Chapter 2
Wetland Socioeconomy: The Case of Lake Maryut (Egypt)

Mohamed A. Abdrabo and Mahmoud A. Hassaan

Abstract 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.

Keywords Socioeconomic analysis • Wetlands • Economic valuation • Stakeholder analysis • Environmental goods and services

2.1 Conceptual Framework

2.1.1 Socioeconomic Contexts

The universally known definition of the environment as 'it includes all surroundings, whether natural or man-made', cannot make sense without taking into account the human dimension. This means that socioeconomic environment represents an integral part of the environment, which interacts with other environmental compartments.

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Thus any management efforts of the environment, both physical and biological, cannot make sense without taking into account the human dimension. It seems unreasonable, therefore, to consider impacts only on flora and fauna and not the local population and economy, for socioeconomic conditions are usually affected by the natural environment, which provides a continuous supply of environmental goods and services.[1]

For instance, environmental deterioration could lead to alteration in the social orders including community attitudes and lifestyle. Moreover, unplanned tourism activities may, in this respect, destroy the cultural, natural and landscape values that could be fragile assets of human communities.

Socioeconomic structures may, meanwhile, affect, positively or negatively, the natural environment and its ecosystems through various human activities (Fig. 2.1). This means that the quality of the environment and community welfare are highly interconnected. This is especially important in developing countries, where people are dependent on the natural environment for their subsistence and livelihood. However, the very behaviour of those people often adversely affects the environment they depend upon for their living (Bunce et al. 2000). It is worth noting, nevertheless, that the interrelationships between natural and socioeconomic environments are generally poorly understood and have largely been ignored in project planning and decision making process.

Socioeconomic environment refers to a wide range of interrelated and diverse aspects and variables relating to or involving social and/or economic variables, or a combination of both. These aspects and variables could, in general, be categorised into four groups including: (1) socio-cultural; (2) demographic; (3) economic;

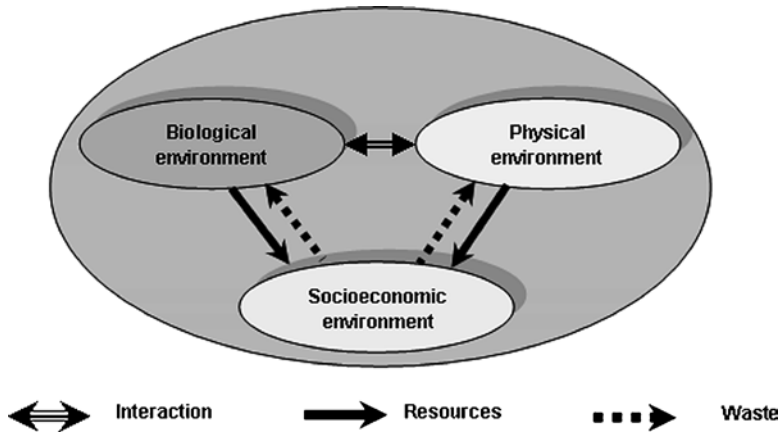

Fig. 2.1 Interrelationships between natural and socioeconomic environments

[1]Environmental goods may include any resources provided by the environment for instance minerals, construction materials, while environmental services are related to environmental ecosystem functions involving for example shoreline protection, biodiversity, recreation and tourism.

and (4) fiscal aspects. Socio-cultural aspects may, for instance, involve issues such as community life in terms of social and cultural attitude, traditions and values, community structure and coherence, cultural properties and archaeological sites. Social aspects may also involve 'housing and community services' such as education, health, police and fire protection facilities, and solid waste disposal. There is also the public infrastructure, including water, sanitation, electricity and roads. Demographic aspects may include population size, age/gender structures, distribution and density. There are also the migration patterns and population trends (for more details, see Intergovernmental Committee 1994).

Economic aspects may include general characteristics of the local economy in terms of structure, employment/unemployment patterns and income generation. There is also the local markets and production patterns (Murdock et al. 1986). Additionally, fiscal aspects are related to public revenues and expenditures including for example different forms of taxation, and spending on infrastructure and social services of local governmental bodies.

It should be kept in mind that better understanding of the socioeconomic context can support a knowledgeable and well informed decision making, with respect to:

- Ensuring efficient use of resources
- Enhancing social aspects
- Protecting human health and safety
- Incorporating environmental values in decision making
- Integrating sustainability perspectives and principles
- Accounting for views and values of community and
- Encouraging public participation in environmental management leading to enhanced feeling of ownership by the end-users

2.1.2 Socioeconomic Structure in Wetland Areas

Wetlands are considered to be amongst the Earth's most productive ecosystems through the various functions they perform; which could be grouped into four categories (de Groot 1992). They include regulation functions, which are associated with the ecological processes contributing to a healthy environment. There is also the carrier functions, as ecosystems provide space for various activities, like human settlement, cultivation and energy conversion. Production functions, meanwhile, through which ecosystems do provide different resources for humans, like fish, fuelwood, timber, rich sediments used for agriculture in the floodplains. Moreover, information functions involve ecosystems provision of scientific, aesthetic and spiritual information (Schuyt 2005).

Wetlands, through such functions, provide a variety of goods and services[2] that support, directly and indirectly, the livelihood of millions of people (Barbier et al. 1997).

[2]It is argued that ecosystem functions are ecosystem functions as long as there are human beneficiaries (Fisher and Turner 2008).

However, there still exists the view that wetlands are 'wastelands', resulting from ignorance or misunderstanding of the value of the goods and services available. This has led governments to see only wetland potentials, which require alteration to ecosystem, for intensive agriculture, industrial and/or residential uses. Furthermore, wetlands have been exposed to various forms of pressures including pollution, waste disposal and landfilling activities.

2.1.3 Economic Valuation of Wetland Functions

It is typically argued that a major reason for excessive depletion and conversion of wetland resources is often the failure to account adequately for their non-market environmental values in development decisions. This means undervaluing wetlands to be lost environmental values, which represents a serious problem when comparing it to land conversion schemes, which is usually associated with marketable outputs. Thus by providing a means for measuring and comparing the various benefits of wetlands, economic valuation can be a powerful tool to aid and improve wise use and management of global wetland resources. The following sub-sections discuss various concepts and techniques related to economic valuation of the environment in general and wetlands in particular.

