



*International Journal of Development and Sustainability*

ISSN: 2168-8662 – [www.isdsnet.com/ijds](http://www.isdsnet.com/ijds)

Volume 3 Number 7 (2014): Pages 1638-1661

ISDS Article ID: IJDS14061701-2



# The introduction of a greeno-meter as a tool for measuring the environmental efficiency of green infra structure master planning: A study of Port Said city, Egypt

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## Abstract

Open spaces systems are at the top of the design hierarchy because of their wide environmental benefits. Parks, green areas, gardens, courtyards, gardens at schools and workplaces, are all example to explain what we mean by urban green open spaces in this research. All these greenery items in the city, with other city planning elements, such as buildings, squares and roads, form the main structure of the cityscape. Today the urban development threats which are attacking our city spaces are numerous, leading us to realize that we must protect the city networks of open space; a green infrastructure master plan (GISMP) framework provides this strategic approach. But how efficient that approach is? This paper aims to develop a tool to evaluate the environmental efficiency of the GISMP when applied. In addition to revealing the potential for urban design where a green infrastructure approach is applied to decrease the impact of redevelopment on the quality of life in situations dealing with population growth and urban sprawl.

**Keywords:** Green infra structure; urban landscape planning; greeno-meter; open spaces; ecological sustainability; the city of Port Said

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**Cite this article as:** Refaat, M.H. and Ahmed, H.F. (2014), "The introduction of a greeno-meter as a tool for measuring the environmental efficiency of green infra structure master planning: A study of Port Said city, Egypt", *International Journal of Development and Sustainability*, Vol. 3 No. 7, pp 1638-1661.

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## **1. Ecological sustainability; a trend in the landscape planning process**

In recent decades there has been a rapid progress in landscape ecology from its traditional centre of study in Europe to the rest of the world. According to Huyck (1994), Ecological planning or landscape planning was developed over the course of three quarters of a century through the work of several men, as detailed by Steiner et al. (1998). These men included, for example, Patrik Geddes, a Scottish botanist who advocated surveying an area to determine its capabilities and limitations, then developing a land use plan based on the results of the survey. Warren Manning, a landscape architect, developed the map overlay technique for conducting such surveys, in about 1913 (Li, F., et al 2009). This technique involved mapping the natural and cultural resources of a place and then overlaying the maps to identify areas suitable for certain types of lands uses, such as urbanization or agriculture. The urban historian Lewis Mumford found that unplanned urban growth and development led to such problems as cities being built on major floodplains, and advocated the use of ecological information in urban planning. Benton MacKaye took all of these ideas in the 1930's and applied them in his work with Tennessee Vally Authority as an environmental engineer. In 1969 Ian McHarg formally lay out (and popularized ecological planning as method of regional planning in his book, *Design with Nature* (Huyck, 1994). Thus, there can be a close correlation in planning for aesthetic, recreational, and biodiversity objectives. Biodiversity clearly gains from association with a wider approach to open space planning (Rookwood, 1995). According to Groot (2006) the ecological sustainability can be understood as the natural boundaries of the carrying capacity of the natural environment (physically, chemically and biologically), so that the impacts of the human use does not irreversibly impair the integrity and proper functioning of its natural processes and components. Opdam (2006) pointed out that landscape planning was defined as "the use of biophysical and socio-cultural information to suggest opportunities and constraints for decision-making about the use of landscapes". His handbook takes sustainability as a basic goal for landscape development it does not provide indicators for ecological sustainability or methods for relating ecological sustainability to the interests of people and the economy in decision-making. With respect to species diversity, a landscape is ecologically sustainable if two conditions are fulfilled. First, the long term persistence probability of the target populations to an unacceptably low level must not be pushed by the changes that are associated with landscape development in the spatial pattern of the landscape. Second, the ecological processes required for resilient populations in respect of a species diversity target and the spatial scale that is ecologically relevant to that target should be supported by the special pattern of the landscape. A third condition is related to the transfer of knowledge: local and regional actors deciding about landscape and land use changes should be able to apply these conditions in a complex planning and design process, even in the absence of expert knowledge about ecological processes (Opdam et al., 2006).

### **1.1. The evolution of the green infra structure networks phenomena**

Green infra structure networks are: indispensable to acquire ecological sustainability, compared to planning based on land suitability alone; allow landscape change without losing the conservation potential for the conservation target; allow stakeholders to negotiate about the area and configuration of the ecosystems

network in the planning area, the use of the network for other functions and the land use in the surrounding landscape, while maintaining a realistic 'ambition level' for conservation ( Ji ,2010).

The IUCN (1992) pointed out that sustainable development is a widely accepted strategic framework in decision-making about the future use of land. However, ecological sustainability is not yet well developed in landscape planning. Green networks can bridge the paradox between reserve conservation (fixing nature in space and time) and development, which implies change (Rookwood, 1995). This is because Green networks can change structure without losing their conservation potential. Thirdly, Green networks facilitate stakeholder decision-making on feasible biodiversity goals (Opdam et al., 2006).

The Green Master Plan methodology should consist of the following steps (Huyck, 1994, p. 124):

- State the objective of the study; define the issue(s) being addressed.
- Do an ecological inventory to define the parts of the system.
- Analyze the parts for the system to show how they work.
- Synthesize to show the interactions between parts.
- Present alternatives for organization of the environment.
- Implement the chosen design.
- Evaluate the results over time.

Now a day, People need a neighborhood that has clear system of streets with short blocks, one that is pedestrian friendly and vehicle friendly. This research focuses on the shortage of green infrastructure in urban design and the scope involves the examination of application of green infrastructure elements, environmental benefits, and improved urban connectivity. All the current city redevelopment projects and government plans are dealing with population growth; urban sprawl and environmental issues, there are still potential problems and concerns about the shortage of green infrastructure (Ji, 2009). Ecology and planning have many common interests; ecology concerned with the functioning of resources, planning focusing on their appropriate use of human's benefit. Planning cannot be achieved without due consideration to ecology (Rookwood, 1995). Ecological sustainability of landscapes can only be achieved on the basis of large-scale cohesive patterns of ecosystems. For planning multifunctional landscapes, green networks are an effective basis for ecological sustainability. Sustainable ecologically-based approaches to planning and management are desirable, and their application is widely advocated.

