Environmental Risk Analysis as an Approach to Achieve the Sustainability for Lake Mariut, Alexandria, Egypt

Prepared By

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ABSTRACT:

Until the eighties, most of Alexandria's domestic sewage and much of the industrial wastewater were discharged directly into the Mediterranean Sea through a number of outfalls along the coast of Alexandria. Pollution of beaches and the inshore waters caused severe impact on Alexandria as a summer resort which forced the local authorities to divert these discharges into Lake Mariut's Main Basin. At that time, the discharge consisted of raw sewage without any treatment what so ever mixed with industrial effluents. The lake's main basin became highly eutrophic and polluted with various chemicals. In addition to the problem of organic inputs, there were many hazardous discharges. Latter, two primary treatment plants were built and started operation in the nineties. The sewage water passes through screens and then sedimentation tanks and a dewatering facility to remove the sludge. Furthermore, some untreated wastewater is discharged directly into the Lake. Excessive eutrophication of lakes is a serious international problem. There has been a great need for a comprehensive information source usable in developing future rehabilitation/protection program.

INTRODUCTION:

Lake Mariut is one of the main northern lakes in Egypt. The Lake extends along the Mediterranean coast and represents the southern borders of Alexandria City. It lies between latitude 30º:07 ˚to north and longitude 29˚:57˚to the east along the Mediterranean covering an area of 65 km2 (almost 15.500 feddans). It is divided into five basins, which are somewhat interconnected to each other by several breaches in the dykes of EL-Umoum drain and Nubaria canal. The Lake depth ranges between 1-3 meters.

This state-of-the art review represents an attempt to delineate the accomplishments of lake restoration-related activities worldwide (1) Lake water eutrophication has become one of the most important factors impeding sustainable economic development in China (2). Restoration means a return to pre-disturbance conditions and relies on historic landscapes or ecosystems as models. It is the most demanding of management paradigms and implies complete re-creation of a system equivalent to the model. Restoration represents the extreme on a continuum of management protocols and is valuable as an ideal. In most cases, it is impractical, uncalled for, or even impossible. Rehabilitation is the repair and replacement of essential ecosystem structures and functions in the context of Eco regional attainability in order to achieve specified objectives (3) To succeed in combating Lake Eutrophication, cooperation of local inhabitants, small factories, and farmers in reducing phosphorus discharge is very important. But the willingness of each player to cooperate would depend on the cooperation of other players and on the level of environmental concern of the society in general (4). Schallenberg et al stated that Lakes provide a wide range of ecosystem services and substantial economic benefits to various regions of New Zealand (5) .However, financial cost of Lake Restoration or rehabilitation as well as socioeconomic cost – benefit analysis hardly have been addressed. The present proposed study focuses on this overlooked element taking Lake Mariut as a case study.

Environmental risk assessment (ERA) is based on comparison of environmental indicators, as they change over time. Current and predicted future ranges of conditions are compared against the historic range of variation for those conditions (i.e., “natural”). The base case, or the historic range of conditions, is determined by monitoring of undisturbed areas and analysis of natural disturbance regimes and historic records. The difference in risk between current and historic conditions is the result of cumulative impacts of past development and disturbance. Future conditions are based on the trends and long-term implications of continuing present management, or the predicted outcomes of potential alternative management options. Assessment of

environmental conditions and indicators is summarized in terms of a "risk index," and generally reported by means of a series of risk classes. As a part of the risk analysis, it may be useful to define specific thresholds, or a low risk benchmark based on best management practices (6). ERA is of particular value because it brings to the forefront the environmental consequences of decisions. In doing so, ERA shifts the focus from justifying the merits of a particular action or strategy, and instead, illuminates likely outcomes and their desirability. By making explicit the factors that pose risks to the environment, ERA requires acknowledgement of risks to the environment before and after decisions are made. Awareness of risk encourages the distribution of accountability and a collective sharing of responsibility for managing that risk, and will hopefully lead to decisions that reduce risk .

