

Water and Development in Greater Cairo (Egypt)

*Fatma Abdel Rahman Attia

Water is the most widespread substance on earth. It is vital for drinking, sanitation, food production, commodity production, and many other things that facilitate human life. It can be said that water is the source of life. Irrespective of this fact, man is continuously threatening water availability mainly due to ignorance. For instance, rapid industrialization and urbanization in many countries have led to severe water pollution. Most efforts spent in the past to manage urban and industrial pollution have concentrated on what is commonly referred to as “end-of-pipe” treatment which focusses on “what to do with the waste once it has been generated”. While improvements in treatment and disposal technology have led to significant reductions in the quantity and types of pollutants discharged into the environment, these “end-of-pipe” methods have proven to be costly and ultimately unsustainable.

At this point, one may think of “prevention” as a substitute for curing or treatment. Prevention is the act of taking advance measures against something possible or probable. For instance, vaccines prevent illness, while antibiotics control it. For our purposes, prevention of both water and environment degradation is the action that minimizes the control or treatment of defects. Generally, the time, effort, and money associated with prevention is less than that associated with control or cure. The combined efforts of prevention and cure will ultimately lead to the conservation of the whole environment, conservation being generally directed to the prevention of wastage, pollution, and other forms of environmental degradation.

This article is a case study presenting the main types of problems that prevent Egypt from fully utilizing its territory and which have led to high population densities,

especially in the capital, Cairo, and its surrounding area. At the outset then, it is important to understand the causes of the problems facing Cairo's environment, with emphasis on those caused by water availability.

GENERAL CHARACTERISTICS OF EGYPT

Geography

The Egyptian territory is almost rectangular, with a North-South length of approximately 1,073 km and a West-East width of approximately 1,270 km (Figure 1). It covers an area of about one million square kilometers.

Geographically, Egypt is divided into four regions with the following land area percentage of coverage: (i) the Nile Valley and Delta, including Cairo, El Fayum depression, and Lake Nasser (3.6%); (ii) the Western Desert, including the Mediterranean littoral zone and the New Valley (68%); (iii) the Eastern Desert, including the Red Sea littoral zone and the high mountains (22%); and (iv) Sinai Peninsula, including the littoral zones of the Mediterranean, the Gulf of Suez and the Gulf of Aqaba (6.4%).

Climate

The country lies for the most part within the temperate zone. The climate varies from arid to extremely arid. The air temperature frequently rises to over 40°C in daytime during summer, and seldom falls to zero in winter. The average rainfall over Egypt as a whole is only 10 mm/year. Along the Mediterranean, where most of the winter rain occurs, the annual average rainfall is about 150 mm/year, decreasing rapidly inland.

Hydrography

The hydrography of Egypt comprises two systems: (i) a system related to the Nile; and (ii) a system related to the rainfall in the past geological times, particularly in the Late Tertiary and Quaternary.

The Nile system comprises the Valley and Delta regions, including Cairo. These are morphologic depressions filled with Pliocene and Quaternary sediments. The Nile enters Egypt at Wadi Halfa, south of Aswan. This area is at present occupied by Lake Nasser. From Aswan to Cairo, the river meanders until it reaches Cairo. At a distance

Figure 1. Geography of Egypt



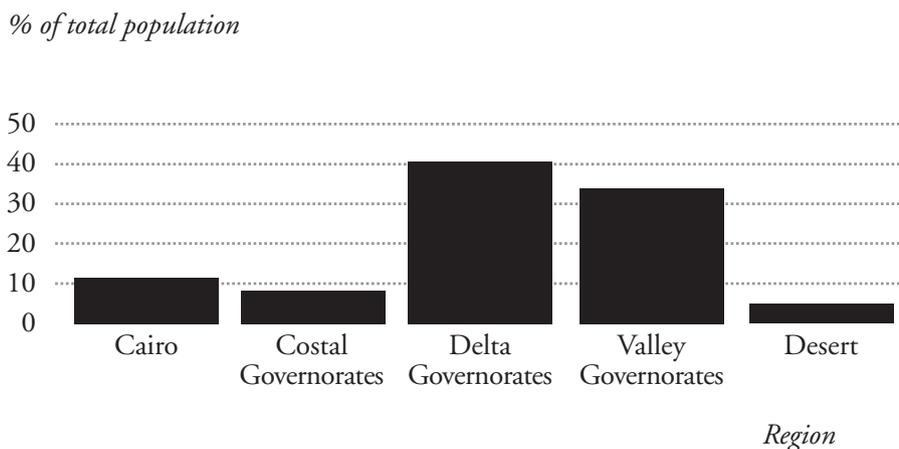
of about 20 km north of Cairo, the river divides into two branches, each of which meanders separately through the Delta to the sea. In the Nile flood plain, extensive man-made drainage systems exist, especially in the traditionally cultivated old land. Some extend to the areas reclaimed for agriculture on the desert fringes of the flood plain. The drainage systems discharge to the Nile itself or to the Northern Lakes and the Mediterranean sea.

The other hydrographic system in Egypt is the complex network of dry streams (wadis), the formation of which dates back to past wet periods in the Tertiary and Quaternary. This system covers more than 90% of the surface area of Egypt in the Western Desert, the Eastern Desert, and Sinai. The main catchment areas drain towards the Nile Valley and Delta, the coastal zones, and inland depressions.

Population Distribution

Egypt's population is estimated at about 63 million (1998). About 11.3% of the population is concentrated in Cairo, 8.9% in the coastal governorates (including the northern portion of the Western Desert), 40% in the Delta governorates, 34.4% in the Nile valley (Upper Egypt) governorates, and the rest distributed among the remaining area of the country (Figure 2). This has resulted in an uneven population density which varies from as high as 20,000 persons/km², in Cairo, to as low as 0.04 person/km², in the desert, thus creating stresses on available facilities and the whole environment.

Figure 2. Population Distribution in Egypt



Geomorphology

The landscape in Egypt can be broadly divided into the elevated structural plateaux and the low plains (which include the fluvial and coastal plains). These geomorphologic units play a significant role in determining the hydrogeological framework of Egypt and the natural constraints facing population distribution. While the structural plateaux constitute the active and semi-active watershed areas, the low plains can contain productive aquifers and are, in places, also areas of groundwater discharge.

