced comfort, amenity and accessibility for all park users.

Figure (4) Social activities in Sydney Park

Source: www.architectureanddesign.com

4.2. Shanghai Houtan Park

This project is located on Huangpu Riverfront in Shanghai, China. It is a regenerative living landscape project that constructed on a brownfield of a former industrial spot, previously owned by a steel factory and there were some industrial structures remaining. The site was highly used as a landfill for industrial materials. The park is 1.6 km in length and 10 to 30 m in width. The park area is around 140000.0 m²

The park project main objective was to design a green Expo, house for a large number of visitors during the expo, illustrate green technologies, transform a unique space to make the Expo an unforgettable experience, and transition into a

permanent public waterfront park after the Expo. The aim of the project was to treat the contaminated river water and revive the degraded riverfront and turn it into a delightful facade with aesthetic value. To achieve that, the project includes a combination of integrated elements, human-made wetlands, urban agriculture, ecological flood control, recycled industrial materials, and structures.

Figure (5) Bird's eye view for Houtan Park



Source: (Yang,2008)

The importance of the project

The project regenerative design strategies used to transform the site into a living system that offers comprehensive ecological services included: Urban Agriculture, flood, water treatment, and Biodiversity combined in an educational and aesthetic form.

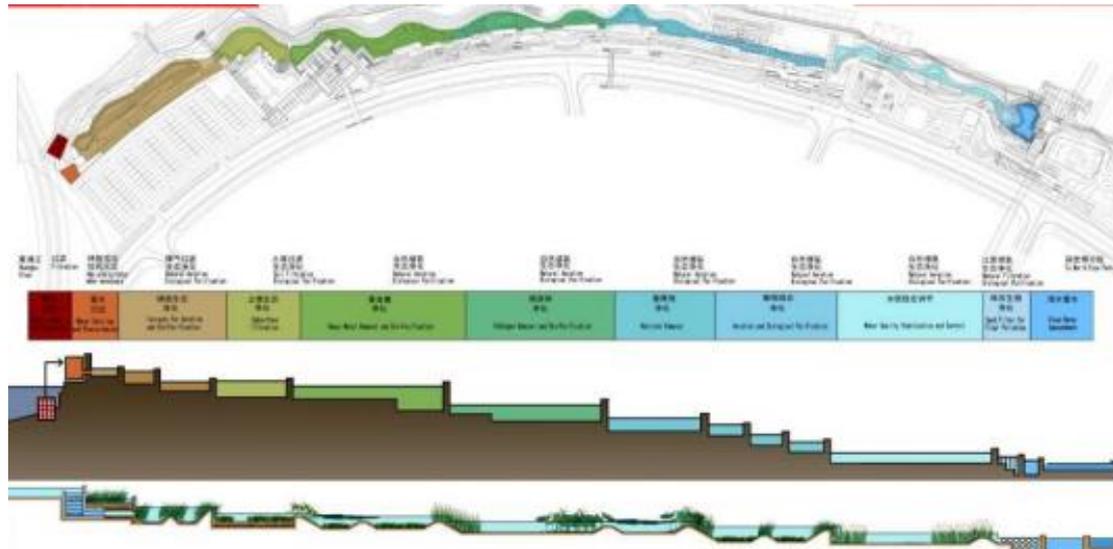
Water treatment

The contaminated water has been cleansed after a long journey through the vegetated terraces and constructed wetland. Several productive crops are vegetated in the park that are harvested by the park managers and that attract wildlife. The park can cleanse 2,400 m³ per day of contaminated water from Lower Grade V to Grade III. The treated water can be used safely through the Expo for non-potable uses.

Terraces and Waterfalls are used to oxygenate the nutrient water, get rid of and hold nutrients and decrease suspended sediments while generating pleasing water features; Diverse species of wetland plants were selected and designed to absorb diverse pollutants from the water.

Flood protection: The wetland also acts as a flood protection buffer between the 20- and 1000-year flood control levees.

Figure (6) Water treatment in The Park from Lower Grade V to Grade III.



Source: www.ASLA.com

Urban Agriculture

Wetland plant sand Crops were selected to generate an urban farm allowing people to observe seasonal variations: splendid sunflowers in the summer, the golden blossoms in the spring, green clover in the winter, and the fragrance of the ripened rice in the fall.

Biodiversity: The project increased the biodiversity of the site dramatically, with 93 species of plants and over 200 species of animals observed. The park had attracted thirty - seven bird species just one year after it was built. The current concrete floodwall was exchanged by a further habitat-friendly riprap that permits native species to grow along the riverbank while keeping the shoreline from erosion.