2.1.3.1 Economic Value of the Environment

It is worth mentioning that, the total economic value of environmental goods and services is the sum of four sub-values including:

- Direct value: which is reflected in the market value of an environmental component (e.g. price of wood in the case of a forest)
- Indirect value: which reflects the functions performed by an environmental component and the indirect benefits that can be derived from it
- Optional value: which is the value of reserving an environmental component for possible use in the future
- Existence value: the value of retaining an environmental component without any possible use in the present or the future

The first three of the above values represent the use value of an environmental component, while the fourth represents the non-use value (Fig. 2.2).

Use values are grouped according to whether they are *direct* or *indirect*; the former could involve both commercial and noncommercial activities, with some of the latter activities often being important for the subsistence needs of local populations in developing countries. Regulatory ecological functions of wetlands may, meanwhile, have important indirect use values. For instance, storm protection may

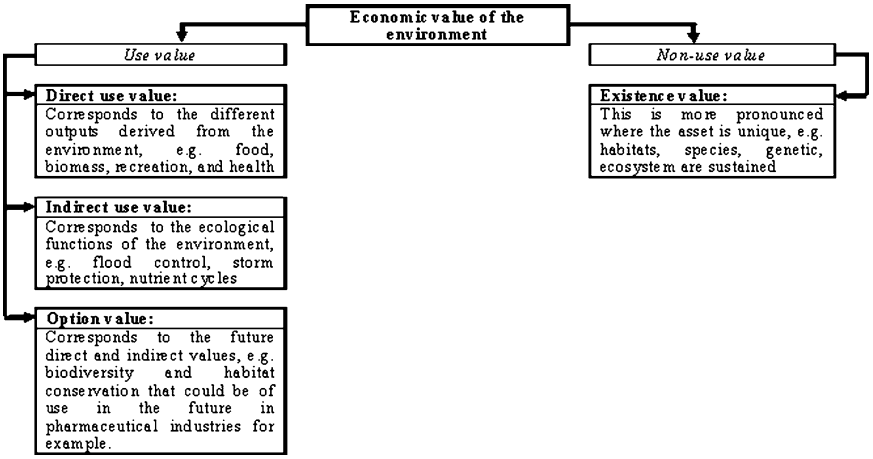

Fig. 2.2 Components of the total economic value of the environment

Table 2.1 Classification of wetland economic value (Cited in Barbier et al. 1997)

Total economic value			
Use values			Non-use value
Direct use value	Indirect use value	Option and quasi-option value	Existence value
• Fish • Agriculture • Fuel wood • Recreation • Wildlife harvesting • Peat/energy	• Nutrient retention • Flood control • Storm protection • Groundwater recharge • External ecosystem support • Micro-climatic stabilisation • Shoreline stabilisation	• Potential future uses (as per direct and indirect uses) • Future value of information	• Biodiversity • Culture/ heritage • Bequest values

have indirect use value either in the form of savings in not having to construct a man-made storm protection or through reducing property damages (Table 2.1).[3]

2.1.3.2 Economic Valuation Concept

Economic valuation means simply eliciting measures of human preferences for or against changes in environmental conditions. It represents an essential step in incorporating environmental considerations into environmental assessment and

[3]It should be borne in mind that the supply of ecosystem goods and services are not monotonous but could be changing overtime (Hein et al. 2006).

decision making, which can provide the potential for more cost-effective public choices, so that limited public funds can be spent to the community's best advantage.

There is a number of techniques available for economic valuation, but the most common is the income and employment multiplier. It works on the basis of an initial income injection into a local economy, that is provided by the wages of direct employees at a proposed installation and any expenditure on local goods and services required for construction and operation of the project[4] (Abaza et al. 2004).

Another aspect of the economic impacts, the secondary impacts, is related to possible impact on the environment and their effects on the environmental services and resources it provides. The difficulty with dealing with environmental goods and services, such as air and water, is that they are not traded in the marketplace and have no prices to reflect their economic value. Thus, it is important, in such cases, to find ways for estimating the economic value of these goods and services.

Economic valuation is of tremendous importance in different contexts, for instance, appraisal of projects or programmes 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 (Fig. 2.3). 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.

2.1.3.3 Techniques of Economic Valuation

In order to estimate the economic value of different environmental goods and services, economists have developed a number of valuation techniques (Fig. 2.4). Each of these techniques has its advantages and disadvantages and cannot be employed generally to deal with every possible case (Pearce 1993). In this context, there are a number of approaches that can be employed for economic valuation purposes, which can be laid in one of four categories, namely, direct and indirect observed approaches, and direct and indirect hypothetical approaches. Observed approaches involve the direct or indirect estimation of value from observations of market behaviour, with the former including market valuation of physical effects, while the later including travel cost, hedonic pricing, avoidance expenditures. Hypothetical approaches base their direct or indirect estimation of value, meanwhile, on responses to hypothetical valuation questions.

- Market Valuation of Physical Effects (MVPE)

The most straightforward way of valuing environmental change is to observe physical changes in the environment and estimate what difference they will make to the

[4] In many economies, increased direct income is either saved or exported from the economy in remittances to family and other kin outside the local area. In this case, the value of the multiplier would be low.