Hydrogeology

The hydrogeological framework of Egypt comprises six aquifer systems (RIGW, 1993):

1. The Nile aquifer system, assigned to the Quaternary and Late Tertiary, occupies the Nile flood plain region (including Cairo) and the desert fringes.

2. The Nubian Sandstone aquifer system, assigned to the Paleozoic-Mesozoic, occupies mainly the Western Desert.
3. The Moghra aquifer system, assigned to the Lower Miocene, occupies mainly the western edge of the Delta.
4. The Coastal aquifer systems, assigned to the Quaternary and Late Tertiary, occupy the northern and western coasts.
5. The karstified Carbonate aquifer system, assigned to the Eocene and to the Upper Cretaceous, outcrops in the northern part of the Western Desert and along the Nile system.
6. The Fissured and Weathered hard rock aquifer system, assigned to the Pre-Cambrian, outcrops in the Eastern Desert and the Sinai Peninsula.

Recharge and Discharge

The aquifer of interest to this study (where Cairo is located) is the Nile aquifer system, bounded by the carbonates. The main source of recharge in areas occupied by agricultural activities is percolation from irrigation water, which are losses from the water supply networks and sewerage systems in urban areas. Discharge from the aquifer is through seepage to the river and groundwater extraction through wells.

Groundwater Quality and Pollution

Groundwater quality depends to a large extent on the quality of the recharge source. In the flood plain, groundwater quality is very much affected by the Nile water quality which is loaded with salts, agro-chemicals, and other ions based on the land use and water supply. In the north, saline water intrusion is the principal type of groundwater pollution. In the urban and sub-urban areas, the majority of the pollution comes from domestic and industrial sources

Water Resources

Egypt is an arid country with rainfall occurring only in winter in the form of scattered showers. The total amount of rainfall may reach 1.5 bcm/year, and may not be considered a reliable source of water due to its spatial and temporal variability.

As such, the main source of fresh water in Egypt is the Nile. Based on treaties among the Nile riparian countries, Egypt's share from the Nile is 55.5 bcm/year, an amount which is secured by the multi-year regulatory capacity provided by the Aswan High Dam.

Groundwater is distinguished into Nile and non-Nile originating categories. The most potential non-Nile aquifer system is the Nubian sandstone which contains non-renewable groundwater. The total groundwater volume in storage in the Nubian sandstone is estimated at 60,000 BCM. The current total extraction amounts about

0.5 bcm/year. However the economic annual maximum extraction cannot exceed 5 bcm/year (based on present water allocations and economic return).

The only Nile-originating system is the flood plain. Groundwater in this system cannot be considered a separate source of water, as the aquifer is mainly recharged as a result of activities based on the Nile water, including seepage from canals and deep percolation from irrigation application (subsurface drainage). The aquifer, however, can be utilized as a regulatory/storage reservoir.

Egypt is also reusing an important portion of the effluent generated from irrigation and domestic water uses; thus, while Egypt is increasing the overall water use efficiency, it is also approaching a closed water system which brings with it all possible environmental problems.

Water and Sanitation

The percent of the population served with clean water is generally higher in the urban governorates than in the rural ones. The percent of population with no access to clean water ranges from 13% to 48% (Figure 3). In these communities, the main source of fresh water comes from shallow, hand-dug wells that may be polluted due to poor local protection means. On the other hand, the percent of houses having no sewerage disposal means ranges from 6 to 49% (Figure 4). In such communities, sewage is disposed in trenches and cess-pools. The government policy is to guarantee a 100% coverage of the country's water supply and sewerage by the end of the year 1999.

Human Settlements

The strategy in regional development in the past concentrated on the development of the main urban areas (Cairo, Alexandria, and the Suez canal cities), while development of the rural areas concentrated mainly on the agricultural sector. This policy, along with the decrease in the economic return from the agricultural sector, has resulted in the continuous immigration from the rural to the urban centers.

Main Environmental Issues

Framing the main environmental issue in Egypt is the morphology of the country, which is characterized by the high plateaux that border the Nile valley. These are considered natural walls separating the Nile valley from the vast deserts. Historically, the population has always been concentrated along the river Nile because it has been the main source of fresh water. However, this situation has resulted in the concentration of human settlements and economic activities on a limited strip of land, which has led to the generation and accumulation of all types of wastes. Table 1 summarizes the major environmental issues in Egypt.

