21 世紀初頭における環境・開発総合支援戦略策定
（国別調査）

エ　ジ　プ　ト　・　ア　ラ　ブ　共　和　国

添　付　資　料

STUDY ON STATUS OF THE ENVIRONMENT AND RELEVANT POLICIES/MEASURES IN EGYPT

Submitted To:

Overseas Environmental Cooperation Center, Japan

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1 *INTRODUCTION AND OBJECTIVES*

1.1 Background

Occupying a total area of about 1,002,000 square kilometres in the north-eastern corner of Africa, Egypt is the continent's second most populous country. The 74 million inhabitants of Egypt mostly occupy a narrow strip of land of the Nile valley and Delta, an area equivalent to only 3% of the country's total area. The four main geographic zones of Egypt are the Nile Valley and Delta, the Western Desert, Eastern Desert and the Sinai Peninsula. The 1,350 km long Nile valley of Egypt is itself also composed of two distinct regions. The southern region of the Nile valley (also known as Upper Egypt), the valley varies in width from 2 to 10 km, surrounded by bordering cliffs. In the second region (north of Cairo), the river splits into two branches, Damietta and Rosetta. The Delta area bounded by these branches is totally flat, highly fertile agricultural land. From an administrative viewpoint, Egypt is made up of 26 governorates; four of which are totally urban (Cairo, Alexandria, Port Said and Suez).

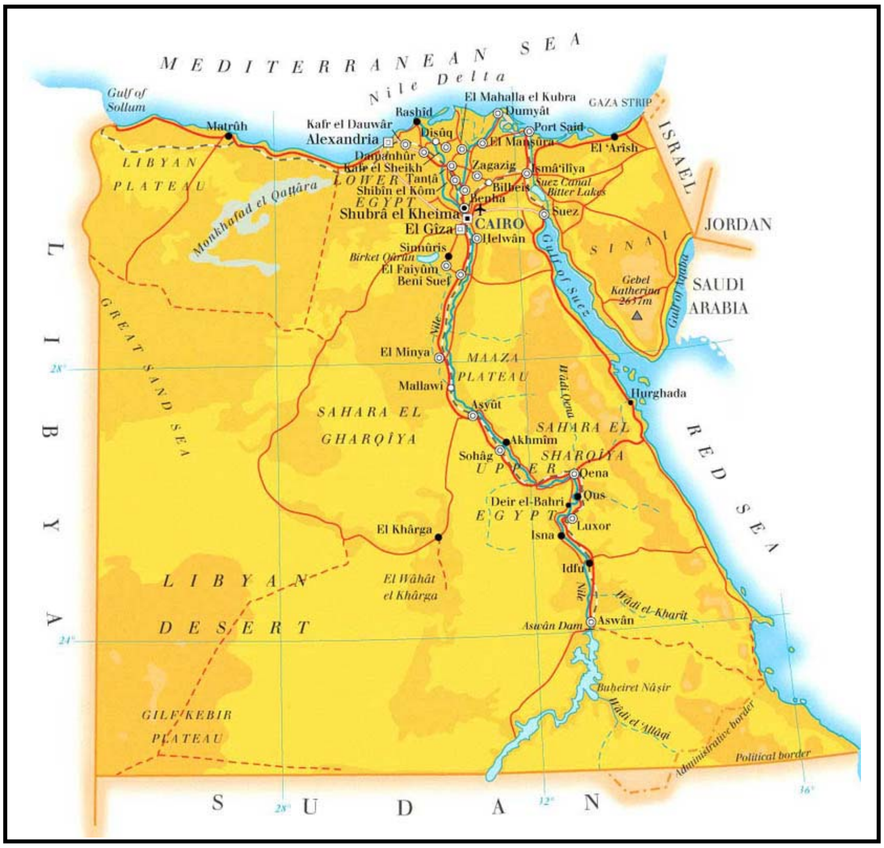


Figure 1.1 Map of Egypt

To tackle various the environmental pollution problems which have resulted from rapid industrialization and urbanization, the Egyptian government established the emission standards in 1994 with an enactment of *Law 4 for the Protection of the Environment*. Egyptian Environmental Affairs Agency (EEAA) was authorized to manage / monitors the compliance to the standards. In response to these efforts, Japan has been providing assistance in the environmental administration by supporting Cairo Central Center (CCC) and Regional Branch Offices (RBOs). Yet, there are still lot of issues to be solved, including issues on solid waste, hazardous management and POPs including PCBs.

1.2 Scope of the Study

The Government of Japan is currently in the process of developing the "***Strategy for Integrated Assistance in Environment and Development***" which will form the basis for the country specific assistance program to be provided by the Government of Japan to the Government of Egypt. The objective of the present study was to aid in the development of this aid strategy by gathering and reviewing the necessary information/data. Thus the results of this study will aid the Government of Japan in determining areas of assistance needed for Egypt in coming years.

In order to aid the development of the bilateral environmental strategy in coming years, a study team visited Egypt during the period of November 20 - December 3, 2004. The aim of the mission was to conduct interview surveys with relevant institutions/organizations, investigate the actual sites having environmental problems, and review existing documents. The study team consisted of the following: Mr. Shoji Nakamura (Senior Consultant at EX Corporation, Japan), Mr. Shin Okamoto (Researcher at EX Corporation, Japan), Mr. Kenji Sakurai (Researcher at the Overseas Environmental Cooperation Center, Japan), Dr. Tarek Genena (Environmental Management Expert, EcoConServ) and Dr. Noha Gaber (Senior Environmental Specialist, EcoConServ).

The approach followed by this mission was a participatory one. Discussions were held with representatives of the relevant Government of Egypt ministries, agencies, institutions, research centers and local government representatives at the Governorate level. Meetings were also held with private sector experts as well as representatives of international donors working in Egypt. This report details the results of the mission meetings as well as provides background information on environmental issues in Egypt. The report focuses on a number of key environmental issues that have been found by the mission to be of priority importance. These are:

- Waste management
- Sewage Treatment in Rural Areas
- Water quality degradation
- Air Pollution

2 LEGAL, POLICY AND INSTITUTIONAL BACKGROUND

2.1 Policy and Legal framework

2.1.1 Laws

Over the past four decades, Egypt has adopted a substantial body of environmental and environment related laws, decrees and regulations addressing various aspects of environmental protection and natural resources management. The most important of these include the cleanliness law number 38 of 1967, Law 48 of 1982 which addresses the protection of the Nile River and its related waterways as well as Law 4 of 1994 for the Protection of the Environment. The enactment of the Environmental Protection Law No.4 of 1994 addressed several significant legislative gaps in the legal framework for environmental protection neglected by the earlier sector laws such as water pollution and waste management laws. A general overview of the existing environmental legal instruments for concerned areas or media is given as follows:

Solid Waste

The Cleansing Law number 38 of 1967 with an amendment by Law 31 of 1976 regulates collection and disposal of wastes from houses, public places, commercial and industrial areas, and is valid for towns at the discretion of the concerned Governor. The Ministry of Housing and Utilities is responsible for the implementation of the law and may submit rules for its execution. Solid waste management is the responsibility of the municipalities; however, in Cairo and Giza a presidential Decree has led to the formation of Cleaning and Beautification Authorities in both cities.

Air pollution

Air pollution is regulated by 11 laws and 10 decrees within different Ministries. Several ministers and other authorities have mandates for air pollution control: Ministries of Housing and Local authorities (requirements for establishing boilers and thermal stations); New communities Authority (Urban planning and land use); Ministry of Industry (Rules and requirements for industrial production, air quality, planning and research); Egyptian Electricity Authority (Criteria for performance and control of production of electric power); Ministry of Interior (Regulation of car exhaust); Ministry of Health (Field monitoring of air quality, research); and Egyptian Environmental Affairs Agency - EEAA (projects, draft legislation proposals, standard specifications, indoor air quality and enforcement).

Protection of the Nile River and waste water discharge

Law 48 of 1982 addresses the protection of the Nile River and its related waterways from pollution. Discharge into the public sewerage networks is regulated by law 93 of 1962.

Natural protected areas

Establishment and management of natural protected areas is solely the responsibility of the Egyptian Environmental Affairs Agency (EEAA) and is governed by law 102 of 1984.

Environmental Law (Law 4/1994)

The Environmental law (law 4/1994) was drafted with a view not to replace previous environment-related legislations but to complement these legislations and to address any legal gaps or needs that are not adequately addressed by these previous laws. Law 4 of 1994 and its executive regulations (1995) define the roles and responsibilities of EEAA, which include regulation of air pollution, control of hazardous substances, management of hazardous waste and control of discharges to marine waters. The law also gives EEAA an array of tools with which to implement and enforce these provisions.

The key features of law 4/1994 could be summarized as follows:

- It re-established EEAA under the Cabinet of Ministers as the highest national authority in charge of environment.
- It requires all new projects and activities to submit an Environmental Impact Assessment (EIA), and gave EEAA the final responsibility of approving them.
- It gave EEAA the power to inspect and enforce the law.
- It established an environmental fund and mandated EEAA with the proposal of economic incentives for the protection of the Environment.
- It addressed gaps in the previous laws concerning air pollution, noise, industrial and municipal discharges to the marine environment, hazardous wastes and sanitary landfilling.
- Finally it increased significantly the fines and penalties for violations.

According to law 4/1994, the EEAA has the responsibility of formulating the general environmental policy as well as the plans for environmental protection and to follow up on their implementation in coordination with the Competent Administrative Authorities. In addition, the Agency is responsible for strengthen environmental relations between the ARE and other countries and regional and international organizations. In specific, law 4/1994 mandates EEAA with the following (as relevant to the study):

- Prepare draft laws and decrees related to the fulfillment of its objects and express its opinion on proposed legislation related to the protection of the environment.
- Prepare studies on the state of the environment, formulate the national plan with the

projects included for the protection of the environment, prepare the estimated budgets for each as well as environmental maps of urban areas and areas to be developed and lay down the criteria to be observed when planning and developing new areas as well as the criteria targeted for old areas.

- Lay down the criteria and conditions, which owners of projects and establishments must observe before the start of construction and during the operation of these projects.
- Conduct field follow-up of compliance with the criteria and conditions that are binding to agencies and establishments and take the procedures prescribed by law against those who violate such criteria and conditions.
- Lay down the principles and procedures for assessing the environmental effects of projects.
- Lay down a plan for environmental training and supervise its implementation.
- Prepare the draft budgets required for the protection and promotion of the environment.
- Propose economic mechanisms to encourage different activities and procedures for the prevention of pollution.
- Coordinate with the Ministry for International Cooperation to ensure that projects funded by donor organizations and countries are in line with environmental safety considerations.

To ensure the effectiveness of policies and decisions taken by the EEAA, which most often cuts across the areas of interest and concern of other competent authorities, the Board of Directors of EEAA (which is chaired by the Minister in charge of Environment) encompass representatives from:

- A representative from each of six ministries selected by the Prime Minister from the ministries concerned with the environment, provided the representative of each ministry shall be a high-ranking official selected by the competent minister.
- Three representatives from non-governmental organizations concerned with the environment selected in agreement with the Minister in charge of Environmental Affairs.
- The head of the Legal Opinions Department at the Council of State
- Three representatives from the public business sector selected by the Minister in charge of Environmental Affairs.

2.1.2 Policies

Environmental policy in Egypt has developed over a number of milestones:

- **<u>The National Environmental Action Plan (NEAP) of 1992</u>**: the first public document to provide the tools for ensuring that “Egypt’s economic growth becomes a sustainable one”. It firmly asserts that “Protecting the environment, among other aspects, is one of the key imperatives imbedded in the concept of sustainable development”.

- **<u>The Policy directives of the Ministry of State for Environmental Affairs in 1998</u>**: These were issued by the Minister of State for Environmental Affairs and updated in 2002 and represent a good start towards establishing an environment management system based on specific programs and outputs that would enable the Ministry of State for Environmental Affairs and the Egyptian Environmental Affairs Agency to set specific targets and report on the achievement of those targets. The updated policy directives are as follows:
  - Strengthening partnership at the national level through full coordination with the national entities that have their environmental projects or their activities have impacts on the environment.
  - Supporting bilateral, regional and international agreements in the environmental field
  - Enforcing Law 4/1994 for the protection of environment and Law 102/83 for nature protection
  - Implementing environmental protection projects through national, bilateral, multilateral funds.
  - Supporting integrated Environmental management systems
  - Supporting the multilateral Environmental agreements to which Egypt is a signatory.
  - Integrate the use of marked based instrument in the field of protection of environment
  - Transfer and adoption of environmentally friendly technologies.
  - Encourage foreign investments in the area of environmental protection through involvement of private sector.
  - Support to the policy of the Decentralization of Environmental Management.

- **<u>The National Environmental Action Plan (NEAP) update of 2002</u>**: Covering the period from 2002-2017, this document is designed to represent Egypt's agenda for environmental actions over the next 15 years. It is also designed to complement and integrate with existing sectoral plans for economic growth and social development. It is viewed as a diagnostic document with qualitative analysis of the environmental issues but with little quantitative analysis for setting priorities, including a plan of strategic actions. However, in contrast to the NEAP of 1992, this document doesn't provide any cost estimate of the strategic actions proposed, which could make its implementation difficult.

- **<u>EEAA Five-Year Action Plan:</u>** Based on the NEAP 2002 and the policy directives, EEAA developed its five year action plan, which includes the following:
  - <u>Integrated solid waste management program</u> to achieve sound management of solid waste and healthcare waste in all governorates of Egypt.
  - <u>Pollution Abatement Program</u> to protect River Nile and water resources and air quality of Greater Cairo
  - <u>Environmental education, training and awareness program</u> to increase public awareness of environmental program and develop human resources within the field of environment.
  - <u>Environmentally friendly technology transfer and support Egyptian exports program</u> to promote the use of environmentally technology in all economic activities.
  - <u>Environmental information and Monitoring system</u> program to enhance the use of information technology specially in the field of environmental management.
  - <u>Nature conservation and protecting Biodiversity program</u> to conserve national biodiversity.
  - <u>Capacity development of EEAA and RBOs program</u> to support the institutional structure of environmental management at the national level.
  - <u>Afforestation and Green area expansion program</u> to support governorates and NGOs in establishing nurseries and carrying out greening projects.
  - <u>Regional Branches Offices of EEAA Program</u> to support renovation and establishing new RBOs at the governorates level.
  - <u>Environmental Protection Fund Program</u>

There is also a strong policy direction away from centralised environmental management activities towards decentralisation at the regional and governorate levels. EEAA has set up 5 regional branch offices (RBOs) covering Greater Cairo, West Delta, East Delta, Central Delta, the Suez Canal and Sinai. Several initiatives have taken place to develop the capacities of these RBOs as well as the Environmental Management Units (EMUs) in each of the 26 Governorates. Administratively, EMUs are a part of each Governorate's structure, yet, operationally, they follow EEAA. Support has been given to some governorates in the participatory process of preparing the Governorate Environmental Action Plan (GEAP). The DFID-funded SEAM (Support for Environmental Assessment and Management) project has supported the GEAP development process in Damietta, Sohag, Qena, Dakahleya and South Sinai. The DANIDA-funded ESP project is supporting GEAP development in Beni Sewif, Aswan. Further support in the future will be needed to ensure sustainability of the progress achieved and to ai d in the implementation of the GEAPs. Developments in this area include the creation of a GEAP unit and an EMU Unit in EEAA. The EMU Unit has been specifically set up to support the protocol of cooperation signed between the MSEA and the Ministry of Local Development.

2.2 Institutional Framework

The number of environment-related institutions is approximately 17, classified into the following categories:

(a) national environmental organisation represented by the Minister of State for Environmental Affairs, the Egyptian Environmental Affairs Agency and its regional branch offices (RBOs), which are charged with overall monitoring and regulatory coordination

(b) institutions with specific operational functions on the environment, which are performed by environmental units in line ministries and by the environmental management units (EMUs) in governorates; and

(c) institutions with an environment support role, including universities and research institutes.

Although the responsibility of environmental protection rests with the Ministry of State for Environmental Affairs and its executive agency, the Egyptian Environmental Affairs Agency (EEAA), environmental issues cut across the activities of many ministries and institutions in Egypt. Consequently, EEAA is mandated to act as a coordinating body and to mainstream environmental considerations into the policies of the line ministries at the national and local levels. Among the most important ministries are: the Ministry of Health and Population, the Ministry of Water Resources and Irrigation, the Ministry of Agriculture and Land Reclamation and the Ministry of Housing, Utilities and Urban Communities.

Table 2.1 delineates the roles and responsibilities of the key relevant ministries and authorities as regards to environmental and environment-related issues and the corresponding legislations.

Table 2.1: Principal institutional framework related to environmental affairs

Institution	Role	Legislation
Ministry of Housing and local authorities	Specifications for licensing and building industrial and commercial shops	Law 453/1954 Law 731/1956
Ministry of Housing and local authorities	Requirements for establishing boiler and thermal stations	Law 33/1976

Ministry of Interior	Regulation of the use of loud speakers	Law 4/1994
Ministry of Interior and its departments	Regulation of traffic and civil defense during natural or man made disasters	Law 148/1959 Law 66/1973
Ministry of Interior	Protection of the Nile and waterways	Law 48/1982
Ministry of Housing	Licensing for wastewater drainage	Law 93/1962
Ministry of Local Administration	Identifying methods for treating ponds and marshes	Law 57/1978
Ministry of Local Administration	Observing rule for public cleanliness	Law 88/1967
Ministry of Housing General Organization for Physical Planning & New Communities Authorities	Urban Planning and Land use	Law 59/1979 Law 3/1982
Ministry of Public Works and Water Resources Ministry of Health	Protecting the river Nile and the waterways from pollution. Regulating discharge of wastewater and reuse of drainage water	Law 12/1984 Law 48/1982
Ministry of Agriculture	Protection of Agricultural Land Use of fertilizers and pesticides Protection of marine life and regulation of fisheries	Law 53/1966 Law 24/1983
Ministry of Health	Control of epidemics and infectious diseases Immunization Regulating choice and use of water sources	Law 137/1958 Law 27/1987
Ministry of Health (Office of Protection against ionizing radiation)	Control the use of ionizing radiation and licensing	Law 56/1960
Ministry of Health Ministry of Agriculture	Control of handling of food stuff Regulations of food containers and packaging Rules for taking samples and analysis of food. Setting specifications for food.	Law 48/1947 Law 10/1966
Ministry of Health Ministry of Interior	Regulating smoking in public places	Law 372/1956 Law 52/1956
Ministry of Industry and Mineral Wealth General Organization for Industrialization (GOFI)	Rules and requirements for industrial establishments and production	Law 21/1958 Pres. Decree 116/1965
General Organization for Industrialization (GOFI)	Regulating the use of toxic chemicals in industry	Law 137/1981 Law 27/1981
Ministry of Electricity Egyptian Electricity Authority	Setting criteria for performance and control of production and use of electric power	Law 12/1976 Law 13/1976
Ministry of Electricity, Nuclear Plants Authority	Specifications for nuclear power plants and licensing	Law 59/1960
EEAA, Ministry of Transport and	Protection of Seashores and seawater from pollution from	International Conventions for Protecting Marine water from

Communication, Sea Port Authorities, Ministry of Petroleum, Ministry of Defense, Ministry of Health	ships or land based sources (domestic & industrial).	pollution by oil and other pollutants Law 4/1994
Ministry of Tourism Tourist Development Authority	Defining the touristic establishment and hotels and issuing licenses Regulating the use of beaches	Law 1/1973 Law 2/1973
Ministry of Culture Supreme Council of Antiquities (SCA)	Definition of historical buildings, and areas, protection of antiquities, and regulations for excavation	Law 529/1953 PD 2828/1071 Law 117/1983

2.3 Environmental Impact Assessment

2.3.1 Overview of EIA System

The legal basis for environmental impact assessment (EIA) is established by Law 4 of 1994. It is implemented through its Executive Regulations (Prime Ministerial Decree No. 338 of 1995), which came into full implementation in 1998. The law and regulations require an EIA for new projects and expansions and renovations of existing ones. Sectoral ministries and Governorates are the Competent Administrative Authorities (CAA) for EIA in Egypt, as they possess the executive powers in relation to development authorization. The Central EIA Department of the EEAA is responsible for supervising the screening process, managing the review of EIA reports, taking decisions on the acceptability of EIA reports and giving an opinion on the development and proposals for mitigation measures.