Figure (7) The terraced wetland is heavily planted to clean the contaminated water.



Source: www.ASLA.com

Education: This project provides a premier educational opportunity for people to learn about agriculture and farming within the city.

Cultural: Inspired by the fields of Chinese agricultural landscape, terraces were shaped to break down the 3–5-meter elevation change from the water's edge to the road, and to reduce the runoff carried to the stream. These terraces are reminiscent of Shanghai's agricultural heritage former to the industrial development of the neighbourhood in the mid-20th century.

People

The important site design challenge was to convert this degraded landscape into a pleasant and safe public space. The pedestrian network is composed of the main loop, some perpendicular roads crossing the wetland and a variety of paths leading among the terraces. Many platforms and enclosed 'containers' are designed as the nodes on the pedestrian network, including the 'hanging garden' recycled from a

Figure (8) numerous platforms and enclosed containers



factory structure and the landscaped dock.

Source : <https://www.turenscape.com/en/home/index.html>

The industrial character of the site is dedicated through the recycling of industrial materials and structures.

The terrace design of the wetland relieves the elevation variation between the city and the river, securely re-connecting people to the water's edge.

Economic:

The project saves half a million US dollars in comparison with conventional water treatment.

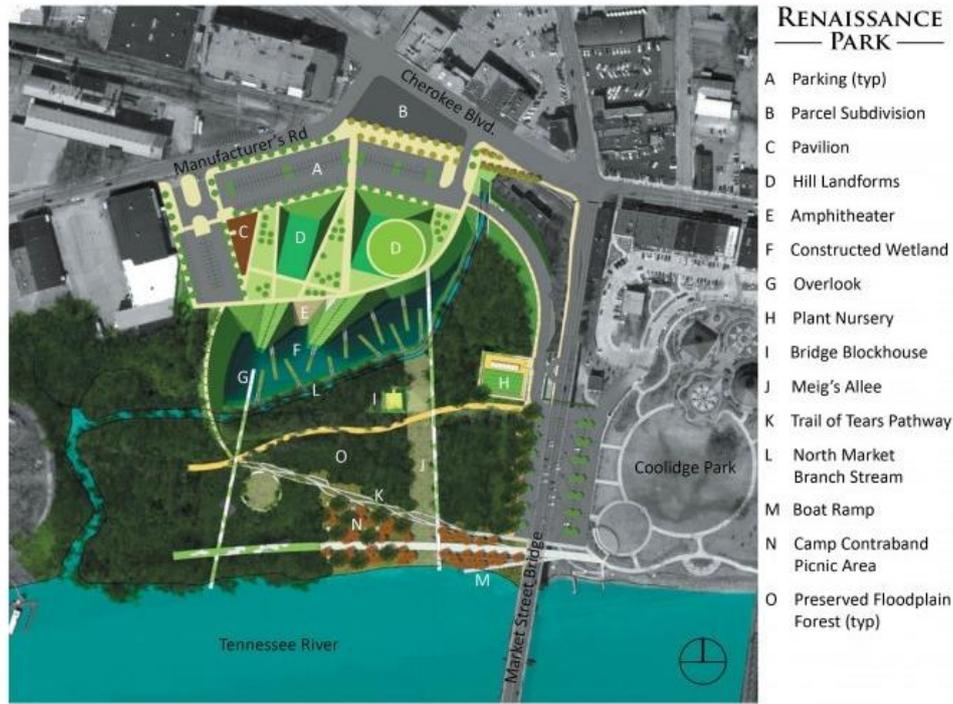
4.3. Renaissance Park, Chattanooga, Tennessee, USA

This project is located on Tennessee Riverfront in Chattanooga. The project budget was 8million \$. It is a redevelopment project of a brown field. The project, which

overlooks the river, has transformed a post-industrial site into a public park that has been a catalyst for reinvestment in the growing North Shore district of Chattanooga.

Renaissance Park area is a 23.5 Acres.

Figure (9) Renaissance Park site plan



Source: Landscape Architects Network www.land8.com

The importance of the project:

The park provides several benefits such as providing clean water, healthy lifestyles, more diverse habitat for wildlife, environmental education, as well as social and economic benefits for people.

Water treatment and flood control:

constructed wetland treats site storm water and increases floodplain storage capacity. The runoff streams in the wetland slowed by rock-filled, steel mesh basket gabions. These gabions also guide the flow of water, affecting it to meander throughout the wetland plant cells which are planted at the back of every gabion. These plant cells are wire-mesh structures planted regularly with native aquatic plants, such as *Scripusatrovirens*, *Typha latifolia*, *Hibiscus moscheutos*, *Sagittarialatifolia*, and more.