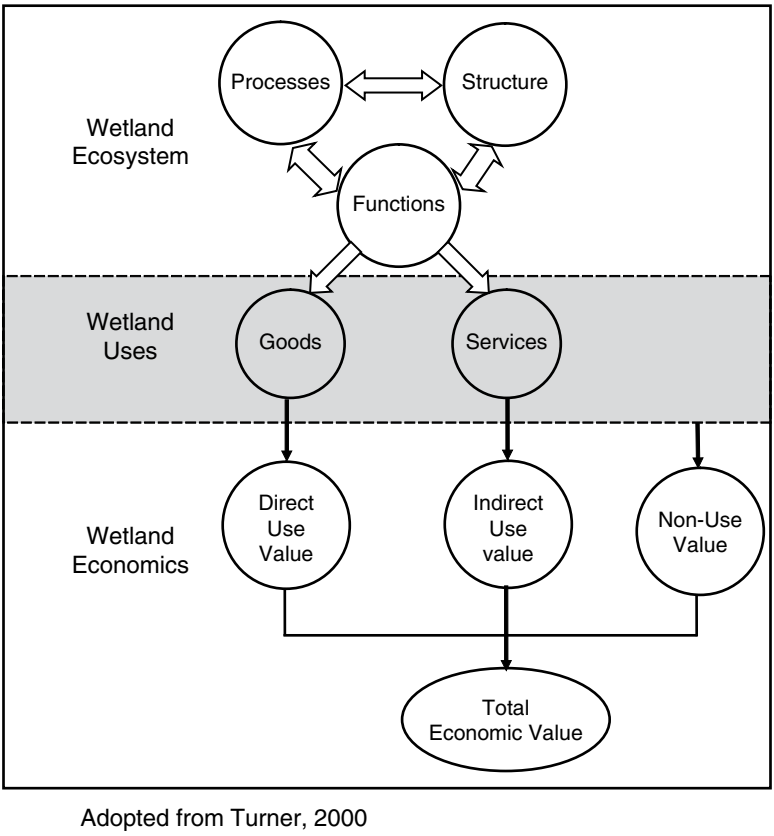

Fig. 2.3 Connections among wetland functions, uses and values (Source: Turner 2000)

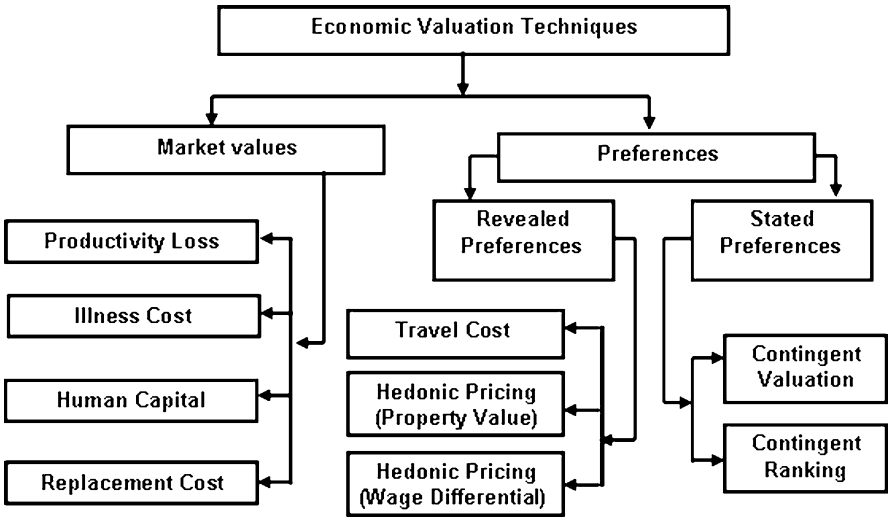

Fig. 2.4 Economic valuation techniques

value of goods and services. For instance, acid rain causes damage to trees and plants, which reduces their market value. Soil erosion reduces the yield of crops grown on site, and may cause downstream farmers and reservoir owners to spend more on removing silt from their property. Within the MVPE category, several techniques are available:

– Under the production function approach, environmental 'inputs' such as soil fertility and air and water quality can be related through econometrics techniques to output, showing how output varies with changes in the various kinds of input.
– Replacement cost method estimates the cost of environmental damage by using the costs which the injured parties incur in putting the harm right.

  Obviously, not all these methods should be pursued in each case; the choice should be made according to:

  • Which type of impacts are more prominent
  • What information is available and feasible and
  • Resources available to the analyst (EDIWB 1995)
  • Hedonic Methods

Hedonic pricing methods are based upon the assumption that goods and services are usually defined in terms of their attributes. This means that the values of these goods and services are the sum of the values of the attributes which they contain. For example, a suit is made up of a number of characteristics, including style or cut, size, fabric type (fibre, weight, and texture), print or pattern, and colour.

The market value of a suit would depend on the set of characteristics it contains, and consumer preference for these characteristics. The values consumer place on a particular characteristic, say fabric type, is inherent in the market value of the suit itself. Two suits would be perfect substitutes for each other, and would have the same market value, if they both possessed the exact same set of characteristics. Likewise, the fewer characteristics two suits contain in common, the more 'imperfect' they are as substitutes for each other, and the less likely they are to have the same market value. The difference in the characteristics that the suits contain, and consumer's preference for these characteristics, explain the difference in the market value of the suits.

When goods or services contain an environmental characteristic the same logic follows – the market value of the environmental characteristic is 'embedded' in the market price of the good or service which contains the characteristic.

The hedonic methods include two valuation techniques: property-value approach, and wage-differential approach.

– Property value and other land values: The property-or land-value approaches rely on real estate prices as an implicit measure of the indirect effects of changes in environmental quality. The theoretical grounds is that people tend, all other things being equal, to prefer homes in quiet, clean neighbourhoods to those in polluted, congested and noisy ones. Accordingly, they are typically willing to pay a premium for a home meeting their preferences.

As market prices for housing reflect the aggregate value that people place on all housing attributes, including environmental ones, the value of the environmental quality is implicit in the housing prices. Such value could be determined by controlling for other relevant housing characteristics, which influence housing prices.

The general approach is to regress housing or land prices on a group of explanatory variables, such as house age, size, design, type of construction, and a number of location variables, including one or more environmental variables such as air quality, or proximity to an environmental amenity. This approach meanwhile requires that there exist a free real estate market and that individual are well-informed about the market conditions in their area of search (Day 2001).

– Wage differential: The wage-differential approach is similar to the property-value approach, except that it attempts to place values on the incremental value of morbidity and mortality associated with certain risk-prone jobs. This information can then be combined with the dose-response functions to estimate the benefit of specific reductions in pollution levels. These functions, derived from epidemiological data, relate the level of pollution exposure to the degree of morbidity – mortality.

Similar to the property value technique, the use of this technique requires well functioning labour markets, with competition, mobility and access to information on job risks. If workers have incomplete information on job risks, this may cause them to misperceive the actual risks and thereby bias the subjective valuations implicit in their wage.

- Travel Cost Method (TCM)

The Travel Cost Method depends on information about the amount of money and time people spend getting to a site to infer a value for that site. Although TC can in theory be used to value almost any non-market good or service; in practice, however, it is only used for the valuation of recreational sites such as parks and beaches. It can also be used to value changes in environmental quality at recreational sites, such as changes in water and air quality.