EEAA has also issued a number of EIA guidelines. The general guidelines were issued in 1995. These describe in detail the screening method, which is based on three lists of project types:

- white list projects with minor impacts (Category A)
- gray list projects which may result in substantial environmental impacts (Category B)
- black list projects for which complete EIA is mandatory due to the magnitude and nature of their potential impacts (Category C).

The guidelines include two screening forms, form A for white list projects and form B for gray list projects. For gray list projects, EEAA may require a scoped EIA, whose is specified by EEAA on the basis of the information presentedby the developer in form B. In 2001, the EIA classification system was updated to include some modifications to the division between the three categories A, B, and C, varying in the severity of possible environmental impacts, as well as the expansion of the lists of facilities in each category to include additional ones, with the purpose of minimizing errors in categorization. Also, in line with the development of sectoral guidelines, the development of sector-specific EIA forms has taken place. In 2001, specific B category forms were developed for the petroleum and tourism sectors. Moreover sectoral guidelines for the sectors of cement industries and land reclamation and petroleum industries were published. Other sectoral guidelines being developed are ones for the sectors of pharmaceuticals, urban development and power generation.

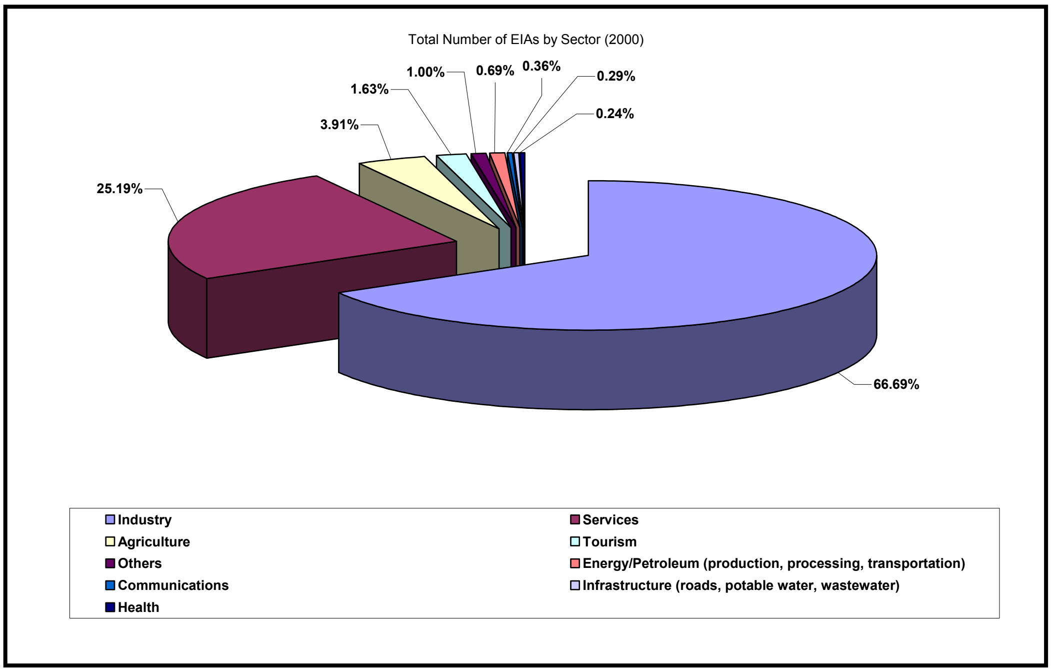
2.3.2 Analysis of the Performance of the EIA System

During the period of 1994-2000 nearly 22,000 EIA studies have been evaluated by EEAA (Table 2.1). In 2004 alone, 6333 EIA were submitted to EEAA.

Table 2.1: Temporal Evolution of EIAs Reviewed by EEAA

Year	Number of EIA's Reaching EEAA	Number of CAA's
1994	7	3
1995	26	4
1996	41	10
1997	87	13
1998	276	25
1999	11056	46
2000	10315	52

The distribution of the EIA studies be sector in 2004 is shown in figure 2.1 and Table 2.2.



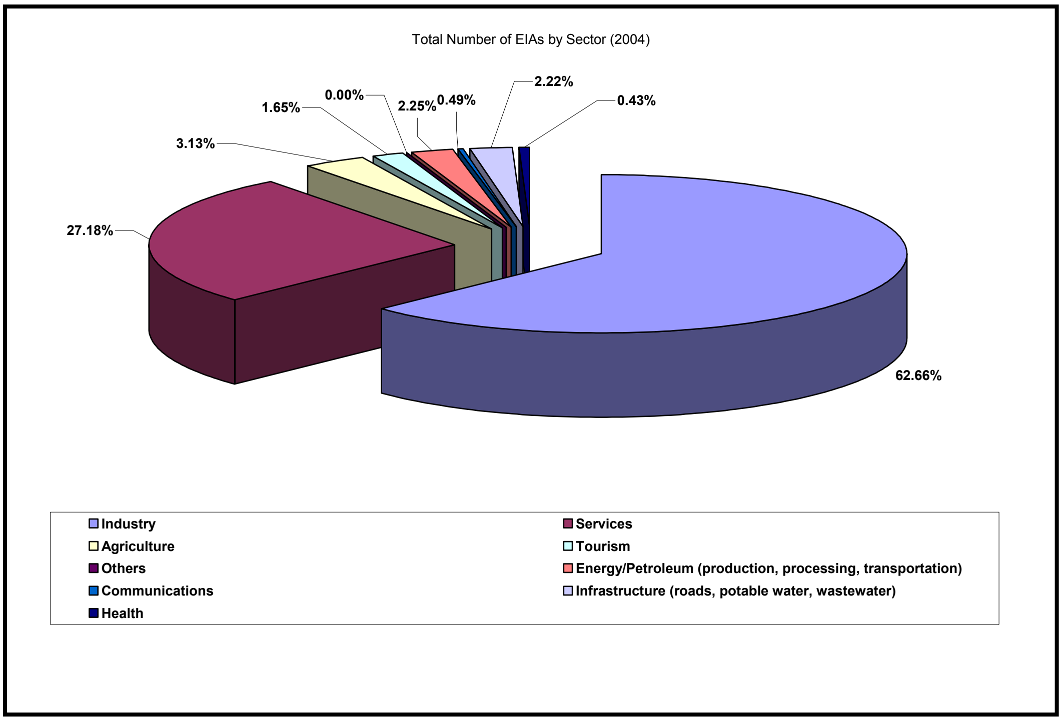


Figure 2.1 Number of EIAs reviewed by sector in 2000 and 2004

Table 2.2 Distribution of EIAs by Sector (Years 2000 and 2004)

Sector	**Total Number of EIAs (2000)**	**Total Number of EIAs (2004)**
Industry	6873	3959
Services	2596	1717
Agriculture	403	198
Tourism	168	104
Energy/Petroleum (production, processing, transportation)	71	142
Communications	37	31
Infrastructure (roads, potable water, wastewater)	30	140
Health	25	27
Energy/Electricity	5	5
Housing and Reconstruction	2	9
Ports/ Airports	1	1
Transportation	1	0
Others	103	0
Total	**10315**	**6333**

Establishing and operating the national system for environmental impact assessment represents a successful implementation of the environmental law 4/1994 and fulfillment of its requirements. Studies have shown that EIAs for coastal tourism and large oil and gas developments are now relatively well established. For the tourism sector, the Tourism Development Authority (TDA) may be considered the main instigator for the relative success witnessed, as it realized early on the importance of environmental management for the tourism industry. For the petroleum industry, the international markets and experience were influential, and EIA experience was transferred. Besides these two areas, the EIA system is not yet fully implemented. The EIA system in Egypt has been found to suffer from several shortcomings:

- Violation without Penalties: Although the law has specified that competent administrative authorities are those responsible for the first approval of the EIAs, yet the law did not determine any penalty for those authorities that do not comply. If an approval is granted to any establishment that did not prepare an EIA, the law did not state any penalties either on the administrative authority, the owner of the establishment or the investor.
- Centralization of Decision Making: EEAA is responsible for reviewing all EIA studies, and despite the support received by some donor agencies to build the capacity of the Agency in that regard, yet the Agency still lacks the required capacities, in terms of number and qualifications of human resources. In 1999, the Agency received an average of 800 EIA studies per month. The EIA department within the Agency, which is still seriously under-staffed, is required to review and comment on all studies within a maximum period of 60 days. Lately, however, measures were taken to decentralize EIA review for, at least, the white list projects.
- Poor Technical Capacity of Relevant Administrative Authorities: The relevant administrative authorities, who bear the greater responsibility in approving the EIAs, may include the local administrative units in the various governorates, the Investment Authority, the Petroleum Authority, the Tourism Development Agency, the New Cities Development Authorities. Most of those agencies lack the needed technical, and sometimes the physical, capacities required. The common practice is that the responsible administrative authority receive the studies from the investors, and send them as-is to EEAA, which increases the burden further on EEAA.
- The technical capacity of the EIA department at EEAA is also lacking. Consultants and investors alike complain from the lack of homogeneity in the evaluation process. EIA studies prepared with the same level of analysis, may sometimes succumb to detailed scrutiny, and other times pass with very limited or minor comments. Moreover, at other times the comments on the EIA studies reflect the poor capacity of the evaluators at EEAA. Comments which inquire about ipso facto information may just lead to further unnecessary delaying of the EIA cycle.
- Lengthy Cycle of the EIA System: The investor prepares the required study, sends it to

the responsible administrative authority, which in turn sends it to EEAA for review and receives comments within 60 days. These comments are in turn sent by the Administrative Authority to the investor to answer and modify the study. The investor sends the modified EIA once more to the Administrative Authority which repeats the process over again until the study is finalized and approved by EEAA. Those procedures extend for a long period of time (up to 2 years in some cases) and represent a main obstacle to investors.

- Quantity Before Quality: One reason for the long period of delay in obtaining the final approval of EEAA on the EIA studies is the inadequate quality of the studies. It has also led to the creation of a feeling of mistrust between the investors and the consulting offices working in that field. There are increasing calls for better regulation of the process, and for establishing clear specifications for the consulting offices allowed to conduct EIA studies.
- Environmental Management at the local Level: Governmental environmental management in Egypt is divided among three levels: the central level, represented in EEAA; the regional level, represented in the eight regional branch offices (RBOs) distributed among different governorates; and local level, represented in the Environmental Management Units (EMUs) within each governorate. Up till now, this institutional system has not been fully established. EEAA bears the full burden of the EIA responsibilities. It is planned to delegate the EIAs for the white list to the EMUs, the EIAs for the grey list to the RBOs, and for EEAA to be involved only with the black list projects.
- Lack of public participation: Public participation is not mandatory in the Egyptian EIA system and as a result is often ignored. Public hearings are held mainly only for overseas funded projects. In general, EIA reports are regarded as confidential documents. There was some evidence of movement towards greater openness. The Governorate of Cairo has scheduled public hearing on the environmental issues in Helwan and in Cairo. These have served a useful purpose in identifying public concerns. Governorates are permitted to retain copies of EIA reports, to enable them to discharge their responsibilities for compliance monitoring. Some developers have voluntarily involved NGOs in EIA studies. Such cases appear to be the exception, however. Support is needed for promoting awareness of the potential benefits of consultation and public participation as this could potentially enhance the effectiveness of the EIA system.
- Absence of Monitoring and Follow-up: The environmental law does not mandate EEAA to monitor and follow-up on the implementation of the EIAs. This responsibility has been given to the administrative authorities, which in most cases lack the capacity and

the interest for follow-up in the field. The Egyptian experience up till now shows that monitoring may be either weak, or absent altogether. A large percentage of the projects do not abide by the requirements of the EIA, and most investors regard the EIA as just another bureaucratic complication, that they have to go through.

- Absence of Environmental Assessment for Mega Projects: The EPL in stipulating the conditions for EIA, required its preparation for projects and establishments performing various activities, however it did not necessitate the formulation of EIAs for the region in which more than one project is located, such as industrial cities for example. Egypt is involved in the implementation of several mega agricultural projects. It is doubtful that timely EIAs have been prepared for those projects. Other politically important developments may also by-pass the EIA process. The EIA may be perceived as just one of many other requirements needed to obtain a license.

PRIORITY

ENVIRONMENTAL ISSUES

3. WASTE MANAGEMENT

3.1 Municipal Solid Waste Management

3.1.1 General Situation

Inefficient and inadequate municipal solid waste collection and disposal is considered one of the most pressing environmental problems in Egypt. Sub-standard solid waste management systems have serious impacts on public health and economic development, especially in rural areas of the country. Of the 60 million tons of waste generated annually, municipal solid waste accounts for 15.3 million tons. The remaining quantities include agricultural waste, construction and demolition wastes, industrial waste, wastewater sludge and waste from clearing of waterways. As growth in waste generation is a function of population growth and economic growth, it is projected that the total municipal solid waste generation is set to increase from 15.1 million tonnes in 2001 to 32.7 million tonnes in 2025 at an average rate of growth of 3.2% (METAP 2004). Currently, the quantity and composition of municipal solid waste varies from one area to another. Average per capita waste generation is higher in urban areas (1.0 kg/person/day) than in rural areas (0.3 kg/person/day). In lower income areas, organic content of the waste can reach 60%.

Municipal solid waste collection and disposal is considered one of the most pressing environmental problems in Egypt. The collection of waste and the subsequent management of wastes, however, has not been protective of either human health or the environment. Very large quantities waste are left uncollected, and wastes that are collected are frequently dumped in the environment. Outside affluent areas, waste is spread out along streets, roads, empty lots, rivers, and irrigation and drainage canals. It may be burned from time to time and is not particularly isolated from residential areas. More organized waste disposal is through land disposal, mostly at uncontrolled facilities. Fifty-six composting plants are reported across the country, and this number is apparently growing; however many have been closed or have operated poorly in the past as a result of inadequate operation/maintenance. Waste efficiency varies greatly from one area to another. In high income areas, collection efficiency can reach 90% in contrast to 10% collection efficiency in rural low-income areas. With the exception of Alexandria, there are currently no sanitary landfills in Egypt. As a result, wastes are generally dumped in open dumpsites, where it putrefies and self-ignites. In rural areas, waste is also sometimes dumped into agricultural drains and irrigation canals, thus significantly degrading water quality.

In most of the large cities, where there is collection of municipal solid waste, three systems may operate:

- *Municipal system*: Operated by municipalities, this is normally limited to street cleaning activities and collection of waste from communal containers. Almost all of the waste collected by municipalities is dumped without any segregation in open dumpsites.
- *Zaballeen System:* This is an informal private system operating mainly in above-average income areas and offering door to door waste collection for a small fee from individual households. The Zaballeen transport the waste to their homes and segregate it in preparation for recycling.
- *Private sector system*: Working under the supervision of municipalities, local private companies operate in several larger cities. The waste collected by these companies is either delivered to the Zaballeen communities or directly to disposal sites. Municipal solid waste services in Greater Cairo, Alexandria, Gharbyia, Luxor, Aswan, Red Sea and South Sinai have been privatised to international service providers.

The roles of the relevant governmental institutions involved in solid waste management are summarised in Box 3.1:

Box 3.1 Roles of Governmental Institutions in Solid Waste Management

A. The role of National Government (through EEAA):

- Establishes the institutional and legal frameworks for solid waste management and provides local governments with guidelines and/or capacity building measures in the field of administration, financial management, technical systems and environmental protection.
- Coordinates with the local units to identify the sites for waste disposal and treatment.

B. The role of Local Government:

- Local government is divided into four levels: governorates, markaz, districts (sub-divisions of the major cities) and local units (at the village level). A governorate is made up of a number of markaz. In each markaz, there is a main city and a number of mother villages. Each mother village has associated satellite villages and (ezab) hamlets.
- The governorates approve the budget and investment plans for solid waste management and distribute the budgets to the districts who are responsible for executing solid waste management and disposal services in urban areas or to the local units, who are responsible for executing solid waste management in rural areas.
- The local authorities (districts or units) are also responsible for the collection of street waste and waste from public spaces, operating existing composting plants and supervising the landfill and dumpsite operation. Local authorities are authorised to carry out this work directly or to contract private enterprises to provide the solid waste management services. In this case, local authorities remain responsible for regulating and controlling the activities and the performance of these enterprises. The local authority is charged with monitoring the adherence to article 39 of the executive regulations to Law 4/ 1994, which stipulates that collectors of garbage and solid waste shall be held to maintain the cleanliness of garbage bins and vehicles
- At the local level, the provision of solid waste management services is the responsibility of the "Cleansing Department" or what is currently known as the "Environmental Improvements and Cleansing Department", be that in the local unit

of a village or a markaz town. The unit is headed by the head of cleansing, who is responsible for the whole operation, i.e. managing collectors, drivers, vehicles and maintenance, presides over the worker supervisors who monitor the work of two groups of cleaning workers (street sweepers and waste collectors). The local unit head usually plans the logistics and arrangements for solid waste collection and transfer.