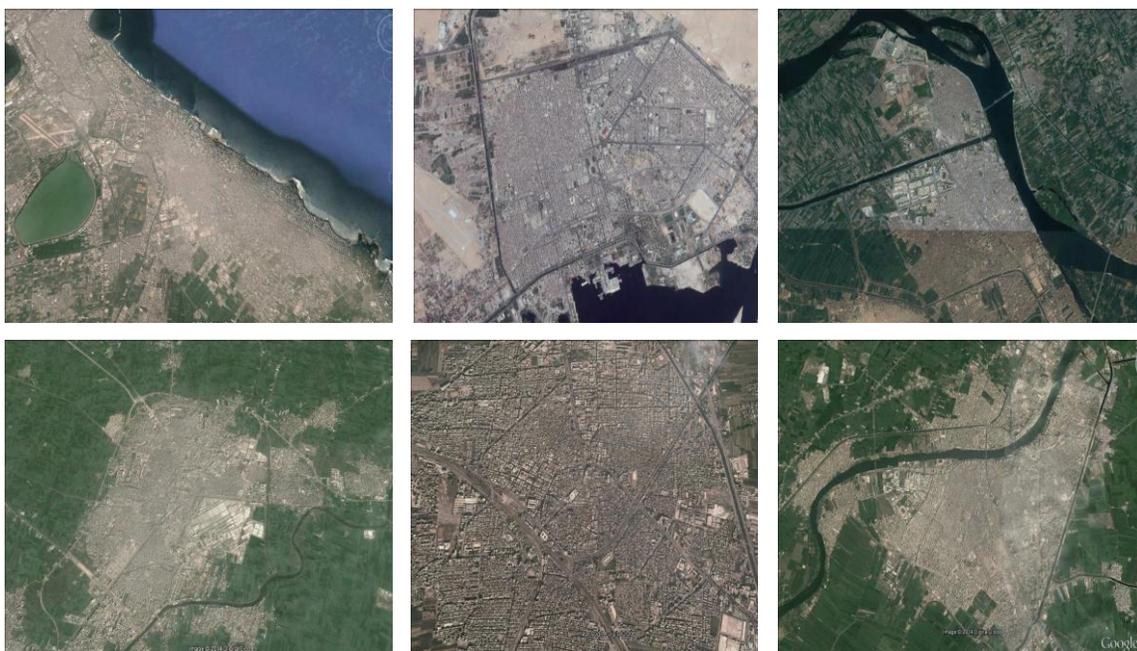
## 2. The Egyptian city illness symptoms

There is scarcely a landscape anywhere in the world which has not been modified as a result of human activity. Over the vast majority of the world's terrestrial surface, nature and culture are inextricably interwoven in a complex pattern of landscape modifications and management practices which serve a great diversity of human objectives (Rookwood, 1995). In Egypt, the Nile valley has concentrated human settlement, since for centuries it has represented an attraction for agricultural activities and formed a favorable environment for human occupation. Today, the populated regions represent only 4% of the country's total area (GOPP 2010). Population density is increasing dramatically in the Nile Delta and valley

and now exceeds 1200 person/km<sup>2</sup> (Yassin, 2013). For this reason, the nation is paying considerable attention to the development of Egyptian deserts in order to redistribute the population and to release the intense pressure on the cultivable land of the Nile valley (Ayad, 2005). In order to have an overall description of Egyptian status diagnoses, a global perspective of dividing the planning process into levels is considered.

## 2.1. Planning Level

In the last three decades, Egyptian Cities have transformed into very dense concrete blocks transforming all open green spaces into a left over tiny little negative spaces in the cities urban fabric, destroying much of their natural habitats. This change in the landscape fabric was not of concern to the governments as well as the local communities. Imam (2006) clearly highlighted that the governance framework for implementing sustainable landscapes is not in place, the need for contiguous landscape stewardship, and reduce over regulation and bureaucracy to balance bottom up and top down approaches. Land lots took over all the greening measures, land parcels invaded all what's left as open spaces. Boulevards and high speed roads took over pedestrian walkways (Yassin, 2013). Figure 1 shows how the growing concern of the upper middle class Cairo residents over the problems of pollution, overcrowding, and quality of life deteriorations a whole, within the city limits, have affected the promotion of many new real-estate developments, as a move to newly developed satellite cities on the outskirts of Greater Cairo. The artificial scenatic landscapes, of lush green open spaces , which contrasts with the surrounding landscape, instead of seeking the conservation of the natural habitats or even understanding and integrating with the natural ecosystems, was the trend by the real estate developers, for marketing purposes in order to attract the Cairo residence (Yassin, 2013).



**Figure 1.** Sample of the existing status of the Egyptian cities, showing the greenery planning status in Egypt (Source: Google satellite maps.)

## 2.2. Urban design level

As we have mentioned earlier, the Egyptian Cities lately, experienced remarkable changes due to overpopulation problem and lack of planned distribution of people, that led to the emergence of major urban problems leading to the deterioration of the quality of life, in the form of the inadequacy of services and utilities, deterioration of historical areas, reduction of fertile land, spread of informal settlements. Also, open space in the urban/suburban environment became a scarce and valuable resource. All these aspects as well as the symptoms of deterioration of ecosystem resources, environmental degradation, water scarcity and poorly distributed benefits are all becoming very noticeable as a result of unhealthy suburban-style development. A sustainable landscape planning perspective is highly required in the Egyptian planning process, as to preserve or restore urban open space solely as habitat for wildlife is seldom successful, due to the greed and hunger of the private, before the public sector, to convert these spaces to commercial or intensive recreational uses are immediate and intense (Johnson, 1995). Egypt belongs to hot and arid climatic zone, hence, the ecological element threshold method is, in practice, one of the best methods to control the quantity of green space. One of the new landscape phenomena's in the Egyptian landscape planning context is the introduction of Golf courses in the gated communities to act as an open green space. Deister (2013) has investigated the phenomena of golf courses in Egypt, from an environmental efficiency point of view; Golf course has proved to have little impacts on controlling hot and dry climate of these residential projects. They visually minimize the negative effects of urban development. But from an ecological perspective, they don't preserve the natural resources and conserve the ecology of the site. In addition, golf courses utilize more public space, consume a great amount of much needed water, increasing costs and requiring high maintenance. Socio-cultural negative impacts are also considered as it decreases the private or semi-private spaces for communal gatherings which are an important socio-cultural norm in the Egyptian context, and provide no safe haven for children to play. Over and above, Imam (2006), proves that golf courses do not constitute an economically viable solution for planning residential developments in Egypt (Figure 2).

The Egyptian cities lack opportunities for integrating the open-space system, transportation system, and storm water management within a green infrastructure design concept to create a livable, sustainable city and balance the availability of land use with conservation of the natural and built environments, and that redeveloping and planning green spaces and urban structure should become the fundamentals of the sustainable urban landscape planning of the Egyptian city. Also in the Egyptian cities in areas of rapid growth, remnants of the past are easily lost. As they are removed, the landscape loses its unique local heritage and takes on the homogenous character of a place recently built. As a result of the rapid speed of degradation in all aspects of the landscape, ecological as well as cultural, there is an urgent need for a better understanding of the interactions between the landscapes and the cultural forces driving them in order to have a sustainable management, leading to the necessity of a Green infrastructure plan to the Egyptian cities (Yassin, 2013).