Figure (10) Renaissance Park Bird view



Source: Landscape Architects Network www.land8.com

Pollutants are decreased by filtration and the microbes' biological action on the roots of the plant inside the vegetated cells.

Finally, Renaissance Park project evidences that a once-polluted area can be changed into an environmentally focused park that treats urban water runoff and is able to hold a 100-year flood.

Saving energy: Energy and maintenance costs have been saved through the use of Passive controls in the inlets and outlets of the wetland.

Recycling: A huge part of the concrete factory floor was reused as filler at the site, where it was cracked, crushed and then reused.

Educational and cultural

- Environmental education is one of the possibilities offered by the park through a group of high piers over wetlands and the riverbank, which also give the opportunity to enjoy wildlife viewing.
- There is a set of signs designed to explain the process of treating rainwater as well as cultural history.
- Some signs highlight the heritage of the site as a strategic river crossing during the civil war
- Park Visitors may get acquainted with the cultural and environmental features through the possibility of an audio tour of the cell phone

Social:

- Several public events are held in the park as well as exhibitions of public art to commemorate the site's role in many important historical events, including the Trail of Tears, liberated slave camps, and the location of the city's first bridge across the Tennessee River.

Figure (11) Social activities in The Park



Source: www.land8.com

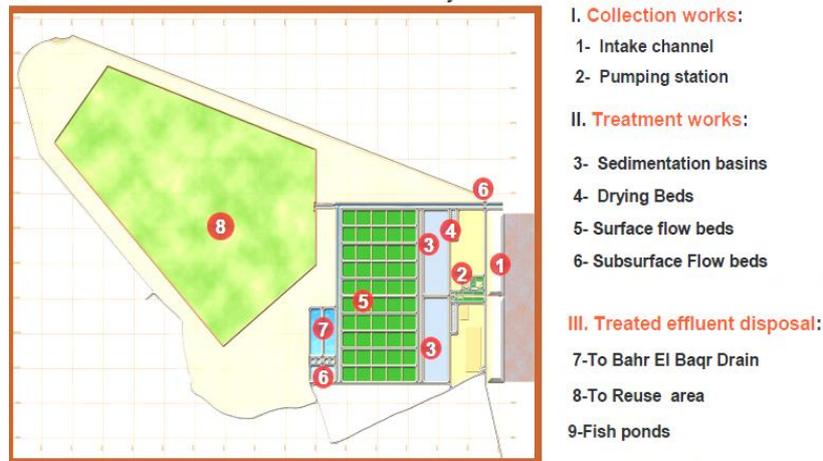
- One of the most distinctive features of the park is the open theatre, which offers the opportunity to sit and enjoy nature.

- As well as walkways that provide opportunities for exercise and walking between nature and wildlife
- A new boat ramp is accessible from the car park under Market Street Bridge, which offers access to the river for kayaks and canoes.

4.4. Local case study - Bahr El-Baqr Constructed Wetland

This project located in El Manzala Lake southeast coast. The lake is a Saltwater lake in northeastern Egypt on the Nile Delta near Port Said, Damietta, Dakahlyia and Sharqya governorates. It is separated from the Mediterranean Sea by a sandy beach ridge which has three open connections between the Lake and the Sea.

Figure (12) Bahr El-Baqr Constructed Wetland site plan



Source: Dia El Din El-Quosy (2008)

These open connections allow an exchange of water between the Lake and the Sea (United Nations Development Agency, 1997)

Bahr El-Baqr Drain is one of the main drains pours in Manazal lake. It carries large mixed amounts of agricultural, domestic and industrial polluted water, with average flow $3 \times 10^6 \text{ m}^3/\text{day}$. That's effective badly in the water quality in the lake. Also, that affected in fish production and water reuse plans in this region.

The Egyptian Environment Affairs Agency (EEAA) has initiated the design and construction of 20 hectares engineered wetland. The Global Environmental Facility / United National Development Program (GEF/UNDP) funds the project, with the main objective of treating 25,000 m³ per day of the polluted drainage water as a demonstration for a low-cost technique for wastewater treatment to protect the ecology of Lake Manzala and the Mediterranean Sea.

A three-stage treatment considered in the constructed wetland starting with pumping station lifting water from Bahr El-Baqr drain that will be retained in the sedimentation basin for 2 days, Figure (1). The high sediment load in the drain consists of approximately 65% sand, 23 % silt, and 12% clay. Sediment adsorbed

organic carbon ranges from 17% to 75% of the total organic carbon levels and is indicative of the high potential for adsorption of metals (TVA, 1999).

