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A Comparative Study of Constructed Wetland Parks as a Model for Sustainable Parks

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Abstract: The world is facing many environmental challenges and ongoing crises that strongly affect the urban, cultural, social, and economic aspects of our life. These challenges gradually develop into major environmental problems, such as climate change and water scarcity in many countries around the world. Constructed wetlands are one of the environmental solutions that are used in many countries to achieve some sustainable goals like water management, flood water control, improved water and air quality, and increased biodiversity and habitats. In addition to being affordable and easy to operate, constructed wetlands are considered a practical alternative to traditional treatment systems. Constructed wetlands represent a natural ecosystem for water treatment, or in other words they are an artificial simulation of natural wetlands that effectively bring many economic and ecological benefits. While many countries have a history of successful and integrated experiences in this field, this research aims at clarifying the importance of using constructed wetlands as multi-purpose gardens, and it discusses these international experiences. The research also recommends conducting further studies in the field of constructed wetlands and using them as a multifunctional tool in Egypt.

Keywords: constructed wetlands, sustainability, sustainable parks, water management.

1. Introduction

Cities face great environmental, economic, and social pressures with the ceaseless increase in population, and these pressures include water scarcity, lack of green spaces, climate change, pollution, and general environmental degradation. With the increasing importance of recycling water in many ways to cover the water demand, constructed wetlands have emerged as a low-cost, easy-to-operate, and practical alternative to wastewater treatment. This technology achieves economic, environmental, social, and urban returns at both medium and long terms. The concept of constructed wetland gardens combines landscape features with ecological functions, thus succeeding in meeting cultural, aesthetic, and recreational needs.

2. METHOD

The research is based on a comparative study between three well-designed, internationally constructed wetland parks that have received international design awards, with subsequent evaluation of these case studies according to the indicators chosen from the theoretical study. This was followed by a set of recommendations on how we could make use of this technology in our Egyptian parks.

3. SUSTAINABILITY

Sustainability is defined as the optimal exploitation of available resources and capabilities, whether natural, material or human, in an effective and balanced environmental and urban manner to ensure the continuity of humanity. The achievement of sustainability in this way works to enhance the overall quality of life of existing groups and allow others to meet their needs in the present and the future.

The concept of sustainability was first referred to at the World Conference on Development and Environment in 1987 when it was formulated as “meeting the needs of people in the present without affecting future generations to meet their needs in the future”. During this conference, some definitions of sustainability were approved, such as sustainability represents the preservation of the ecological, economic, and social systems that make up the urban environment, or the process that involves dealing with resources in a harmonious manner which is compatible with the current and future needs of humanity. It can also be said that sustainability is the development procedures that endorse the quality of human life taking into consideration the degree of tolerance of environmental systems.

4. SUSTAINABLE PARKS

The main goals of sustainable parks’ design are to conserve natural resources such as water and energy, reduce waste and water runoff, and enhance the quality of life for all people around it [1]. To achieve these goals, gardens must deal with water and soil as valuable resources and conserve existing plants and other physical resources to be more efficient.

Designing a sustainable park must consider the use of native plants, wildlife habitats, and recycling to maintain the environmental value of gardens in addition to social values because sustainability is more of a social concept than a technical or biological one [2]. Sustainable parks respond to the environment, regenerate it, and can contribute to the development of healthy communities.

Sustainable landscaping isolates carbon, cleans air and water, increases energy efficiency, restores habitat, and creates value through significant economic, social, and environmental benefits.

4.1 Selected Sustainability Indicators

The sustainable landscape indicators have been studied by many researchers to understand the main factors that contribute to achieving the sustainability of landscapes, as well as the indicators from the global sustainable development goals of the United Nations, and the national sustainable development goals. The proposed framework focused on the three main pillars of sustainability: environmental, social, and economic. The indicators chosen must be relevant and reflect the process they aim to assess [3].