2 . LITERATURE REVIEW

2.1- Lake's ecosystem characterization.

Until the eighties, most of Alexandria's domestic sewage and much of the industrial wastewater were discharged directly into the Mediterranean Sea through a number of outfalls along the coast of Alexandria. Pollution of beaches and the inshore waters caused severe impact on Alexandria as a summer resort which forced the local authorities to divert these discharges into Lake Mariut's Main Basin. At that time, the discharge consisted of raw sewage without any treatment what so ever mixed with industrial effluents. The lake's main basin became highly eutrophic and polluted with various chemicals. In addition to the problem of organic inputs, there were many hazardous discharges. Latter, two primary treatment plants were built and started operation in the nineties. The sewage water passes through screens and then sedimentation tanks and a dewatering facility to remove the sludge. Furthermore, some untreated wastewater is discharged directly into the Lake. Excessive eutrophication of lakes is a serious international problem. There has been a great need for a comprehensive information source usable in developing future rehabilitation/protection programs. This state-of-the art review represents an attempt to delineate the accomplishments of lake restoration-related activities worldwide (8).Lake water eutrophication has become one of the most important factors impeding sustainable economic development in China (9(.Restoration means a return to pre-disturbance conditions and relies on historic landscapes or ecosystems as models. It is the most demanding of management paradigms and implies complete re-creation of a system equivalent to the model. Restoration represents the extreme on a continuum of management protocols and is valuable as an ideal. In most cases, it is impractical, uncalled for, or even impossible. Rehabilitation is the repair and replacement of

essential ecosystem structures and functions in the context of Eco regional attainability in order to achieve specified objectives(10(.To succeed in combating Lake Eutrophication, cooperation of local inhabitants, small factories, and farmers in reducing phosphorus discharge is very important. But the willingness of each player to cooperate would depend on the cooperation of other players and on the level of environmental concern of the society in general (11).

Miguel et al stated that Lake Mariut is a 90-150 cm deep brackish water lake located in the north of Egypt southeast to the Alexandria city, belonging to the Nile River Delta, and one of the most heavily populated urban areas in Egypt and in the world. By the end of the 19th Century, the development of irrigation systems of the adjacent fields made of Mariut Lake an intermediate water body to receive the excess of water from the irrigation channels. Then the water was pumped out to the Alexandria Bay (13). Due to the gradual and continuous land reclamation projects, the area of the lake shrinked to about 14,000 feddans with an average water depth of 120cm and the water level ranges between 3.1 to 2.85m below sea level. The lake is divided by the Desert Road, Nobaryia Canal, and Omoum Drain into four basins namely lake proper (Main Basin), Fish Farm, South western, and North western Basin. A pumping station is established at El Max to keep the water of the lake below that of the surrounding cultivated land. The lake receives large amounts of drainage water mainly through El Omoum Drain. Other sources of water supply entering the lake are the Kalaa Drain and the rainfall during winter[14]

2.2- Discharges into the Water Body

Until the eighties most of Alexandria's domestic sewage and much of the industrial waste water were discharged directly into the Mediterranean Sea through a number of outfalls along the coast of Alexandria. Pollution of beaches and the inshore waters caused severe impact on Alexandria as a summer resort; this made the local authorities decide to divert These discharges into Lake Maryut's Main Basin. At that time, the discharge consisted of raw sewage without any treatment what so ever mixed with industrial effluents. The lake's main basin became highly eutrophic and polluted with various chemicals. In addition to the problem of organic inputs, there were many hazardous discharges. Latter, two primary treatment plants were built and started operation in the nineties. The sewage water passes through screens and then sedimentation tanks and a dewatering facility to remove the sludge. Furthermore some untreated wastewater is dumped directly into the Lake.(15) Lake Maryut basins are recharged with agricultural drainage water via a number of drains most important of which are the Omom Drain, Nubaryia Drain, West Nubaryia Drain and AlQalaa Drain.