- The local authority also specifies the intervals and timing of waste collection and transportation, in keeping with the conditions of each area.
- In coordination with EEAA, the local authority specifies the siting of solid waste treatment, burning or disposal facilities.
- The local authority also identifies the sites that can be used for disposal of construction and demolition waste and issuing the licenses related to the transport and disposal of these wastes at the specified locations.

C. The role of the Ministry of Water Resources and Irrigation:

- Protection of the River Nile, its branches and waterways from pollution from solid waste and with the aid of Waterways police to fine violators.

A number of donor agencies are also currently supporting solid waste management initiatives:

Agency	Governorates
USAID	Cairo (South Zone), Qalubiya and Alexandria
KfW	Qena and/ or Kafr El-Sheikh
Government of the Netherlands	Fayoum
DFID	Sohag, Qena, Damietta and Dakehleya
EU LIFE Program	Identifying possible landfill sites in Governorates
Finland	Beni Sweif

3.1.2 *Solid Waste Management Regulation*

Laws

The main legislation relating to solid waste management in Egypt is Law 38 for 1967 as amended by Law 31 for 1976. The law regulates the collection and disposal of solid waste from residential areas, commercial and industrial establishments, and public places. It prohibits the placement of wastes or wastewaters in areas other than those specified by the local council. It is important to note that the law only applies to cities and villages that have designated by a Governor’s decree. A summary of the most significant articles of the relevant solid waste management laws is provided in table 2.2. In addition to these Laws, some cities have their own Ordinances; and if a specific rule is violated, an inspector will issue a notice, which would usually be followed by a fine.

Table 3.1 Solid Waste Management Relevant Legislation

Law and Article	Description
Law 38 for 1967, Article 6	Requires that the local council issue a license for all workers employed as waste collectors.
Law 38 for 1967, Article 8	Stipulates that local councils may impose a cleanliness tax on all housing units equivalent to 2% of the rental value. The money collected from this tax enters a fund for public cleanliness. The budgetary allocations for public cleanliness are also to be included in this fund.
Law 38 for 1967, Article 10	States that the rules of this law are applicable to cities and the villages that are specified by a decree by the governor. This only applies after 30 days from the decree being advertised in the official gazette.
Ministry of Housing Decree # 134 for 1968	Implements Law # 38 for 1967 and declares specifications and locations of dumping places, and methods of treatment (e.g. dumping, composting and incineration). The local council is given the right to determine the number of waste collection licences and specify the waste collection frequency and times given local conditions.
Law 31 for 1976	Defines "garbage and solid wastes" as including domestic and industrial waste. It also specifies garbage containers, means of transportation, and the periodicity of solid waste collection.
Ministry of Justice Decree (MoJ 3137/1976)	Identifies the following local government employees as having authority to enforce Law 38/1967: • Governorate housing administrators • Governorate health department administrators • Governorate health affairs representatives working in environmental protection • Governorate or local unit general manager for urban environmental protection • Engineering Division administrators for town and district councils • Municipal organisation administrators and engineers • Environmental protection monitors in local units • Physicians at health offices and units in towns, districts and village units • Heads of village units in rural areas • Technical personnel supervising cleaning services in local units • Cleaning and draining monitors and supervisors
Law 4 for 1994 Article 37	Requires environmental review assessments of new developments, including solid waste related establishments (such as composting plants, landfills, incinerators, etc.). Prohibits the burning, disposal or treatment of solid waste except in designated areas far away from housing or industrial or agricultural areas as well as from

	waterways. The executive regulations for this law define the specifications, conditions, and the minimum distance between the specified areas and these regions. The local units, in agreement with EEAA, assign the sites for dumping, treatment, or burning solid waste according to the requirements of this article.
Prime Minister's Decree No. 338 for 1995, Article 38	Promulgates the Executive Regulations of the Law for the Environment Prohibits the burning, disposal or treatment of solid waste except in designated areas far away from housing or industrial or agricultural areas as well as from waterways. This article of the Executive Regulations of the Law permits the incineration of infectious waste generated by medical care in hospitals and health centers, with certain provisions.
Prime Minister's Decree No. 338 for 1995, Article 39	States that collectors of garbage and solid waste shall maintain their garbage bins and vehicles in a clean state. Garbage bins shall be covered tightly so that no offensive odours shall emit, and also to avoid becoming a source for attracting and growing flies and other similar insects, or a focus for attracting stray animals. The garbage contents shall be collected and transported at suitable intervals according to the conditions of each area. The quantity of garbage shall not exceed the capacity of any of these bins at any time.

National Integrated Solid Waste Management Strategy

A national strategy addressing solid waste management in the period of 2000-2010 has been developed. The National Strategy defines a planning framework for the establishment of an integrated municipal solid waste management system. The framework identifies: (i) the strategy purpose, goal and objective; (ii) the targets to be pursued, as well as the performance benchmarking set-up and (iii) the seven strategic action areas. The short-term goal of the National Strategy is centred on addressing the problem of solid waste accumulations while the long-term aim is building a proper infrastructure required for establishing an effective and efficient system, based on effective legislation, reliable technical and management standards, viable institutional set-up and efficient infrastructures. The policies identified as guiding principles for the implementation of the National Strategy include the following points:

- Central government shall be the facilitator for the establishment and implementation of the National Strategy.
- Implementation of the National Strategy shall be the responsibility of the governorates.

- Operations of the solid waste management system shall be the responsibility of the governorates/ local governments either by direct ownership and operation or through contracting services to capable private companies.
- Central government and governorate planning shall be integrated and shall foster a "Government-Public-Private-Community Partnership"
- The "polluter pays principle" and full cost recovery shall be applied as being essential for private-sector entrance and system sustainability.
- Adherence to the "reduce, reuse, recycle and recover" hierarchy will be required.
- The public shall be fully involved in and made aware of all steps of the planning, development and implementation of the Strategy.

The strategy stresses the need for the establishment of local solid waste management data collection and reporting system, which can be connected to a national network to facilitate monitoring of the progress made on achieving the National Strategy targets and relevant performance indicators (Table 3.2).

Table 3.2: Government SWM National Strategy Targets and Relevant Performance Indicators

Target	Performance Indicator	5 years	10 years
Minimum collection coverage: • Large cities • Capitals of governorates • Small provincial towns • Large villages	Collection efficiency	• 90% • 80% • 70% • 60%	• 99% • 90% • 80% • 70%
Sanitary landfill disposal	% of land-filled vs. total generated	80%	90%
Recovery: • Composting • Recycling	% of land-filled vs. total generated	• 50% • 40%	
Source separation (wet, dry and hazardous)	% of separated vs. total generated	40%	50%
Source reduction	% of reduction referred to normal growth		5%
Cost recovery		100%	
Funding	% of Gross Domestic Product	0.35%	

The general objective of the National Strategy is to enable local Governorates to provide and implement an effective suitable solid waste management system. Based on this strategic objective, Local Governorates are expected to develop action plans that include objectives related to:

- Coverage level of collection and transfer of the daily generated waste in urban and rural areas.
- Coverage level of treatment (urban and rural)
- Coverage level of final disposal (urban and rural)
- Minimisation of the amount of waste to be treated and disposed of
- Increasing rates of re-use and recycling
- Institutional set-up
- Participation of NGOs
- Removal of existing accumulations

The lessons learned from the implementation of the Strategy are summarised in table 3.3

Table 3.3 SWM Lessons Learned

Solid Waste Management Component	**Lesson Learned**
Policy, Legislative, Institutional	The GOE decided to privatize solid waste management services to international operators in a number of major Governorates. However Rural Governorates that tried to attract international operators mostly failed. Consequently, Solid Waste Management Services are currently not addressed in Rural Areas. High level (Ministerial) Committee was established to closely monitor the progress concerning privatization. This proved to be an effective follow-up mechanism
Planning	Planning for privatization of Solid Waste Management was not given the needed time nor effort by the national authorities. Local authorities (especially rural Governorates) do not have the competence to conduct the preparatory work nor to manage the privatization process. Accordingly the privatization process was hampered in a number of Governorates. The Qena Governorates planned and implemented a SWM service on a commercial basis (not private). The quality and efficiency of the service provided is comparable to international operators
Financing and Cost Recovery	Collection of the SWM service fee on top of the electricity bill proved to be a reasonably acceptable cost recovery mechanism however it was

	subsequently deemed to be unconstitutional and this fee collection was halted.
Private Sector Participation	Privatisation of SWM in Alexandria (where a successful process has been followed and excellent service at affordable cost is provided) and in other Governorates (where the process has not been as smooth). Commercialisation of SWM collection service in Qena City, linked to a beautification initiative. Investment cost was borne by the municipality, and cost recovery is undertaken on a commercial and financially sustainable basis. During the preparatory work for privatization there was no consideration for the involvement of the private sector, especially the Zabbaleen. Currently this is causing a social problem.
Public Awareness and Public Participation	Selection of landfill sites in a number of cases has not been subject to a through EIA process nor public participation. This has posed a serious threat to the SWM service from a public opinion as well as a legal point of view
Technology Application	Government led efforts in this regard have focused on compost production. The high organic content of the waste stream has led to centralize composting initiatives. These facilities have demonstrated that centralized composting can be undertaken, but these initiatives have often not been sustainable because of one or more factors such as poor technology selection, inadequate capability to manage/operate/maintain equipment, inadequate cost recovery and poor integration into waste management initiatives (e.g. to remove of compost contaminants prior to composting or delineation of cost-effective compost markets).

3.1.3 Solid Waste Management in Rural Areas

For the rural areas, the National Strategy for Integrated Solid Waste Management sets an ambitious target of 60% collection efficiency in larger villages by the year 2005 (and 70% efficiency by 2010). However, rural areas are subject to a set of limiting conditions and constraints, which necessitate that innovative municipal solid waste management systems and financing schemes, are developed. The constraints challenging the implementation of successful municipal solid waste management in these areas include:

- geographically scattered rural communities, each containing relatively small populations and relatively large distances separating them;
- poor accessibility within the villages, due to their unpaved, narrow streets;
- the limited availability of land that can be used for disposal has led to the waste being

dumped into agricultural drains and irrigation canals, thus significantly degrading water quality;

- being low-income areas, the ability and willingness of the residents to pay for solid waste management services is limited;
- limited technical capacity in rural municipalities areas about sound municipal solid waste management practices; and
- insufficient profitability making it unattractive to private sector companies.

In rural areas, in particular, the implementation of effective solid waste management systems is faced with a number of constraints. These constraints are related to environmental conditions, institutional/ administrative issues, financial matters, technical deficiencies and planning and legal limitations.

The main constraints identified in this report may be summarised as follows:

- **Institutional/ Administrative Issues:**
    - Lack of an actor who has overall responsibility of ensuring the efficient implementation of the solid waste management system
    - Lack of follow-up and supervision of service provision

- **Policy/ Planning/ Legal Issues:**
    - Limited coordinated and long-term solid waste management planning
    - Solid waste management activities are mainly reactive and performed on an ad hoc basis.
    - No clear incentives or pressure on governorates to develop and implement solid waste management plans.
    - Little coordination between villages and activities of one village may negatively impact on a neighbouring one
    - In planning for solid waste management services, local government officials only consider collection equipment requirements without critical assessment of the overall situation.
    - Legal constraints affecting solid waste management include the lack of enforcement of laws related to solid wastes and cleanliness

- **Financial Issues:**
    - Lack of financial resources allocated for solid waste management services.
    - Spending from cleansing fund is not limited to solid waste activities and could include street lighting and upgrade and beautification activities
    - Local units are highly dependent on governorate and central government

funding (which are hardly sufficient to cover the operating costs) and even funds that are raised locally must go directly into the governorate budget who then allocates these funds in the following year's budget for the local units.
  - Municipalities generally do not benefit from the sale of recyclable materials.
  - CDAs involved in solid waste management face problems of unwillingness on the part of some of the residents to pay for the service and collecting the fees.

- **Technical/ Operational Issues:**
  - Limited capacity at all levels of local government and in the community based organisations for solid waste management technicalities of the most suitable collection and disposal methods.
  - Lack of accurate information on the solid waste generation rates and waste composition.
  - Lack of or inadequate maintenance of equipment and unreliable collection.
  - Lack of regular routes and times and supervision results in wastes accumulating in certain areas.
  - Locations of dumping sites and compost plants may not be suitable for all villages.
  - Lack of a formal mechanism to collect and recycle recyclable materials.

- **Environmental Issues:**
  - Lack of suitable land for disposal or construction of compost/ separation plants and this is especially evident in the Delta than in Upper Egypt.
  - The final disposal of the removed waste from watercourses poses a further problem as in addition to the limited land available for disposal, there is limited coordination between the local units and the district irrigation engineers.
  - Absence of basic water and sanitation services impacts on the provision of solid waste management services by placing it on a lower level of priority than other infrastructure components.

- **Socioeconomic Issues:**
  - Lack of public participation.
  - Limited environmental awareness

3.2 Hazardous Waste Management

Handling of hazardous substances in Egypt is regulated by Law 4/1994 for the environment (articles 29 to 33) and its Executive Regulations (articles 25 to 33). The regulations stipulate that handling of hazardous substances can only be carried out after a permit is issued by the concerned authorities, which are six line ministries (Agriculture, Industry, Health, Interior, Petroleum, Electricity) each in its field of competence. An Egyptian Hazardous Substances Information and Management System has been developed. It provides basic guidelines and information to ensure safe handling of hazardous substances and aids in the dissemination of such information through an information network. The system and guidelines are based on international ones, adapted to suit Egyptian needs and conditions. The system would allow the exchange of information between EEAA and the six line ministries involved in the permitting procedures, with a view to developing a common format for permit issuing. Building on the success of the hazardous substances system, it is proposed that an information system be developed for hazardous waste management. It is proposed that the system will be able to track the handling of hazardous wastes, based on the principles of life cycle assessment.

According to the National Environmental Action Plan of 2002, Egyptian industries produce an estimated 4 to 4.5 million tons of solid wastes per year. Of this amount, hazardous industrial wastes form an estimated 100-150 thousand tons per year. Therefore, effective control of the generation, storage, treatment and disposal of these wastes is highly important. The competent authorities involved in hazardous waste control and licensing include EEAA (and its regional branch offices), six line ministries, and the Governorate Environmental Management Units. There is an immense need to promote awareness between hazardous waste producers as to the classification of hazardous waste and how to manage it. A successful project has been implemented for hazardous waste management in Alexandria. The project (now in its second phase) aims to establish sustainable systems for prevention, minimisation, storage, collection, transportation, recycling, treatment and disposal of all significant groups of industrial hazardous waste in the Governorate of Alexandria.

4. *SEWAGE TREATMENT IN RURAL AREAS*

In total, an estimated 10 million cubic meters of domestic wastewater is generated by all governorates per day (based on the population studies and rates of water consumption, equivalent to 3.5 billion cubic meters/year.) Approximately 1.6 billion cubic meters/year receives treatment. Access to sewerage systems is predominantly in urban areas, with about 77% of the population of Cairo connected to sewage collection networks. In rural areas, where about half of the population reside (35 million persons), 95% of the people have no access to sewer systems or wastewater treatment facilities. Table 4.1 provides data on the Potable water and sanitation networks coverage in the Governorates of Egypt.

Table 4.1 Water Supply and Sanitation Coverage Across Egypt

Governorate	Population (,000)[1]	Population connected to public network (%) [2]	
		Water	Sanitation
Cairo	6,801	80.49	75.03
Alexandria	3,339	90.03	60.56
Port Said	472	89.42	41.83
Suez	418	63.24	89.38
Total Urban	**11,030**	**80.42**	**66.60**
Damietta	914	88.94	45.87
Daqahlia	4,224	77.89	44.43
Sharqia	4,281	54.00	28.96
Qalyibia	3,301	54.54	22.46
Kafr El-Sheikh	2,224	66.89	16.01
Gharbia	3,406	69.34	18.33
Menofia	2,760	52.69	6.03
Behira	3,994	51.60	10.88
Ismailia	715	57.63	23.97
Total Lower	**25,819**	**62.52**	**23.50**
Giza	4,784	71.05	39.14
Beni Suef	1,859	38.35	4.71
Faiyum	1,990	49.37	12.07
Minya	3,310	31.99	2.95
Asyut	2,802	49.79	3.90
Sohag	3,123	45.67	4.38
Qena	2,442	43.71	4.00
Aswan	974	41.61	6.88
Luxor	361	55.47	9.10
Total Upper	**21,646**	**37.27**	**9.98**
Red Sea	157	46.57	9.92
New Valley	142	80.34	68.60
Matrouh	212	54.52	12.45
North Sinai	252	74.54	22.08
South Sinai	55	33.61	24.75
Total Frontier	**818**	**62.15**	**26.48**
Total Egypt	**59,313**	**59.75**	**26.25**

Source: The Environmental Profile based on:

(1) Central Agency for Public Mobilization Statistics, Statistical Year Book, 1993-1999;

(2) Computed based on number of persons per room, number of rooms per residential building, number of residential buildings connected to public networks for delivery of drinking water and collecting wastewater.

In rural areas, septic tanks are mostly used to collect and partially digest the wastewater. In the rural areas of the Nile Delta, where high population densities exist along with high groundwater table, serious health risks arise from this practice, as the partially digested wastewater seeps into the ground and pollutes the groundwater. Raw sewage is also discharged into the agricultural drains and in Upper Egypt, all drains flow back into the Nile. In areas, where wastewater treatment facilities exist, the flows of municipal wastewaters greatly exceed the design capacity of the plants and this overload results in a poor effluent. This in turn further degrades the water quality in the agricultural drains. As such, mixing drainage water with the freshwater for irrigation purposes makes the use of this water risky for public health. The main pollutants in wastewater are pathogens, nutrients and oxygen demanding compounds. Additionally, as many of the wastewater collection networks in urban areas (especially Cairo) also serve industries and commercial activities, high levels of potentially toxic substances, such as heavy metals and organic pollutants may also exist. These elements become concentrated in the sewage sludge, which also produces a problem for the safe disposal and/ or reuse of this sludge.

By the year 2017, an additional capacity of treatment plants equivalent to 1.7 BCM is targeted (National Water Resources Plan, 2002). Although the capacity increase is significant, it will not be sufficient to cope with the future increase in wastewater production from municipal sources and therefore, the untreated loads that will reach water bodies are not expected to decline in the coming years, as demonstrated by the following table.