5. WETLANDS

A wetland is defined as a land in which the surface of the water is close to the surface of the land [4]. The definition that is adopted by the Ramsar Convention for Wetlands is: "Wetlands represent areas of swamps, marshes, peatlands, or waters whether being natural or artificial, permanent or temporary, with stagnant or flowing water, including the marine areas whose water depth at the receding waters does not exceed six meters, and may include coastal areas adjacent to wetlands, islands or marine bodies of water, with a depth of more than six meters at islands located within wetlands" [5].

6. CONSTRUCTED WETLANDS

6.1 Definition of Constructed Wetlands

Kadlec and Knight (1996) initially defined natural and constructed wetlands as areas where the soil is waterlogged. All wetlands that are created by man specifically to improve water quality as a primary objective are then called Constructed Wetlands. The water to be treated is very diverse and includes municipal, industrial, and agricultural wastewater, rainwater and surface water pollution in rivers and lakes. The main difference between natural and constructed wetlands is the origin of their landform [6].

Canadians have defined wetlands as lands that have a water level at, near, or above the land surface and have been saturated for an extended period enough to enhance the hydrological processes as indicated by aqueous soils, aquatic plants, and various types of biological activities that are adapted to the wet environment [7].

Thus, a constructed wetland can be defined as a synthetic wetland that simulates the functions of a natural wetland but in a more controlled environment, and its main purpose is to manage and purify water. It was applied in China in the Shanghai Garden Project which aimed to treat polluted river water and indeed the garden was able to purify 2400 cubic meters of polluted water per day from the fifth to the third level [8].

6.2 Importance of Constructed Wetlands

The benefits of constructed wetlands include the ability to improve water and air quality, save and conserve energy, improve habitats, enhance biodiversity, and improve quality of life and food production. Constructed wetlands have the advantages of lower construction, operating and maintenance costs due to minimal energy consumption and lower labor costs with a reduced need for waste disposal. Operational support in contrast to traditional gray systems is extremely reduced.

The importance of constructed wetlands is not limited to that only, but also includes environmental benefits such as power generation from biogas. It has been proven that aquatic plants that grow in the main and secondary banks such as the Nile rose plant can be efficiently used in biogas generation.

6.3 Constructed Wetland Design Indicators [9]

6.3.1 Water quality

Wastewater generated from sewage, rainwater runoff, or agricultural discharges is treated efficiently through various elements of constructed wetlands, such as filtration by plants, digestion by bacteria and algae, and soil absorption of pollutants. In addition, some chemical reactions and volatilization activities may also contribute to the elimination of these pollutants.

6.3.2 Water storage

Constructed wetlands can be used as temporary water storage bodies to manage rainwater runoff and provide protection against floods, as they are used as a water sponge to mitigate the effects of flood disasters and regulate water quantities.

6.3.3 Air quality

Trees and plants improve air quality, reduce the amount of greenhouse gases, and also reduce carbon dioxide levels.

6.3.4 Energy conservation

Constructed wetland treatment system does not require large energy consumption, unlike traditional treatment systems that have very high consumption rates of energy resources. Some constructed wetlands are also used for biogas power generation.

6.3.5 Habitat and biodiversity enhancement

The constructed wetlands are an excellent habitat for wildlife with a wide variety of flora and fauna.

6.3.6 Quality of life

In constructed wetlands, the aesthetic value is manifested through landscape design where water bodies are combined with different types of vegetation and thus have a distinctive role in increasing recreational opportunities for community members.

6.3.7 Food production

As the population increases, so does the required food expenditure. Constructed wetlands can provide a lot of food supplies by growing various plants in and around them.

7. SUSTAINABLE WETLAND PARKS

Constructed wetland technology meets the requirements of water and sanitation treatment and at the same time creates green spaces in the urban environment.

Wetland gardens are used to treat sewage, industrial and agricultural waste, and rainwater runoff, instead of using traditional methods of water treatment that consume enormous amounts of energy and chemicals and have high operating and maintenance costs. Wetland gardens provide recreational and educational activities, and a habitat for wildlife thus increasing biodiversity besides aesthetic values.