Figure 3. Water Connections By Governorate

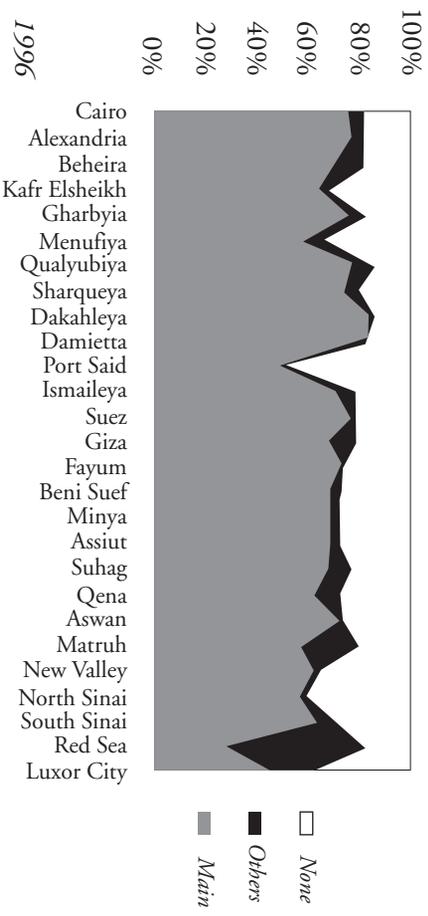


Figure 4. Sewerage Disposal By Governorate

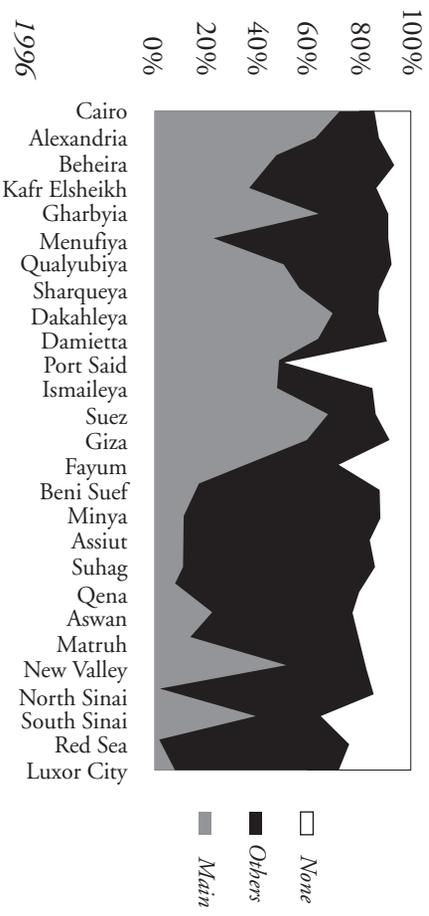


Table 1. Summary of Issues in Egypt

ISSUE	CAUSES
1. Partial utilization of Egypt's territories.	1.1 Nile valley morphology and type of boundaries. 1.2 Aridity and poor distribution of water resources over the country's area.
2. Unbalanced population distribution and continuous immigration from rural to urban areas.	2.1 Lack of regional plans and facilities/services to the rural community. 2.2 Continuous decrease of job opportunities in the rural areas, especially in the farming sector.
3. Lack of suitable potable water and sanitation in some regions, especially the rural ones.	3.1 The economic conditions of the country. 3.2 Concentration of activities in the urban regions/governorates.
4. Continuous decrease of percapita water resources.	4.1 Deterioration of water quality. 4.2 Poor enforcement of water protection legislation. 4.3 Increase of water-intensive cropping. 4.4 Inefficient use of water on the farm level. 4.5 Inefficient water distribution. 4.6 Low efficiency of urban drinking water supply.

SPECIFIC CHARACTERISTICS OF GREATER CAIRO

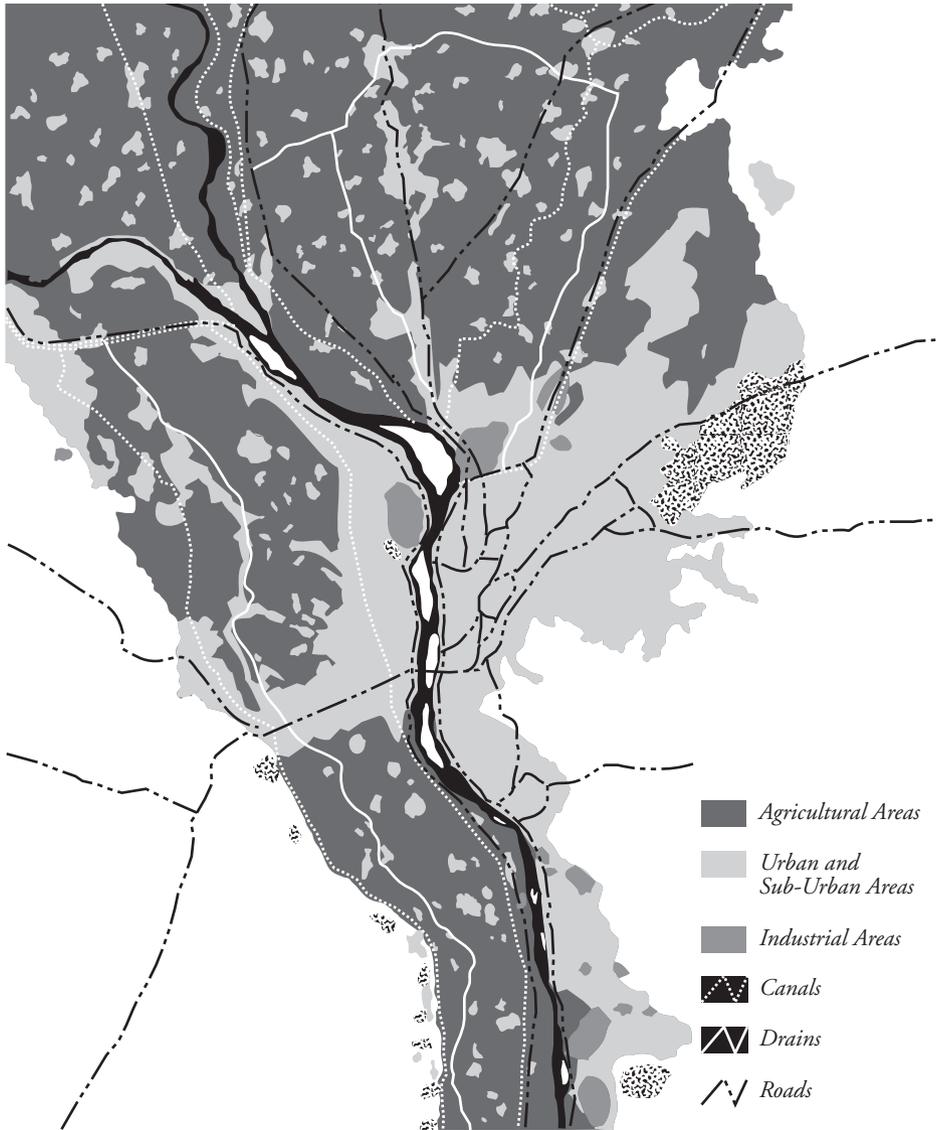
Location and Physical Characteristics

Cairo, the capital of Egypt and the most populated city in Africa, is located along the river Nile. It covers an area of 353 km², with an average length along the river of about 50 km. Two governorates form a natural extension of Cairo, Qalyubiya in the north and Giza in the south. The three governorates together constitute the so-called "Greater Cairo".

Land Use

Various types of land use are found in Greater Cairo, including (see Figure 5): (1) urban and suburban; (2) agricultural; and (3) industrial.