Projections of Wastewater Treatment Coverage

Year	Population	People Serves	People Not Served
1997	60 Million	18 Million	42 Million
2017	83 Million	39 Million	44 Million

5. *WATER QUALITY DEGRADATION*

The conventional water resources in Egypt are limited to the Nile River, groundwater in the Delta, Western deserts and Sinai, rainfall and flash floods. Each resource has its limitations on use. These limitations relate to quantity, quality, location, time, and cost of development. The Nile is the predominant source of fresh water in Egypt. Presently, its flow rate relies on the available water stored in Lake Nasser to meet needs within Egypt's annual share of water, which is fixes at 55.5 Billion Cubic Meters (BCM) annually by an agreement signed with Sudan in 1959.

Water is needed in Egypt to irrigate vast areas of agriculture land, to generate electrical energy, to meet the growing demands of expanding villages and cities, industrial needs and navigation. As the population in Egypt increases and as the demands of society become more complex and divers, the requirements placed upon available water supplies continue to rise. The threat of Nile water resources being insufficient in quantity and quality in the near future requires immediate, efficient and co-ordinated action. Reuse of drainage water appears to be one of the most promising, practical and economical means of increasing the Egyptian water budget. However, reuse of drainage water has its limitations and drawbacks. Available information shows that the river Nile, its branches, canals and the drains are suffering from an alarming increase in the pollution through waste water. The drainage system particularly is receiving the heaviest pollution loads. The major sources of water pollution are municipal and rural domestic sewage, industrial waste water and agricultural chemicals [salts, nutrients and pesticides]. Although the impact of discharge of these wastes on ambient water quality of the Nile has not been significant in recent years due to the high dilution factor and the high self assimilation capacity of the Nile water, special attention should be given to mitigate pollution from these sources as their effects may become significant during low flow years. This is the present situation in Egypt, where dependence on the Nile system makes management of its quality as important as management of its quantity.

5.1 *Pollution of Agricultural Drainage Canals*

Throughout Egypt, the course of irrigation and drainage canals is a total of approximately 55,000 km. The catchment areas of these watercourses are divided into districts which have boundaries different to political boundaries delineating governorates or markazes. Degradation of water quality in the Nile River and associated irrigation and drainage canals is a major issue in Egypt. The severity of present water quality problems in Egypt varies among different water bodies depending on: flow, use pattern, population density, extent of industrialization, availability of sanitation systems and the social and economic conditions existing in the area of the water source. Discharge of untreated or partially treated industrial and domestic wastewater, leaching of pesticides and residues of fertilizers; and navigation are often factors that affect the quality of water.

5.1.1 Sources of Pollution

Water quality monitoring of the Nile River and associated irrigation and drainage canals is undertaken by twenty-five different agencies, under seven ministries. Each monitoring program has different objectives, different sampling locations and covers different water quality parameters. Furthermore, most of these monitoring activities are not conducted on a regular basis. Also, there are many gaps in geographical coverage, with the main Nile River receiving the most attention. Monitoring of the canals has only recently been included in the monitoring programs and information about water quality along the length of drains in Upper Egypt is very limited. Most water quality monitoring programs focus on conventional parameters and limited data is available on important parameters such as pesticides, heavy metals and hydrocarbons. Data on the quality of sediments, phytoplankton and fish is also very meager.

<u>Municipal Wastewater</u>

Of the sources of pollution to surface water, discharge of raw sewage, especially in the rural areas of the Nile Delta is the most critical. Most waterways receive raw sewage either directly from housing units and sewage/ sludge emptying trucks. (See Section 4).

<u>Industrial Wastewater</u>

The industrial sector is an important user of natural resources and a contributor to pollution of water. There are estimated to be some 24,000 industrial enterprises in Egypt, about 700 of which are major industrial facilities. The spatial distribution of industry in Egypt is influenced by the size of the employment pool, availability of services, access to transportation networks, and proximity to principal markets. The manufacturing facilities are therefore often located within the boundaries of major cities, in areas with readily available utilities and supporting services. In general, the majority of heavy industry is concentrated in Greater Cairo and Alexandria.

Approximately 387 million cubic meters of industrial effluents are discharged to the Nile, its canals and drains. Some 34 large industrial facilities discharge into the Nile between Aswan and Cairo. During the past few years the river Nile was given special priority for addressing the pollution from industrial sources. Primary treatment of wastes for most of these industries directly discharging to the Nile is reported to have been undertaken.

Discharges from a number of industries were directed to public sewerage networks or agricultural drains. However, as of February 2000, ten of these facilities still were not in compliance with some of the effluent concentration discharge standards set in Law 48 (see Table 5.1). In addition, it is argued that attempting to focus only on stopping the direct industrial discharges to the Nile, has not solved the problem, and might have caused even more serious complications. By directing industrial discharges to the sewerage networks, municipal wastewater treatment plants would be overloaded and their efficiency would be reduced. Some industries diverted their discharges to adjacent agricultural drains, seriously degrading the quality of its waters and rendering it unusable.

Table 5.1 Effluent Quality from Major Industries Discharging to the Nile

	Law 48 Limits & Recorded Discharges Levels (exceeded standards in bold)								
Source of Pollution	**pH (6-9)**	**BOD 30 mg/I**	**COD 40 mg/I**	**TDS 1200 mg/I**	**TSS 30 mg/I**	**Oil & Grease 5mg/I**	**Nitrate 30 mg/I**	**Inorgan. Phosp. 1 mg/I**	**Fe 1 mg/I**
Kima Factory (Aswan)	**9.4**	4	**55**	**1920**	15	**6.4**	**450**	0.20	0.11
Kom Imbou Sugar Factory	5.7	**83**	**657**	410	**67**	**9.3**	2.1	0.06	0,85
Idfou-1 Sugar Factory	**9.3**	**410**	**1440**	365	**65**	**5.6**	2.2	0.04	0.23
Idfou-2 Sugar Factory	5.2	**81**	**600**	225	**42**	**5.6**	1.3	0.04	0.74
Qous Sugar Factory	7.5	**77**	**189**	240	22	--	1.0	0.15	0.40
Sohag Oil Factory	7.6	8.5	33	**1374**	**145**	**7.3**	3.5	0.04	0.39
Coca Cola Bottling Factory	**11.3**	**83**	**256**	737	**39**	**5.9**	3.5	0.14	0.27
Elhwamdia Sugar Factory	1.1	**440**	**3850**	**8192**	**60**	**17.6**	10	**7.50**	--
Salt and Soda Factory	--	**130**	**155**	--	**387**	**9.4**	--	--	--
Talkha Fertilizer Factory	**10.2**	**98**	**204**	**1350**	**67**	**7.6**	**128**	--	--

Notes: Data as of February 2000; dash (--) indicates information not available.

Source: Ministry of Water Resources & Irrigation. March 2001, “A Memorandum to be presented to the Ministerial Committee for River Nile Protection from the Pollution of Canals, Drains and Groundwater” (in Arabic).

Agricultural Drainage

Apart from being the largest consumer of water, agriculture is also a contributor to water pollution. Drainage water seeping from agriculture fields are considered non-point sources of pollution. These non-point sources are, however, collected and concentrated in agricultural drains and become point sources of pollution for the River Nile, the Northern Lakes, and irrigation canals in case of mixing water for reuse. Moreover, these non-point sources of pollution may also influence the groundwater quality. Major pollutants in agricultural drains are salts; nutrients (phosphorus & nitrogen); pesticide residues (from irrigated fields), pathogens (from domestic wastewater), and toxic organic and inorganic pollutions (from domestic and industrial sources).

The Egyptian Public Authority for Drainage Projects (EPADP) is responsible for the improvement and maintenance of land drainage networks in the agricultural lands of Egypt. It has the following tasks:

- determine the desired water table conditions that permit an optimum crop production;
- identify areas where poor drainage conditions limit crop production;
- design drainage systems for these areas according to a set of design criteria that prescribe effective and efficient water table control;
- install drainage systems in these areas;
- operate and maintain (O&M) drainage systems to ensure performance according to design criteria;
- transfer ownership and responsibilities to the system users, i.e. the farmers.

EPADP has installed sub-surface and surface drainage systems to reduce water-logging (high water table) and prevent salinization of agricultural lands. The provision of over 2.5 million hectares with drainage systems was started in 1973 and is expected to be completed in 2010.

5.1.2 Water Quality in Agricultural Drains in Upper Egypt

According to a recent survey (2002) of water quality in the Nile River system in Egypt carried out by the USAID funded Agricultural Policy Reform Program, there are 67 agricultural drains discharging into the Nile River in Upper Egypt (from Aswan to the Delta Barrage). The data indicates that out of the 43 major drains in Upper Egypt, only 10 are in compliance with the standards set by Law 48/1982 (Article 65) regulating the quality of drainage water which can be mixed with fresh water. The remainder of the drains exceed the consent standards in one or more of the parameters. The worst water quality is that of Khour El-Sail Aswan, Kom Ombo, Berba and Etsa drains. In terms of organic load, it was found that the highest organic load is discharged from Kom Ombo drain (218.1 ton COD/d, 59.7 ton BOD/d). This is followed by El-Berba drain (172.7 ton COD/d; 59.7 ton BOD/d). It is worth mentioning that these two drains contribute 76% of the total organic load (calculated as COD) discharged into the Nile by drains from Aswan to Delta Barrage. This is followed by Etsa drain which contributes about 11% of the total COD load (56.8 ton COD/d). Table 5.2 shows the results of water quality monitoring studies for a number of key parameters in the agricultural drains of Upper Egypt. Table 5.3 shows the organic and inorganic loads discharged by major agricultural drains in Upper Egypt to the Nile River.

Table 5.2 Water quality of agricultural drains in Upper Egypt.

No.	Drain Name	Location (KM)	Discharge mm3/day	COD mg O_2/l	BOD mg O_2/l	DO mgO_2/l	TDS mg/l	FC MPN/100ml	Heavy Metals
	Consent Standard			**15 mg/l**	**10 mg/l**	**5 mgO_2/l**	**500 mg/l**	**5.00E+03**	**3**
1	Khour El sail Aswan	9.9	0.10	102	32.80	1.91	1190	3.25E+04	0.31
2	El Tawansa	37.3	0.01	8	1.01	6.16	710	3.50E+03	0.50
3	El Ghaba	46.6	0.19	11	1.00	7.8	570	1.85E+03	0.75
4	Abu Wanass	47.2	0.20	7	1.28	7.03	463	3.00E+03	0.39
5	Main Draw	48.9	40 l/s	17	1.48	7.34	460	3.00E+04	0.61
6	El Berba	49.1	0.15	113	42.70	3.85	414	2.25E+04	0.70
7	Com Ombo	51.0	0.14	151.6	41.50	2.25	325	2.25E+04	2.15
8	Menaha	55.0	-	4	1.52	7.86	285	7.50E+03	0.26
9	Main Ekleet	57.0	0.02	4	1.53	9.21	340	1.50E+03	2.44
10	El Raghama	64.7	0.04	10	1.55	8.56	390	1.75E+03	0.30
11	Fatera	70.5	0.78	5	2.04	7.7	564	3.50E+03	0.54
12	Khour El sail	70.8	0.17	2	1.05	9.07	500	2.00E+03	0.34
13	Selsela	73.9	50 l/s	3	1.25	6.38	380	3.20E+03	1.26
14	Radisia	99.9	0.13	16	3.06	9.02	1430	2.30E+03	0.22
15	Edfu	116.2	0.27	15	1.59	9.49	817	3.00E+03	2.37
16	Houd El Sebaia	139.5	0.05	16	1.83	6.77	495	1.75E+04	0.76
17	Hegr El Sebaia	149.1	0.05	19	2.55	7.82	670	4.50E+03	0.51
18	Mataana	187.7	0.12	39	3.15	6.45	613	1.75E+04	1.29
19	El Zeinia	236.0	NA	NA	NA	*	*	*	NA
20	Habil El Sharky	237.7	0.08	30	1.78	8.45	560	4.00E+02	1.06
21	Danfik	251.6	0.01	34	2.52	8.51	367	1.50E+03	1.05
22	Sheikia	265.3	0.06	37	1.72	7.55	662	3.75E+03	4.68
23	El Ballas	270.7	0.01	144	10.78	9.17	1395	1.50E+04	0.59
24	Qift	275.9	0.03	30	1.60	9.11	375	2.50E+03	0.39
25	Hamed	331.2	0.07	11	1.00	7.18	1015	9.00E+02	0.35
26	Magrour Hoe	340.4	0.06	21	3.24	8.2	185	1.60E+03	1.05
27	Naga Hammadie	377.8	0.21	13	2.17	8.11	375	3.30E+03	1.67
28	Mazata	392.8	0.01	10	2.19	8.37	495	2.50E+02	0.23
29	Essawia	432.7	0.07	9	2.43	6.61	200	1.50E+03	0.51
30	Souhag	444.6	0.05	9	2.81	7.42	440	8.00E+02	0.38
31	Tahta	486.4	0.01	21	2.01	7.86	980	1.40E+03	0.29
32	El Badary	525.4	0.12	6	3.27	7.25	255	9.00E+02	0.48
33	Bany Shaker	588.6	0.02	13	2.25	7.47	485	1.00E+04	0.30
34	El Rayamoun	637.4	NA	21	15.85	2.77	290	1.50E+03	0.16
35	Etsa	701.2	0.57	100	38.00	1.58	575	3.50E+04	0.19
36	Absoug	780.5	0.19	29	1.89	7.34	640	3.00E+03	0.34
37	Ahnasia	807.2	0.54	14	1.31	7.08	610	3.75E+03	0.26
38	El Saff	871.3	NA	NA	NA	*	*	*	NA
39	El Massanda	879.6	0.14	45	4.99	5.57	715	3.00E+03	0.19
40	Ghamaza El [illegible]	884.5	0.06	42	2.52	6.37	235	9.50E+02	0.46

	Soghra								
41	Ghamaza El Kobra	885.0	0.05	32	3.79	7.39	290	7.50E+02	0.28
42	El Tibeen	898.1	0.02	25	15.20	3.71	840	3.25E+04	0.39
43	Khour Sail Badrashin	910.2	NA	NA	NA	*	*	*	NA

: *Not in compliance with Standards in the Law*

Table 5.3 Loads of organic and inorganic pollutants discharged into the Nile from Upper Egypt drains.

No.	Drain Name	Location (KM)	Discharge mm3/day	COD kg/day	BOD kg/day	Heavy metals kg/day
1	Khour El sail Aswan	9.9	0.098837	10.08137	3.241854	0.030333075
2	El Tawansa	37.25	0.006484	0.051872	0.006549	0.003245242
3	El Ghaba	46.55	0.194087	2.134957	0.194087	0.146341598
4	Abu Wanass	47.15	0.199061	1.393427	0.254798	0.078330504
5	Main Draw	48.85	0.003456	0.058752	0.005115	0.002106432
6	El Berba	49.1	0.15282	172.6866	65.25414	0.10720323
7	Com Ombo	51	0.143865	218.0993	59.70398	0.309122726
8	Menaha	55	NA	0	0	0
9	Main Ekleet	57	0.020166	0.080664	0.030854	0.049174791
10	El Raghama	64.65	0.044712	0.44712	0.069304	0.013346532
11	Fatera	70.45	0.779492	3.89746	1.590164	0.418197458
12	Khour El sail	70.75	0.170387	0.340774	0.178906	0.058016774
13	Selsela	73.85	0.00432	0.01296	0.0054	0.005454
14	Radisia	99.85	0.1307	2.0912	0.399942	0.02908075
15	Edfu	116.2	0.2689	4.0335	0.427551	0.63742745
16	Houd El Sebaia	139.5	0.048989	0.783824	0.08965	0.037256135
17	Hegr El Sebaia	149.1	0.049541	0.941279	0.12633	0.02524114
18	Mataana	187.7	0.122499	4.777461	0.385872	0.158207459
19	El Zeinia	236	NA	0	0	0
20	Habil El Sharky	237.7	0.079119	2.37357	0.140832	0.084222176
21	Danfik	251.55	0.008224	0.279616	0.020724	0.00865576
22	Sheikia	265.3	0.05983	2.21371	0.102908	0.279794995
23	El Ballas	270.7	0.006383	0.919152	0.068809	0.003788311
24	Qift	275.9	0.032637	0.97911	0.052219	0.012744749
25	Hamed	331.2	0.067068	0.737748	0.067068	0.023239062
26	Magrour Hoe	340.35	0.058709	1.232889	0.190217	0.061497678
27	Naga Hammadie	377.8	0.2149	2.7937	0.466333	0.35920535
28	Mazata	392.75	0.005868	0.05868	0.012851	0.001329102
29	Essawia	432.7	0.074202	0.667818	0.180311	0.037731717
30	Souhag	444.55	0.0475	0.4275	0.133475	0.01826375
31	Tahta	486.4	0.006276	0.131796	0.012615	0.001829454
32	El Badary	525.4	0.11994	0.71964	0.392204	0.05703147
33	Bany Shaker	588.6	0.019602	0.254826	0.044105	0.005968809
34	El Rayamoun	637.4	NA	0	0	0
35	Etsa	701.15	0.567976	56.7976	21.58309	0.105359548
36	Absoug	780.5	0.194386	5.637194	0.36739	0.066965977

37	Ahnasia	807.2	0.541652	7.583128	0.709564	0.138933738
38	El Saff	871.3	NA	0	0	0
39	El Massanda	879.6	0.14148	6.3666	0.705985	0.02624454
40	Ghamaza El Soghra	884.5	0.059616	2.503872	0.150232	0.027214704
41	Ghamaza El Kobra	884.95	0.048036	1.537152	0.182056	0.013618206
42	El Tibeen	898.1	0.02017	0.50425	0.306584	0.007795705
43	Khour Sail Badrashin	910.15	NA	0	0	0
sum				516.6321	157.8541	3.449520092

5.1.3 Water Quality of Agricultural Drains in the Delta Region

Delta drains receive discharge from predominantly untreated or poorly treated wastewater (domestic & industrial), as well as drainage of agricultural areas. Therefore, they contain high concentrations of various pollutants such as organic matter (BOD, COD), nutrients, faecal bacteria, heavy metals and pesticides. Furthermore the drainage water in the Delta region is becoming more saline; on average its salinity increased from 2400 g/m3 in 1985 to 2750 g/m3 in 1995. The salinity concentrations also exhibit an increasing trend in a northwards direction. For example, in the southern part of the Nile Delta drainage water has salinity between 750 and 1000 g/m3, whereas the salinity in the middle parts of the Delta reaches about 2000 g/m3 and in the northern parts between 3500 and 6000 g/m3.