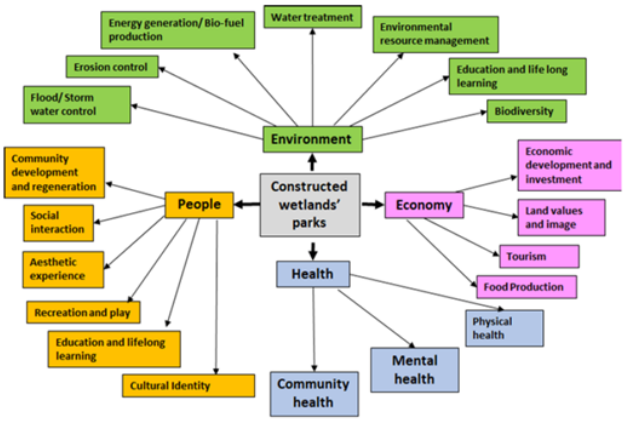

Fig 1: Values of wetland parks for sustainable communities [10]

International Case Studies:

This paper discusses and analyses three different wetland projects from different countries and climatic zones, that have succeeded in various fields of development and have positively impacted the sustainability of the community.

Criteria for selecting the case studies:

- Being a constructed wetland park.
- Being multifunctional and diverse parks.
- Being in diverse climatic zones.

7.1 Wadi Hanifa Development Project

7.1.1 Project location

Wadi Hanifa is the largest and most important valley near Riyadh, Saudi Arabia. It is a unique environmental site with a length of 120 km and an area of 4000 km2. It is located in the heart of the Najd Plateau. This eastern valley descends from the Tuwaij Mountains to the desert region southeast of the city of Riyadh [11].

Fig 2: Geography of Wadi Hanifa, KSA. [12]

7.1.2 Challenges

The valley was originally a natural reservoir for the drainage of rain waters runoffs, but many parts of the valley were then abused in an unfair and destructive manner to the environment like disposing the municipal and factory waste into the valley until the deterioration reached its maximum limits. The area that receives this drainage or watershed is more than 4000 km2 [13].

7.1.3 Design methodology

The design methodology is to transform the problems and challenges of the valley into a new opportunity and preserve and protect the environment and turn it into a strong element in the region. The most vital component of the project was to restore the valley to its nature that fits with the arid desert environment in Riyadh. This has resulted in creating a new landscape of desert greenery and limestone rocks that blend perfectly with the surroundings.

Figure 3: Visitors enjoying the water and natural rock formations in Wadi Hanifa [14]

7.1.4 Project analysis

The project design is harmonious with the desert nature of the region and the culture of Saudi society, where nature and natural materials such as stones were extensively relied upon.

- Paths: pedestrian paths are designed in a way that allows the public to reach places of interest easily. The length of the pedestrian paths is 47 km, and the length of the paved paths is 7.4 km. The pedestrian paths consist of dust paths paved in a way that allows smooth movement for pedestrians, and strollers for children and the disabled, and they are protected by rocky formations on both sides that function as delineators for the paths. These paths are equipped with seating areas and sites prepared as picnic breaks.
- Seating places: Wadi Hanifa project provided several seating areas in the open spaces near the water and gardens along the valley and expanded to the surrounding recreational areas. There are also spaces for families in the form of semi-enclosed areas with greater privacy, areas to interact with nature, barbecue areas, and shaded areas along the park. All these specialized spaces are surrounded by limestone walls. Stones and other materials used for seating are of natural sources and were utilized as part of the design.