Water flow by gravity from the sedimentation basin to ten surface-flow engineered wetland treatment beds. The wetland beds will be operated in parallel to investigate the treatment performance for different hydraulic loading rates with an average retention time of 2 days and different plant species. Combinations of plants species in the treated cells will include common reed, cattail, water hyacinth, etc.

Figure (13) Baher El Bakar Wetland aerial view in 2006 and 2016



Source: Ahmed Ali Rashed (2017)

Project achieved list of targets could be summarized in:

Environmental

- Treating water with average 25,000 m³ per day. This water will be used in creating new habitats and return back to the river without pollution.
- Agriculture farm with an area 91 acres. It produces agriculture crops since 2016
- Fish ponds 60 acres

Social

- The projects provided new jobs for local communities
- Training centeris organizing workshops and training programme for increasing awareness

Educational

- Research Centre in a project helping and develop using constructed wetland technology in Egypt under supervising from the national water research center.

Economical

- Project saved more than 700,000 \$ /year in water treatment cost
- Increasing agriculture productivity and water reuse

- Fish production
- Use of excess and contaminated plants in bio fuels.

5. COMPARATIVE ANALYSIS OF CASE STUDIES

Table (1) Case Studies Economic, Environmental and Social Benefits

	Sydney Park	Houtan Park	Renaissance Park	Bahr El-Baqr CWL
	Sydney, Australia	Shanghai, China	Chattanooga, USA	Al Manzala Lake, Egypt
Environmental	<ul style="list-style-type: none"> - captures and cleanses around 850 million litres of stormwater a year. - The project is delivering the City's largest water harvesting system - Increases the biodiversity of the site, the wetlands are attracting new wildlife to the park, which has the highest population of native bird species in the local area, including 22 wetland species. 	<ul style="list-style-type: none"> - Cleans up to 634,000 gallons of polluted river water daily, improving the water's quality from Grade V to Grade II. -Increased the biodiversity of the site, with 93 species of plants and over 200 species of animals observed. - Sequesters an estimated 242 tons of carbon annually in park's extensive wetlands. - Successfully demonstrated state-of-the-art design and construction techniques, resulting in 8 national design patents and 20-30 subsequent ecological water purification projects that employ the techniques created for Houtan Park. 	<ul style="list-style-type: none"> - Removed 34,000 cu yd of contaminated soil from the 100-year floodplain and sealed it safely within the park's iconic landforms. - Increased floodplain storage by 9.32-acre feet through creation of a constructed wetland. - Reduces irrigation water demand by 74% or 1.6 million gallons per year. - Improved habitat value of the North Market Branch stream from "marginal" to "suboptimal". USEPA Rapid Bioassessment habitat scores rose from 60 in 2002 to 122 in 2014 	<ul style="list-style-type: none"> - Cleans up to 25,000 m3 per day of the polluted drainage water. - Reuse more than 6,387,500 m3 /year from water in agriculture and productivity - Agriculture farm with an area 91 acres. Production of crops such as beets, cabbage, tomatoes and eggplants with an average of 20 tons per acres. - Fish ponds 60 acres. Produce different types of fish, representing an average of 70 tons per acres. - increase habitats quantities and qualities
Social	<p>park provide multiple social activities in the landscape that can be playful, exciting and sometimes quiet and peaceful, but at all times linked to water narrative of capture, movement, and cleansing.</p>	<ul style="list-style-type: none"> - Provided recreation and educational opportunities to some 590,500 visitors during the 2010 Shanghai World Expo. The park continues to provide these benefits to city residents and visitors from around China and the world. 	<ul style="list-style-type: none"> - Promotes a healthy lifestyle that the park offers outdoor activities. - Attracts an estimated 145,220 visitors annually - Influenced the housing choice of willing to pay a premium to live close to the park. 	<ul style="list-style-type: none"> - The training center makes workshops and training programme for increasing awareness in local communities.
Economic	<ul style="list-style-type: none"> - Saves in water treatment costs that the wetland purification system is used in the water features. - offers job opportunities for the community. - Increases the property values for the near urban area. 	<ul style="list-style-type: none"> - Saves \$116,800/year in water costs at the adjacent Expo Park where 264,000 gallons of water treated by Houtan Park's wetland purification system is used in the water features. - Reduced waste and saved an estimated \$17,300 by reusing 37 tons of steel and roughly 34,000 post-industrial bricks found on the site 	<ul style="list-style-type: none"> - Stimulates economic development and neighborhood reinvestment. in redevelopment projects adjacent to Renaissance Park. - Contributes to an increase in property values. - Saved in construction cost by reusing factory floor as fill. - Reduces maintenance labor cost per year compared to an adjacent park with large expanses of lawn and ornamental plantings. 	<ul style="list-style-type: none"> - Saved more than 700,000 \$ /year in water treatment cost - Agriculture production 1,820,000\$/y - Fish production 2,000,000 \$ /y - create 1500 direct jobs chance for local communities in agriculture, fishing, transportations and administration, indirect jobs more than 3500 chance.