Figure 5. Land Use in Greater Cairo



Source: Research Institute for Groundwater (RIGW)

Demographic Features of Greater Cairo

Cairo city is witnessing a steady natural population increase, including immigrants from rural areas. Giza is the major recipient of Cairo's population spill-over. To the north, in the stretch between the northern portion of Cairo city and QualyubiYa, the region has witnessed quick urban and industrial developments. Table 2 summarizes the number of districts and the distribution of population in Greater Cairo.

Table 2. Greater Cairo Districts and Population (1998)

Governorate	No. of Districts	Population ('000)
Cairo	34	7,100
Giza	10	4,700
QualyubiYa	6	3,200
Greater Cairo	50	15,000

Though the population density varies from one district to another within Cairo city, and from one governorate to the other within Greater Cairo, among the three Governorates, the most populated is Cairo city.

Housing Patterns

A wide variety of housing patterns are found in Greater Cairo, including common residential patterns, shanties, cemetery residence, and extreme slum areas. Shanties are made of wood or steel sheets, usually consisting of one room for the whole family. All shanties belong to the broad slum areas category and are generally similar with respect to their random planning and lack of facilities. Cemetery housing – a significant housing pattern which is present in Cairo only – consists of more than one room, in addition to the other facilities. Slum-housing in Egypt is generally a broad term given to illegal constructions, and extremely slum-housing are even the poorest in facilities. However, after a while, authorities have no other choice than to consider them legal and to start to supply them with minimum facilities. With the exception of the common residential areas, the rest are characterized by their random planning and growth, along with the lack of many facilities. Table 3 summarizes the number of uncommon residential areas, and the number of districts they are found in.

Table 3. Uncommon Residential Areas in the City of Cairo

Shanties		Cemetery		Slum	
Districts	Number	Districts	Number	Districts	Number
24	58	4	15	15	73

Water Supply

The sources of municipal water supply in the urban and sub-urban areas are diverse, including: (i) water treated from the Nile; (ii) a mixture of water treated from the Nile and groundwater; and (iii) groundwater alone. The responsibility of operation is also different. Whereas Nile water-based systems are operated by a governmental Organization, groundwater systems are operated by city councils. The total water production capacity is about 5.1 million m³/day (excluding private wells production in the sub-urban and rural areas). Table 4 summarizes the potable water production schemes in Greater Cairo (excluding wells operated by city councils and private wells).

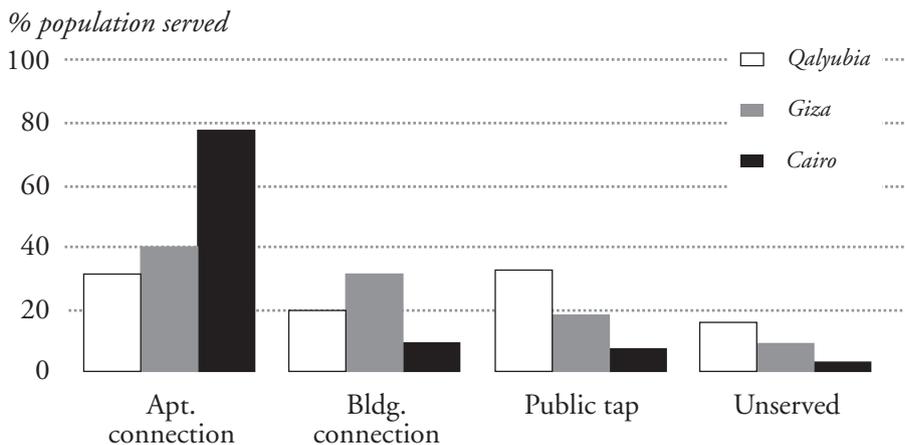
Table 4. Potable Water Production Schemes in Greater Cairo

Nile water		Mixed		Groundwater		Total	
No.	%	No.	%	No.	%	No.	%
11	61	2	11	5	28	18	100

In the scope of the several consecutive national infrastructure development plans, a considerable portion of Cairo city is presently supplied with piped water (about 97% of the urban part of the city and about 75% of the rural portion). As previously mentioned, the coverage is expected to reach 100% by the end of the year 1999.

Household water supply is distinguished into public taps (PTs) and house connections (HCs), the latter being either in apartments (each apartment having its own connection),

Figure 6. Water Supply Status Greater Cairo



or in the building (where people sharing the building are all served by one connection). Figure 6 illustrate the type of potable water service in Greater Cairo.

Irrigation water is also supplied from both Nile water and groundwater. Groundwater systems are generally private, but water distribution from the Nile is the responsibility of the government. Groundwater withdrawals in Greater Cairo for irrigation amount to about 100 million m³/year.

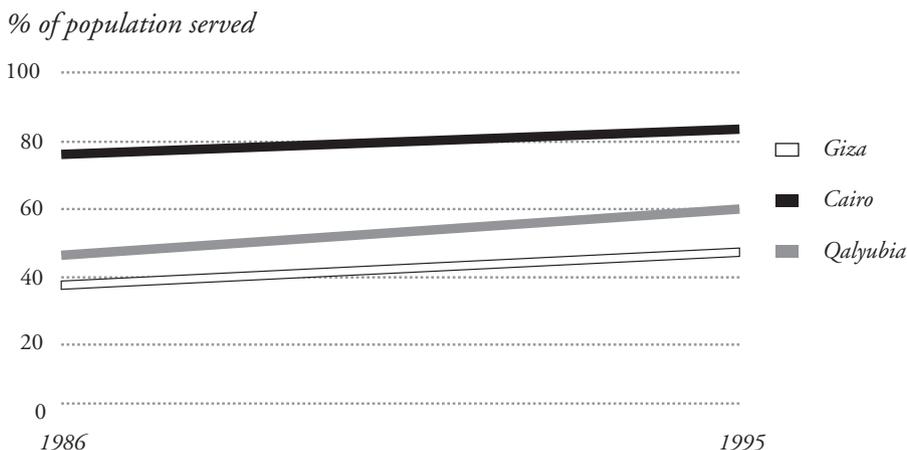
Sanitation

In Egypt, one very clear trend in water supply and drainage (whether agricultural or domestic) is that they are not implemented simultaneously. Normally, the installment of water supply infrastructures precede drainage ones. Not done intentionally, this is normally due to the lack of funds, with the assumption also that drainage problems will take some time before any repercussions are felt.