- The design of the park: the design was concerned with satisfying the needs of different age groups. Attention was paid to people with disabilities in the Wadi restoration design. The design is generally suitable for the nature of the place and is in harmony with the desert characteristics of the region.
- Water elements: this project has succeeded in providing good water treatment outcomes while creating a unique natural space. A series of natural stone dams are built to introduce oxygen into the water as it passes through the stones. This helps reduce the amount of water pollution in the valley and works as a tool to control the speed of the water to achieve the highest level of water purification.
- Plant elements: the process of restoring the vegetation cover in Wadi Hanifa started on a set of foundations, the most prominent of which were: re-planting the plants that were previously among the components of the valley in the past and adopting a level of dense forestation that can be preserved with own natural capabilities of land and groundwater. More than 35,500 shading trees, 6,000 Palm trees, 2,000 Acacia trees, and a total of 50,000 shrubs have been planted covering more than 70 km of valley basins, and 35 acres have been planted with local herbs and perennials.

7.1.5 Project benefits

This project achieved many economic, social, and environmental benefits. At the economic level, the project yielded agricultural revenues from the use of pure water in addition to fish reproduction in the lakes and fish farms around the valley. Also, this project led to an increase in real estate prices. With water scarcity in many developing countries, this project represents a cost-effective way to produce clean water and help create a healthy environment that supports welfare.

At the environmental level, 17.7 million cubic feet of industrial and municipal waste were removed. Riverine habitats were increased by planting 115 acres with local plant species and 35 acres with local herbs and perennials. These areas extended by an additional 47 acres between 2010 and 2015. The project supports 15 types of birds, 9 types of fish, 3 types of mollusks, 2 types of amphibians, and 3 types of reptiles. It also succeeded in reducing the use of drinking water for gardening and irrigation facilities by 92.5 million gallons per day by using biologically treated urban wastewater instead [15].

At the social level, the new garden has become a place of joy and recreation for the residents and visitors of Riyadh who were able to spend pleasant times with family or friends because of its widespread public facilities, footpaths, toilets, barbecue places, and other activities. This project is considered a model for the integration between gray and green infrastructure because of the comprehensive planning and distinctive design that value the nature element [16].

Fig 4: Social areas and family activities [17]

7.2 Weiliu Wetland Park

7.2.1 Project location

This project is located in Xianyang, China, with an area of 1.25 km2. It is about 3,200 meters long and 470 meters wide. This project is designed by Yifang Ecoscape and completed in May 2017.

Fig 5: Location of Weiliu park [18]

7.2.2 Challenges

The project site had several key issues: the natural floodplain had been significantly altered due to rapid urban construction, which put more flood pressure on the site. The area adjacent to the urban estuary has also been urbanized causing significant loss of local habitat and biodiversity. The northern side of the site was at a higher level and most of the land was occupied for small industrial activities while other plots were used as vegetable gardens and lotus ponds by the citizens. In the south on the lower side, there were many deep pits, due to the improper mining of sand. This led to the cumulative discharge of sewage and rainwater into the river. A plan to establish a new green infrastructure was developed through a series of strategies: adaptive flood control, water quality improvement, wastewater reuse, and biodiversity restoration.

7.2.3 Design methodology

The project focused on the following set of design goals to achieve:

- Creating integrated green infrastructure.
- Water purification and the establishment of wetland parks.
- Flood control.
- Entertainment.

The project was divided into four areas:

- A green path moved through the middle of the garden and represents the main backbone of the garden surrounded by willow trees. All the trees were kept and quickly became a unique scenic feature of the park.
- Active Park and Recreation Park: designed at the high-altitude area (380.0 ~ 383.1 m) which can withstand 20-year flood events (7,080 m3/s). As this area has the least flood risk on the site, it is designed to provide rich waterfront experiences for residents through various entertainment venues, including a green path, waterfront plaza, opera amphitheater, orchards, floor gardens, exercise spaces, cafes, kiosks, etc.
- Constructed wetlands: designed at the area of medium elevation (380.60 ~ 382.70 m) where it can withstand flood events for 10 years (5,910 m3/s). This area consists of subterranean and surface wetlands for wastewater flow and flood retention, acting as a barrier between the city and the river and creating spaces for recreational activities such as walking, fishing, and picnicking in the wetland area.
- Nature wetlands: designed at the low elevation area (374.0 ~ 381.0 m) with the risk of 5-year floods or precipitation. As a floodplain area, this area was designed to protect and restore natural wetlands and adapt to changing water level in the river. The stones have been created as a path for visitors to walk along.