In a recent study published by the Drainage Research Institute (2000), it has been estimated that the Delta and Fayoum drains receive about 13.5 billion cubic meters of wastewaters per year. Almost 90% of which is contributed from agricultural diffuse source, 6.2% from domestic point sources, 3.5% from domestic diffuse sources and the rest (3.5%) from industrial point sources. It was also found that Bahr El-Baqar drain receives the greatest amount of waste water (about 3 billion cubic meters/year). This is followed by Bahr Hados, Gharbia, Edko and El-Umoum, with an average flow of 1.75 billion cubic meters/year for each. The wastewater received by the rest of the drains is less than 0.5 billion cubic meters/year for each.

In terms of organic loads, as expressed by COD and BOD values, Bahr El-Baqar drain receives the highest load followed by Abu-Keer drain. Also, El-Gharbia Main receives significant amounts of organic pollutants.

Table 5.4 Effluent (m3/day) discharged to drains

Drain	Domestic point Sources (m3/day)	Industrial Point Sources (m3/day)	Domestic Diffuse source (m3/day)	Agricultural Diffuse source (m3/day)	Total (m3/day)
Bahr El-Baqar	184000	64268	122795	4521678	6548741
Bahr Hados	80000	6135	207754	4836000	5129889
Faraskour	2490	0	13272	186758	202520
El-Serw El-Asfal	7710	0	18769	508515	534994
El-Gharbia Main	156500	44460	293315	3927556	4421831
Tala	179	300	45076	1087148	1134318
Sabal	79000	0	39925	1196384	1315309
No. 8	0	0	42428	469848	512276
Bahr Nashart	22000	13968	108915	968859	1113742
No. 7	12500	0	39778	390056	442334
No. 1	39350	20960	78329	1204654	1343293
No. 9	0	0	88029	595644	683673
Zaghloul	0	0	1838	122890	124728
Edko	20000	7470	57346	4232034	4316850
Borg Rashid	0	0	0	311246	311246
El-Umoum	25000	0	81890	5163208.9	5270098.9
Abu-Keer	0	22897	15803	621592.2	660292.2
El-Batts	22396	0	26213	1468340.8	1516949.8
El-Wadi	3000	0	13272	1600340.6	1616612.6
Total (m^3/day)	2311740	180458	1294747	33412753	37199698
Total (Billion m3/year)	0.84	0.066	0.47	12.2	13.6
% Ratio	6.20%	0.50%	3.50%	89.70%	

The following findings on the water quality of major agricultural drains in the Delta region are drawn from the Drainage Research Institute study carried out in 2000.

5.1.3.1 Bahr El-Bagar Drain

The Bahr El-Bagar drain is 106 km long and has two main branches: the 73.2 km Qalubia drain and the 66 km Belbaise drain. The total catchment area of Bahr El Bagar drain system is 760,000 feddan including 300,000 fedan for Qalubia drain, 60,000 feddan for Belbaise drain and 400,000 feddan for Bahr El-Bagar drain downstream from the intersection of the two main branches. The total discharge pumped to Lake Manzala is 1.4 bcm/year.

Bahr El-Bagar drain basin is located in a very densely populated area of the Eastern Delta passing through Qalubia, Sharkia and Ismailia Governorates. The water of Bahr El-Baqar is used unofficially for irrigation and contributes much to groundwater pollution in the Sharkia Governorate.

All sewage and industrial wastewater, treated and untreated, from the eastern zone of Greater Cairo is dumped into the Belbaise drain through the effluents of both Gabal Asfar and Berka treatment plants. The capacity of Gabal Asfar plant is 1,200,000 m^3/day, while that of the Berka treatment plant is 600,000 m^3/day.

The state of the Qalubia main drain is more serious than the Belbaise drain. Qalubia's main 14 branches (intermediates) collect treated and untreated wastewater legally and illegally from the heavily populated area of Shobra El-Khemma and its large industrial area, together with the urban communities of Qalubia and Sharkia Governorates. Because of the good quality of Bahr El-Bagar drain with respect to salinity (800 ppm), some mixing pump stations were constructed to cover the shortage of water in canals supplying irrigation water for legal and illegal rice. Rice covers almost 80% of Sharkia Governorate lands in summer. The main mixing pump station on the Qalubia drain is called El Wady, located at the end of the drain, before the connection to Bahr El-Bagar drain. This pump station was constructed to supply El Wady canal with 307 mcm/year. El Wady canal has a maximum freshwater discharge of 2.0 mcm/day.

Bahr Al-Baqar drain receives very high organic load from domestic (point & diffuse sources) and industrial sources. The primary source of pollutant load (in terms of flow and pollutant concentration) is domestic point discharges of raw sewage.

5.1.3.2 El-Gharbia Drain

The Gharbia drain has a catchment area estimated at 700,000 feddan and covering a heavily populated area in Gharbia and Kafr El-Sheikh Governorates. Gharbia drain has two mixing pump stations downstream from El-Segaeia. The first is El-Hamoul, which has a discharge of 1.5 million cubic meters per day, reaching 1.8 million cubic meters per day in summer to supply Bahr Terra canal. The second is Botteta mixing pump station, which supplies Rowaina canal with 600,000 m^3/day. Botteta mixing pump station is not operational at present due to the pollution coming from the wastewater effluent of the sugar beet factory.

The current quantity of reused drainage water from Gharbia drain is estimated to be about 1 billion cubic meters per year, which is a considerable amount of water compared to total reuse in Egypt. This is in addition to the large quantity of unofficial drainage use which puts the Gharbia drain in the highest priority list for protection from pollution.

At present, El-Gharbia drain receives very high organic loads from domestic diffuse sources, which indicates low coverage with sanitation systems in this catchment area. Approximately 61.1% of the BOD load received by this drain is from domestic diffuse sources, 21.4% from domestic point sources and the rest from industrial sources.

5.1.3.3 Edko Drain

Edko drain in Behera Governorate supplies El-Mahmoudia canal with water in order to cover the need for irrigation along the canal and for drinking water for Alexandria City. Like all drains in the Delta, Edko drain catchment area covers a highly-populated governorate in which the quality of water in the drain system (main drain and its branches) is deteriorating due to legal and illegal dumping of domestic wastewater.

Most of the organic load received by this drain is from domestic diffuse sources (90.2 %). Domestic point sources represent only 3.2% and the rest (6.7%) is contributed from industrial sources.

5.1.3.4 Mouheet Drain

El Mouheet drain in Giza is considered one of the most polluted main drains, coming second only to Bahr El-Bagar drain in the Eastern Delta. The situation of El Mouheet drain is of greater concern than Bahr El-Bagar as it dumps its water into the Nile (Rossetta Branch) via Rahawy drain while Bahr El-Bagar empties into Lake Manzala. The total length of the drain is 70.2 km from the beginning to Rahawy pump station. The main drain starts at El-Badrasheen and ends at Mansouria. It receives water from six intermediates on the eastern side dumping its water in Gennabiete El Mouheet El Youmna drain. Gannabiete El Mouheet El-Youmna has 11 intermediates coming from the eastern side and one from the west. It also receives drainage water from Gannabiete El mouheet drain El-Yousra, with its one intermediate on the left side. The whole system discharges into the Nile through Rahawy Pump Station on the Rossetta Branch. This Pump Station is currently not in operation since due to the high water levels in the drain, the water flows into the Nile by gravity.

Two main treatment plants are located within the drainage basin of El Mouheet drain: Abu Rawash and Zenein plants with maximum effluents of 700,000 and 400,000 m^3/day, respectively. There are also limited treatment plants within the drain catchment area.

5.1.3.5 El-Salam Canal

The Salam Canal was constructed to supply irrigation water to 200,000 feddan in the western Suez Canal region and 440,000 feddans in the East and North of Sinai. The water supplied to the El-Salam Canal is composed of freshwater from the Nile and water from the drains in the Delta. Drainage water supplied to El-Salam canal is estimated to be 2 billion cubic meters per year. This quantity is derived from the drains Bahr Hadous, Lower and Upper Serw together, if needed, and Farasqour drains. This drainage water will be mixed with another 2 billion cubic meters per year of freshwater drawn from the Damietta Branch to reach a total discharge of 4 billion cubic meters per year.

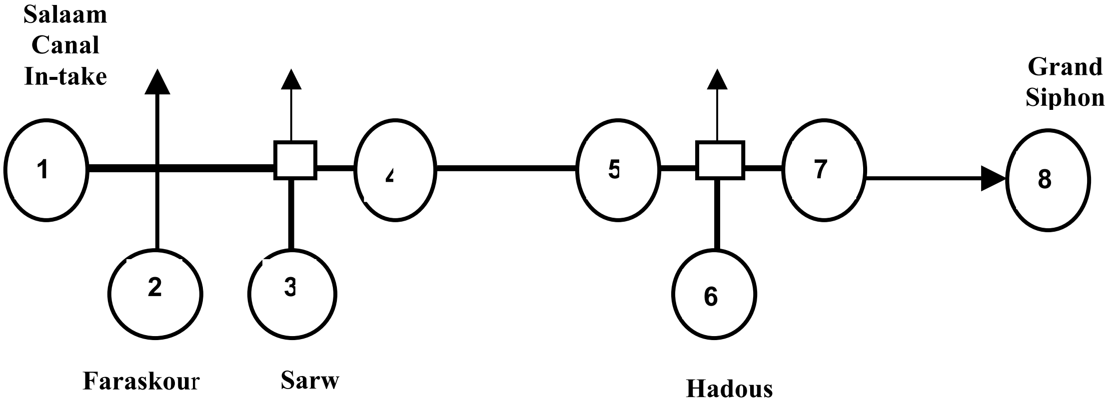


Figure 5.1 Schematic of El-Salaam Canal

Since the catchment area of Bahr Hadous, Upper and Lower Serw, and Faraskour drains is highly populated, all drain systems within the region are susceptible to pollution from legal and illegal dumping of domestic and industrial wastewater. The current proposed mixing ratio of 1:1 between drainage and freshwater might be enough to reduce the pollution to acceptable levels.

Most of the water received by Bahr Hadous drain (94.3%) is from agricultural diffuse sources. Although the domestic diffuse sources contribute only 4% of the total discharge, this fraction contributes 94.7% of the organic load received by Bahr Hadous, expressed as BOD. Assessment of the available data on the water quality of Faraskour, Serw and Hadous drains indicates that the fecal coliform counts in the water of the three drains exceed both WHO and Egyptian standards for use of water for unrestricted irrigation, especially Hadous which gave very high fecal coliform counts (92000 MNP/100). It is worth mentioning however, that a great reduction of the counts takes place downstream of the points of mixing along El-Salam canal, which indicates the importance of the self purification in surface water bodies. The same observation apply to physico-chemical characteristics. However, all samples showed exceedingly high intestinal helminth eggs, particularly ascaris, taenia, haokworms, and hymenolepis diminuta.

5.2 *Pollution of Red Sea, Suez Canal, Gulf of Suez and Gulf of Aqaba*

5.2.1 Background information

The Red Sea is a long, narrow body of water separating northeast Africa from the Arabian Peninsula. It is nearly 2000 km of navigable waters connected at the south with the Indian Ocean, and joins the Mediterranean Sea at the north of the Gulf of Suez. The Red Sea is 1932 km long and averages 280 km in width, and is shared by Egypt, Sudan, Ethiopia, Republic of Yemen, Saudi Arabia, Jordan and Israel. It is a semi-enclosed, narrow water body with no river inputs. The area of the Red Sea is about 437,970 km^2 and its mean depth is 491 m. In the north the width is only 175 km but southward it increases to a maximum of 370 km near Jizan, then decreases to 30-40 km at Bars El-Mandab. The deeper basin of the Red Sea is separated from the Gulf of Aden by shallow channel shoals about 100 m deep, off Hannish Island.

Figure 5.1 The Red Sea, Gulf of Suez and Gulf of Aqaba

The Red Sea and its gulfs, Gulf of Aqaba and Gulf of Suez, constitute a unique and valuable ecosystem. The Red Sea is valuable, not just as a unique environment, but as one of a high diversity, great scientific and ecological sensitivity and of great beauty and tourist-value. Their natural resources provide a substantial economic support for the region. The Red Sea resources contribute substantially to Egypt's economy, particularly in the areas of oil production, navigation, tourism and fisheries.

The Gulf of Aqaba in the northern Red Sea is a warm water body, approximately 180 km long and on average 8 km wide, and attains a depth of about 1355 m. It is a deep basin with narrow shelves, which comprises two isolated depressions separated by a submarine sill. The northern depression is about 1,100 m deep and the southern depression is about 1,420 m deep. The maximum depth within the Gulf of Aqaba is observed near the east coast with a depth of 1,829 m. The Gulf of Aqaba is a marine environment enclosed by arid lands that experience extremes of temperature and exceedingly low levels of precipitation. These conditions have led to the evolution of unique, and hence internationally important, coral reef and marine ecosystems, which are particularly susceptible to damage from pollution or other forms of environmental impact. The Gulf of Aqaba also represents a natural resource of major economic significance to the four riparian countries (Egypt, Israel, Jordan, and Saudi Arabia) in terms of access to sea transportation and the development of tourism and other industries along its shores.

The Gulf of Suez is relatively shallow, with a maximum depth of about 64 m; outside its mouth the depth drops sharply to about 1255 m. In contrast, the Gulf of Aqaba attains a depth of about 1355 m and is separated from the deep waters of the Red Sea by an entrance less then 100 m deep. The Gulf of Suez has a relatively flat bottom with a depth ranging between 55 and 73 m. Hence, the Gulf spreads a shallow basin filled with the surface water of the Red Sea. The Gulf of Suez is the area the most at risk of pollution in the Red Sea, particularly oil pollution.

Sinai Peninsula is a strategic national security zone for Egypt. Sharm El-Sheikh area, located at the southern part of Sinai, was declared as a protected area because of the diversity of wildlife species and other available natural resources. Sharm El-Sheikh area is characterized by barren terrain with limited vegetation cover, diversity of landscapes, clear skies and clear water with shallow coral reef community. The entire Sinai region is deeply dissected by the river valleys (or wadis) that eroded at earlier geological periods. These river valleys break the surface of the plateau into series of detached massifs with a few oases scattered here and there. Sinai is a triangular peninsula, the base points to the north and it's apex to the south. Most lowlands slope gently towards the Gulf of Suez, the lowest forms the El-Qaa coastal plains. In the southern zone, the mountains come close to the sea forming a bold and rocky coastline that runs into the Gulf of Aqaba. The Sinai coastline varies among alternating high mountains, hills and fine-grain yellow sand beaches. The natural wealth of the Sinai region is characterized by internationally recognized coral reefs, clear warm coastal waters, outstanding desert landscapes, sites of cultural and religious importance, and near permanent sunshine. Those resources, coupled with their proximity to European tourism markets, have stimulated the rapid growth of tourism development that the region is currently experiencing.

5.2.2 *Oceanographic and Meteorological Conditions in Gulf of Aqaba and Gulf of Suez*

Oceanographic and meteorological conditions in the Gulf of Aqaba and Gulf of Suez is described here before proceeding to investigate the marine pollution in the gulfs. For lack of general data on the meteorological conditions in Sinai, the data available for Sharm El-Sheikh is taken to be representative of the conditions in South Sinai.

Air Temperature: The climate is arid, with a yearly average net evaporation of 1 cm/day. The monthly variations of air temperatures of Sharm El-Sheikh region, generally varies from 17.8ºC to 20.3ºC in winter, from 24.1ºC to 31.7ºC during spring, from 31.5ºC to 32.7ºC during summer, and from 20.4ºC to 26.8ºC during autumn.

Relative Humidity: The maximum values of humidity vary from 54.6% to 63.5% in the winter months (November to April), which is a relatively high relative humidity. In the summer months; from May to October; the maximum values of humidity vary from 47.5% to 55.6 %, showing that the summer months are more arid.

Winds: Winds blow mainly from the north-northwest direction throughout the year. Winds also reach the area from other directions but with lower frequency; from April to October, winds are prevailing either from southeast or northeast direction. From November through March, winds swing less frequently from east to west beside the dominant northern winds.

Cloud Cover: The Red Sea is a very unclouded area. The cloudiest months are from December to March when more than one-quarter cover is to be expected for 30-40% of the time. For the rest of the year cloud cover is very small, 10-20%, with long cloudless period from June to September.

Rainfall: Rainfall in the region is extremely sparse and localized. The rain is mostly in the form of showers of short duration, often associated with thunderstorms and occasionally with dust storms, resulting in poor visibility. Over the Gulfs of Suez and Aqaba, showers are very infrequent. All of the rainfall in the region occurs within just a few days, mostly in December; during some years none falls. Measured during a 20-year period, the average annual rainfall was about 25 mm for the Gulf of Aqaba. Climatological studies of the area document the large deficit between the amount of precipitation and evaporation. Rainfall at the northern end of the Gulf of Aqaba is normally 22 mm per year. Evaporation is 179 mm, eight times precipitation, leaving a deficit of 157 mm per year. Inflow of waters from the Red Sea balances the deficit.

Tide: The physiographic configuration of the Red Sea, and the Gulf is long, narrow and an almost closed embankment, dictate the nature of the tides. Tides are semi-daily and their characteristics differ in the two Gulfs. In the Gulf of Suez, a nodal point occurs near El-Tur about 180 km north of the southernmost limit of the Gulf. The tidal range in the Gulf of Suez, near its northern limit, is about 2 m, decreasing southward to 0 m at El-Tur and increasing again up to about 60 cm near Ras Mohammed. The tidal range in the Gulf of Aqaba is about 70 cm at Taba and 90 cm near Sharm El-Sheikh. No nodal point exists along the Gulf of Aqaba. The groundwater levels are very dependent on the tidal range in the sea level because the materials underlying the supra tidal zone are very permeable. In summer, evaporation causes the water level to sink a maximum of 10 cm, and more seawater is supplied. In winter, with decreasing evaporation less seawater is supplied even though the winter tides run much higher than the summer tides. It has been observed that the water level rise in winter occurs rather quickly (within a few days). This is due to a sudden rise in tidal levels all along the Red Sea and the Gulf of Aqaba in fall. This phenomenon is not related to the tides themselves, but to the climatic responses (e.g. monsoons) to the movement of the sun around the equinox.

Land and Sea Breezes: As in all coastal areas prone to strong solar heating, the shores of the Red Sea, like in Sharm El Maya and Naama Bay shores, experience diurnal wind changes commonly referred to as land and sea breezes. The sea breeze, a flow of air from the sea towards the land, develops during day light hours, usually reaching maximum strength in early or mid afternoon. The reverse flow, land breeze, occurs at night but most strongly developed around dawn. In the absence of other factors, land and sea breezes tend to flow more or less at right angles to the shoreline.