The wastewater collection and treatment systems in Greater Cairo are administered and managed by a government organization. Domestic wastewater from residential areas is removed either by conventional systems or by on-site sanitation means. Conventional systems end at treatment facilities where wastewater is treated, and may be reused. On the other hand, on-site sanitation means are very poor due to the lack of periodic de-sludging.

Realizing the importance of sanitary drainage, the government has allocated large funds to the sector, which has helped increase the level of service over the last 10 years (see Figure 7). Still, a large percentage of the population lacks this service.

Figure 7. Waste Water Service Greater Cairo



Industrial Wastewater

A variety of industries are found in Greater Cairo. The major areas with high industrial concentration are located in Helwan, south of Cairo, and Shubra El Kheima, in the north. Moreover, many small industries are spread throughout the city. The large factories are classified as shown in Table 5.

Table 5. Classification of Main Industries in Greater Cairo

Type	Number	%
Chemical Industries	23	18
Textile and Spinning Industries	27	21
Metal Industries	7	6
Food Industries	32	25
Engineering Industries	29	23
Mining and Refractures Industries	9	7

These industries consume about 162 million m³/year of water, and discharge about 130 million m³/year. Till the year 1980, the majority of the industries discharged their wastewater into fresh water bodies, including the river Nile itself. Later, and up to the year 1998, irrespective the number of environmental laws, factories were still discharging their effluent into fresh water bodies (see Table 6). Since February, 1998, the Nile became free of industrial outfalls, while the other water bodies are still awaiting the enforcement of law.

Table 6. Breakdown of Industrial Effluent By Disposal Mode (Public)

Effluent Disposal Mode	Discharge (mcm/year)	% of Total
Sewers	55.5	43.5
Groundwater	6.5	5
Irrigation Canals, including the Nile	24.5	19
Agricultural Drains	21.0	16.5
Unidentified	20.0	16

PROBLEMS ASSOCIATED WITH WATER SUPPLY AND DISPOSAL IN GREATER CAIRO

General

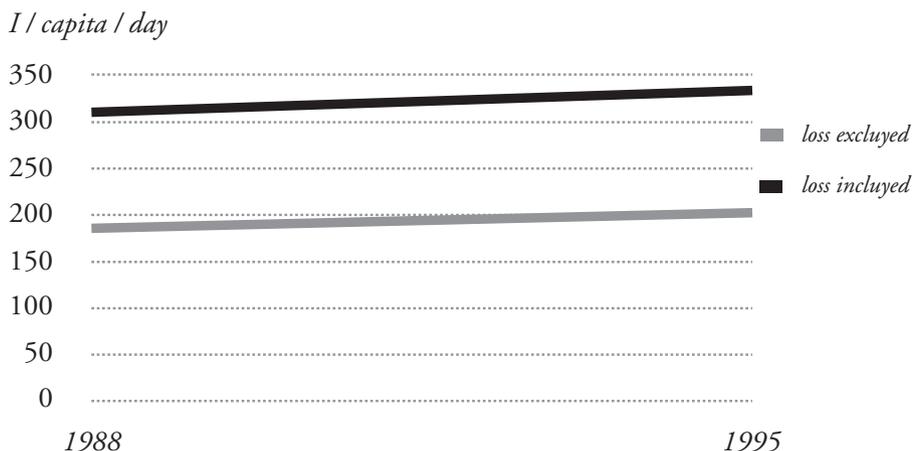
From the previous sections, one may conclude that great efforts are being made by the central as well as the local governments to increase water availability and its coverage all over Greater Cairo. These efforts, however, are not being felt by the inhabitants, neither in the sub-urban and rural areas, nor in the core of Cairo city. The main reason is that efforts cannot keep pace with the rate of population increase and the city's expansion. Another reason stems from the sanitation problems associated with water supply in unserved areas, problems which put constraints on the use of water.

In the following section, the main problems accompanying water supply are summarized, including: (a) water losses; (b) municipal and rural domestic wastewater; (c) wastewater effluent quality; (d) industrial wastewater effluent; (e) agricultural drainage; and (f) groundwater vulnerability to pollution.

Losses From the Municipal Supply Network

The major problems resulting from the extension of the municipal water network, accompanied by a lack of maintenance, has resulted in high seepage losses reaching about 40% of the delivered water (1995), as shown in Figure 8. Although efforts in

Figure 8. Illustration of Water Supply Efficiency in Greater Cairo Per Capita Water Consumption



the last ten years have brought distribution efficiency to a higher percentage, high losses continue to occur.

Municipal and Rural Domestic Wastewater

As mentioned before, the expansion in the water supply services is not always accompanied by a conjugate development in the sewerage system (including construction and rehabilitation). As a result, deficiency in the rehabilitation of the sewerage system has led to leakage, in the range of 15 to 20% of the total conveyed flow. In a pattern similar to the water seeping from the water supply network, this leaking wastewater takes two main routes, to low topographic spots within the city, or to the groundwater by deep percolation.

In those parts of the city where the conventional sewerage system is still lacking, the local systems are constructed by the local councils and end at a canal or a drain. Inhabitants of these areas, being supplied by such a wastewater removal system, have started to behave in their water consumption similar to those connected to a conventional sewerage system with respect to water consumption and wastewater generation. This results of this behavior have thus increased the pollution load to canals and drains.

In the unserved areas, where on-site sanitation is practiced, the most common type is a simple leaching pit. If the prevailing type of soil and groundwater permit deep percolation, wastewater reaches the groundwater table carrying all types of pollutants. This condition is more severe than leaking sewers with respect to groundwater pollution due to the fact that pit wastes are more concentrated in both organic and inorganic loads. If the soils and groundwater do not allow percolation, the accumulated wastewater is regularly emptied by vacuum trucks which deposit their loads into the nearest channel or agricultural land. A more serious condition may arise if regular emptying is not available, as it necessitates inhabitants entry into the pit for manual removal of sludge.