Fig 6: Weiliu Park site plan [19]

7.2.4 Project analysis

- Paths: pedestrian paths are designed flexibly. As for the paving materials, they are varied. The main path of the project is paved with colored asphalt, and there are wooden paths and stone paths integrated with green spaces. Most of the hiking trails pass over wetland basins, so visitors can enjoy the water.
- Seating places: the project provided several seating areas, including stone benches near water and green areas. There is also a quiet yard with wooden benches for gathering and rest.
- The interior design of the park: the design of the garden was concerned with providing the needs of different age groups. This was manifested in the presence of designated places for children to play and interact with water in a safe way and the diversity of functions and activities for the spaces within the garden. The internal paths helped reach the various spaces easily. Activities are diverse and engaging, the colors that dominate the project are so cheerful that they create an artistic experience in nature.
- Water elements: small dams re-oxygenate the water while also becoming a play feature. Wetlands are designed in the area that enhances water quality. Water terrace is built for aeration, and aquatic organisms such as fish can prevent algae growth which helps maintain water quality. The polluted wastewater is collected to the treatment plant and then to the constructed wetlands for purification, and then it is used for irrigation or recreational activities such as the water playground and others. The water quality stabilization area is designed as a landscaped wetland surrounded by waterfront paths and platforms. Then the pure water flows into the shallow pools in the waterfront square, where visitors can rest, and children can play with water.
- Plant elements: existing trees were preserved as well as nectar plants and reed ponds. The design applied a slight morphing of the soil and careful replanting of trees and shrubs and some aquatic plants including Nelumbo Nucifera, Arundo Donax, and Acorus Calamus which were introduced to restore habitats and shelters for riverine animals and amphibians.

Fig 7: Water features in Weiliu Park for children [20]

7.2.5 Project benefits

The project achieved many social, economic, and environmental benefits [21]:

- Economic: the cost-benefit study showed that the average construction cost of the park is less than a third of similar local parks in the city, in addition to an increase in the value of the real estate in the neighboring areas.
- Social: the park's social benefits were reflected in the results of a general survey which mentioned that of the 462 valid questionnaires received, the overall satisfaction rate for the new park was 94%, with satisfaction rates for rest, nature experiences, children's leisure, and recreational activities for the elderly at 90%, 86% %, 77%, and 80% respectively. The park also provides diverse entertainment experiences and opportunities for audience engagement and offers environmental education for citizens.
- Environmental: the constructed wetland can treat about 8,000 cubic meters of wastewater per day on average, with the total amount of water reused after treatment reaching 2.4 x 106 m3 annually. In addition to water quality improvement, the constructed wetlands provide opportunities for environmental education and experiences and increase the biodiversity of the site.

7.3 Sydney Park Water Re-Use Project

7.3.1 Project location

The Water Reuse Project at Sydney Park in Australia is one of the city's largest environmental projects and forms an integral part of Sydney's Sustainable Strategy 2030 and targets meeting 10% of water demand through domestic water collection and reuse in the park. This project is located in Sydney Australia with an area of 16,000 square meters. The project was established in 2015 and was designed by Turf Design Studio, Environmental Partnership, Alluvium, Turpin, Crawford, Dragonfly and Partridge.