From the comparative analysis and the previous table, it is clear that the international experiences of constructed wetland parks have achieved environmental, economic and social sustainability with different degrees according to the methodology used in the design or project objectives. Overall, practical experience proved the great value of these projects.

Regarding the Egyptian experience, it can be concluded that the concept of constructed wetland did not go beyond the functional concept to more comprehensive concept. As all current Egyptian experiences are aimed only at water treatment and using treated water in irrigation of agricultural lands.

Towards using constructed wetlands as a tool of achieving sustainable development, the research team conducted a proposed study of constructed wetland in Egypt.

6. RESEARCH PROPOSED CASE STUDY

6.1. Greater Cairo

Greater Cairo region is the biggest region in Egypt in population density. It consists of three governorates which are considered mega cities (Giza, Cairo, Qalyobia). All the governmental and administrative services are located within this region. The population of Greater Cairo is 24.5 million people according to the statistics report year (CMPAS 2019). River Nile flows from the south of Cairo to the north with a length of more than 60 km. The Nile is considered as a natural and administrative boundary between the two governorates of Giza and Cairo.

Greater Cairo suffers from many urban and environmental issues. The most threatening one is air and water pollution. Water pollution is mainly concerning the Nile, which is the main source of water in Egypt (EEAA 2016). There are many urban problems in Greater Cairo. Slums are the most urgent problem, where 8,614 million people live in informal settlements according to the statistics report 2016.

Most of the slum areas suffer from the problem of sanitation and the absence of wastewater treatment plants, that caused the discharge of sewage water on agricultural drainage, which flows into the Nile. Greater Cairo suffers from a severe shortage of green areas and open spaces due to the urban extension, resulting in many environmental and social problems. Traffic and walkability are also pressing issues that make the situation worse.

6.2. Materials and Methods

The research team has conducted an initial study to apply constructed wetland parks on the Nile front as a solution to maintain the environmental balance and introduce new approaches to urban and social problems towards sustainability of greater Cairo.

From survey study and investigation with cooperation from the ministry of irrigation –the official institution has authority on river Nile waterfront - team selects Torra Location as shown in fig (14)

Figure (14) Torra Nile front in Cairo & Project area land use



Source: Google Maps, edited by researchers August (2018)

Site located in 29°55'36.71"N, 31°16'54.52"E . It is covered 90 acres including waterfront, two small islands and Shallow water areas between the islands. The site was part of the cement factory belong to the government. It stops production in 2013 after many campaigns against it. South of Cairo is the most polluted area in Cairo (EEAA 2018). Air pollution and water pollution is one of the main problems affected in people health in this area (Moussa, M.I., Abdelkhalek, A.M.2007).Site potentials could be summaries in:

- The location in the south of Cairo that could have a positive effect on the Nile because the Nile flows from the south to the north.
- The location is near industrial hub in Helwan. It has negative effects on Cairo environment. The proposed project idea could enhance Cairo environmental conditions.
- The chosen location is near to middle class and low economic communities which figure the biggest ratio of populations in Egypt.
- Near some informal areas mixed with formal urban areas which are suffering from the lack of infrastructure.
- Shortage of parks and open spaces near the site, raise the value of the proposed project.
- The site was chosen to be within the government or public properties so that the project can be implemented.

6.3. Proposed project site SWOT analysis

This SWOT analysis was conducted by the researchers, based on the outcomes of the summer school that was organized in collaboration between the Benha University, TU Berlin, and Arch space international group titled “Urban resilience and

regeneration”, Sept. 2018. Authors have conducted an analytical study of the current situation of the site on Nile riverfront and the context as shown in table (2).