Wastewater Effluent Quality

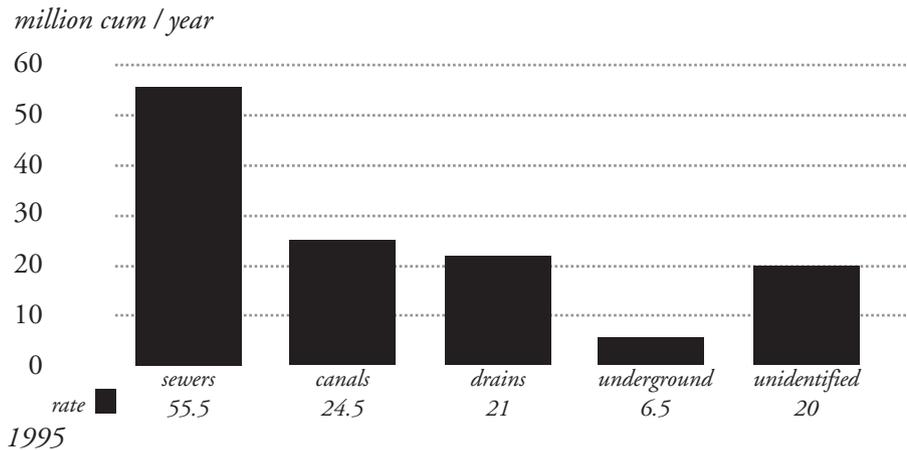
At present, only half of the wastewater collected in Greater Cairo receives biological treatment. However, the effluent of most facilities is deposited into an agricultural drain, a practice that implies serious biological pollution. Although self-purification of water may take place, the high biological loads may cause severe depletion in dissolved oxygen levels, leading to septicity. This type of pollution endangers the inhabitants living along the drains due to direct contacts with the drain water or due to seepage to groundwater which may represent their only source of potable water.

Industrial Wastewater

The Egyptian laws dictates internal treatment of industrial wastewater prior to its discharge into sewers. However, a large portion of the effluent is still disposed untreated

into water bodies or sewers (see Figure 9). Even when disposed into sewers, the end result is that the effluent often reaches the groundwater due to the corrosive nature of the wastewater. Evidence of this has been observed in areas with high intensity of factories. Those disposing their effluent into the groundwater (injection wells or pits) are even worse, as pollutants do not get any chance for degradation.

Figure 9. Modes of Wastewater Disposal Industrial Effluent Disposal Greater Cairo Greater Cairo



Agricultural Wastes

In irrigated areas, the level of applied water is generally higher than the evapotranspiration to prevent salt accumulation in the root zone. The excess water percolating downward carries salts and chemical residues. From the surface to the groundwater, some chemicals experience attenuation due to chemical reactions (nitrogen compounds), while others persist (chloride and pesticides). A significant factor in the pollution of groundwater from agricultural activities is the human factor, where knowledge concerning the application of chemicals (types, rates, and timing) is of high importance in the leaching of such chemicals to groundwater.

Although some types of pesticide have been abandoned, traces are still detected in groundwater underneath the old cultivated lands. Examples include DDT, DDD, and DDE with concentrations reaching 9 mg/l. Other types of detected pesticides include malathion, and curacron (reaching 6 and 4 mg/l, respectively). Figures 10 and 11 show the change in nitrogen and pesticides' concentration in the path to groundwater.

Figure 10. Nitrate Trend in Groundwater

m, below water table

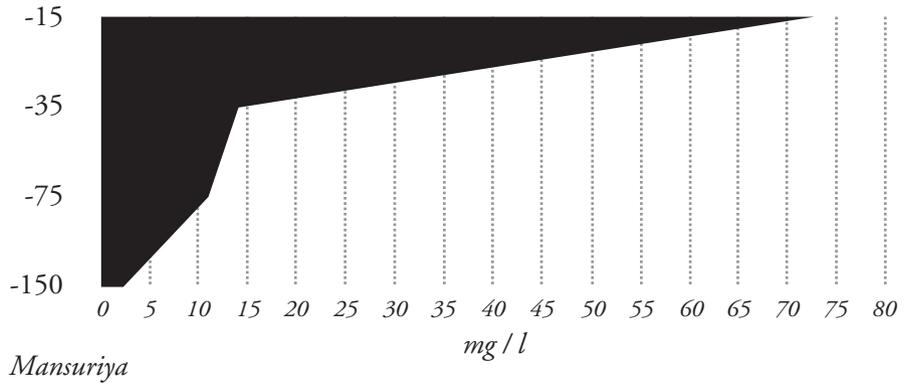
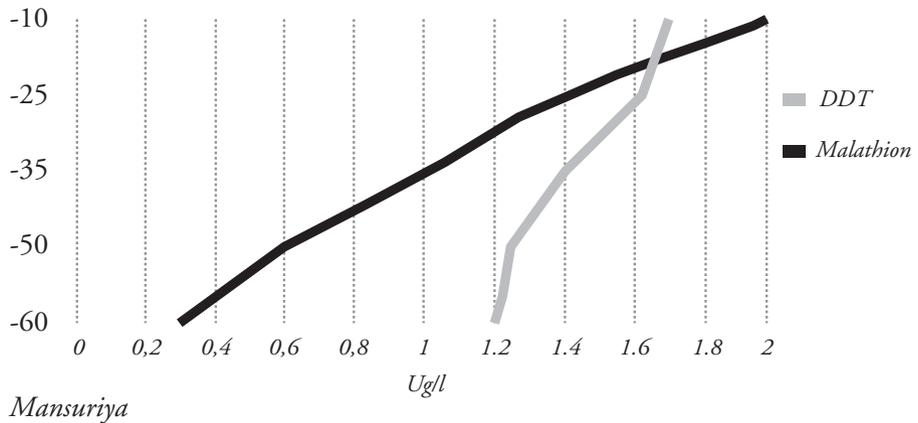