Water Movement and Current: The fundamental movements of surface water follow the winds, so that the northerly wind of summer drives surface water south for about four months at a velocity of 12-50 cm/sec, while in winter, the flow is reversed, pushing water into the northern Red Sea from the southern part; the net value of the latter movement is greater than the summer current to the north, and the drift continues to the northern end of the Gulf of Suez. The main surface drifts are slow moving and are easily modified and even reversed by local effects and by small tides.

Although south-flowing currents, generated by the prevailing northern winds, exert a major force that affect the sea marginal depositional environments, other northward-moving currents in the southern parts of both gulfs counteract this influence. These northward-flowing currents include currents resulting from salinity differences. A warm less saline surface water current flows into the gulfs from the Red Sea replacing waters lost by evaporation and lost by an out flowing deeper density current of more saline cooler waters. Stormy winds from the south at the tip of the Sinai Peninsula drive currents northward in both gulfs.

The common storms in the Gulf of Aqaba accompanied by winds of up to 45 to 80 knots provide considerable bursts of energy to these currents. Because some of the high winds are southerly, especially in winter, one can expect to find the normal long shore current's flow to be temporarily reversed. Currents in the southern part of the gulf are most affected by strong southerly winds. Oceanic currents in the Indian Ocean change the level of the Red Sea and the gulfs seasonally. The effects in both gulfs are sea levels that are about 30 cm higher in winter than in summer.

Water temperature: The water temperature is lower in the northern parts than in the southern part of the Red Sea. Sometimes, sudden changes of temperature occur from one area to another, especially in the central part of the area. This change may reflect the natural barriers that prevent free mixing of waters in the area and thus inhabiting regular changes. The Gulf of Suez water affects the northern and western side of the Red Sea down to 200m in depth. Surface temperature declines slightly towards the entrance of the gulfs, owing to the influx of cooler water from the Gulf of Aqaba, and there is also a gradual decrease of temperature in the northerly direction. The mean annual maximum and minimum water temperatures of the coast of the Gulf of Aqaba are higher than those of the Gulf of Suez.

In Sharm El-Sheikh area the surface water temperature in summer (June 1996) showed a variation from 25.5ºC to 27.3ºC, with an average of 26.1ºC. In winter (February 1997) the temperatures were lower than that of summer showing less variability at the surface, ranging from 22.6ºC to 23.2ºC, with an average of 22.9ºC.

Salinity: The salinity gradient in the Gulf of Suez is five to six times greater than the values recorded for the Red Sea or Gulf of Aqaba. The distribution of surface salinity in Sharm El-Sheikh lagoons showed values from 40.2% to 40.7%. Salinity show limited variation in spite of the presence of desalination plants in Naama and Sharm El-Maya Bays, but it seems to be with negligible effect. In Port Bay, the salinity distribution showed an increase in the

North West direction indicating the effect of land drainage resulting from human activities in this area

There is considerable evidence that, in a given latitude, salinities are higher on the western side than in the east so that isohalines are aligned generally from north-north east to south-southwest. The difference between the two sides in the same latitude sometimes amounts to as much as 1%.

The inflow current from the Red Sea at surface is a less saline, whereas the more saline (denser) waters, resulting from the large evaporation precipitation ratio, sinks and forms a counter flow to the south. A sill at the Strait of Tiran (depth 252 m) separates the Gulf of Aqaba from the Red Sea and restricts deep circulation. The salinity increases from south to north in the Gulf of Aqaba (40% to 42%). Low winter and high summer values of salinity are observed. High values (greater than 41%) in August, and low values (40.3%) in March.

Dissolved Oxygen: The measured dissolved oxygen concentration in the surface water of the Red Sea is near to saturation values. The saturation values are in the range of 4.8 to 6.5 ml of oxygen per liter depending on temperature and salinity values. The saturated layer in the Red Sea extends to about 100 m depth. Below 100 m in the Red Sea, the dissolved oxygen concentration values drop to only 10 – 25% of the saturation values. The Gulf of Suez resembles the Gulf of Aden in this and in many others of its characteristics, and has no oxygen minimum, while in the Gulf of Aqaba, there is a gradual decline with depth but never to lower than about 50% saturation. The dissolved oxygen in the water of Sharm El-Shiekh area showed more or less homogeneous distribution. However, the oxygen content at 100 m layer was significantly lower in spring, yet still indicating a well oxygenated condition (5.3 mg/l).

Horizontal distribution of dissolved oxygen concentrations in summer at the surface of the lagoons in Sharm El-Sheikh showed values ranging from 4.32 to 4.77 mg/l, and from 95.53% to 107.63% saturation. In winter, oxygen distribution showed higher values (5.32 – 5.66 mg/l) than that of summer, which may be attributed to lower temperatures. Super-saturation of oxygen values is shown in Sharm El-Maya Bay in summer due to photosynthetic activity.

Acidity/Alkalinity (pH): The distribution of pH values at the surface water in summer showed values ranging from 8.25 – 8.42 reflecting low variation. In winter, pH values were lower than that recorded in summer with a variation range of 8.0 to 8.18. The observed higher pH values at surface water in summer could be attributed to the photosynthetic activity due to higher temperature and long light span.

Nutrients: Most of the Red Sea water has been considered oligotrophic with the exception of small areas off the Sinai Peninsula. The upper waters of the Red Sea are nutrient-poor, with nitrate being depleted more than phosphate. High levels of nitrite and ammonia have been recorded in the upper waters, which can be considered as an indicator of high bacterial activity. Seasonal variations occur in dissolved nutrient concentrations near shore and that local eutrophication is resulting from anthropogenic inputs. Water in the Gulf of Aqaba and Gulf of Suez is poor in nutrients compared with the Indian Ocean.

5.2.3 Environmental Threats from Pollution-Generating Activities and Natural Causes

The information presented in this section is compiled from various sources of material. For the activities imposing environmental damage in the Gulf of Aqaba, specific data is available for Ras Mohamed, Sharm El-Sheikh, Nuweiba, Dahab, Eilat, and Taba. Similarly, for the Gulf of Suez, some relevant data was made available by references to Lake Timsah, Suez Canal, Suez Bay, Suez Harbour, Port Tewfiq, Zeitia, Suez City, and Ain Sukhna. In general, the pollution-generating activities in the Gulf of Aqaba were easily accessible, and more pertinent to the South Sinai area than that which was available for the Gulf of Suez.

5.2.3.1 Gulf of Aqaba

The Gulf of Aqaba's environmental problems are primarily induced by tourism and associated activities as well as maritime traffic, which result in marine, aquifer, soil, and noise pollution, and destruction of coral reef and desert ecosystems. In addition, environmental issues, which are related to the management of wastewater and solid waste, are exacerbated by the increasing resident population of the coastal cities and the numbers of tourists visiting the area. Human impact on the environment can be summarized into seven broad categories, as follows: tourism, ship-based activities, wastewater management practices, solid waste management practices, ferry traffic, marine aquaculture, and cruise-boating. Environmental threats from natural causes are also of concern and can be categorized into floods and southern winds.

Tourism

An estimated 500,000 tourists visited the Gulf of Aqaba coastal zone in 1996 and more than 3 million are expected in 2017. The relatively rapid growth of tourist visitation since the late 1980s has spurred interest in further development of tourism as an additional source of foreign income. Environmental concerns relate to the impact that these developments and the increase in numbers of tourists will have on the resources that tourists visit the Aqaba coast to enjoy.

The most rapidly growing threat in the region is from tourists, who are drawn to the continual bright sunshine, high temperatures, sandy beaches, and spectacular diving opportunities. The potential for tourism had always existed in the region, but had been thwarted by decades of hostilities and political conflict. Sites like Ras Mohammed attract divers from around the world, while the beaches of the region are packed with tourists, particularly during European holidays. The infrastructure needed to attend to the needs of tourism, i.e. shopping centres, hotels, airports, roads, dive boats, resort construction, all increase the environmental stressors on the coral reefs, but perhaps the greatest single threat from tourism is sheer ignorance. Divers, many of them unfamiliar with coral, frequently kick up sand, step on coral, or actually break off pieces of living coral as souvenirs. Dive clubs, which send divers into the reef without instructions or guidance, bear much of the blame for such actions, but even appropriate diver behaviour is linked to reef degradation at high levels of activity. It has been estimated that sites hosting more than 6,000 dives per year degrade rapidly; meanwhile, many sites around Sharm El-Sheikh and Dahab far exceed that threshold. Coral photographers, eager to get closest to the reef and distracted by their equipment, inflict over two-thirds of the damage, despite accounting for less than one-fourth of the dives.

Ship-based Activities

Between 1985 and 1991, an average of 1,600 vessels handling 13 to 20 million tons of cargo each year, including oil, minerals and chemicals, entered the Gulf of Aqaba through the Strait of Tiran. The lack of a local capacity to contain and control any significant accidental spills of oil is a major concern. Other environmental issues relate to marine pollution resulting from frequent small spills of oil and other contaminants. In addition, waters are polluted by garbage and animal carcasses thrown overboard by ferries and ships. Reefs are also destroyed by ships that accidentally miss the navigational waterway through the Strait of Tiran.

However, on a day-to-day basis, small, recurrent leaks from cargo and pleasure ships, land-to-sea transfers, and the discharge of oily ballast water produce more pollution and do more environmental damage overall than one-time events like a large spill. Indeed, 97% of all oil spills into the sea are in amounts smaller than 4,000 liters, and the catastrophic spills that attract the most press attention, like the *Torrey Canyon* or *Exxon Valdez*, amount to less than 25% of all the oil spilled annually. In the Gulf of Aqaba, such recurrent spills around the ports are already associated with the degraded health of local reef ecosystems.

Wastewater Management Practices

All urban areas are connected to biological oxidation sewage treatment systems. However, the population of Dahab and Nuweiba are not fully serviced due to insufficient infrastructure or lack of maintenance. This problem may affect up to 60% of the resident population. The remainder of the sewage is poorly treated before being released into the desert. Environmental concerns relate to possible health impacts of seepage from septic systems, pollution of marine water and degradation of coral formations. Sewage treatment facilities in the Middle East region are poor in general, often amounting to little more than open settling pools. The impact of sewage on coral reefs can be unpredictable, but devastating in some circumstances. Sewage creates localized areas of high nitrogen, which leads to algal blooms and deoxygenated "dead zones." In addition, sewage sediment settles on corals, particularly in regions without strong currents, choking the coral to death.

Solid Waste Management Practices

The cities in South Sinai, the port of Nuweiba, and the tourism resorts currently generate about 50 tons of solid waste per day. This has increased to 120 tons per day in 2002, and is expected to further increase to 220 tons in 2017. The municipal dumps are located unfenced and open to desert areas near the coastal desert road. Environmental concerns relate to the effectiveness of both the collection and disposal systems, which have resulted in the presence of unsightly refuse in urban and tourist development areas and throughout the desert adjacent to the town dump where open burning of rubbish also results in air pollution.

Ferry Traffic

Oil transport into Nuweiba is minimal. A current problem is that of shipboard waste from the Gulf of Aqaba ferry between Nuweiba and Aqaba. Much of this waste is non-biodegradable and is carried ashore by currents, adding to the problems on the coral reef and Sinai coastline. In addition, similar problems arise from land-originated solid waste from the three bordering countries.

Marine Aquaculture

Spurred by the demand for fresh fish from the expanding tourism industry of Eilat, the rapid development of marine aquaculture in the Eilat region has already resulted in severe pollution of the marine waters surrounding the clusters of fish cages. The lack of regulation of this activity by the Israeli Government is raising concern of further eutrophication of marine waters in the Taba Area.

Cruise-Boating

A visible marine pollution problem from maritime activities is the condition of the waters of the small harbor at Sharm El-Maya, in Sharm El-Sheikh. There is an accumulation of oil and sludge from the fleet of diving boats and other vessels that occupy the harbor. Further, there is no effective waste collection system in the harbor. On-board sewage and solid waste are discharged indiscriminately into the harbor waters, with obvious and detrimental impacts on the nearby hotel beaches. The potential for increasing the number of boats using the harbor poses a major localized environmental threat.

Floods

Desert sheet floods sporadically supply large amounts of rainwater. Such floods have occurred in the 1950s and in 1979 and 1980. In 1975, in the airport area of Sharm El-Sheikh, a rainfall of 44.5 mm was observed. On October 20th 1979, 75 mm of rain was observed at Sharm El-Sheikh, which corresponds to the average rainfall of 7 years in this area. Another catastrophic rain was observed on the 25th to 27th of December 1980, when 20.5 mm of rain was observed at Sharm El-Sheikh. This demonstrates the force of the desert sheet floods and also the patchy distribution of rain and the difficulties in estimating the influence of rainfall on such systems.

Southern winds

The common storms on the Gulf of Aqaba which are accompanied by winds of up to 45 to 80 knots provide considerable bursts of energy to water currents. Because some of the high winds are southerly, especially in winter, normal long shore current's flow tends to be temporarily reversed. The southern part of the gulf is the area most affected by strong southerly winds. Oceanic currents in the Indian Ocean change the level of the Red Sea and the gulfs seasonally. The effects in both gulfs are sea levels that are about 30 cm higher in winter

5.2.3.2 Gulf of Suez

Tourism

The negative impacts of coastal tourism are evident in Suez Canal's lakes and Ain Sukhna. These impacts include physical destruction of coastal habitats by construction works, dredging, and pollution from wastewater discharge from coastal resorts. The lack of proper land-use planning, including effective zoning and environmental review procedures in the coastal zone, particularly with regards to urban development and tourism expansion, is a growing problem in many parts of the region. Development often proceeds without the benefit of adequate planning or evaluation of potential environmental impacts. In some cases local authorities allow construction activities that are inconsistent with land use to proceed.

Ship-based Activities

One of the main sources of marine pollution in Suez Canal and Gulf of Suez is from ship-based sources. Transport of oil continues to play a critical role in marine pollution in the northern Gulf of Suez and Suez Canal. This transport traffic results in chronic marine pollution from discharges of oily ballast water and tank washings by vessels, operational spills from vessels loading or unloading at port (e.g. SUMED Pipeline Company Terminals), accidental spills from foundered vessels, and leaks from vessels in transit in Suez Bay. Other forms of ship-generated waste include oily sludge, bilge water, garbage and marine debris.

The Suez Harbour has always been an important Egyptian gate on the Red Sea since historical times. The growing activity of this harbour has led to an increasing rate of urbanization in the whole region. Taking advantage of the site location, several industries have been established all of them along the western coastal stretch of the Suez Bay down to El-Adabiya in the south. The growing industrial activities coupled with the fact that Suez represents the southern entrance of the Suez Canal have resulted in the transformation of the whole Suez Bay into a large harbour. More than 100 ships and tankers are waiting daily to cross the canal to the Mediterranean.

Wastewater Management

The first elements of a municipal wastewater collection and disposal system for Suez were installed during the mid 1920s. The system was expanded and modified during subsequent years, providing service to Port Tewfik area and to about 70 percent of the urbanized area of Suez at the time hostilities broke out in 1967. During that conflict, a considerable amount of damage was done to the system. Additionally, the city was evacuated and not reoccupied until 1974. During this period further deterioration occurred through disuse and lack of maintenance. Since 1974 and concurrent with general reconstruction efforts, work has proceeded to rehabilitate and to expand the existing sewerage system.

Until August 1995, the treatment plant was primitive and of limited efficiency. It included primary treatment ponds of 5 acres. The wastewater was then discharged into the bay through El-Kabanon Drain, an open drain, 6 km south of Suez. The sewerage system was constructed to serve 98% of the domestic and commercial wastewater, while 2% were discharged directly to the sea. In 1999, the discharge amounted to 75,000m^3/day in winter, increasing to 85,000 m^3/day in summer.

A new wastewater treatment plant has been constructed, and is fully operational. It provides treatment capable of meeting the legal effluent standard for BOD (Biological Oxygen Demand) and TSS (Total Suspended Solids). The planned system of treatment includes 4 aerated oxidation ponds and 2 basins for mechanical separation of settled solids. The precipitated sludge is dredged every 6 –12 months (depending on the amount of solid material), transported to drying lagoons and then stockpiled for possible use for agriculture purposes. The plant is designed to treat 260,000 m^3/day.

However, the discharge of municipal wastewater at Lake Timsah and Suez Bay continues to present considerable management problems, despite the significant progress made over the last decade through investments to control pollution from this source. In the region, especially on Lake Timsah and south of Suez, the discharge of domestic sewage contributes, through nutrient loading and high biological oxygen demand, to the eutrophication of coastal waters around selected population centers, major ports and tourist facilities. The prevailing wind in Suez Bay is north-northwest causing seawater extension toward the offshore. Occasional easterly winds during winter confine the wastewaters near to the west coast.

Industrial Activities

The development of Suez is seen as centering on a mix of labor and capital-intensive industries, developed on the existing base of petroleum and petrochemical plants. Industries in Suez City that are functional at present include a fiberglass boat building plant, machine shop and assembly plant, merchant steel mill, ship scrapping yard, general engineering foundry, ceramic tiles plant, and denim plant. Industrial effluents, in the form of thermal pollution from power and desalinization plants, hypersaline brine water from desalinization plants of Ain Sukhna hotels, particulate matter and mineral dust from fertilizer and cement factories, and chemicals and organic wastes from food processing factories at Suez City, contribute to the land-based sources of pollution affecting coastal waters in the Gulf of Suez and neighbouring water bodies.

From the fertilizer and chemical industry, El-Nasr Company produces 1000 ton/day of ammonium nitrate, 500 ton/day of calcium nitrate and 50 ton/day of ammonium sulfate, besides, aqua-ammonia, sulfuric acid and nitric acid as byproducts. The company is located 2 km inland at about 8 km southwest of Suez City. The factory uses freshwater for cooling and the effluent discharge amounts to $60x10^3$ m^3/day of low saline water (2.5%). As expected, this water is loaded with ammonia, phosphate and nitrate in addition to certain metals e.g. Cu, Zn and Pb (Copper, Zinc and Lead, respectively). As for the cement industry, Suez Cement Factory lies 40 km south of Suez City. The manufacture of cement is a high temperature process, converting more than 30 raw materials to a fine gray cement powder. The process is energy consuming and results in atmospheric discharge of several pollutants. It was estimated that more than 10 g Pb and 600 mg Cd per ton of cement produced is released into the atmosphere. This indicates how huge the amounts of trace elements that could be added to the atmosphere through cement production. The cement factory lies on the coastal strip of the Gulf of Suez (5 km inland). Its location and the prevailing northwest winds heighten the amount of heavy metals and dust contributed by the factory to the marine ecosystem.