Table (2) SWOT analysis of the proposed site

POSITIVE	NEGATIVE
<ul style="list-style-type: none"> ▪ Infrastructure (water and electricity) is good in buildings. ▪ Nile View ▪ Most of the building are Mix-use ▪ Transportations are available ▪ Site soil is agricultural type. ▪ There are four islands saturated in front of the site. ▪ Good social relations in local communities <p style="text-align: right;">S</p>	<ul style="list-style-type: none"> ▪ Poor condition of street network ▪ No parking areas ▪ No pavements for walking ▪ No green areas or open spaces ▪ No connection between the two sides of The Nile (No bridge) ▪ Building condition is poor ▪ Informal areas ▪ weak sewage system ▪ Pollution from factories’ wastes ▪ High density population ▪ Lack of awareness <p style="text-align: right;">W</p>
<p style="text-align: right;">O</p> <ul style="list-style-type: none"> ▪ Location and available waterfront area ▪ The promenade of Nile River ▪ The appearance of the islands in the Nile river ▪ Empty lands in the area ▪ Closed factories can be used in multilabel usage as public spaces. 	<p style="text-align: right;">T</p> <ul style="list-style-type: none"> ▪ Illegal building extension ▪ Change of Nile river water level ▪ Informal sprawling ▪ Cement factories are source of pollution ▪ Pollution is moved towards the residential area by the wind’s direction. ▪ Health problems occur due to garbage and irregularities

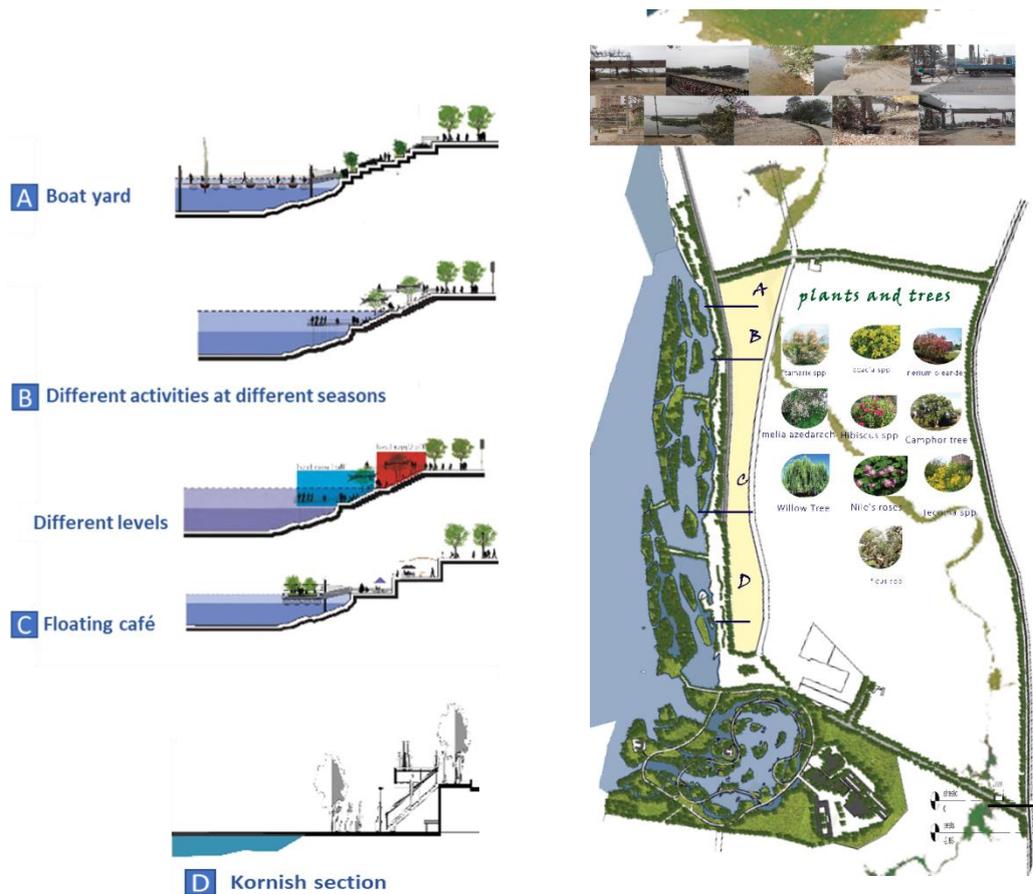
6.3. Proposed design for project selected site

In collaboration with a team of students and researchers at MTI University, a preliminary design was carried out to achieve objectives of the project in the period from February 2018 to May 2018.

The conceptual design was carried out by a group of experts in the fields of urban design, land scaping, environmental design and agriculture.

Project impact assessment:

Benefits of using constructed wetland park on the Nile waterfront are significant. According to project impact assessment indicated that, it could be considered as an effective method of increasing urban ecosystem and reducing pollution.