These drains carry agricultural drainage water resulting from the irrigation of an area of 450000 feddans of cultivated lands located south of Alexandria which contains high concentrations of various chemical fertilizers and pesticides.

2.3 -Environmental Problems of Lake Maryut

Undoubtedly the pollution and deterioration of Lake Maryut is evident for Alexandria inhabitants as well as visitors using Cairo-Alexandria road who can easily detect the problem by smelling the unpleasant odor when approaching the city of Alexandria .

The bad smell of hydrogen sulfide coming out of the main basin of Lake Maryut and AlQalaa Drain due to the sanitary drainage discharge of the East Treatment plant fills the air. Such phenomenon is known as Lake Maryut Problem which has existed now for dozens of years and is considered a rich field for experiments of academia scientists(15).

2.3.1-The Environmental Problems could be summarized as follows :

Severe decrease in the concentration of dissolved oxygen in some parts of the main basin of the Lake and Leading to a Great Drop in Fish Production (15).

An increase in the density of water plant growth (green canopy) such as reeds that impede water current movement hence leading to a decrease in the oxygen dissolving rates in the Lake water in addition to consuming dissolved oxygen.

Presence of organic pollutants (agricultural pesticides and industrial wastes) and inorganic pollutants such as (heavy components) in high concentrations at some parts of the Lake and drains whether in the water itself or the precipitations found in the Lake. The north eastern basin (main basin about 5000 feddans) is the most polluted basin particularly its eastern part .

Unpleasant odor at the entrance of Alexandria City leaving a bad impression for visitor and adversely affecting tourism and investment in the area .

Informal Areas and activities Most of the fishermen went to reside in Gheit Al-Enab area, Al- Qabbary area – western part Ezbat Nadi Al-Said and Al-Metrass areas. Furthermore Informal settlements started to spread on the Lake banks and shores with deteriorating living conditions (15).

MATERIALS AND METHODS

QuickBird from Digital Globe is the highest-resolution multispectral commercial remote sensing Satellite now operating, offering Imagery from 60 cm resolution. Launched October 18, 2001.QuickBird collects multi-spectral and panchromatic Imagery concurrently and Pan-sharpened products in natural or infrared colors are offered. Strips up to 250 km long can be collected in a single pass. QuickBird provides the widest swath, largest on-board storage, and highest resolution of any current

commercial satellite. QuickBird is designed to efficiently and accurately Image large areas with industry-leading geo-locational accuracy (16).

QuickBir2002 QuickBird 2014

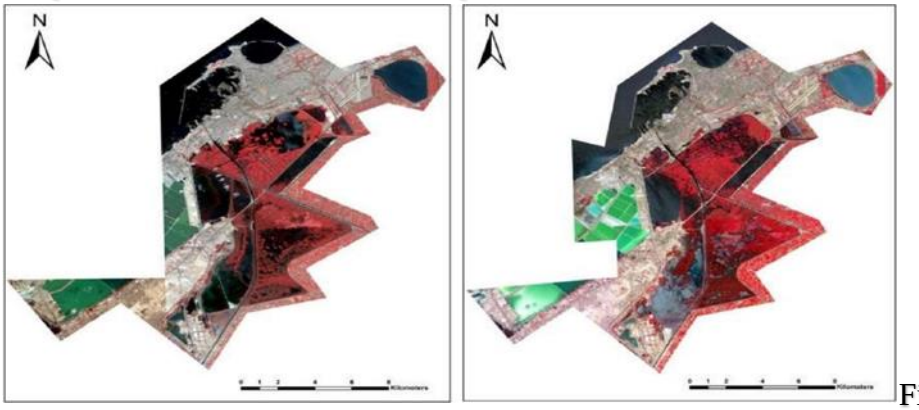


Figure (8): Scene of QuickBird Mariut Images

3.1-Economic valuation

Economic valuation is of tremendous importance in different contexts, for instance, appraisal of projects or programs cannot be comprehensive or adequate without economic valuation of their environmental impacts. Also, setting national priorities for environmental policy is better informed if economic values of environmental resources impacts are known with some degree of certainty. Moreover, the entire objective of sustainable development could not be interpreted without some idea of the value of various environmental assets. this means that economic valuation can provide the potential for more cost –effective public choices, so that limited public funds can be spent to the community`s best advantage (17).