Dredging and Filling Operations

Dredging operations of Suez Canal, and dredging and filling operations associated with urban expansion, industrial development and tourism along the coast of canal lakes and Gulf of Suez are a significant source of environmental degradation in the region. Sedimentation from these operations suffocates the surrounding benthic communities and has an adverse effect on other ecosystems to which currents transport the suspended sediment. The net results are the irreversible loss of the most productive coastal ecosystems – sea grass beds and dependent marine communities.

Offshore and inshore oil production

Extensive oil production operations are taking place in the Gulf of Suez, both inshore and offshore. The spills from oilrigs and ships have severely affected the inter-tidal zone in the central and southern parts of the Gulf of Suez. Many rocky shores are blanketed with oil pavements and oil is found buried beneath a thin veneer of wind blown sand in some beach areas. Not only are the direct effects of spills of importance, but also, of much concern are the drilling operations themselves. The discharge of drill mud and rock cuttings during operations results in high turbidity of water probably extending for a few kilometers in depth. The sediment loading from drilling operations has killed hermatypic corals.

Beside the super tanker traffic to and from oil terminals, there are two major refineries in Suez: El-Nasr Petroleum Co., and Suez Petroleum Co. They are located in the Zeitia area about 3 – 5 km south of Suez City. Atmospheric pollution is mainly caused by sulfur oxides, hydrocarbons, nitrogen oxides, and carbon monoxide, which are released during burning gases. The refineries in Suez have old burners and the combustion of released gases is not complete, therefore causing a high emission factor for gases. Emission of elements such as As, Cd, Co, V, Ni and Cu (Arsenic, Cadmium, Cobalt, Vanadium, Nickel, and Copper) are also included.

Power Generation

The thermal power station at Ataqa (8 km South of Suez) is one of the largest in Egypt designed to generate 900 megawatt/hour of electric power. Cooling water is taken from the Suez Bay via an open canal extending over a half kilometer into the sea. A water temperature rise of about 1^0C due to the thermal effect of the effluent is recorded in the near shore waters. The cooling effluent is about 200 m^3/hour, while the sewage discharge is 100 m^3/day.

Fishing

Improper resource management, in conjunction with a lack of low enforcement, is a barrier to sustainable development of the marine resources in the Gulf of Suez. Ultimately, this poses a serious threat to its biological diversity and productivity, and puts at risk the livelihood of people engaged in potentially sustainable activities, such as fisheries and aquaculture. The status of fisheries is unknown because of a lack of stock assessment and incomplete and unreliable fisheries statistics. Interviews of fishermen reported declines in catches and average size of fish landed, which indicates over-fishing and stock depletion. The present situation is attributed to destructive fishing practices, possible exploitation beyond maximum sustainable yield, the absence of fisheries management plans, and a lack of surveillance and enforcement of existing regulations.

5.2.4 Sources and Levels of Pollution

EEAA conducts regular monitoring of the coastal water quality through the Environmental Information and Monitoring Program (EIMP). Coastal water quality data is obtained by carrying out regular field sampling studies throughout the year. A total of five field sampling studies are undertaken in the Red Sea coastal areas by the EIMP throughout 2003 (January, March, May, July, September). Samples were obtained from 40 sampling points (figure 5.2) located on the Red Sea coast, Gulf of Suez and Gulf of Aqaba and the samples analysed for the following parameters: temperature, salinity, pH, dissolved oxygen, nutrients (ammonia, nitrate, nitrite, phosphate, silicates), chlorophyll and bacterial counts. Based on the data obtained from the latest available EIMP monitoring reports as well as other sources, the general quality of the coastal waters in these areas may be assessed and the sources of pollution from land and marine-based activities identified. The sources of pollution can be categorized into: sewage, persistent organic solids, radioactive material, heavy metals, oils (hydrocarbons), nutrients, sediment mobilization, and litter.

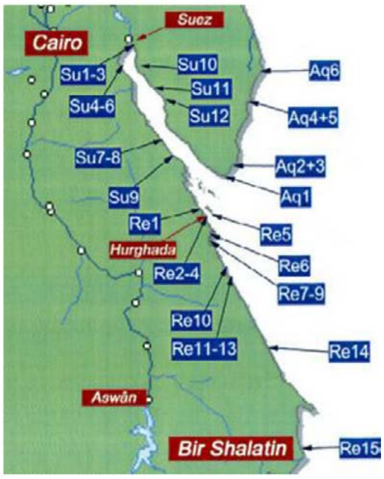


Figure 5.2: Sampling points in the Gulf of Suez, Gulf of Aqaba and Red Sea

5.2.4.1 Gulf of Suez Region

The marine environment of the Suez bay is subjected to mixed sources of pollution (industrial, agricultural and domestic sewage) through the direct discharge of El-Kabanon drain, which is considered the main industrial and sanitary drain. Approximately 120,000 m^3 /daily of sewage is dumped through El-Kabanon drain into the Suez Bay. The sewage discharged into the Suez Bay contains 93.76 ton/year of ammonia, 0.305 ton/year of nitrite, 0.397 ton/year of nitrate, 52.93 ton/year of inorganic phosphate, 0.409 ton/year of copper, 3.65 ton/year of zinc, and 0.120 ton/year of lead.

In the Gulf of Suez region, the Ras Gharib beach suffers from the highest levels of bacterial pollution. This is primarily due to the discharge of raw sewage from the city of Ras Gharib directly into the Gulf of Suez. Other locations with the Gulf of Suez where high levels of bacterial counts were identified include Kabanon beach (where the source of pollution is the discharge of wastes from the area's meat processing facility), Raks beach (source of pollution is nearby port) and Attaka port (where the primary source of pollution is the ship-building industry). Nutrient levels (ammonia, nitrate, phosphate and chlorophyll) were found to be highest in the area surrounding Suez city due to the discharge of untreated sewage and industrial wastewater as well as the wastes resulting from ships waiting to cross the Suez Canal.

Research was carried out on heavy metal pollution in Suez Bay, where the bay is subjected to industrial run-off from oil refineries, fertilizer plants, and power station in addition to sewage and garbage. The heavy metal concentrations ranged from 7.2 to 147.7µg/l for Zn, 10 to 62.6µg/l for Cu, 0.7 to 12.1µg/l for Pb and 0.01 to 1.27 µg/l for Cd, respectively. Adabiya station showed the highest values because of the various pollution sources discharged (i.e., harbours, sewage, and industrial drains), while in contrast the station of Ain Sokhna showed the lowest concentrations.

In the Suez area, investigating the possibility of using seaweed as an indicator for trace metals pollution was carried out in 2003. The study investigated the trace metals concentration within sediment, water, and seaweed. In water, the annual mean concentrations were 0.272, 0.166 and 0.438 ppb for dissolved, particulate, and total Cadmium (Cd), respectively. While in sediment the Cadmium concentration was 5.670 ppm. Lead (Pb) in water showed annual mean concentrations of 1.096, 2.085, and 3.181 ppb for dissolved, particulate, and total lead, respectively; while in sediment lead concentration was 29.748 ppm. The annual mean concentration of Copper (Cu) in water was 0.972, 0.782 and 1.561 ppb for dissolved, particulate, and total copper, respectively. The total annual mean concentration of copper in sediment was 8.785 ppm with the highest value being 10.454 and the lowest being 3.506 ppm. Finally the recorded Zinc (Zn) annual mean concentrations were 20.76, 258.54, and 279.30 for dissolved, particulate, and total zinc, respectively. The mean Zinc concentration in sediment was 22.771 ppm. The study concluded that sediment is highly polluted by cadmium and in less degree by lead. Also the metal concentrations correlated with industrial activities.

The Ain Sukhna area in the Gulf of Suez was also found to suffer from extensive chronic petroleum pollution inputs as it is evident in the vicinity of the SUMED pipeline company terminals, which include both floating and land-based receiving terminals.

In the Suez area, a study was carried out in 2003 to measure nutrient salts around the Suez Bay and down to Ain Sukhna area. Nitrate concentration ranged between 0.650µg at-N /l and 25.780µg at-N /l. The highest value of nitrate recorded was attributed to the fertilizer waste from El-Nasr fertilizer factory and sewage waste disposal from El-Kabanon drain. El-Nasr Factory produces 1500 ton/day of nitrate salt and discharges 14000m^3/ day of low saline wastewater. Nitrite concentration varied between 0.150 – 3.740 µg at-N /l. The nitrite concentration recorded was higher than that recorded previously in 1999 (0.00- 2.90 µg at-N /l). Ammonia concentrations ranged from 0.57 -89.290 µg at-N /l with an annual mean of 9.952 µg at-N /l. Also, ammonia concentration recorded in 2003 was higher than the one recorded in 1999, which ranged from 0.14 to 19.39 µg at-N /l. Finally, the recorded values of Phosphate ranged between 0.22 – 1.64 µg at-P /l while the recorded values in 1999 was lower and ranged between 0.04 -1.21µg at-P /l.

5.2.4.2 Gulf of Aqaba

The sewage problem in Sharm El-Sheikh area is very limited or eventually controlled because of the Law 4/1994 where any direct discharge of untreated or treated sewage to the marine environment is prohibited. All hotels have to comply with these requirements and have acquired a sewage treatment system, or have been connected to the city sewer system. The treatment should be of tertiary or at least secondary treatment, where the remaining sludge is trucked away to the city municipal dumping area and the liquid effluents is treated to meet specified limits before being discharged to wells. The bacterial counts for total coliforms recorded in Sharm El-Maya (in Sharm El-Sheikh) and the acceptable counts in the guidelines were 9–26 and 100 (cfu/100ml), respectively. The presence of faecal bacteria was attributed to the previous use of Sharm El-Maya as a berthing site for more than 200 motorized boats. These boats evacuate their waste in the water directly (none of the boats had holding tanks for their waste, and there was an absence of onshore waste receiving facilities). After 1999 the count of total coliform decreased as a result of moving the boats to the new jetty at Sharm El-Mena. A new port established in 1999 at El-Sharm Bay (TRAVCO Port) forced, by law, 300 diving boats anchoring there to carry septic tanks for wastewater, which are later pumped to the city sewer system by special receptors in the jetties. Only 80% of the boats, however, apply this system, while the remainder still discharge their wastewater directly into the Gulf of Aqaba without treatment, causing serious pollution and damage to the habitats of the bay and the adjacent reef.

During the rehabilitation of Sharm El-Maya project in 1999, the heavy metal concentrations in the bay sediments were measured. Generally, the measured metals (Copper,Cu,; Zinc, Zn; Cadmium, Cd; and Lead, Pb) showed significantly higher levels (7.3, 68.9, 3.5, and 20.8 ppm) i.e., 2 to 4 times higher compared to the control site concentration (4.8, 29.4, 1.2, and 5). Although, trace metals in the bay sediment showed clearly higher levels than the control site, most of the values were found to be within the range of the comparative survey made on sediment samples collected in 1983 and 1984. The range of the metals were 13-80, 15-100, 0.1-2 and 0.8-15 mg/kg-dry weight sediment for Cu, Zn, Cd, and Pb, respectively. On the other hand the metal concentrations in Sharm El-Maya water ranged between 0.08-0.115, 0.131-0.509, 0.143-0.169, and 0.390-0.533 mg/l for Cu, Zn, Cd, and Pb, respectively.

In 1999 levels of Total Petroleum Hydrocarbons (TPH) were measured at Sharm El-Maya bay in sediments and water samples. The calculated mean of TPH in surface and deep water (close to the bottom) was 351.3 – 295.3 ppb, respectively; and 43.1 – 32.2 ppb at the control site. Generally, the TPH levels had a narrow average between the minimum and maximum-recorded concentrations. In the surface water of the bay, TPH concentrations ranged between 185.6 – 591.8 ppb. While in deep waters, the concentrations were 134.5 and 618.7ppb. The Total Petroleum Hydrocarbon content was analyzed in surface (0 – 20 cm) and deep sediments (20 – 40 cm). The highest concentrations were found to be in the surface sediments rather than the deep sediments at all the investigated sites including the control site. The minimum levels were recorded in the surface and deep sediments of the control site (14 and 6 ppm). The highest concentration was found in the inter-tidal sediments (1263.5 ppm) while the lowest concentration was recorded in the deep sub-tidal sediments (57.1ppm).

5.2.4.3 Other Red Sea Coast areas

In other areas along the Red Sea coast, the primary source of elevated bacterial counts is the discharge of untreated sewage, whether from human settlements, tourist villages or directly from recreational boats. In general, dissolved oxygen levels were found to be within acceptable levels, with the notable exception of the coastal areas bordering major cities, ports and a number of tourist villages, where discharges of untreated sewage and industrial wastewater result in severe localized deterioration of the water quality. In these areas, dumping of solid wastes and litter into coastal waters is also a major environmental problem. The results of surveys showed that most of the litter originated from safari and diving boats. The different items collected were shredded car tires used as boat fenders, empty food and beverage cans, gas lighters, glass bottles, oil filters, and empty barrels.

5.3 *Pollution of Northern Lakes*

Four coastal lagoons fringe the North coast of the Nile Delta area in Egypt: Lake Manzala, Lake Mariout, Lake Edku and Lake Burullus. One further lake also borders the Mediterranean Sea in the North of Egypt, Lake Bardawil in the Sinai Peninsula. The environmental quality of Lake Bardawil, which is a Ramsar site is considered to be pristine. The other four lakes on the North coast of Egypt, however, suffer from a great deal of environmental pressures.

5.3.1 *Lake Edku*

Lake Edku lies 40 km east of Alexandria and 18 km west of Rosetta. It is a shallow (1.0-1.5 m depth) brackish water lake with one connection to the Mediterranean at El Meadia. The surface area of the lake has decreased considerably over the past century due development on the shallow areas of the lake, currently reaching 19-20,000 feddans from an original 51,000 at the end of the 19^{th} century. As a coastal lagoon, the habitat in Lake Edku was akin to that of a marine environment, containing fish of the Mediterranean Sea. Since the construction of the drainage network in the Beheira Governorate in the 1920's, the lake has become a repository for the waters emanating from the drainage of a catchment area of 200,000 feddans. The lake receives water from three drains along the southern and eastern sides. Seawater is primarily affecting the western side of the lake near the outlet. After construction of the Aswan High Dam, the annual drainage in the lake has increased. This has caused an increase of the level of the lake to 16 cm above sea-level, which has facilitated the discharge of lake water out to the Mediterranean Sea.

The waters of Lake Edku are composed of 90% agricultural drainage water and 10% seawater. As a result of this the salinity of the lake has decreased considerably and this has led to significant changes in the biological and chemical characteristics of the lake. Agricultural drainage water is conveyed to the lake through three main drains: Edku Khairy drain, Tard El-Boseily drain and Tard Barseek drain. The drainage water is also polluted by untreated domestic and industrial wastewaters which ultimately reach the lake.

5.3.2 *Lake Mariout*

Composed of five main basins separated by sand banks, with an approximate total area of 17,000 feddans, Lake Mariout is the smallest of the Northern lakes. It is also considered to be the most polluted. Also, being approximately 20 meters away from the Mediterranean Sea, it does not have a direct discharge point out to sea to aid in its purification. The depth of the water in Lake Mariout ranges between 3-5 meters. The Nubariyah Canal and Omum agricultural drain also cute across the lake. Some of the lake's basins receive discharges from the Omum drain or the Nubariyah Canal. The only discharge point from the lake is through the Mex pumping station, which regulates the water level in the lake (2.2-2.4 meters above sea level). The Omum drain and other agricultural drains are the major sources of water for the lake, delivering in excess of 12 million cubic meters of water polluted with agricultural runoff, untreated or partially treated municipal wastewater and industrial effluents per day. Furthermore, the effluents from a petroleum refinery and a number of other industries directly discharge their effluents into the lake. The discharges to the lake may be divided as follows:

- Agricultural drainage water from Omum drain (60%)
- Agricultural drainage water from Nubariyah Canal (22%)
- Untreated industrial effluents and partially treated sewage (13%)

The water quality in the basins of lake Mariout that receive industrial effluents is characterised by high levels of nutrients (nitrate and phosphate), elevated concentrations of BOD and COD and faecal bacteria (see table 5.1). The lake sediments also contain high levels of heavy metals (iron, nickel, chromium, zinc, copper and lead). During the summer months, and especially in the eastern portion, the lake may exhibit anaerobic conditions resulting in emissions of noxious gases (ammonia and hydrogen sulphide). The water quality in the other basins of the lake which only receive agricultural drainage water exhibit high levels of total dissolved solids and lower levels of nutrients and heavy metals.

Table 5.1 Results of water quality analysis on samples from Lake Mariout on 4 October 2004 (sampling and analysis carried out by West Delta Regional Branch Office of EEAA)

Parameter	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Standard according to Law 48/ 1982
Temperature (° C)	29.5	25.7	25.6	26	27.6	26.8	Not to exceed 5 ° C more than ambient (35°C)
Turbidity (NTU)	20	4	40	32	12	0	Maximum 50 NTU
pH	7.1	7.8	7.2	8.5	8.0	8.0	7.0-8.5
Salinity (%)	0.1	0.28	0.28	0.22	0.38	0.28	No standard
Dissolved Oxygen (mg/l)	0.5	0.5	3.1	6.9	6.8	8	Minimum 4 mg/l
COD (mg/l)	227	44	73	132	117	7.5	No standard
TDS (mg/l)	1139	2444	3869	4930	5260	3849	Maximum 650 mg/l

Key:

- **Sample 1:** Basin 1 from infront of the discharge point of the Western wastewater
- **Sample 5:** Navigational channel

treatment plant
- **Sample 2:** Center of basin 1
- **Sample 3:** Omum Drain
- **Sample 4:** Center of basin 2
- **Sample 6:** Basin 3
- **Sample 7:** Basin 4
-

5.3.3 Lake Manzala

Lake Manzala is located on the northeastern edge of the Nile Delta, separated from the Mediterranean Sea by a sandy beach ridge. The two water bodies are connected at three points, allowing for some water exchange. The lake is large, shallow, and brackish and exposed to high levels of pollutants from industrial, domestic, and agricultural sources. The Bahr El Baqar drain transports water from eastern Cairo for 170 kilometers to the lake, carrying large amounts of particulate matter, nutrients, bacteria, heavy metals, and toxic organics. Methane and hydrogen sulphide bubble up to the surface, releasing greenhouse gases. Only the hardiest of organisms can tolerate Lake Manzala at the entrance to the Bahr El Baqar drain but still suffer from deformities, discoloration, and stunted growth. The lake exhibits a number of other environmental problems. Fish production overall is high and once supplied 30 percent of Egypt's total catch. In recent years, however, Lake Manzala's fish have had a reputation for being chemically and microbially contaminated. Tainted drinking water from the lake leads to enteric diseases. Fish and bird species have substantially declined in the area. Land reclamation has also reduced the lake surface by half, and, despite declining quality of life and standards of living near the lake, human populations are increasing, exacerbating the lake's problems.