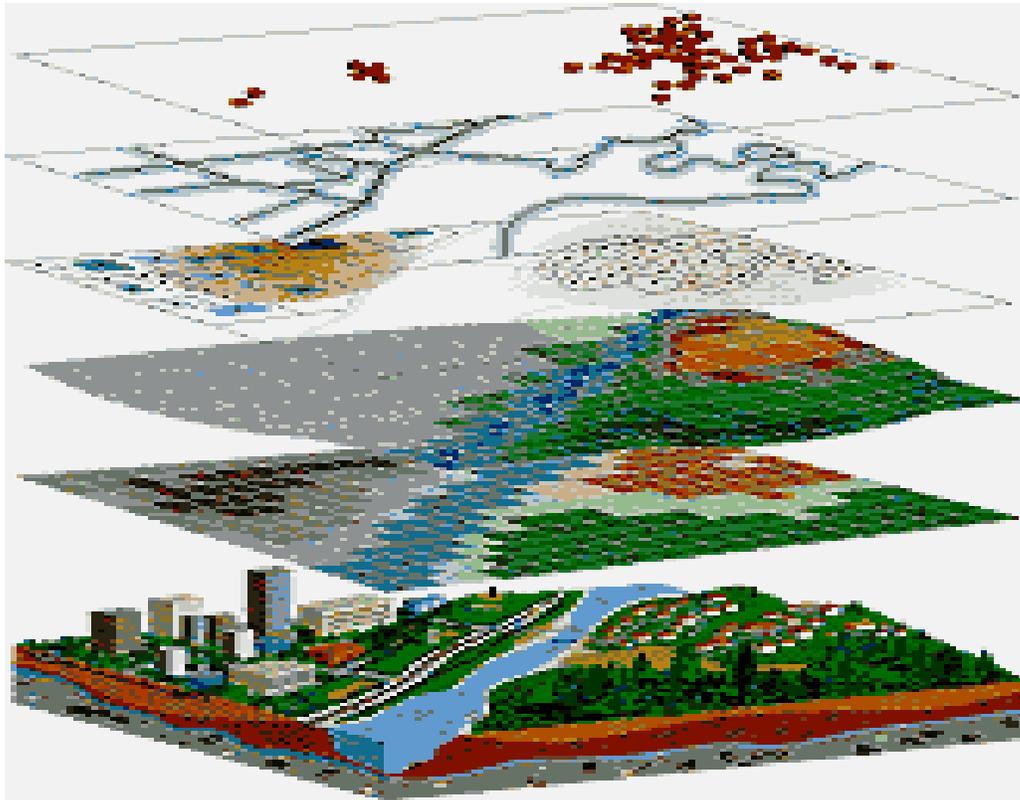


**Figure 2.** Sample of the existing Urban open spaces in the Egyptian cities varying from gated communities showing the golf course concept of green spaces in Egypt, and the ordinary Egyptian cities open spaces network infra structure (Source: Google satellite maps)

### 3. The Green Infra Structure Master Planning Concept (GISMP)

Green infra structure master planning involves designing landscape management plans based on the natural ecosystem properties of the landscape in question, as well as on the needs of the humans who interact with the landscape. Landscape planning as a method has its roots in the philosophical tradition of viewing nature as teacher rather than servant, and humans as part of rather than separate from nature (Huyck, 1994). It is a

method for regional planning that appears to have begun with the general idea of looking to nature for inspiration in decision-making about human activity.



**Figure 3.** The Layer Cake System as a concept in the Green Infra Structure Master Plan (Source: Antrop, 2006, p 24)

Green infra structure master planning provides the theoretical framework, explicit methodology, and flexibility needed to answer long-terms, holistic, systems-level questions about sustainable ecosystem management; it provides a bridge between social goals and biological action. According to Hassan (2011) Green infra structure master planning is the study of interactions among landscape elements. It has provided a foundation for planning landscapes in general and green networks in particular. Green infra structure master planning principles enable us to achieve an integral understanding of the development of landscapes, since it deals with their structure, functioning and changes occurring in them. This insight is considered as a framework that assists to distinguish key ecosystems for maintaining biodiversity in landscape. The evolution of Green infra structure master planning as a distinct discipline has placed emphasis on measuring and mapping the landscapes' physical elements (structure and pattern) in order to associate them with processes (Franke, 1996). In addition to documenting land use and related (structural) changes, a number of other countryside/landscape properties such as visual, aesthetic and acoustic properties and their changes

have also been of great interest to landscape planning and management (Morse et al., 2011). Ji (2009) pointed out that green infrastructure is seen as a conceptual framework providing real ecological, economic, and social benefits, an interconnected network of park systems and a wildlife corridor that preserves ecological function and creates a balance between built and natural environments. Stigsdotter (2005), mentioned that green infrastructure refers to either green features or environmentally friendly engineered structures, such as a substructure or underlying facilities, constituting a conservation network that addresses the ecological and social impacts of sprawl and the accelerated fragmentation of open land. Li (2009) suggests that green infrastructure involves natural and managed green areas in both urban and rural settings, which concerns the strategic connection of open green areas and the provision of multiple benefits for people. Ahren (1995), describes the term as constructed and natural open spaces, ranging from parks and playgrounds to farm lands, stream valleys, forests, and mountains. In urban areas, open spaces refers to parks and urban forestry, which can reduce energy usage costs and create clean, temperate air (Ji, 2010). Li (2009) developed an ecological concept planning of urban greening in Beijing, China. They proposed three spatial scales for “green space” planning, including: regional scale (i.e., the entire area of the province); the city scale (i.e., the urban area with its suburbs and the surrounding urban zone) and the neighborhood scale (i.e., typical areas within the urban area). In this research we shall focus on the city scale level.