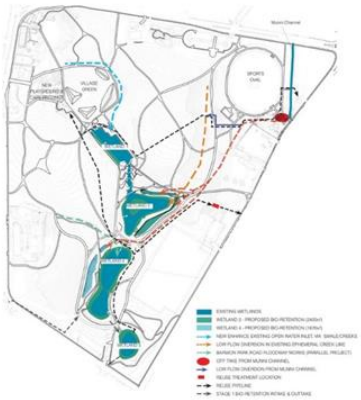

Fig 8: Sydney Park Site Plan [22]

7.3.2 Design methodology

The design methodology is to connect water, people, topography, urban life, plant life and nature. Wastewater from urban areas is collected in the project's wetlands, treated, and disinfected for reuse within and outside Sydney Park and nearby industries. Also, rainwater is collected, purified, and then used to fill the swimming pool every day, providing a sustainable supply for the garden. The cost of this system was $11.3 million.

7.3.3 Project analysis

- Paths: pedestrian paths are designed in a way that allows the public to reach places of interest easily. As for paving materials, some paths are paved with asphalt, and there are also wooden paths.
- Seating places: seating places were distributed on the sides of the pedestrian paths (wooden benches), and seating areas were provided also at the water elements.
- The interior design of the park: the design was concerned with providing the needs of different age groups, especially the places designated for children's games that were sufficient and varied. The design relied on the diversity and proximity of activities within the park, as it provides cafes and barbecue spaces near the children's bike path and near the wetlands and public toilets in the park. The internal paths helped people reach these various spaces easily.
- Water elements: the project provides the largest water collection system in the city, where 850 million liters of rainwater are cleaned annually. It also includes a group of waterfalls. Showing water flows and water reuse was an important part of the project, as it highlights the intrinsic relationship between water, urban life, and people and raises awareness of water's importance.

Fig 9: Social activities in Sydney Park [23]

7.3.4 Project benefits

This project achieved many economic, social, and environmental benefits:

- Economically: it saves the costs of water treatment and purification, provides job opportunities for community members, and increases the value of neighboring properties.
- Socially: the park provides various social activities that can be funny, exciting, and calm, all of which are related to water.
- Environmentally: this technology captures and cleans about 850 million liters of rainwater per year. The project provides the largest water collection system in the city and increases the biodiversity of the site. The wetlands attract new wildlife to the park which includes the largest number of local bird species in the area including 22 wetland species [24].

7.4 Comparative Analysis of Case Studies

Project	Wadi Hanifa	Weiliu Wetland Park	Sydney Park
Location	Riyadh city, Saudi Arabia	Xianyang city in China	Sydney city, Australia
Area	4000 km2	1.5 km2	16 km2
Project cost	160 million dollars	13 million dollars	11 million dollars
Design methodology	The design methodology is to transform the problems and challenges of the valley into a new opportunity and restore the valley to its nature, matching with the arid desert environment in Riyadh.	Establishing an integrated green infrastructure for water purification and flood control.	The design methodology is to connect water, people, topography, urban life, plant life, and nature.