The premise of TCM is that users travel from various places to spend time at a site. Although no fee is charged to access the site, there is a cost involved in travelling to and from the site. This cost, which is the amount of time and money individuals spend getting to and from a site, can be used to derive a demand function for the site. Once demand has been derived, it is possible to estimate the benefits (including consumer's surplus) associated with the site.

It should be stressed that the cost of travelling to a site is not directly used to value the site. The cost of travel is used to establish the relationship between the cost of travelling to the site and the number of visits to the site. This information is then used to derive a demand curve for the site, by assuming that visitors will respond to increases in admission costs in the same way as they do to increases in travel costs (Boardman and Weimer 1996).

TCM is best used for valuing a single recreational site. Although TCM techniques have improved considerably since the earliest studies were carried out, it has not gained wide acceptance because large data requirements make it a time consuming and expensive process.

Most TCM models take into account a number of variables in addition to travel cost, including, income, education, and alternative recreational opportunities (Dixon et al. 1994).

- Contingent Valuation Method (CVM)

Contingent Valuation Methods are used to obtain values for non-market goods or services. It is a survey technique that attempts to elicit information about individuals' (or households') preferences for a good or service by asking an individual a question or a series of questions about how much they value a good or service.

Using CVM involves three steps: (a) Designing and conducting a CV survey to elicit individuals' values for a good or service, (b) analysis of Willingness To Pay (WTP) responses, and (c) estimation of overall benefits or costs associated with existing conditions.

A CVM questionnaire typically has three parts: (a) a detailed description of the environmental situation being valued, (b) a series of questions about the socioeconomic and demographic characteristics of the respondent; and (c) one or more questions that determine how much the respondent is willing-to-pay for the good or service if confronted with the opportunity to obtain it under the specified terms.

The most important concern when employing CVM is the high risk of receiving biased answers. Such bias include: (a) strategic bias, (b) information bias, (c) starting point bias, and (d) hypothetical bias (Table 2.2).

2.1.4 Towards an Integrated Socioeconomic and Ecosystem Perspective

Wetlands management is considered to be an issue of great importance not only for environmental conservation sake, but also for the benefits and livelihood support they provide to population. Wetlands, meanwhile, are threatened by a variety of factors including poverty and economic inequality; pressure from population growth, immigration and mass tourism; and social and cultural conflicts (Kontogianni et al. 2001). Such conditions are compiled by ignorance or misunderstanding of the value of the goods and services supplied by wetland ecosystems.

Table 2.2 Values of environmental goods and services and their preferred valuation techniques (Moons 2003)

Value	Preferred valuation techniques
Direct use – recreation	Travel cost method Contingent valuation method
Direct use – hunting, timber	Market values (prices)
Indirect use – ecosystem functions	Production cost function Dose-response function Damage function Contingent valuation method
Option value	Contingent valuation method
Non-use value	Contingent valuation method

This means that economic valuation of these goods and services could contribute to more informed policy and decision making. However, the essence of overall socioeconomic valuation of wetland ecosystem functions is not only to quantifying such functions. Rather, the main issue of concern is to determine how society is affected by such functions. This means that economic analysis, as suggested by Turner et al. (1998), should take into account the influence and the range of relevant stakeholder interests.

2.2 The WADI Experience on Maryut Study Site

2.2.1 Socioeconomic Contexts: A Background

Lake Maryut is one of the northern Egyptian lakes, located in the north western coast of Egypt. The lake extends for 80 km along the north-western coast of Alexandria and 30 km south and is divided into a number of basins by highways and railroads. In contrast to other northern lakes in Egypt, Lake Maryut is a closed lake, not connected with the sea. The average depth of the lake ranges between 0.55 and 1.2 m. The level of water surface is −3 m compared to Average Sea Level.

The area of the lake extends for about 20 km between 31°01′48″ and 31°10′30″ North and 29°49′48″ and 29°57′00″ East. The lake is divided into four main basins; Main Basin, Southeast Basin, Southwest Basin, Aquaculture Basin (Fig. 2.5).

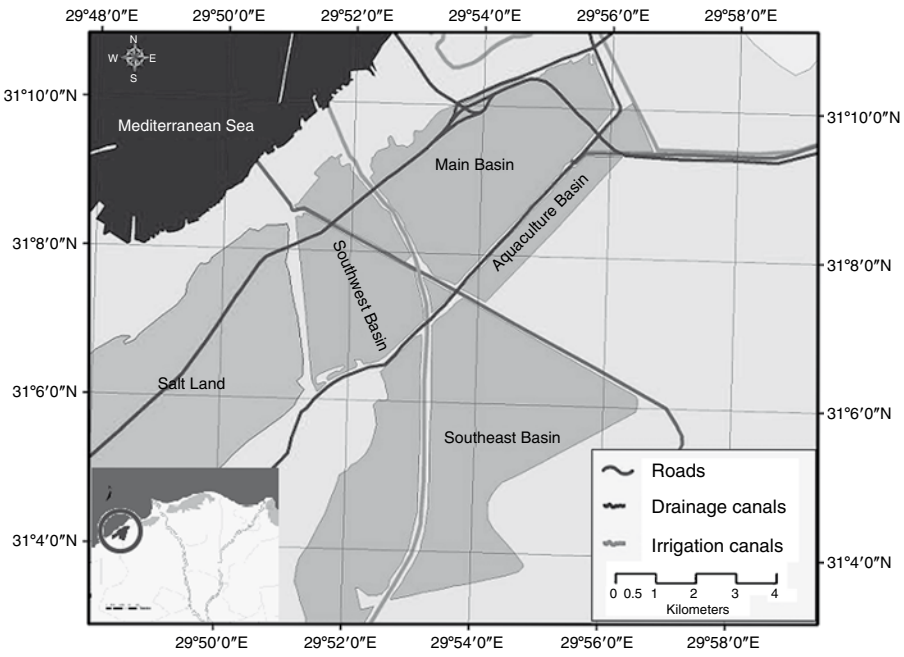

Fig. 2.5 Main basins of Lake Maryut

Nearby the lake there is a wide area of newly-reclaimed land which includes a number of human settlements, mainly rural. Most of these settlements discharge their domestic wastewater (sewage) into irrigation and drainage canals, which discharge their water ultimately into the Lake through El Qallah Drain. Also there is an industrial complex nearby the Lake (mainly petrochemical industries), these industries discharge industrial wastewater into the Lake after some sort of treatment.