### 3.1. The green infra structure master plan principles and components

The American Society of Landscape Architects describes green infrastructure at two scales: national or regional level, and urban level. The national or regional level refers to interconnected networks of park systems and wildlife corridors; and the urban level refers to parks and urban forestry, but also to green roofs, walls, and other techniques to reduce energy consumption and storm water runoff (Opdam et al., 2006). Ecological land use patterns are divided in to three groups: “connected wildlands”, “productive rural areas” and “compact towns and cities” (Johnson, 1995). There are four aspects which forms the pillars of any ecological network; area, quality, density and permeability of the matrix. In planning, these four features can be used as four spatial strategies to design ecologically sustainable landscape. The planners developed a Green Infrastructure master planning (GISMP) to guide and contain urban expansion (Opdam et al., 2006). The GISMP is a structural network within the landscape consisting of the threatened landscape elements and of areas with a specific strategic importance. The goals of the GISMP are to preserve the integrity and identity of the natural and cultural landscape, to maintain a sustainable, functioning ecosystem, to protect cultural treasures and to provide recreational opportunities. Green infrastructure as an interconnected network to conserve natural ecosystem values and functions, sustain clean air and water, and provide a wide range of benefits to people and wildlife. Green network can create a meaningful contribution to more livable cities by bringing together planning and ecology. They associate people with nature and bridge the gap between human needs and natural processes in rapidly urbanizing regions in the developing world (Morse et al., 2011). In conclusion, greenways are the backbone of any urban. They are the links and nodes, the green lungs that give a development its landscape character. They form an environmentally pleasant web of overlapping networks pedestrian, cycle-ways, not only express scenatic value but also have ecological and environmental

importance (Fabos and Ryan, 2004). Ji (2010) mentioned that Benedict & McMahon (2001) summarized seven principles or initiatives for a successful GISMP:

- **Principle 1:** To plan and protect interconnected green space systems, successful initiatives can be used as the framework by sharing similar strategies
- **Principle 2:** Design and plan green infrastructure before development. Restoration of natural systems is far more expensive than protecting and preserving existing landscapes. It is essential to identify and protect critical ecological sites and linkages in advance.
- **Principle 3:** Linkage is a key point. The network of different system components is critical to maintain vital ecological processes, services and biodiversity of wildlife populations. Green infrastructure also requires linkages among different agencies, nongovernmental organizations, and the private sector.
- **Principle 4:** Green infrastructure functions across multiple jurisdictions and at different scales, which means green infrastructure systems should connect across urban, suburban, rural and wilderness landscapes and strategically incorporate green space elements and functions at corresponding scales.
- **Principle 5:** Green infrastructure is grounded in sound science and land-use planning theories and practices, with disciplines including conservation biology and landscape ecology, urban and regional planning, and geographic analysis and information systems.
- **Principle 6:** Green infrastructure, as a critical public investment, should be included in the annual budget. Resources should be tapped in state and federal agencies for planning and management activities.
- **Principle 7:** Green infrastructure involves diverse stakeholders, with stakeholders of the initiatives having diverse backgrounds and needs. Successful green infrastructure efforts forge alliances and interrelationships among various organizations (Fabos and Robert, 2004).

From Table 1, in conclusion land development in particular can have a negative impact on diversity within most ecosystems. Because open spaces and natural systems are important to the future of cities, it is critical for communities to plan and develop such spaces and systems as an integral part of the urban fabric. Also, connectivity is a positive attribute of urban design. Green infrastructure is fundamentally a network of networks by connecting green infrastructure elements, these elements, spaces, multi-user routes or cycle paths are linked as networks. In addition, these linkages have ecological, recreational, amenity and aesthetic outcomes, which are enjoyed by users. This systems network shows that systems are not only connecting elements within themselves, but also one to another, forming multiple layers of "lines" to link streets, pedestrian ways, open spaces, and storm water features which are physically scattered throughout the district (Ji, 2010). In addition the guiding principles for the development of the (GISMP) should be evolved based on the selected growth scenario and the green lines. These should also be primarily concerned with green connections, which are particularly important to water management and biological diversity, as well as cultural heritage sites and recreational facilities (Fabos, and Ryan, 2004).

**Table 1.** GISMP principles initiatives and impacts on producing a city's Sustainable landscape development

<b>GISMP Principles</b>	<b>Socio-culture Values (Design Criteria)</b>	<b>Natural-Environmental Values</b>	<b>Economic Benefits</b>	<b>Management /Implementation</b>
1.To plan and protect interconnected green space systems	It integrates functions and makes life-giving processes visible and meaningful.	Sustainable resource management in land and water resources.	It forms a set of open spaces that serves and guides smart growth.	To manage development pressures and access to green spaces and wider green infrastructure.
2. Design and plan green infrastructure before development.	Recreation relating to greenways and the use of non-car routes to address public health and quality of life issues	Regional development and promotion of overall environmental quality and quality of life.	Provides a solution to land fragmentation.	Provides a broad, unifying vision for the future.
3. Linking of the network different components.	Linking parks for people.	Biodiversity relating to the importance of connectivity of habitats at a variety of landscape scales.	Decrease threats of urban sprawl in favor of economically balanced sustainable development	Ensuring that both green space and development are placed where most needed and most appropriate.
4. The system should be connected across urban, suburban, rural and wilderness.	Linking natural areas to treat fragmentation and preserve biodiversity.	Supports essential ecosystem functions.	It forms a set of open spaces that serves and guides smart growth.	Providing a framework for integrating diverse natural resource and growth management activities in a holistic, ecosystem-based approach.
5. Green infrastructure is grounded in sound science and land-use planning theories and practices.	Identifying and protecting interconnected open spaces systems to benefit wildlife and ensure a sustainable future	In ecological systems, connectivity is vital for the movement of organisms through the landscape.	Provides a solution to land disintegration.	To manage development pressures and access to green spaces and wider green infrastructure.
6. Green infrastructures, as a critical public investment, should be included in the annual budget.	Focusing on connectivity that is to connect green elements, links and networks.	Conserves land for human use.	Economic management of development pressures.	Resources are tapped in state and federal agencies for planning and management activities
7. Successful green infrastructure efforts forge alliances and interrelationships among various organizations.	To promote development that does not degrade environmental quality	Open spaces provide places for recreation, social interaction, psychological renewal	Enabling conservation and development to be planned in harmony, not in opposition to one another.	Increasing awareness of environmental and economic importance.

(Source: the authors, after, Fabo, Rayan & Ji)

The components of the GISMP may be summarized as follows:

- **A. Green ways**

According to (Ericson, 2004), the term Greenways is now referred to as a strip of land dedicated to recreation and the movement of pleasure vehicles (passenger, not commercial automobiles). He also added that Greenway systems have helped to provide both the space and the ecological protection necessary for overlaid greenway networks. Greenbelts, in contrast to both greenways and park- ways, are swaths of natural or open land surrounding cities or towns. They often contain a mix of public land and privately held land on which development restrictions are placed.

The greenway system consists of the following components:

- Environmentally sensitive areas.
- Waterway corridors.
- Linkages.
- Major open spaces.
- Agricultural areas.
- Scenery and views.

We may point out those Greenways objectives have developed and changed over time, this due to the recognition of its importance by the recreation, transportation and conservation aspects (Erickson, 2004).

- **B. Green belt**

Originating in the Garden City Movement of the early 20th century in Great Britain, greenbelts were meant to control urban growth by protecting a ring of undeveloped land, often forested or agricultural, around the city. At the city scale, an inner green belt is proposed to control the urban sprawl process. This greenbelt at the city scale has several advantages: representing a zone for conservation; constructing a transitional zone with the function of resisting the urban sprawl; constraining the urban development, maintaining bio-diversity and enhancing recreation activities (Hassan et al., 2011). Traditionally, urban development planners include green belts to protect the landscape from urban sprawl. These, however, usually remain unimplemented mainly because most are planned as artificially and arbitrarily as the urban developments themselves. They are barriers to development rather than structures that positively support the local ecology. Greenbelt planning remains a planning strategy and land-use policy worldwide, where they are used to check unrestricted sprawl, prevent neighboring towns from merging, assist in protecting the countryside, preserve historic values, and promote urban regeneration.