3.2- Economic valuation techniques

Means simply eliciting measures of human preferences for or against changes in environmental conditions. It represents an essential step in incorporating environmental considerations into economic work.

In this respect , there are a number of approaches that can be employed for economic valuation purposes, which can be laid in one of five categories, namely , direct and in direct observed approaches, and direct and indirect hypothetical approaches, observed approaches in valve the direct or indirect estimation of value from observations of market behavior , with the former in clouding market valuation of physical effects , while the latter include travel cost , hedonic pricing , avoidance expenditures . Hypothetical approaches base their direct or in direct estimation of value, meanwhile, on responses to hypothetical valuation questions. The essence of these approaches as

well as their applicability to the case of Lake Maryuit is discussed in remaining part of this section(18) .

3.3- Market prices

It is reliable to estimate the value of the damage resulting from pollutionon fish production, where market prices can be estimated easily. If a factory exchange reduces the amount of perplexing fish by a certain percentage as a result of industrial drainage pollution, the cost of pollution can be estimated by the decrease in the amount of fish production and its market value as a result of industrial exchange.

But this method is taken because all the decrease in fish productivity is due to the industrial exchange only, while the shortage in fish may be due to many other factors, the markets may be uncompetitive and the monopolistic product wants to produce a smaller quantity and offer it at a higher price and the markets may be distorted due to subsidies and shares Taxes, forced delivery, and the following forms illustrate how to measure the environmental damage resulting from sanitation and industrial drainage on the lake (19)

Results and Discussion

The main objective of this study is to assess environmental risk analysis for lake to achieve the Sustainability. Any conflict affecting the wetland areas requires an overview of their Regional socioeconomic structure. The search for objectivity involves the use of economic valuation techniques applied to the environmental goods and services the wetland area can supply. The use of such techniques in the case of Lake Maryut enables the authors to observe the following main issues: conflict of interests among the stakeholders; deterioration of water quality; declining area of the lake due to its transformation into crop fields or urban areas; declining fish production; vital function of the lake as a deterrent to the urban expansion of Alexandria City.

Costs benefit analysis:

In general, fishing activities is one the most dominant economic activities in Lake Maryut, which made the Lake an enormous source of fish production in terms of quantity and quality. There is, also, the aquacultures, which occupy large areas of the Lake.

According to recent statistics, there are 2,073 fishing boats in the lake and 20,000 fishermen. Taking into consideration that the average family size is 4–5 persons, this means that about 100,000 inhabitants rely on fishing activities in the Lake to earn their livelihood.

According to the market price of fish in 2018, the average price for a tonne of fish was about L.E. (Egyptian Pounds) 20,500. The total market value of the fish production

from Lake Maryut in 2018 was about L.E. 114,000,000 Bolty This means that the average annual value of fish production per Acre equals to L.E. 2,545

•Market value of fish = Average price × Quantity = 20,500 × 5,600

•Total Market Value = L.E. 114,000,000

•Average annual value of fish production per Acre = L.E. 2,545

Concerning the decline in Lake Area due to land filling activities that took place between 1984 and 2018, it was estimated to be about 800 acre. Additionally, some 1,176 acres are threatened to be dried up and lost as they are totally cut from the Lake system by the establishment of new roads crossing the lake body. This means a total loss of about 1,976 acres of the Lake and consequently the loss of annual fish production, due to area decline, is estimated to be about L.E. 5,028,920.