2.2.2 Main Issues

The main issues in the case of Lake Maryut can be concluded in three issues including:

- Conflict of interest among stakeholders

The area of the Lake is supposed to be managed according to Law 124 of 1983, which states that the General Authority of Fisheries, Ministry of Agriculture, is the main agency responsible for managing water bodies (Article 2). The law also states that it is forbidden to discharge industrial waste water, pesticides or any similar toxic or radioactive compounds into the water (Article 15) and to fill up or drying any parts of the lake (Article 20). Law 4 of 1994 'Law of Environment', meanwhile, assigns the responsibility of protecting the environment and monitoring the discharges of various activities into the environment, including water bodies, to the Ministry of State for Environmental Affairs.

Lake Maryut involves a large number of stakeholders, at national and local levels with sometimes conflicting interests (Fig. 2.6). At the national level, four main stakeholders were identified including; the Ministry of Irrigation and Water Resources, which sees the lake as a contingency place for disposing of agricultural wastewater and thus interested in keeping the level of water in the lake as low as possible. There is also the Ministry of Agriculture, represented by General Authority of Fisheries, which attempts to attain effective use of Lake for fish production through proper management of the lake for instance in terms of higher water levels and quality, area preservation and vegetation cover control, etc. The Ministry of Housing and Reconstruction has been interested in development schemes in the Lake vicinity including for instance the construction of a number of new roads across the lake. This has led to further subdivision of the Lake into small basins; some of which are drying up as they are totally disconnected from the Lake area. The Ministry of State for the Environment is the main government agency responsible for protecting and improving the environment, including wetlands, in Egypt. However, the Ministry does not have enough power to effectively protect the Lake and improve its environmental quality. It could be argued accordingly, that each of these stakeholders, though all are government bodies, have different interests

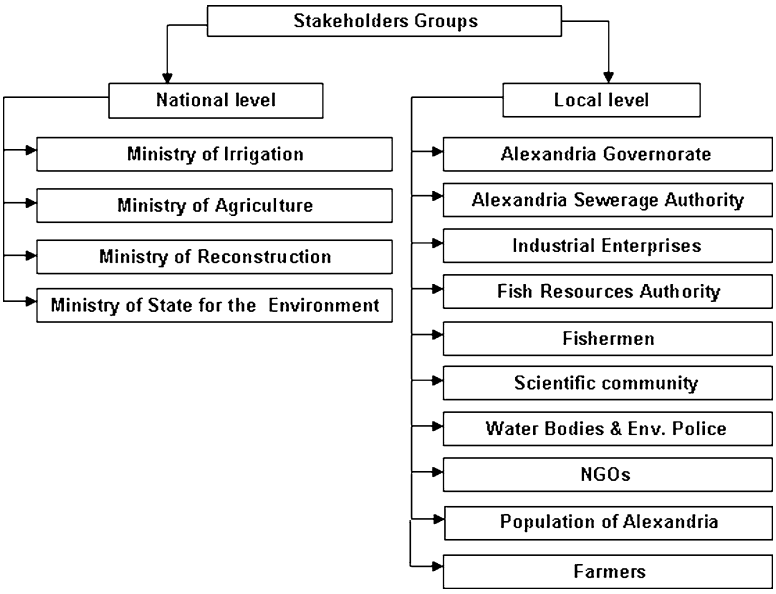

Fig. 2.6 List of stakeholders groups at both national and local levels

and visions, mostly conflicting, for the lake. Thus, large part of the problem lies with these governmental bodies and shed doubts on their ability to protect and manage the Lake. Moreover, such a trend is expected to continue as it was found that Alexandria Governorate adopted a development strategy that call for environmental rehabilitation of the lake (Alexandria Governorate 2007), while attempts to landfill parts of the lake, by government and private bodies, are still on-going.

The main stakeholders at local level, meanwhile, include a wider diversity of bodies, with Alexandria Governorate being interested in providing land for rapid urban expansion both for residential uses and creating investment opportunities. Despite the Governorate, as typically stated by local officials, large-scale land filling activities are actually carried out by governmental bodies, supposed to protect the Lake area from illegal land filling activities. There is also Alexandria Municipal Wastewater Authority, responsible for the collection and proper disposal of wastewater, which dumps more than 300,000 m^3 of municipal mostly untreated or primarily treated sewage water mixed with irrigation wastewater into the main basin of the Lake, through El Qallah Drain.

Such conflicting interests represent one of the main causes of environmental quality deterioration experienced in the Lake. There is also the Water Bodies and Environment Police, which is responsible for protecting the water body of the Lake and its vicinity through the enforcement of the Law 4 of 1994 'Law of Environment'. Despite their executive powers, this body is suffering from limited financial and human resources.

A number of nearby industrial firms are either discharging their untreated industrial wastewater into the Lake or using the Lake water for cooling purposes. Due to ineffective enforcement of environment law and the connections of these industries, this group has been away from the arms of the law but unfortunately has highly negative attitude towards the Lake. The fishermen and fish traders, meanwhile, have been on the losing end of the equation losing their livelihood due to deteriorating quality of water. Their voices are not well heard as they have been socially excluded and politically powerless.

The scientific community, represented by Alexandria University with its various academic institutions, have been involved in conducting diverse research work on the Lake. However, this group, despite of its positive interest and supportive attitude towards the Lake, has been largely interested in the Lake for scientific purposes. Local non governmental organisations (NGOs) are interested in protecting the environment and supporting the common causes of the population of Alexandria but have limited political, financial and human resources.

In addition to above-mentioned groups of stakeholders there are the farmers living and working in the area located to the south of the Lake. There is also, the population of Alexandria in general who have a stake in its natural resources, including the Lake, but are not aware of the potentials of such an ecosystem.

Based on the above analysis of the stakeholders and their interests in the case of Lake Maryut, it could be argued that the conflicting agendas of different government bodies are not helping the Lake case. Such conditions, is amplified by the fact that various stakeholders have different attitude and interests as well as have different levels of power and financial political and human resources. Furthermore, the absence of cooperative approach between various stakeholders leads to further deterioration of environmental quality of the Lake.