Paths	Pedestrian paths are designed in a way that allows the public to reach places of interest easily. Pedestrian paths consist of dust paths paved in a way that allows movement They are protected by rock formations that mark trails and are provided with seating and picnic resting sites.	The pedestrian paths in the garden are designed to allow passing over the wetland basins so that visitors can enjoy the water. As for the paving materials, the main path of the project is paved with colored asphalt, and there are wooden paths and stone paths.	Walking paths of stone are designed above the bodies of water as starting points that help people to explore the water treatment systems. As for paving materials, some tracks are paved with asphalt, and there are also wooden tracks.
Entries	The project was keen on traffic safety, as the entrances to the project are not on the highway.	There are many entrances to the project from the main street and each entrance has a car park next to it.	There are many entrances to the project in every direction, and they are suitable for the project site. It includes 4 parking spaces which are located in convenient places around the park.
Places to sit	Open spaces are provided near the water and gardens There are private areas for families in the form of semi-enclosed camps. There are areas to interact with nature, barbecue places, and shaded areas along the park. Each of these chambers is situated on a stepped platform surrounded by limestone walls.	The project provided several places to sit including stone benches near water and green areas.	Seating areas have been distributed along the sides of the pedestrian paths, wooden benches, and by the water elements.
Water elements	A series of natural stone dams are built to oxygenate the water as it passes.	Small dams re-oxygenate the water to the wetlands and at the same time become a feature for play.	The project offers the largest water harvesting system in the city and it contains a group of waterfalls.
Plant items	Vegetation that was once a component of the valley has been replanted with more than 35,500 shading trees, 6,000 palm trees, 2,000 acacia trees and a total of 50,000 shrubs covering more than 70 km of the valley basins.	Existing trees were preserved as well as nectar plants and reed ponds. The design applied a slight morphing of the soil and careful replanting of trees, shrubs, and some aquatic plants.	The project had 22 species that attracted new wildlife to the park.
Environmental benefits	About 17.7 million cubic feet of industrial and municipal waste are removed annually. The project supports 15 species of birds, 9 types of fish, 3 types of mollusks, 2 types of amphibians, and 3 types of reptiles. It reduces drinking water consumption for gardening and irrigation purposes by 92.5 million gallons per day by using biologically treated urban wastewater.	The constructed wetland can treat about 8,000 cubic meters of wastewater per day on average with the total amount of water reused after treatment reaching 2.4 x 106 m3 annually. In addition to water quality improvement, it increases the biodiversity of the site.	This technology captures and cleans around 850 million liters of rainwater per year. The project introduces the largest water harvesting system in the city, increases the biodiversity of the site, and attracts new wildlife to the park, which has the largest number of native bird species in the area, including 22 wetland species.
Social benefits	It has become a place of entertainment and recreation for the people of Riyadh to spend time with family and friends because of its public activities, footpaths, toilets, and barbecue places and other activities.	The social benefits of the park were reflected in the results of a public survey which mentioned that the overall satisfaction rate for the new park was 94%. It provided diverse entertainment experiences and opportunities for audience engagement and promoted environmental education for citizens.	The park provides multiple social activities in the landscape that can be playful, exciting, and peaceful, all of which are associated with water.
Economic benefits	The project generated agricultural revenues from the use of pure water, and there was fish reproduction in the lakes and fish farms surrounding the valley, and this project also led to an increase in real estate prices.	A cost-benefit study showed that the average construction cost of the park is less than a third of similar local parks in the city, in addition to an increase in real estate values in the surrounding areas.	It achieved good savings on water treatment and purification costs, provided job opportunities for the community, and increased the value of existing nearby properties.

8. RESULTS

According to the theoretical and analytical study, constructed wetlands are a low-cost technology that can be combined with gray infrastructure to achieve many social, economic, and environmental activities.

Constructed wetlands represent a solution to several urban and climatic problems, such as the heat island effect,

high levels of pollution in Egyptian cities, and wastewater and rainwater management. They are an effective alternative because of their low cost and energy savings.

Constructed wetlands are a good example of increasing biodiversity as in Sydney Garden, providing a strong economic impact from agricultural areas as in Bahr El Bakar project.

Wetlands increase community cohesion and participation, in addition to raising community awareness of the importance of water and its preservation.

9. RECOMMENDATIONS

According to theoretical and practical studies, this technology is economical and easy to implement in the Egyptian climate as tool for managing water problems in Egypt, which suffers from water poverty.

At the state level: scientific and executive institutions must cooperate to apply this technology and benefit from it at the largest scale of Egyptian cities, with the help of research and studies that empower the investment in this technology to achieve economic and environmental returns in the long term.

At the level of cities: the construction of these wetlands must be repeated within cities so that they are multi-functional and combine entertainment and functionality and integrates gray and green infrastructure and green infrastructure.

On the social level: the community must be involved at every stage of the project (planning, designing, and implementation).

At the academic level: the research found a deficiency in landscape research in this regard despite the huge number of faculties of architecture in Egypt.

The research also recommends conducting more research in the field of constructed wetlands and their use as a multi-functional tool.

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