•Lost annual fish production due to area decline = A × B

Where: A = Average annual value of fish production per acre

B = Lost area between 1984 and 2018

•Lost annual fish production due to area decline = L.E 2,545 × 1,976 Acre = L.E. 5,028,920

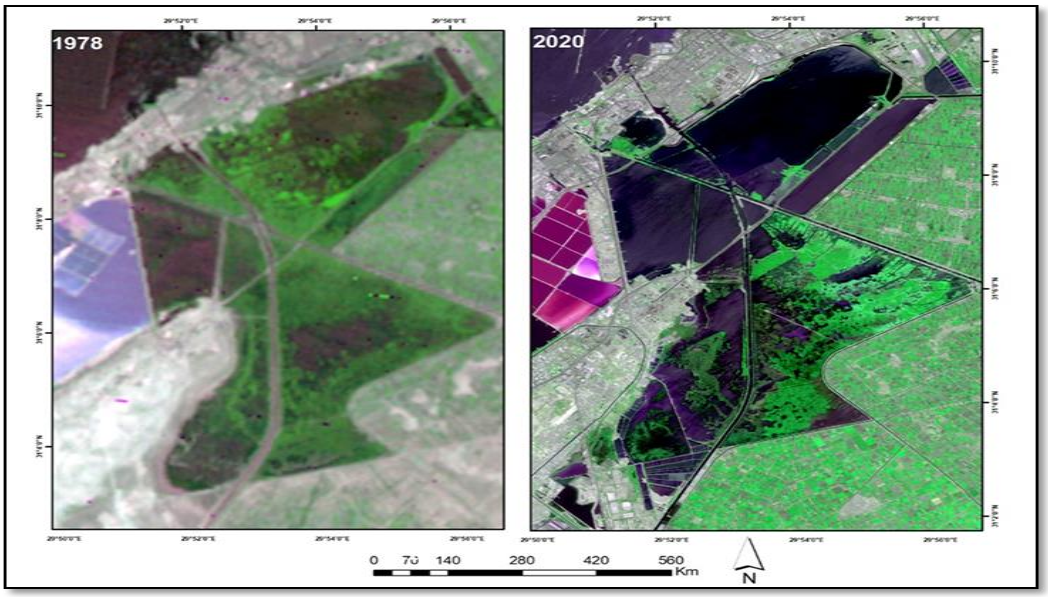
Such a decline in fish production was of concern to fishermen, in a survey conducted in 2007, who suggested that the average daily fish catch in the past the fish catch ranged between 10 and 30 kg. Average daily catch nowadays, again as stated by the fishermen, did not exceed 10 kg despite the extra efforts they had to put into fishing (20).

The total economic value of fish production from the lake, based on above estimates, assuming 5%, 7.5% and 10% discount rates, equals to L.E. 84,000,000; 56,000,000; and 420,000,000, respectively. The present value of the foregone fish production due to land filling and drying activities, assuming again 5%, 7.5% and 10% discount rates, equals L.E. 100,580,000; 67,040,000 and 50,290,000, respectively. This means that the total economic value of returns on fish production, including lost production due to land filling and drying activities, range between L.E. 470,029,000 and 940,578,000. It is worth mentioning in this respect that these estimations undervalue the value of fish production from the Lake, which could have been higher if optimum conditions in the Lake, in terms of water quality and depth, were maintained.

4.1- Change in fish catch

The decline in fish production, as a primary impact to pollution and land filling, has had secondary impacts in the form of lost jobs either as fishermen or those working in the supporting sector, for example marketing and boat maintenance and consequently their households livelihood. In order to assess the socioeconomic conditions in Lake Maryut, a wide range of data was

collected through a field survey. For that purpose a preliminary questionnaire form developed and used in conducting a pilot survey covering a relatively limited number of cases in the area of Lake Maryut and its surroundings. Due to the fact that the Lake is supporting the livelihood of thousands of people in its vicinity the decline in fish catch does not only affect fishermen but also those working in supporting jobs, for example salesmen, transportation, etc. The fishermen and associated workers may be seen as vulnerable groups that have high illiteracy rate and low skills to be able to seek other jobs. They also have no social security7 or health insurance. Such conditions have led, according to the socioeconomic survey conducted in 2017.



Figure(29): The Different Between Before Rehabilitation In 1978 And After In 2020

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