- Deteriorating physical conditions of the Lake
- Deteriorating water quality

The Lake has been receiving, since the mid-1980s, considerable quantities of untreated or partially treated industrial, agricultural and municipal wastewater. Thus, water quality of the Lake has declined considerably, despite partial treatment of some discharged industrial and municipal wastewater. This has been the case especially in the case of the Main Basin of the Lake, which is bordered by highways from three sides and by the Nubaria Navigation Canal and El-Umum Drain from the west side (Fig. 2.5). The basin receives heavy industrial and domestic untreated wastewater, primary treated domestic wastewater and agricultural wastewater (El-Bestawy et al. 1999). For instance, some 300,000 m^3 of untreated municipal and irrigation wastewater, through El Qallah Drain, is dumped daily into the Main Basin. This in addition to the uncontrolled dumping of industrial wastewater located to the north of the Lake (Table 2.3).

One of the main pollution problems in the Lake has been the high concentration of heavy metals, the most obvious of which is Lead, which was found to be considerably higher than recommended standards. This pollution problem has been highlighted by a number of research literature suggesting high degrees of bioaccumulation of this

Table 2.3 Pollution levels in Lake Maryut (Source: Field work conducted in March 2007 by Centro de Estudios Avanzados de Blanes, Spain, WADI project)

Pollutant	Maximum	Minimum
Oxygen (mg/L)	127.51	0.9
Oxygen (%)	16.8	0.05
pH	8.54	6.8
Ammonium (mg/L)	118.68	0.07
Nitrate (mg/L)	15.96	4
Nitrite (mg/L)	0.63	0.02
Chromium (mg/L)	0.17	0.012
Lead (mg/L)	9.72	1.2

dangerous pollutant in the fish of the Lake. It was suggested, in this respect, that the fish caught, mainly from the Main Basin, is usually contaminated with heavy metals and other pollutants affecting it suitability for human consumption. It is worth mentioning that the heavy metals pollution problem is also associated with the accumulated heavy metals accumulated over the past couple of decades into the Lake sediments.

As a result of deteriorating water quality of the Lake, fishing activities have been experiencing steady decline in quantity and quality of harvest.

- Declining area of the Lake

In spite of the existence of adequate legal framework and a number of implementing agencies (see Section 2.1 above), such legalisation has never been effectively implemented to control illegal land filling and polluted wastewater in the Lake. The area of the Lake has been declining over the past couple of decades due to filling in activities to acquire land for urban development of Alexandria City and the construction of the highway across the Lake. For instance, it was found that Lake Maryut has experienced a noteworthy decline, of about 3.24 km^2 representing about 4.63% of its area, during the period 1984–2002. This decline in the area of the Lake was found to be uneven between various basins of the Lake, with the Main and the Southeast Basins experiencing the largest decline in absolute terms compared to other basins. For instance, about half of the overall decline in the Lake area occurred in these two basins, which lost 1.59 and 1.13 km^2, respectively. This could be mainly due to that the location of Main Basin that is adjacent to built-up area of Alexandria City. Also, the Southeast and Southwest basins have declined by about 0.32 and 1.13 km^2, respectively.

It could be argued that, this reduction in Lake area, can be attributed to the land fill up activities for land acquisition purposes. For example, the area of the Lake adjacent the entrance of Alexandria City, was filled up by Alexandria Governorate and sold to private investors for the purpose of developing a commercial centre and upper class residential compound in addition to some other activities. Furthermore, other forms of encroachment on the Lake body, undertaken this time by the central government, took the form of the construction of a highway across the Lake body. This highway, called 'Mehwar El Taameer', was erected on the Lake body in

2002–2004 with a length of about 13.2 km of roads.[5] This, it could be suggested, shows that large-scale land filling activities are actually carried out by governmental bodies, supposed to protect the Lake area from illegal land filling activities. Thus, large part of the problem lies with these governmental bodies and shed doubts on their ability to manage and interest in protecting.

Moreover, such a trend is expected to continue as it was found that Alexandria Governorate adopted a development strategy that relies on more encroachment on the Lake body.

It could argued that such a decline in Lake area means not only loss of socio-economic and environmental goods and services, but also the viability of the Lake ecosystem itself. These services include preventing intrusion of salt water to the aquifers and agricultural fields surrounding the Lake. Also, the Lake has a role in adjusting the climate of Alexandria. Moreover, the Lake is considered as an ecosystem, which is a habitat for various species. The next sub-section represents economic valuation of one of the main functions of the Lake.

2.2.3 Economic Valuation of Lake Ecosystem

It is typically argued that a good starting point for an informed policy and/or decision making concerning an environmental resource is to identify the benefits associated with this resource. In the remaining part of this section, an attempt is made to identify different ecosystem goods and services being produced by Lake Maryut. Thereafter, an estimation of the economic value of the ecosystem goods category Lake, in an attempt to the show its real economic contribution, is made. For that purpose a complete list of different ecosystem functions as well as the goods and services of the Lake, was developed. The list included for example fish production and potentials for developing recreational and tourism activities in the Lake. Thereafter, the potentials for employing different economic valuation techniques were employed in an attempt to value such goods and services were assessed.

It was found, in this respect that the values of some of these services were quite difficult to estimate; for instance adjusting local climate of Alexandria City. Moreover, some valuation techniques were not applicable to the case of Lake Maryut, for instance, travel-cost approach, as it requires that the sites to be valued should be unique in that people would be travelling from different places to it so that a demand function for it could be derived, which is again not the case for Lake Maryut. Similarly, the Hedonic-pricing method requires the presence of a free functioning market of real estates and that either records of these real estate values before and after pollution or of similar areas that could be used as control cases are available.

[5] This is the length of roads only crossing the lake.

Yet, none of these conditions were found to exist in the case of Lake Maryut. It could be suggested, therefore, that this paper, in this context, could be seen as setting the bases for more comprehensive work on estimating the total economic value of the Lake.

2.2.3.1 Market Value of Fish from the Lake[6]

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.

Fish production from the lake, has experienced considerable decline over the past 2 decades (Fig. 2.7), that is since domestic wastewater, and thereafter, was accompanied with illegal industrial wastewater being disposed of directly in the Lake, was first dumped in it. This presented severe signs of environmental degradation including for instance: lack of oxygen, discolouration and algal blooms (EEA 2006).