Figure (15) Torra Wetland Park proposed design

Source: Design Team 2018

Environmental Benefits

- Increasing urban biodiversity and create a park with total area 90 acres it will be new lung to Cairo.
- Reduce air pollution and resource of green health
- Water treatment for 1200 m³ /d and water reuse in agriculture landscape (Salwa M. Abou El Ella 2014)

Social Benefits

- Create a new public park and increase the quality of life for local communities
- Increase awareness and encourage people to save water resources
- Create new jobs for local communities

Economic benefits

- By comparison of the actual cost of pitching work on sides of the river to constructed wetland establishing cost the study indicated that will reduce 30% from city water projects expenses.

- In operation cost according to study and an official report from housing ministry water treatment by wetland will reduce cost by 50 % (Rasha El Gohary and MüfitBahadir 2017).
- Investment in the productive landscape in the project with 40 acres area will cover the operation cost and make new income for the wetland park.

7. Discussion and suggestions

Research has shown that application of constructed wetland parks is a good and economical tool to achieve sustainable development goals. That concluded from all the studied projects, as shown in table 3.

- Constructed wetlands are also important because they compensate for the loss of natural wetlands and the consequent disruption of the ecosystem.
- Constructed wetlands are good example of increasing biodiversity within cities as illustrated by the experience of Shanghai and Sydney. They offer strong economic effect from agricultural areas as shown in Bahr al-Bakr experience.
- The range and impact of the experience varies between the medium and long term because it requires years to recognize the impact. For example, economic returns can be measured after one or two years after project running.
- Research has also shown that the use of this concept in Egyptian construction is an effective approach.
- Constructed wetlands proved to be an economic means compared to the construction of river walls in Egyptian urban areas.
- These parks will be constructed in urban spaces within the Egyptian city, which will increase the quality of life in the city.
- This technique is a good way to re-use water in Egypt, that Egypt suffers from water poverty and in need for cheap and effective technologies for water treatment in the coming decade.
- The research reached these results through community participation during the research period.
- On the academic level, the research found deficiencies in the Landscape courses, despite of the huge number of architecture faculties in Egypt.
- However, the idea of creating constructed wetland park is a new and promising field if used and practiced.
- Lack of technicians and specialists in aquatic plants another field of research and training needed by the Egyptian market.
- In order to achieve the objectives of these projects, the time gap between the development of the plans as Manzala Lake Project in 1997 and its implementation in 2006 and achieving results should be reduced.
- Finally, research recommend for further research in the field of the urban, environmental and economic levels of constructed wetlands.

Table (3) Benefits of studied experiences

Benefits		Sydney Park	Houtan Park	Renaissance Park	Bahr El-Baqr CWL
			Shanghai, China	Chattanooga, USA	Manzala Lake, Egypt
Environmental	Improving water quality	●	●	●	●
	Reducing Grey Infrastructure Needs	●	●	●	●
	Reducing Flooding	●	●	●	⊙
	Increasing the Biodiversity	●	●	●	●
	Improving Air Quality	●	●	●	●
	Reducing Atmospheric CO2	●	●	●	●
	Energy Production	●	●	●	⊙
	Reducing Urban Heat Island	●	●	●	○
	Reducing Noise Pollution	●	●	●	○
Sociocultural	Social interaction	●	●	●	○
	Improve Aesthetics	●	●	●	○
	Providing recreation opportunities	●	●	●	○
	Providing educational opportunities	●	●	●	●
	Healthy lifestyle	●	●	●	●
	Enjoying nature	●	●	●	⊙
Economic	Increase property Values	●	⊙	●	○
	Use of recycling materials	⊙	●	●	○
	Save in water treatment cost	●	●	●	●
	Provide Job opportunities	●	●	●	●
	Food Production	⊙	●	●	●
	Touristic value	●	●	●	○