- **C. Park open system**

John Olmsted and Frederick Law Olmsted Jr., stated (1903) "A connected system of parks and park ways is manifestly far more complete and useful than a series of isolated parks." (Erickson, 2004 p.21). Ahern, (1995), referred to Lynch (1972) who has described other advantages of linking open spaces into a system: The open space system not only makes the city visible, but also the larger natural universe. It can give the observer a sense of the more permanent system of which he and the city are only parts. To convey a sense of the web of life, of the intricate interdependent system of living things, will be

even more important (Ahern, 1995). It was proposed that urban parks need to be regarded as core areas in the city, that an outer green belt is to surround the city; and that green corridors along rivers and streets will connect the cores and the outer areas (Fabos, and Ryan, 2004). Thus, an organization of urban green spaces based on landscape-ecology principles, in respect to using linear (e.g., green ways) and non-linear elements (e.g., parks), encompasses the connectivity and networking of green spaces in urban areas better than considering them separately ( Hassan et al., 2011).

#### **4. A proposed blue print in applying and promoting the Green Infra Structure Master Plan in Egypt (GISMP)**

In an attempt to understand how cities can function ecologically, in contrast to past and current trends, this study considers the application of green infrastructure master planning (GISMP) to urban areas by making efforts to mitigate the negative impacts of urban infrastructure development.

This concept may be applied at different scales of landscape-units. It is mainly formed of three steps:

- (1) Function-analysis: in that stage the translation of ecological complexity into a limited number of ecosystem (or landscape) is done.
- (2) Function valuation: the valuation of the ecological, socio-cultural and economic methods.
- (3) Conflict analysis: at that stage the integration of analytical valuation methods with stakeholder participation techniques to facilitate the application of function-analysis and valuation at different scale levels occurs. The analysis of the nature and magnitude of value to human society the Once the functions of an ecosystem or landscape are known, through the goods and services provided by the functional aspects of the ecosystem or landscape unit (Groot, 2006).

##### **4.1. The Egyptian experience in promoting Green Infra Structure Master Plan (GISMP)**

Recent surveys have shown that good quality of Egyptian life has declined in several cities, as city planning does not necessarily contribute to the citizen needs. One of the possible reasons is the decline of urban areas and the limited amount of green areas (Yassin, 2013). Urban green areas are outdoor spaces with a sufficient amount of vegetation. It has been widely believed that urban green spaces are important components of urban ecosystems, and provide several environmental and social services that contribute to the quality of life in cities.

In addition, several studies reported that the social implications of lifestyles and attitudes to nature and sustain ability will lead to higher demands for urban green space (Li et al., 2005). During the last three decades, the Egyptian government established 22 new cities. Most of these cities were established in desert environments (NUCA, 2010). One of the fundamental aims of the planning of these new cities pays much attention to a balanced environment to allow Egyptian citizens to enjoy their lives and for the new generations to live in a healthy city (Hassan et al., 2011). The selection of urban green areas in the Egyptian cities is primarily based on expert's knowledge and strongly affected by the existing City Master Plans

(Deister, 2013). There is no formal method for the site selection process (Huyck, 1994). Very few studies investigated the process of landscape planning of green areas in existing or new cities in Egypt on empirical basis. Although as we mentioned earlier, urban green spaces, as a particularly important part of urban ecosystems, provide various environmental and social services that actively add to the quality of life in cities. Urban connectivity within the open space system helps to promote environmental quality by putting a focus on green elements, links and networks and manages development pressures. Access to green spaces and enhanced green infrastructure, which brings positive impact on diversity within most ecosystems, is a remedy for long-term urban landscape decline and ensures a sustainable future (Fabos, and Robert, 2004).

#### 4.1.1. Applying the GISMP draft on the city of Port Said

According to Ahern (1995), within this overall view of GISMP as a strategic planning tool, there are four principal strategies that may be employed, individually or in various combinations. These strategies are defined as protective, defensive, offensive and opportunistic.

- A protective strategy may be employed when the sustainable processes and patterns, are supported by the existing landscape .
- A defensive strategy is often applied as a result of the fragmentation of the existing landscape as when core areas are already limited in area and isolated. The main purpose is to seize the negative processes of fragmentation. The defensive strategy is often necessary as a last hope.
- When a possible landscape configuration is articulated, understood and accepted as a goal the offensive strategy is required. The employment of nature development and to build new elements in previously disturbed or fragmented landscapes is the main difference between the offensive and the protective and defensive strategies . Planning knowledge, knowledge of ecological restoration, and significant funding are main pillars of the offensive strategy ( Groot, 2006).

In general, the GISMP design procedure takes into account the following steps:

- 1. Identify the site's inherent environmental, topographic, and cultural features; summarize the opportunities and constraints.
- 2. Coordinate and integrate green infrastructure elements, principles and guidelines into three site design systems open space system, transportation system, storm water management system.
- 3. Ensure links between different land uses within the site and with adjacent neighborhoods.
- 4. Conceptualize open space linkages, enhancement of pedestrian and cycling movement, and regenerative solutions for storm water management to improve urban connectivity (Ji, 2010)

The GISMP focuses on forming an integrated network of green infrastructure for the site. This corridor will allow the fragmented urban landscape systems to be reunited with the waterfront area, promote a strong pedestrian and cycling corridor between downtown and the waterfront, and accelerate the transformation of an unfriendly environment part of the city into a vibrant urban landscape.

#### 4.1.2. The city of Port Said urban landscape features

Port Said city is situated in north east Egypt extending about 30 kilometers (19 mi) along the coast of the Mediterranean Sea. It is located at the north of the Suez Canal, with an approximate population of 603,787 (2010). The city was established in 1859 during the building of the Suez Canal. According to the Human Development Index in 2009 and 2010, Port Said has been ranked the second among the Egyptian cities. Fishing and industries, like chemicals, processed food, and cigarettes forms the economic base of the city. Port Said is also an important harbor for exports of Egyptian products like cotton and rice, but also a fueling station for ships that pass through the Suez Canal. It is very famous among the local Egyptian tourism market on being a duty-free port, as well as a tourist resort especially during summer. The city has several very famous architectural landmarks such as, the Lighthouse of Port Said , which is known to be the first building in the world built from reinforced concrete. Figure 3 and 4 shows the city location and historic evolution.