Figure 11. Pesticide Trend (DDT and Malathion) in Groundwater

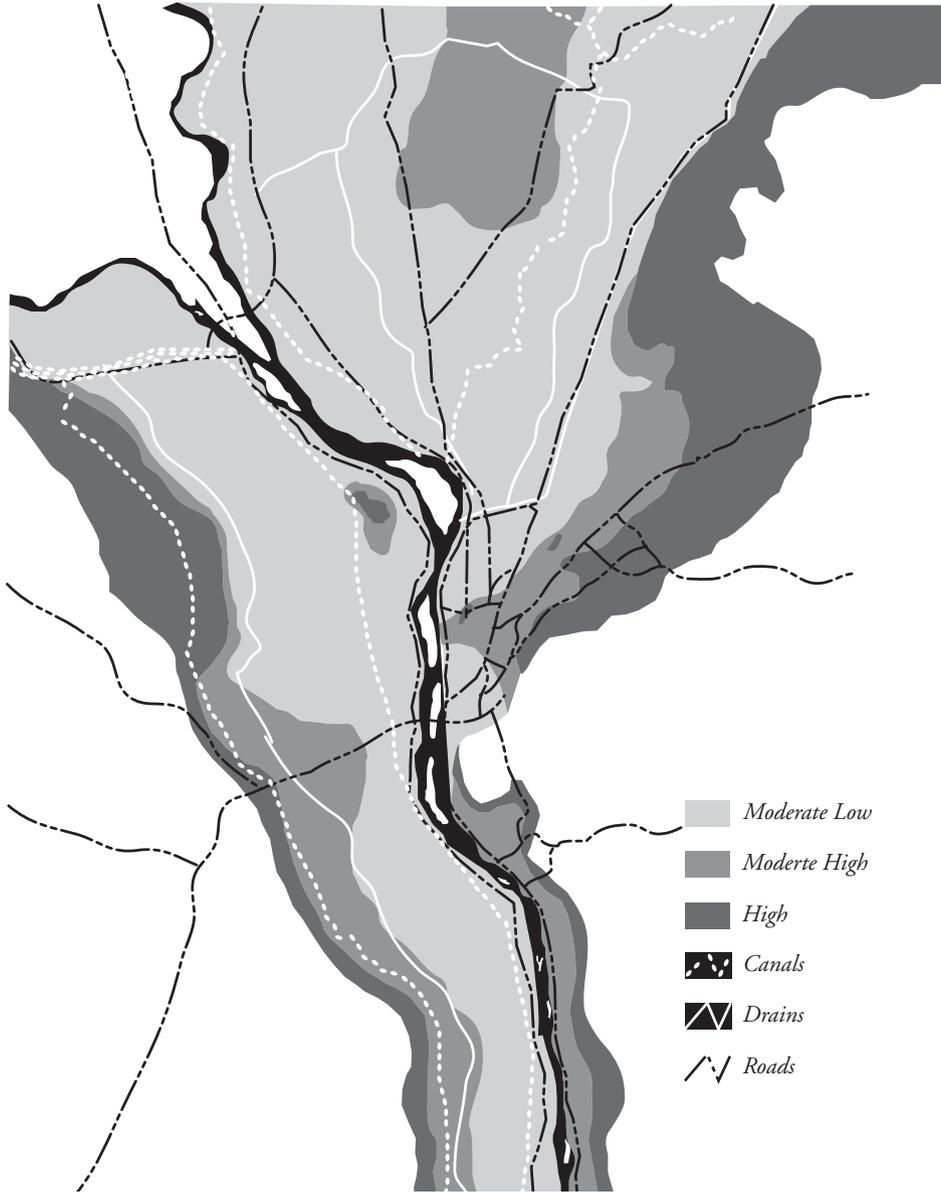
m, below water table



Vulnerability of Groundwater to Surface Pollution

The vulnerability of groundwater to pollution from the surface is largely determined by the soil leaching capacity, the depth to groundwater, and the direction of natural vertical groundwater flow. In Greater Cairo, the groundwater vulnerability to surface pollution varies from moderate to high, as shown in Figure 12.

Figure 12. Qualitative Classification of Groundwater Vulnerability to Surface Pollution in Greater Cairo



Source: Research Institute for Groundwater (RIGW)

It can be seen that the major portions subjected to groundwater pollution from surface disposal are the fringes where agricultural activities take place, and where domestic wastewater is disposed in pits. If we realize that in these areas, groundwater is the main source of potable water (rural areas), one can determine the condition of potable water.

WATER AVAILABILITY IN MEGALOPOLIS-A SOURCE OF WEALTH OR PROBLEMS

General

Human health depends not only on the availability of water, but on the reliability of the water supply and safe sanitation. The situation presented herein concerning Greater Cairo indicates that while water availability has been increased greatly in the last decade, this effort – while appreciated – has not been timely accompanied by the creation of proper waste evacuation means. If the present trends in both the supply and sanitation systems continue, with the poor public awareness and poor enforcement of environmental laws, the present problems will increase.

Awareness and Community Participation

Two very important factors in the chain of actions are public awareness and community participation. A test has been made to promote both in one of the most populated rural areas located on the western fringes of Greater Cairo, known as El Mansuryia.

Example of an awareness and public participation campaign

Characteristics of the pilot area

The selected area for conducting the Public Awareness and Participation Campaign (PAP) is El Mansuryia Unit, which is located west of Cairo. It comprises Mansuryia main village (the mother village), with a few satellite villages. The population of the area is 65,000, and the total area under irrigation is 15,000 acres.

Potable water is available from two groundwater drinking schemes in the area, while the small villages depend only on hand pumps. Groundwater is pumped 18 hours daily at a rate of 60 l/s with no storage facility. Accordingly, water is not available during the night. Chlorine tanks are available at the station, but they are not always used, indicating that water pumped to consumers is not

always treated and may therefore be polluted, especially in the view of disrupted pumping in the pipes which may result in adverse seepage from the drainage water (water table) to the water distribution pipelines. The groundwater station has only 2,300 connections within the main village, leaving more than 65% of the inhabitants unserved. Hence, extensive reliance is made on hand pumps, a phenomenon that gives rise to the high rate of water pollution and its related diseases in the village.