Such production have seen, over this period, two peak quantities, the first in 1986, where fish was caught by the pollution and in its attempt to avoid pollution was easily caught by fishermen. The second was in 1999–2000, when some low

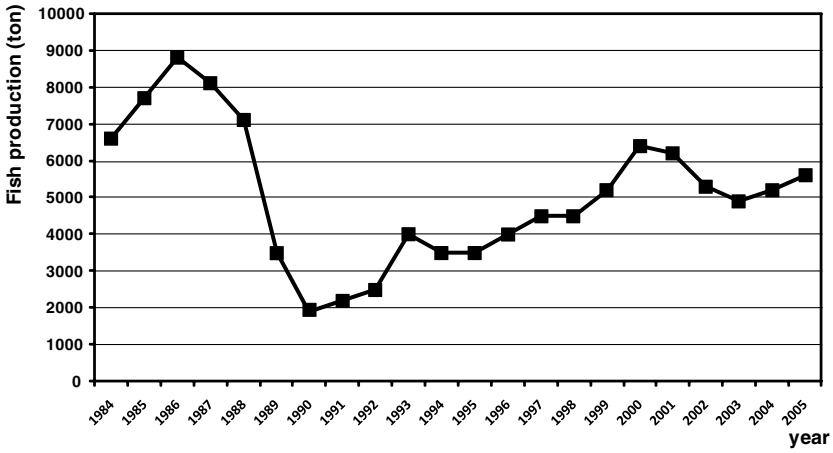

Fig. 2.7 Fish production (1984–2004) (Source: Fishery Resources Public Authority)

[6] This include both fish catch and aquaculture production.

cost measures were taken to divert domestic wastewater from coming into the main basin. However, these measures were half way abandoned due to conflicts between different governmental bodies and thus production started to decline again. In addition to the effects on quantities of fish caught, the quality of fish was also deteriorating as it became contaminated with various pollutants, the most serious of which is heavy metals (for more details see for example EEA 2006; Saad 2003).

According to the market price of fish in 2005, the average price for a tonne of fish was about L.E. (Egyptian Pounds) 7,500. The total market value of the fish production from Lake Maryut in 2005 was about L.E. 42,000,000. 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* = 7,500 × 5,600
- Total Market Value = L.E. 42,000,000
- 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 2002, 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 = $A \times B$

  Where:

  A = Average annual value of fish production per acre
  B = Lost area between 1984 and 2002

- 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 (Fig. 2.8).

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.

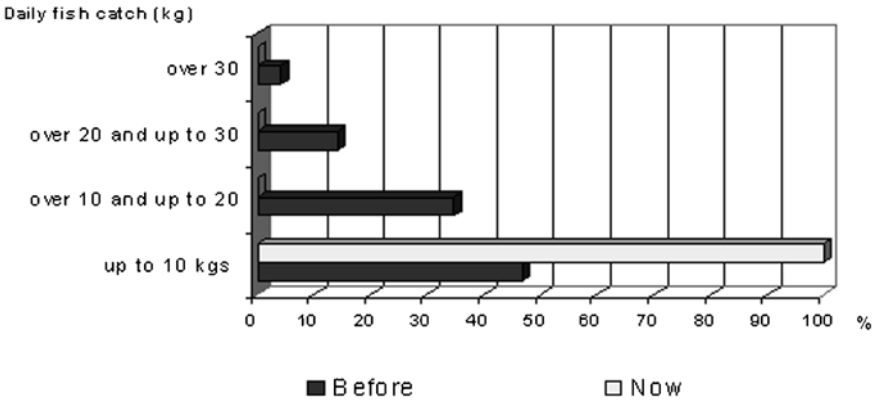

Fig. 2.8 Change in fish catch

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 security[7] or health insurance. Such conditions have led, according to the socioeconomic survey conducted in 2007, to as many as half of the fishermen's children to drop-out from the education system as they did not afford schooling costs and/or support their by working in the informal sector.

2.2.3.2 Value of the Lake Function as a Deterrent to Urban Expansion

The urban expansion in Alexandria City amounted, during 1972–2002, to 29.76 km^2. Also, it is noticed that the various administrative sections of the study area did not expand equally in temporal and spatial scales. At spatial scale, the old inner

[7] It was suggested that fishermen receive the monthly retirement from the Fishermen Society was no more than 70 L.E.

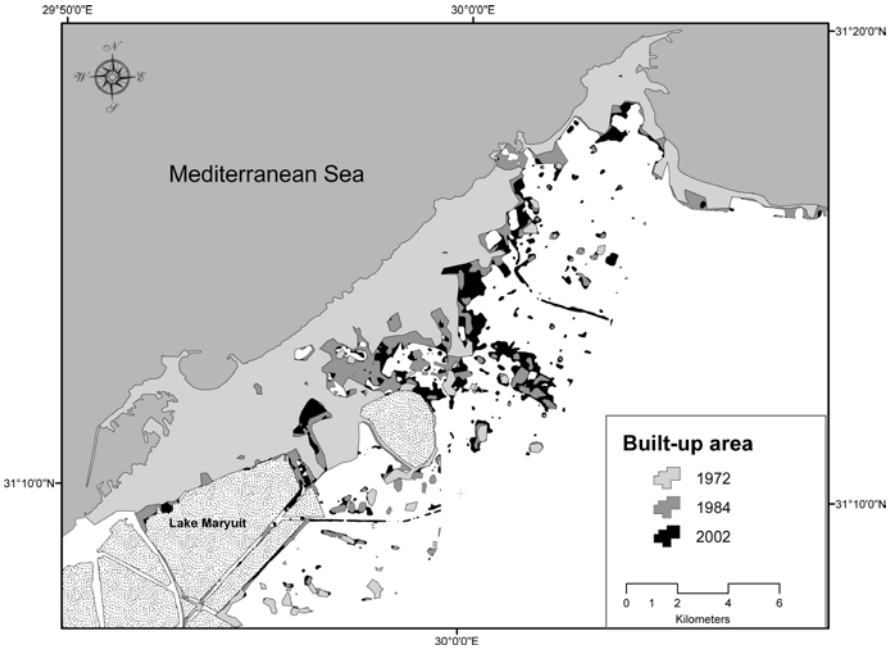

Fig. 2.9 Urban expansion in Alexandria over the period 1972, 1984 and 2002

section of the city such as El Attareen, El Laban, El Manshia and El Gomrok did not experience any expansion during the period between 1972 and 2002. Other sections, which have rural fringe, experienced considerable expansion at rates ranging between 2.12% and 49.89% during the period 1972–1984 and between 1% and 28.10% during the consequent period 1984–2002 (Fig. 2.9).