The urban landscape fabric of the city is characterized by the city a distinctive look of numerous old houses with grand balconies on all floors. Port Fuad is Port Said's twin which is located on the eastern bank of the canal. The two cities form one coherent urban fabric, to the extent that there hardly is any town centre in Port Fuad. The free ferries running all through the day are the main mode of connection between the two cities. Together they form a metropolitan area with over a million residents that extend both on the African and the Asian sides of the Suez Canal. During the nineteenth and the first half of the twentieth century Port Said acted as an international hub it was inhabited by various nationalities and religions. Most of them were from Mediterranean countries, and they coexisted in tolerance, forming a cosmopolitan community (Figure 5) (GOPP, 2010).

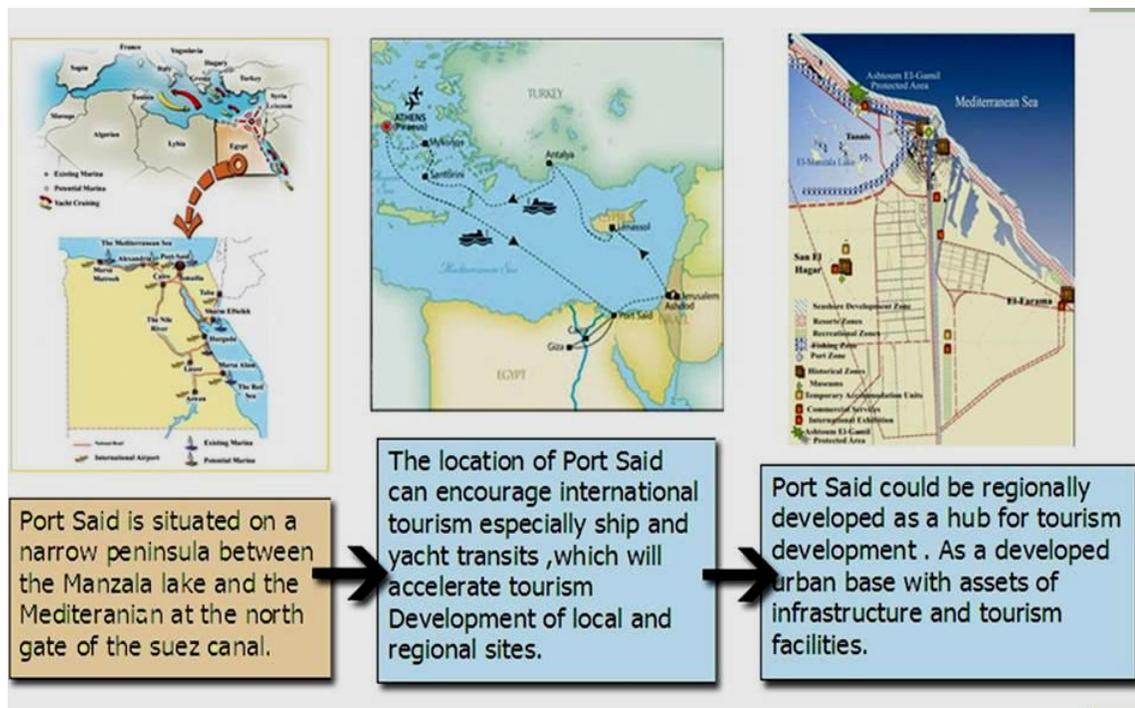


Figure 3. The Regional context of the city of Port Said city (Source: Farrahat, 2011)

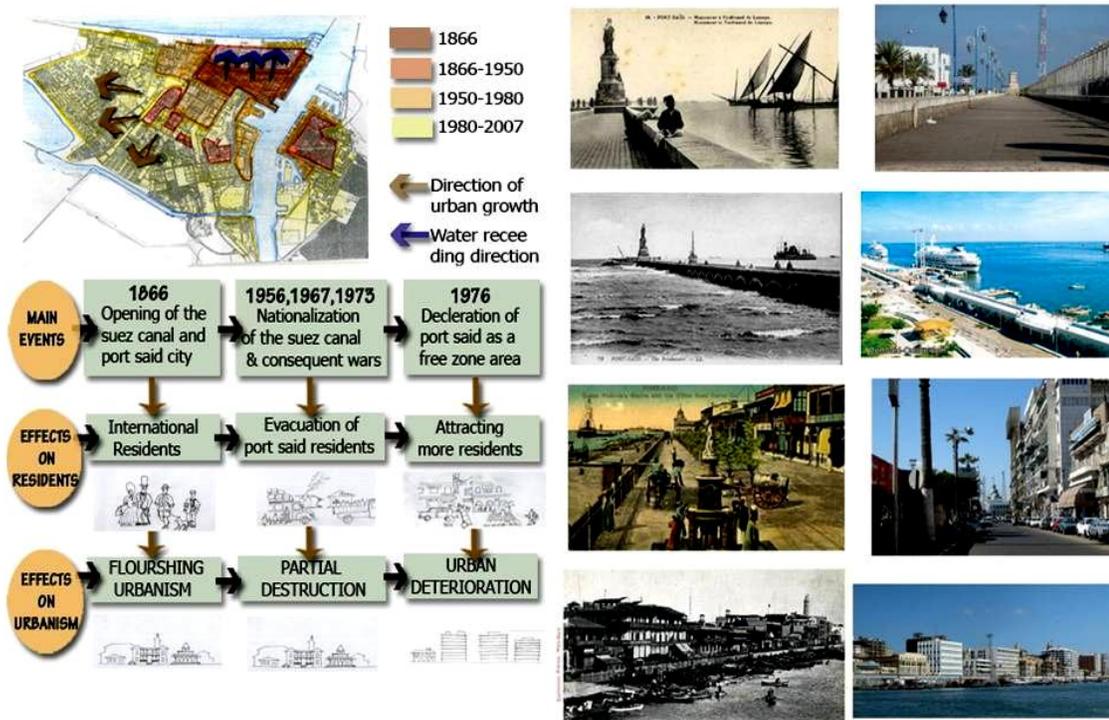


Figure 4. The Historical Evolution of the city of Port Said city (Source: Farraha, 2011)