● Yes

⊙ Maybe

○ No

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REFERENCES

- Abo El Ella S., Al-Samman T., (2017), A guideline for improving the quality of water in drains using plants, Egyptian Ministry of water resources and irrigation.
- Abu Zeid, K., Elrawady, M., CEDARE (2014), " 2030 Strategic Vision for treated wastewater reuse in Egypt", Water Resources Management Program- CEDARE.
- American Society of Landscape Architects, "ASLA" (2010). Shanghai Houtan Park: Landscape as a Living System, Shanghai, China.
- American Society of Landscape Architects, "ASLA" (2018). Green Infrastrcutre :Constrcted Wetlands.
- M. Negm et al. (eds.), (2018) Egyptian Coastal Lakes and Wetlands: Part I - Characteristics and Hydrodynamics, Hdb Env Chem, DOI 10.1007/698_2018_249, Springer International Publishing AG
- A.M. Negm and M. Abubashim (eds.), Sustainability of Agricultural Environment in Egypt: Part II - Soil-Water-Plant Nexus, Hdb Env Chem, DOI 10.1007/698_2018_309,
- Ahmed Ali Rashed (2017) Lake Manzalaengineerd Wetland a successful model for the Medtranian Sea projection https://www.researchgate.net/profile/Ahmed_Rashed16/publication/306292650_ENVIRONMENTAL_PROTECTION_OF_LAKE_MANZALA_EGYPT_AND_REUSE_OF_TREATED_WATER_BY_A_CONSTRUCTED_WETLAND/links/57b733d208aedfe0ec9382a9.pdf
- Dia El Din El Quosy.(2008)., Lake Manzala Engineered Wetland Port Said, Egypt. Project Reprort . United Nations Development Agency, New York, The United States.
- Ezeah, C., Reyes, C.A.R. and Gutiérrez, J.F.C. (2015) Constructed Wetland Systems as a Methodology for the Treatment of Wastewater in Bucaramanga Industrial Park. Journal of Geoscience and Environment Protection, 3, 1-14.
- Groot R.S. de, Alkemade R., Braat L., Hein L., Willemen L., (2010) Challenges in integrating the concept of ecosystem services and values in landscape planning, management and decision making, Ecological Complexity 7, 260–272
- Holding Company for Water Supply and Waste Water, (2011), Governorates Data Sheets.
- Hussein I. Abdel-Shafy, Ahmed Dewedar. (2008) Constructed Wetlands for Urban Wastewater Treatment in Egypt, *International Journal of Environment and Sustainable Development*. 12(2012):27 -32
- Kadlec, Robert H., Knight, Robert L. (1996). Treatment Wetlands. Boca Raton, Fl., Lewis Publishers.
- Landscape Architects Network, (2016) How This Toxic Industry Site Turned into an Environment-Protecting Wonder. <https://land8.com>.
- Kevin L. Erwin (2009) Wetlands and global climate change: the role of wetland restoration in a changing world, *Wetlands Ecol Manage* (2009) 17:71–84, Springer
- Moinier S., (2013) Constructed Wetlands redefined as Functional Wetlands, Deltares SO MT Kennis.
- R.B.E. Shutes,2001 Artificial wetlands and water quality improvement - Environment International 26 pp. 441 – 447

- Moussa, M.I. and Abdelkhalek, A.M.(2007). Meteorological Analysis for Black Cloud (Episodes) Formation and its Monitoring by Remote Sensing. *Journal of Applied Sciences Research*, 3(2): 147-154
- Rasha El Gohary, MüfitBahadir (2017). Conceptual Economic Evaluation of In-Stream Engineered Wetlands, Agricultural Production, and Land Use-A Case Study. *International Journal of Current Engineering and Technology*. Vol.7, No.4:1610 -1621
- Salwa M. AbouElElla. Improve the drainage water using In-stream Wetland (Case study)-Egypt. *Nat Sci* .2014;12(6):96-104]. (ISSN: 1545-0740). <http://www.sciencepub.net/nature.14>
- S. Ganjali, K. Shayesteh, A. Ghasemi, H. Mohammadi,(2014) Environmental and strategic assessment of ecotourism potential in Anzali Wetland using SWOT analysis. *Caspian Journal of Environmental Sciences*. 2014, Vol. 12 No.1 pp. 155~164
- Sohair I. Abou-Elela(2017). Constructed Wetlands: The Green Technology for Municipal Wastewater Treatment and Reuse in Agriculture, Unconventional Water Resources and Agriculture in Egypt, Hdb Env Chem, DOI 10.1007/698_2017_69, Springer International Publishing
- Tennessee Valley Authority, Summit Hill Drive and Knoxville, Tennessee . (1997), Project Document Lake Manzala Engineered Wetland, United Nations Development Agency, New York, The United States
- The United States Environmental Protection Agency(2000) Wastewater Technology Fact Sheet Wetlands: Subsurface Flow, EPA 832-F-00-023September 2000
- Vymazal J. (2010) Water and nutrient management in natural and constructed wetlands. Springer Verlag London, UK
- Wu H, et al, (2015). A review on the sustainability of constructed wetlands for wastewater treatment: Design and operation, *Bioresour Technol*.
- Yang Wu., Chang Jie., Xu Bin., Changhui Peng, Ying Ge, (2008) Ecosystem service value assessment for constructed wetlands: A case study in Hangzhou, China, *ECOLOGICAL ECONOMICS* 68 pp.116–125
- Zhang D., Gersberg R. M., Kea T. S., (2009) Constructed wetlands in China, *Ecological Engineering* 35 pp.1367–1378