6. AIR POLLUTION

6.1 General Situation

Poor air quality, especially in urban areas (primarily Greater Cairo, Alexandria and other urban centers) is a major contributor to the high cost of environmental degradation in Egypt. According to the estimate of 1999, the cost of environmental degradation in Egypt is of the order of 4.8% of GDP. Of that total amount, 2.1% of GDP (an equivalent to 6.4 billion Egyptian Pounds) is attributed to the impacts of poor air quality on health and quality of life. The poor air quality is as a result of both natural and anthropogenic sources. These anthropogenic sources may in turn be categorized as stationary (point) sources or mobile (non-point) sources. Stationary/ point sources of air pollution include industrial facilities, thermal power stations and some commercial and residential activities. Other major stationary sources of air pollution are the burning of municipal solid wastes and agricultural residues. Mobile sources include passenger cars, buses, trucks and motorcycles. There is an estimated 1.5 million vehicles in Cairo alone. For the past five years, there has been continuous public concern related to the degradation of air quality in the major cities of Egypt and, in particular, in Greater Cairo. This concern was sparked by the occurrence of a "Black Cloud" appearing in the skies of the capital in November 1998. The cause was a thermal inversion climatic phenomenon trapping air pollutants from a multiple of sources in and around Cairo. One major cause attributed this to the open burning of solid waste in general, and agricultural residues in particular.

Data on air quality monitoring is available from a number of sources, such as the Danida-funded Environmental Information and Monitoring Programme (EIMP), which established 42 monitoring stations across Egypt, including 27 in Greater Cairo (Figure 6.1). The distribution of the locations of the monitoring stations is shown in table 6.1

Table 6.1 Distribution of EIMP Air Quality Monitoring Stations

Location	Cairo	Alexandria	Delta	Upper Egypt	Sinai and Suez Canal Cities	Total
Industrial	3	3	3	2		11
Urban	1	1	2	4	1	9
Residential	4	2	1	2	1	10
Traffic	3					3
Remote	1	1			1	3
Mixed	2	1	1	1	1	6
Total	**14**	**8**	**7**	**9**	**4**	**42**

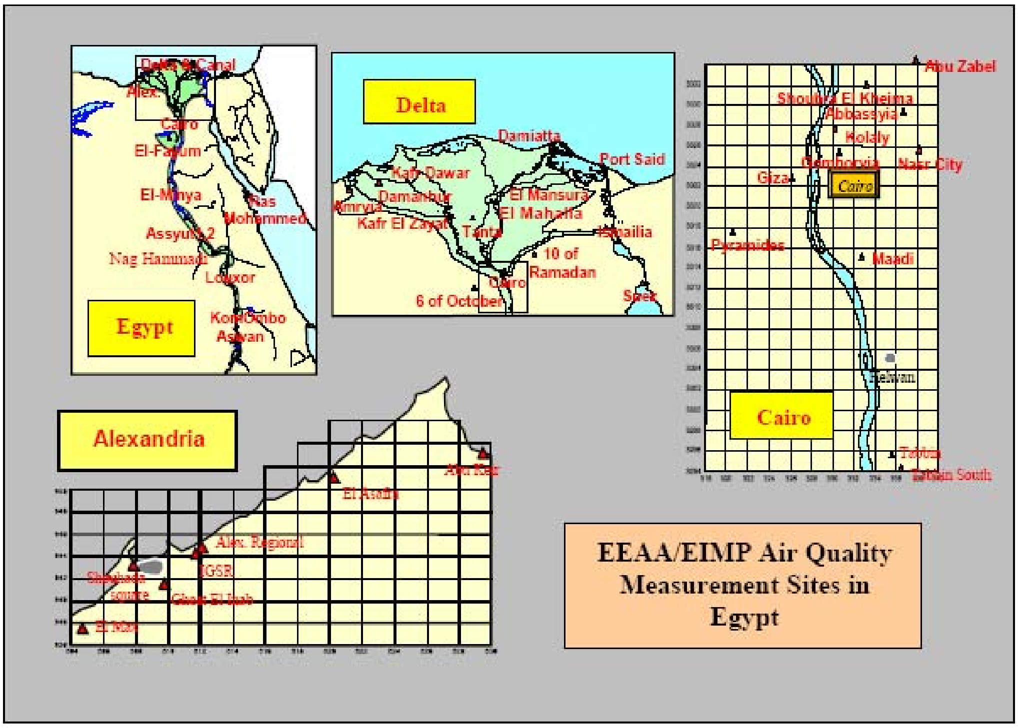


Figure 6.1 Locations of EIMP air quality monitoring stations

The EIMP project has published monthly and yearly reports on air quality in Egypt since 1999. These reports are available through the EEAA website and show an improvement in the quality of air during the period of 1999-2004. The EIMP annual report for 2003 states that as a result of the arid and mostly desert landscape of Egypt as well as the high population densities in the Nile valley and Delta, the sources of air pollution are located throughout the country. These sources include industrial emissions from the burning of fossil fuels, the open burning of municipal solid wastes or agricultural residues and highly congested traffic areas. In addition to these sources, natural factors related to the arid desert environment result in seasonal increases in particulate matter in the air.

In 1998-1999, coarse particulate matter (PM10) concentrations ranged between 145-275 microg/m^3, and could reach 850 microgram/m^3 in some areas with significant seasonal variations. The upper 24 hours ambient concentration of PM 10 decreased from an average of 280 micrograms/m^3 in 2003 to 190 microgram/m3 in 2004. In Cairo, 4-5 out of 11-17 monitoring sites are exceeding the average limit of 70 microgram/m^3. According to the EIMP annual report of December 2002, and monthly reports in September 2003 and 2004 on air quality in Egypt, the annual air quality limit value of 60 microg/m^3 for SO_2 (according to Egyptian Law No. 4) has been exceeded only in four monitoring sites, three of which are in Greater Cairo. Kom Ombo in Southern Egypt exhibits a higher SO_2 concentration. Also the WHO limit for NO_2 is 40-50 mg/m^3. This value has been exceeded at four to six monitoring sites, five of which are in Greater Cairo particularly in the city center, and the residential areas of Maadi, Nasr City.

The USAID-funded Cairo Air Improvement Project (CAIP) has also put into operation an air quality monitoring system, which has operated for the past 5 years. The air quality monitoring and analysis component of CAIP established a network of 36 monitoring sites in greater Cairo to sample the air for CAIP's target pollutants, lead and fine particulate matter (in two size fractions, PM10 and PM2.5). The network began operation in the fall of 1998 and continues to present, now operated by EEAA. Analysis of air quality data supports decision-making and communications activities. The activity has carried out a variety of specialized analyses: two of the largest were a complete inventory of lead releases to the air in Cairo, and a source attribution study that defines contributions to air pollution from vehicles, industry, and open burning (garbage and agricultural waste). The source attribution study (SAS) undertaken by the CAIP in 2001 is the only one that has been carried out to date. This study estimated the contributions of various sources to particulate matters (PM) and volatile organic compound (VOC) levels in Cairo. The results of the study (figure 6.2) showed that:

- Vegetation burning is the primary contributor to the five particulate matter (PM2.5) fractions and accounts for 52% of pollution. It is also the number two contributor in the PM10 fraction, which, with desert dusts, contributes to 60% of PM10 pollution;
- Mobile sources are secondary and tertiary contributors to PM2.5 and PM10, respectively. Mobile sources are therefore the second most important contributor to Cairo's poor air quality;
- Ammonium chloride comes in third position on the list of the most important contributors to poor air quality in Cairo. The main source of this are fertilizer plants; and
- Lead smelters and motor vehicles account for 80% of Volatile Organic Compounds (VOCs) emissions in Cairo's air.

The results demonstrated that "base load" pollution of greatest concern to health comes mainly from a few industry types, vehicles, and garbage burning. During the fall period, agricultural burning can more than double the amount of pollution from garbage burning.

The myth that most of Cairo's particulate matter comes from desert dust — and hence cannot be addressed — was dispelled.

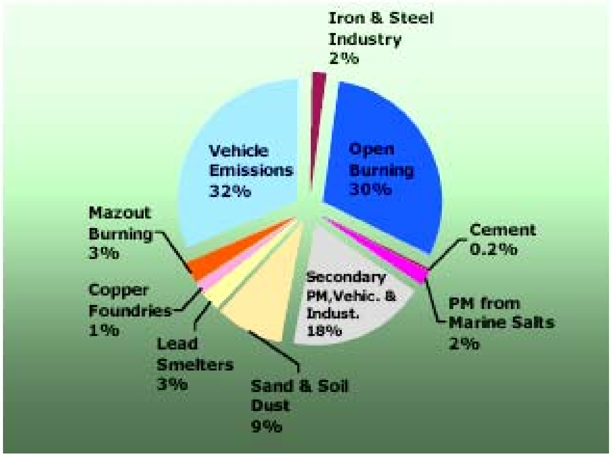


Figure 6.2 Results of Source Attribution Study

6.2 National Policies and Programs to Reduce Air Pollution

6.2.1 Energy Conversion (Compressed Natural Gas fuel in motor vehicles)

One of the programs initiated by the CAIP to aid in tackling air pollution was the Conversion of Vehicles to CNG program. In association with the Cairo Transit Authority and the Greater Cairo Bus Company, CAIP assisted in the switch of their bus fleets from diesel to natural gas. The government's move to use natural gas is part of a broader energy strategy to capitalize on an abundant natural resource. The foundation of the program was a demonstration fleet of natural gas transit buses, a model of US technology transfer to Egypt. Fifty buses were procured under the project, with chassis manufactured in the United States and shipped to a local factory in Egypt for final assembly. The first bus began rolling on Cairo's streets in April of 2000, and the fleet has now been in daily transit operation for nearly 4 years, traveling more than 10 million kilometers. In addition, two garages were constructed, Al Moustakbal at the Cairo Transit Authority (CTA) and Al Amal at the Greater Cairo Bus Company (GCBC), to house a total of up to 400 CNG buses. Funding of $5 million from the Egyptian government made the garages possible. Each was designed and equipped for safe operation and maintenance of advanced CNG vehicles. The project provided an additional $1 million for maintenance equipment, and introduced computerized management systems and enhanced maintenance practices. Arrangements with local fuel suppliers created dedicated fueling stations at each garage. Furthermore, a state-of-the-art heavy duty vehicle testing facility at Misr Lab, a division of Misr Petroleum Company, was created to serve a research and development and national certification function for buses and trucks. It is available to the government, universities, and the private sector.

At the end of 1999, when CAIP's fleet was being manufactured, government initiatives resulted in 20,000 taxis converting to CNG and 17 CNG fueling operating stations throughout greater Cairo. By 2003, more than 50,000 natural gas vehicles were being served by a greatly expanded fuel distribution network. A favorable CNG versus gasoline fuel price as well as soft financing of the conversions have raised Egypt to seventh place worldwide in the number of CNG vehicles on the road. Today, with a fleet of CNG buses, dedicated maintenance and fuelling stations, national safety standards, and a state-of-the-art emissions laboratory, the stage is set for a more fundamental shift to alternative fuels for a cleaner environment.

6.2.2 Lead Pollution Abatement

A study carried out in 1994 as part of the preparatory work for the CAIP concluded that lead was the most hazardous substance polluting Cairo's air. Since leaded gasoline was phased out in Cairo in 1997, smelters, located in and out of city limits, had since become the biggest lead pollutants. The Lead Pollution Abatement Program, a component of the CAIP aimed at assisting lead smelters in controlling their emissions. CAIP implemented the Lead Smelter Action Plan, developed in the mid 1990s based on the recognition that lead smelters were the primary source of lead pollution to the environment following the removal of lead in gasoline. Activities focused on short-term reductions of lead entering the environment as well as longer-term activities to evaluate contaminated sites and ultimately reduce demand for lead-bearing products. The primary activity focused on upgrading and relocating smelters, many of which were located in the downtown area of Shoubra El Kheima. An initial survey defined the extent of the problem in terms of numbers and approximate capacity of smelters operating. CAIP prioritized activities based on smelter size, focusing on the largest, a smelter owner controlling about 65 percent of the national production. For the large smelter owner, the project provided extensive engineering design support, leading to the eventual construction of a new facility at Abu Zaabal, outside of the densely populated downtown areas. Economic analysis ensured the profitability of the new facility. Planning for a local landfill ensured sound waste disposal. The project provided analogous design and financial feasibility support to small and medium smelters. All smelters received training to allow more environmentally sound, yet profitable performance. In tandem with the relocation effort, contamination at old smelter sites was assessed. CAIP developed preliminary plans to clean up lead from the primarily residential areas that were the most affected. Remediation of these areas will be tackled through the upcoming USAID funded project, LIFE.

6.2.3 Vehicle Emission Testing, Tune-Up and Certification (VET)

Recognising the significance of the more than 1.5 million vehicles to Cairo's air pollution, this program (also a component of CAIP) aimed at reducing harmful vehicle emissions by putting in place a legally mandated program to test and tune-up the vehicles during the licensing process. Initial planning and design work focused on a "centralized" program with all testing done by the private sector at dedicated test-only facilities across the city. Tune-ups would be done elsewhere in private garages. Several phases were completed. The first "Quick Start" program, put testing and diagnostic equipment in private fueling stations for a non-mandatory pilot period, developing public awareness and technical capacity in low emissions tune up. In the second phase CAIP designed, equipped and operationalized an on-road testing program for more than 50,000 cars, light trucks, and motorcycles. At the same time, a "model" testing center was designed, constructed, and equipped to serve as a blueprint for future testing facilities throughout Egypt. This facility is now the National Technical Center operated by the Egyptian Environmental Affairs Agency (EEAA). Following a legal decree issued in December 2002, CAIP furnished equipment, training, and communications support for the program beginning in two of the three Cairo-area governorates: Giza and Qalyubia on June 1, 2003. CAIP also provided equipment and training for the Cairo governorate program, which will begin shortly. Finally, and as a companion to CAIP's efforts with CNG buses, the project has supported an emissions testing and tune-up program for the thousands of diesel public transit buses in Cairo.

6.2.4 National Air Quality Strategy

A recent accomplishment has been formulation of a national strategy for air quality. The strategy was formulated by EEAA and endorsed by its board of directors in 2004. This strategy was conducted through a consultation process with national stakeholders. It mentions the most polluting sectors as energy, transport, industry, agriculture and proposes actions for each one. Also in an effort to find a solution to reduce the effect of the "black cloud", EEAA and the Ministry of Agriculture have set up a series of collection trials on the agricultural residues, such as central collection and densification (shredding and baling) mainly for animal feed.

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ANNEXE: PROGRAMME OF MEETINGS

Date	Meetings	Persons Met
Sunday 21 Nov		
	Kick-off Meeting at EcoConServ	
	Egyptian Environmental Affairs Agency (EEAA) International Cooperation Department	• Ms. Maysa El Gohary, • Ms. Yasmine Fouad, • Ms. Heba Hassanein
	Egyptian Environmental Affairs Agency (EEAA) Industrial Pollution Control Unit	• Eng. Hanan El Hadary, • Eng. Yasser Askar
	Egyptian Environmental Affairs Agency (EEAA) Industrial Inspection Unit	• Eng. Ahlam Farouk Abdel Hameed
	Egyptian Environmental Affairs Agency (EEAA) Nature Protection Sector	• Dr. Mostafa Foda
	Egyptian Environmental Affairs Agency (EEAA) Environmental Management Sector	• Dr. Fatma Abou El Shouk
	Egyptian Environmental Affairs Agency (EEAA) Environmental Quality Sector	• Dr. Mawaheb Abou El-Azm
Monday 22 Nov		
	Egyptian Environmental Affairs Agency (EEAA) Hazardous Substances Department	• Eng. Tarek Eid El Ruby
	Egyptian Environmental Affairs Agency (EEAA) Air Quality Department	• Eng. Ahmed Aboul El Seoud
	Egyptian Environmental Affairs Agency (EEAA) Waste Management Department	• Mr. Amin El Khayal
	Ministry of Water Resources & Irrigation, Water Quality Management Unit,	• Dr. Mohamed Abdel Khaleq
Tuesday 23 Nov		
	Energy Services Business Association (ESBA)	• Dr. Salah Hafez • Ms. Heba El Rimaly • Mr. Maamoun El Saka
	Federation of Egyptian Industries Environmental Committee,	• Dr. Sherif El Gabaly • Fouad El Guendy
	Gharbeyia Governorate	• Gen. Mohamed El Kayyaty
	Organization for Energy Planning and Consumption	• Dr. Hany El Nakeeb
Wednesday 24 Nov		
	National Water Research Center	• Dr. Hossam Fahmy (Drainage Research Institute) • Dr. Ahmed Khater (Groundwater Research Institute)
	Danish Royal Embassy	• Ms. Inge Marie Lorenzen
	Egyptian Public Authority for Drainage Projects (EPADP)	• Eng. Hussein Elwan • Eng. Amal Mohamed Ali
Thursday 25 Nov		
	FCC, Spanish Waste Management Company operating in Giza and Cairo.	• Manuel Ledesma
	General Organization For Industrialization Garden City	• Eng. Galila El Bohy
Friday 26 Nov	Free day	
Saturday 27 Nov		
	Alexandria Regional Branch Office, EEAA	• Mohsen El Diwany
	Composting Plant	
	Alexandria Hazardous Waste Management Project	• Markku Aaltonen
Sunday 28 Nov		
	GTZ	• Christian Nels
	USAID	• Mr. Dick Edwards
	EPADP	• Eng. Hussein Elwan

Monday 29 Nov		
	Agricultural Research Centre (Soil & Water Research Institute)	• Dr. Shaalan Nasr Shaalan
	Trip to afforestation Project	• Mrs. Hoda Rashed
	Solid Waste Management Dept. EEAA	• Eng. Amin Khayal
Tuesday 30 Nov		
	New and Renewable Energy Authority	• Eng. Laila Abdel Qawi
	Wrap-up meeting at EcoConServ	
Wednesday 1 Dec	Donor's Workshop at Cairo House organized by EcoConServ	