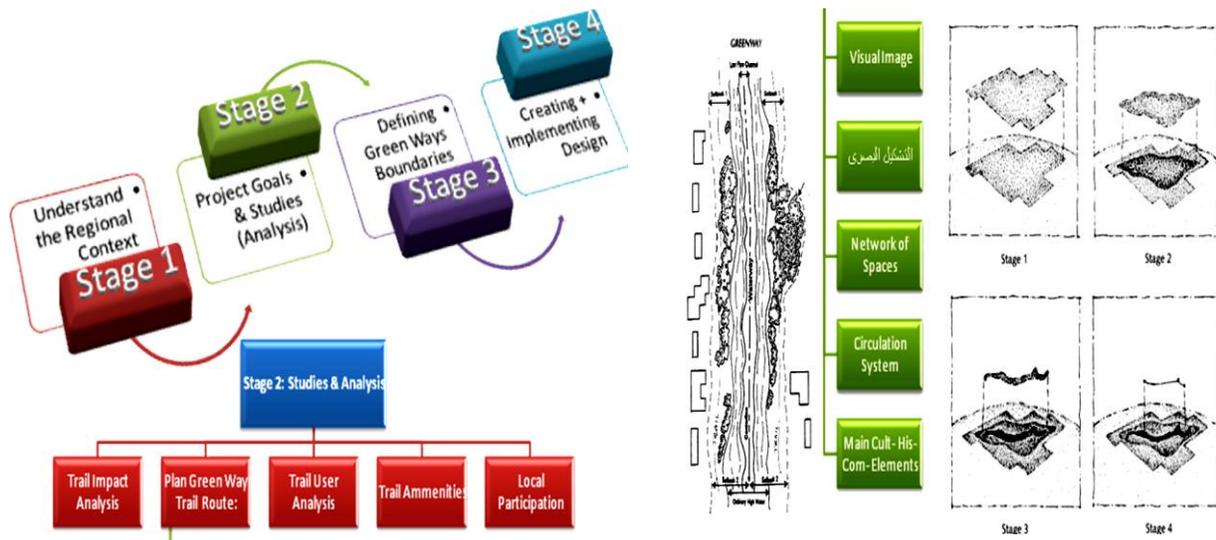


Figure 5. Existing valuable buildings at the city of Port Said city (Source: Farrahat, 2011)

### 4.1.3. The City of Port Said GISMP

From the previous literature as well as the findings of Table 1, in order to form a coherent GISMP for the city of Port Said the following methodology was applied (Figure 6) :

- 1) Recognition and addressing the needs of both people and nature in the city.
- 2) Providing a holistic, ecosystem-based approach as framework for integrating diverse natural resource and growth management activities.
- 3) Ensuring the land suitability of both green space and development.
- 4) Identifying vital ecological areas and connectivity prior to development.
- 5) Identifying opportunities for the restoration and enhancement of functioning systems in already developed areas.
- 6) The communities must be enabled to create a system that is greater than the sum of its parts.
- 7) Harmonizing the planning of conservation and development, not in resistance to each another.



**Figure 6.** The GISMP of the city of Port Said city process (Source: Hossam, 2011)

### 4.1.4. The City of Port Said GIMP Concept

The previous process was done so that the green infrastructure master plan may help to create a plan for high performance landscapes, integrated with emerging ecological realities and urban infrastructure needs, but also reflecting a contemporary aesthetic value which, at the same time, can promote urban connectivity. Land use analysis, detailed surveys for networks of all forms, visual landscape assessment and a detailed study of the city's hubs and sites was done in order to evaluate the city potentials which will form the main structure of the GISMP (Figures 7, 8, 9, 10).



Figure 7. Port Said city existing land use (Source: Farrahat, 2011)



Figure 8. Some detailed action areas analysis, the Water Front of the city of Port Said city (Source: Farrahat, 2011)



After analyzing all data from surveys and concluding with the main decisions, solution alternatives were formed to find the most suitable and efficient scenario for the GISMP. These alternatives differ in land uses as well as of the existing free undeveloped lands, and in the circulation systems (pedestrian and vehicular and the added bike route) (Figures 11).

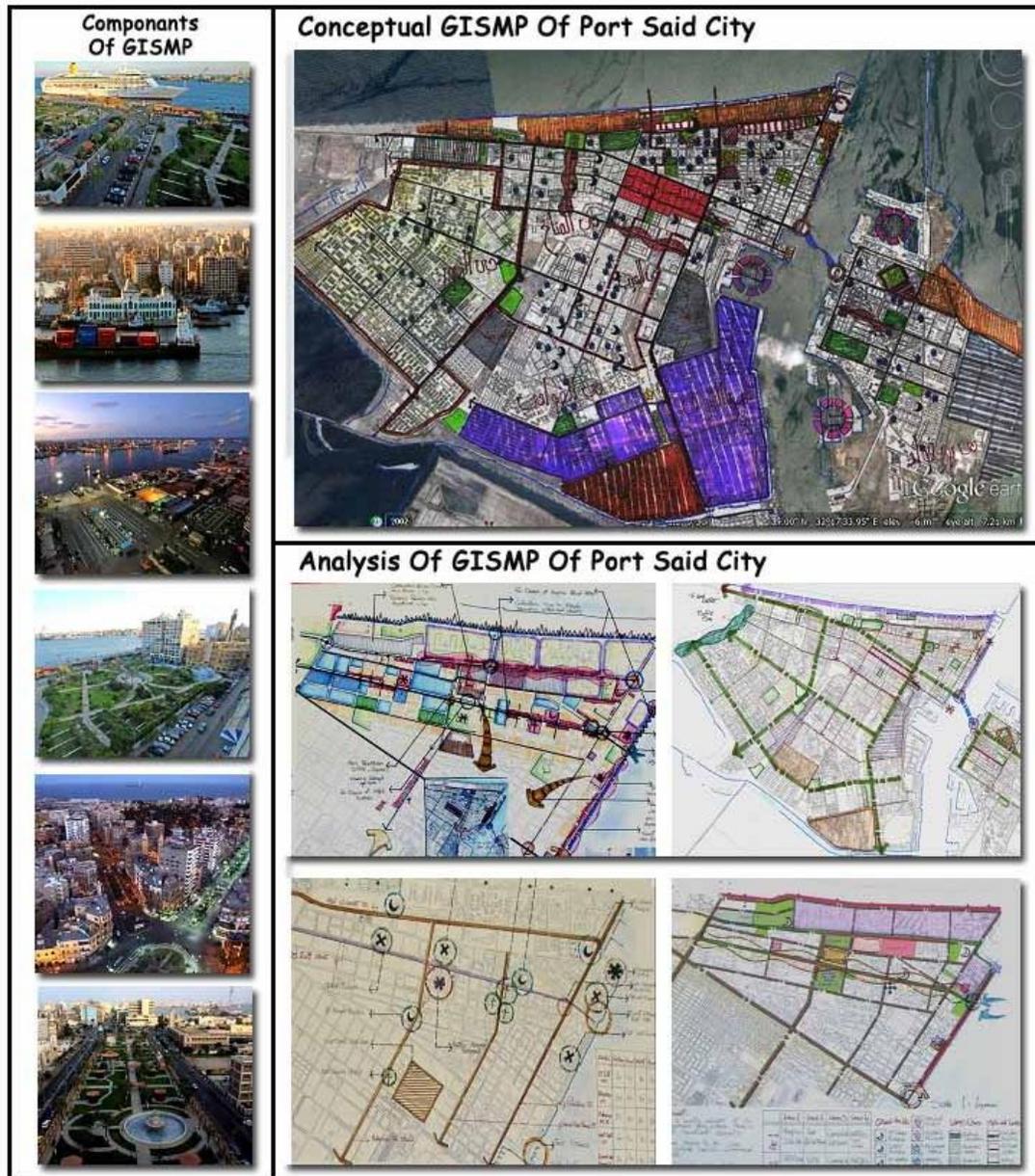


Figure 11. Conceptual GISMP for the city of Port Said cit (Source: by the author)

The following criteria were taken into account while selecting the detailed action areas for the GISMP, functional efficiency, economical aspects, feasibility and visual interest.