From a temporal perspective, the same sections which experienced varied expansion rates at different periods of time, for instance, the built-up area of Sedi Gaber section expanded rapidly during the period 1972–1984 (49.89%), thereafter, its expansion slowed down in the consequent period 1984–2002 (9.75%). Generally, this was the case in most sections that experienced expansion of its built-up area. The only exception was in the case of Montazah section which maintained high rate of expansion in the two consequent periods of time.

The derived size of the expanding areas in Alexandria City is then regressed against distance from city centre, area of adjacent section and population in adjacent section. Table 2.4 shows the results of the Ordinary Least Square (OLS) linear model statistical analysis of urban expansion in Alexandria City. It was found according to this analysis that the distance to the city centre and the area of adjacent section were of the right sign and significant at 5% and 1% significance levels. The population size in adjacent area was, meanwhile, found to be insignificant (Table 2.4).

Table 2.4 Statistical analysis of the OLS linear model of urban expansion in Alexandria City. Standard error is reported in parenthesis

R-Sq 68.8%	
R-Sq (adj.) 63.9%	
Variable:	
Intercept	1.6934 (0.7601)**
Distance to city centre (km)	–0.06436 (0.02714)**
Area of adjacent section (km^2)	0.10775 (0.03699)*
Population size of adjacent section	-832×10^{-8} (432×10^{-8})

* Significant at 1% significance level
** Significant at 5% significance level

The regression equation is:

$$E = 1.69 - 0.0644D + 0.108A - 0.000008P$$

Where:

E: represents the expanding area by section (m^2)
D: is the distance from that section to the city centre
A: area of the adjacent section
P: is the population size of that section

This represents a rough estimate of urban expansion experience in Alexandria, which is considered to be a reasonable means to assess urban expansion pressures in the Lake direction. Yet, further in-depth study of the, economic and socioeconomic factors influencing urban expansion in terms of magnitude, nature and directions is need to provide a more precise assessment.

The estimation regression equation is then utilised in projecting urban expansion in the vicinity of Lake Maryut, over the same duration, assuming that the Lake did not exist. According to this equation, the total area that could have encroached on in the Lake vicinity was found to be 7.3 km^2. It could be argued that such an impact is magnified by the fact that all parts if the Lake are located within a range of 3–19 km from city centre.

Yet, the valuation focuses on the potentials for urban encroachment on agricultural land located behind the Lake, which is located behind the 6 km distance from the city centre. This is because agricultural land starts to appear in the satellite images after that distance from the city centre. It is estimated, using the above mentioned equation for urban expansion that the area that could have been encroached on in that region, if the Lake was not present, equals to 6.44 km^2, which is about 1,465 Feddans (1,533 acres) (Fig. 2.10). The market value of this area, assuming a price per Feddan of L.E. 100,000, is estimated to be about L.E. 147,000,000. It is worth mentioning that this value does not include the value of the Lake area itself, but rather its function as a barrier to urban expansion.

It should be mentioned that such an economic valuation based upon a rough estimate of urban expansion experience in Alexandria, which is considered to be a reasonable means to assess urban expansion pressures in the Lake direction.

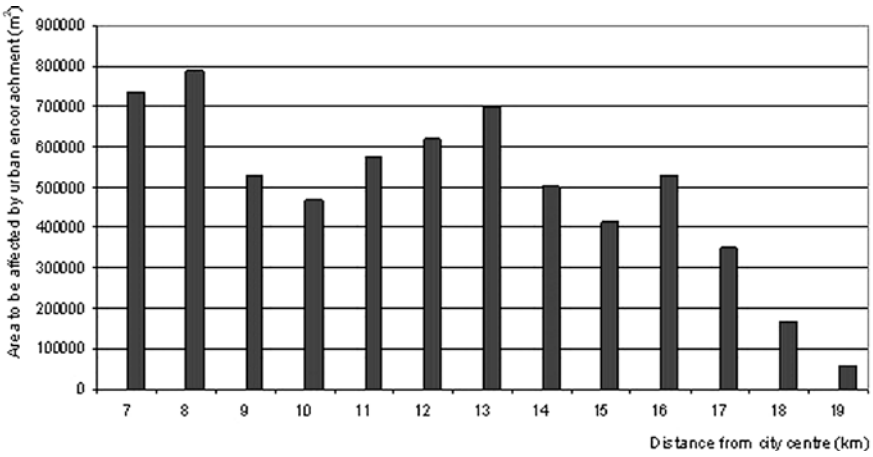

Fig. 2.10 Estimated urban expansion experienced in Alexandria City at different distances from the city centre (1972–2002)

Yet, further in-depth study of the, economic and socioeconomic factors influencing urban expansion in terms of magnitude, nature and directions is needed to provide a more precise assessment. Such an analysis would require the inclusion of other factors such as the improvement of infrastructure and city function, the promotion of industrial technology and the increase of service industry.

2.3 What Should Be Done?

In the shadow of various stakeholders' and conflict in their interests, Lake Maryut has been subject to a wide ranges of pressures. In such a situation there should be a twofold strategy to deal with the issues of concern in the Lake. A short term strategy needs to focus on preserving the Lake area and prevent further deterioration of its conditions. Such a strategy would require the establishment of a powerful institutional setup for the Lake involving main stakeholders. It is worth mentioning that this setup can only succeed in its mission with a clear and precise mission and executive powers. This setup need to have adequate human, political and financial resources to be able to manage the Lake and strike a balance between conflicting interests of various stakeholders.

The long term strategy, meanwhile, should aim at improving the environmental quality of the lake. Firstly, the initiated agency that will be responsible for the Lake has to develop a list of possible strategic scenarios for improving the environmental quality of the Lake. Economic, social, technical and environmental feasibility of each of the proposed scenarios should be assessed. It should be noted that such scenarios should be adopted through a comprehensive dialogue among various stakeholders, including the general public and beneficiaries, including fishermen. The adopted scenario should spill clearly the roles and responsibilities of all stakeholders involved.

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