To investigate the state of groundwater quality, the extent and type of pollution, 28 samples have been collected and analyzed. The results have been illustrated in a simple way to communicate to the inhabitants.

Objectives and Strategy

The objective of the Public Awareness and Participation Campaign (PAP) is to promote awareness by the officials and inhabitants of Mansuryia of the dimensions, reasons, and effects of water pollution (deep and shallow), and of the options and the relevant procedures to minimize the negative and hazardous effects of this problem.

The PAP strategy was based on three premises:

1. Any activity conducted within an Egyptian village, particularly one that aims at the direct participation of the people, can not be implemented without the preliminary consent and support of the leaders in that village. Approval by these groups and their willingness to participate in the PAP greatly enhances the “permeability” of the messages disseminated and their effect on the inhabitants.
2. Just as input from village headmen is important to increase the legitimacy of the PAP, direct contact with the women in the villages is also significant, since, as many earlier studies have shown, women are the main users of the water and therefore constitute one of the strongest targets for the PAP.
3. Although literacy levels in the two pilot villages were expected to be higher than the average for Egyptian villages, print material was deemed less likely to produce a measurable effect on the people than visual aids, especially in view of the penchant for Egyptian village inhabitants for watching T.V.

Approach

For purposes of efficiency, adequate coverage and permeability of the messages disseminated, the following steps were taken in the preparation for the PAP:

1. Meetings have been held with the unit official to inform them about the PAP objectives, solicit their support for communication with the people, and seek their assistance in the organization and implementation of the gatherings.
2. Informal talks and small gatherings have been held with some of the inhabitants to obtain their views and opinions about the problem of public groundwater and hand pump pollution and to inform them of the PAP. The people contacted were asked to spread the word on the upcoming public gatherings.

3. During the above visits, brief inspections were made about the situation of the public and private drinking wells. Information was obtained on the use and maintenance of these wells by the inhabitants and their opinions were taken down on the quality and taste of the water.
4. Photographic slides and cartoon drawings were developed as presentation aids for the public gatherings.

Implementation

The gatherings have been held in two days, as follows:

1. The first public gathering was held on September 6 at the conference hall (refurbished by the village council for the gathering) of the Mansuryia Local Unit headquarter. Some 40 participants attended. These have been selected by the local unit officials as the most influential men in the area. A slide presentation informed participants on the effects of poor well construction on groundwater pollution, the harmful effects of extensive fertilizer and pesticide application in agriculture, and other faulty practices that have been noticed during the visits to the villages. A demonstration on the mechanism of water infiltration through the soil down to the groundwater has been made with the help of a sponge.
- 2) The second public gathering was held on September 9, and was targeted exclusively for the female inhabitants of the villages. The same presentation was given, with more emphasis on the role of women in reducing the effects of well pollution. Negative practices in cleaning and maintaining the wells were highlighted, together with the improper handling of water from the wells.

Results

Results obtained can be summarized as follows:

- 1) In general, the inhabitants of the villages, as well as the governorate, district, and local unit officials were very receptive to the PAP and the messages that were disseminated. Many of them admitted that while they acknowledged the problem of water pollution in their area, they were never fully aware of its profound ramifications and long-term effects. The majority were alarmed at the negative prospects of the groundwater pollution on their children.
- 2) Surprisingly, women were found to be more difficult to convince than men. Indeed, many of the women who attended the second public gathering had to be collected one by one from their homes, as they were reluctant to come on their own. But, once they were exposed to the seriousness of the problem they were greatly disturbed and became more receptive to the messages disseminated.
- 3) Participants were particularly influenced by a sample of water extracted from a domestic hand pump in the village, which was left for few days in a container (jar) for impurities to settle.
- 4) Several people, however, started to complain about lack of funds for the construction of deep wells and proper sewerage systems. But they accepted the idea of sharing in these costs. This motivated the officials, who proposed the construction of new water stations having higher capacity, along with the extension of the distribution system and implementation of a sewage system. In response to this announcement, the inhabitants said they would be willing to share in the costs, but they wanted to move the stations to the outskirts of the village.

CONCLUSIONS AND RECOMMENDATIONS

Greater Cairo encompasses a combination of urban and rural communities. Rural areas have been steadily socio-economically developing and adapting to urban practices to meet the requirements of the growing population.

The combined impact of urbanization and industrialization has necessitated the expansion of water supply infrastructures. The lack of sanitary infrastructures has created acute problems, which can be summarized as follows:

1) A continuous rise of the groundwater table in the urban areas as a result of leaking sewage and potable water, especially in low topographical spots, which will continue threatening the safety of old buildings and ancient ruins.

2) Health problems in the rural areas, associated with the continuous pollution of potable (ground)water.

3) Increased pollution of fresh water bodies from industrial activities, associated with the continuous disposal of wastes and their injection in groundwater.

4) The whole environment of the city will become unhealthy and the water presently available will decrease due to the continuous pollution of fresh water bodies.

A few actions can help to solve the present problems and help to sustain the environment, among which are the following:

1) Overall land and water use planning.

2) Timely supply of conventional sewerage means with water supply.

3) Enforcement of environmental laws, especially with respect to industrial wastewater treatment and disposal.

4) Enhancement of public awareness and public participation with respect to water and sanitation.

References

Gooprasert W., (1986). " Social Aspects in Water Supply and Sanitation". Proceedings, World Water 86 Conference, London, UK.

Meyer CF (ed.), (1973). "Polluted Groundwater: Some Causes, Effects, Controls, and Monitoring", US (EPA), Report no. EPA-600/4-73-001b, Washington DC, 282 pp.

RIGW/IWACO, (1989). The Hydrogeological Map of Cairo, scale 1:100,000.

RIGW/IWACO, (1991). Design of a Monitoring Network for Groundwater Quality in the Cairo Mapsheet area, technical note.

RIGW/IWACO, (1991). Investigation of Groundwater Pollution from Domestic Activities in Egypt, technical note.

RIGW/IWACO, (1991). Investigation of Groundwater Pollution from Agricultural Activities in Egypt, technical note.

Shata, Abdu, (1988). "Geology of Cairo", Bulletin of the Association of Engineering, Vol. XXV, No. 2, pp 149-183.