## 5. Applying the Greeno-meter on the GISMP of Port Said city

There are two levels of evaluation for the GISMP principles initiatives and impacts on producing a city's Sustainable landscape development, the first level is concerned with the four dimensions of sustainability, Socio-culture Values, Natural-Environmental Values, Economic Benefits and Management/Implementation methods. The suggested Greeno-meter deals with the specialized level of evaluating the GISMP natural-environmental values. The main criteria of evaluation that the Greenometer evaluate are:

- Planning and protection of green space system.
- Integrating existing network with future city development.
- Typology and variety of landscapes.
- Connectivity of the overall green network included in the GISMP.
- Pre-requisite studies done before/ during formulation of GISMP.
- GISMP reservation of future land parcels.
- Increasing awareness of environmental and economic importance with stakeholders.

Based on the profound analysis, reviewing and discussing of several GISMP references and projects, Table 2, came up with a concluded check-list/blueprint listing all the efficiency natural-environmental evaluation aspects and their characteristics which should be taken into account while evaluating any GISMP. The paper utilizes the indicators of table 1 in an innovated GISMP natural –environmental efficiency measurement tool named as Greeno-meter. The idea of the Greeno-meter tool is to act as a pro-active and reactive tool that bears the ability to sensitively measure the degree of efficiency between the GISMP principles and its natural environmental application aspects. The model measures the degree of environmental aspects statistically on equal basis, for the seven main principles of the proposed GISMP natural and environmental values. The score of each indicator was calculated using the Z-score technique which was then summed to calculate the final score for each category. Since there are different types of indicators used to measure each theme, there is a need to transfer all of them into one value which can be easily understood. In a prior work, Coombes and Wong (1994) suggested the use of Z-scores that scale all component variance scores to one score. To do this, each theme was transformed into a 'Z-score'. The 'Z-score' standardizes the values of all indicators, putting them on the same scale of reference and allowing them to be directly compared and analyzed (Webbera and Clinton, 1999). Therefore, each theme will be presented in a score describing its level of efficiency through which an overall judgment can be drawn. The exact value for each indicator was determined based on project design analyses and a site visit during summer 2013. In this context, the study employs an Eco-Meter ranging from ( $Z= +1$ ), high efficiency, to ( $Z= -1$ ), low efficiency.

Table (2) and (Figure 12) summarize and explain the overall assessment of the city of Port Said conceptual GISMP. The paper aiming to test the achieved Greenometer conducted a practical analytical study on the city of Port Said GISMP concept and came out with the following evaluation:

**Table 2.** Applying the Greeno-meter on the GISMP of the city of Port Said city

GISMP Principles	Natural-Environmental Values	Efficiency Evaluation Aspects	Port Said city GISMP Concept Efficiency Evaluation
1.To plan and protect interconnected green space systems	Sustainable resource management in land and water resources	Planning and protection of green space system.	-0.5 
2. Design and plan green infrastructure before development	Regional development and promotion of overall environmental quality and quality of life.	Integrating existing network with future city development.	-0.18 
3. Linking of the network different components	Biodiversity relating to the importance of connectivity of habitats at a variety of landscape scales.	Typology and variety of landscapes.	-0.48 
4. The system should be connected across urban, suburban, rural and wilderness.	Supports essential ecosystem functions.	Connectivity of the overall green network included in the GISMP.	-0.48 
5. Green infrastructure is grounded in sound science and land-use planning theories and practices.	In ecological systems, connectivity is vital for the movement of organisms through the landscape.	Pre-requisite studies done Before/ During formulation of GISMP.	-0.5 
6. Green infrastructures, as a critical public investment, should be included in the annual budget.	Conserves land for human use.	GISMP reservation of future land parcels.	-0.8 
7. Successful green infrastructure efforts forge alliances and interrelationships among various organizations.	Open spaces provide places for recreation, social interaction, psychological renewal	Increasing awareness of environmental and economic importance with stakeholders.	-0.8 
<p>Low efficiency    -1    -0.75    -0.50    -0.25    0    +0.25    +0.50    +0.75    +1    High efficiency</p>			

(Source: authors based on Barmelgy and Ibrahim, 2014)

From the above evaluation we may deduce that the GISMP was successful in the planning and protection of the greenway system as well as, integrating the existing network with the future city development. The GISMP did not efficiently connect the various landscape typologies within the city. While, it failed to increase awareness among the city inhabitants of its importance within sustaining the overall city landscape.



**Figure 12.** Greeno-meter assessment for the city of Port Said city (Source: by the author)

## 6. Conclusions and findings

In order to guide development and respond to changes, GISMP should be introduced to provide a more informed and systematic way of considering priorities in the spatial planning process, and environmental friendly techniques which can be molded to fit into design situations.

GISMP should be identified as one way to conserve natural systems and areas within urban communities. GISMP and urban connectivity are not just ways of providing an improved infrastructure for the landscape, but are also a system for more informed decision-making and more creative thinking in urban and regional environmental planning. In this research we came out with several principles which form the backbone of any GISMP, as well as evaluating their natural and environmental aspects. It may be well noticed that diverse green space elements should be linked into a system that functions as a whole. A comprehensive planning for the green spaces system is required; this plan should take into consideration the maximization of the ecological, social, and economic benefits, functions, and values. Green space systems should be laid out with a general bird eye view, to incorporate green space elements at each district of the city with the overall green structure of the city. Open space should act as a positive space not a negative one as it will keep its character

of being open if it does not. People must enjoy the functional as well as the visual aspects of these spaces. Green infra structure plan at neighborhood scales should necessarily incorporate various parks and supplementary green ways to establish a green network that is ecologically more effective than the sum of the individual green spaces. This green infra structure concept will form a strong base for building a garden city or an eco-city in the future. It seems reasonable to assume that landscape has an important role in people's well-being since the landscape in general provides invaluable resources for education, health and recreation. Thus it is often claimed that providing people with a greater freedom to access the open green spaces is important as a factor contributing towards the promotion of a number of social objectives. These include promoting quality of life, health equality and social diversity as well as economic welfare.

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