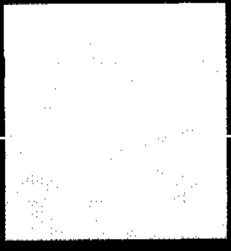
Ministry of Water Resources and Irrigation, Egypt

Adopted measures to face major challenges in the Egyptian Water Sector

FROM THE HAGUE 2ND WORLD WATER FORUM 2000
TO THE KYOTO 3RD WORLD WATER FORUM 2003

SEPTEMBER 2002



Note

This report is prepared in response to the request of the World Water Council (WWC) to report on the main measures adopted by countries to face future challenges in water management. The measures are categorized based on the Ministerial Declaration's seven challenges of the 2000 Second World Water Forum.

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Foreword

In March 2000, the Government of The Netherlands, in partnership with the World Water Council, hosted the second World Water Forum and convened a parallel Ministerial Conference. The overall theme that emerged from the World Water Vision and the Ministerial Conference is "Water Security in the 21st Century". It is an idea that links water resources management issues to wider development and environmental concerns. These issues are reflected in the seven challenges identified in the Ministerial Declaration. The challenges reflect the international consensus on water security and provide a structure in which the key themes for future support to the water sector can be identified. The seven challenges are the following: meeting basic needs, securing the food supply, protecting ecosystems, sharing water resources, managing risks, valuing water, and governing water wisely.

This report summarizes the main actions and measures implemented by MWRI, Egypt to achieve improved water management and to face future water challenges. It presents the new policies and programs implemented in the water resources management sector. These efforts are categorized based on the Ministerial Declaration's seven challenges where all the projects and programs implemented to meet a certain challenge are described briefly to demonstrate the Egyptian experience in meeting these challenge and achieving water security and sustainable development.

It includes all measures which MWRI has adopted and are centered around re-planning of water resources, and modification of the water allocation and distribution procedures to satisfy the increasing demands without urgent need to increase the water supply significantly in the short run.

Comprehensive water management program are implemented to raise the water use efficiency and increase the food production. Most of these programs included improvement and modernization of the water distribution system at both the macro and the micro levels. They also included maintenance and rehabilitation of the water control structures. Some of the measures taken were soft measures dealing with institutional reform. Several new entities have been established to achieve the overall goal of implementing sustainable water resources policies including water resources development, water demand management, and water quality conservation. Laws and legislation are also considered soft measures for protection of the environment and to achieve sustainable utilization of reused and recycled water. Cooperation and coordination among the Nile Basin countries is needed to realize sustainable and safe water resources management.

As it has been shown in the above and described in details in the report, the institutional reform lies in the heart of the integrated approach of water resources management of the Egyptian water resources. This institutional reform aims to strengthen the political, technical, legal and administrative arrangements that lead to save water, and in general maximize the return from using the limited investment available to the water sector in Egypt.

Dr Mahmoud Abu-Zeid

MINISTER OF WATER RESOURCES AND IRRIGATION, EGYPT

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Water challenges
and institutional reform
the Egyptian perspective

Introduction

Water is a finite and vulnerable resource that is essential to all forms of life on earth. Worldwide water is becoming an increasingly scarce resource. In past times, at least in non-desert areas, water availability was not questioned. Water was easily available from surface and groundwater sources and ready to be applied in multiple uses (Attia, 1997).

With the increasing population on one hand and environmental degradation on the other, pressure has been intensified on the available water resources (Attia, 2001). Tsakiris and Todorovic (1997) reported that the scarcity of water resources, the unfavorable distribution of water resources in time and space, the increasing demands for water, the pollution of water resources, the variability and instability of climate, and the change of socio-economic activities had necessitated the search for rational ways of effective planning and management of water resources. Water institutions, formal as well as informal, water laws, water policy, and water administration are under going remarkable changes worldwide (Saleth and Dinar, 1999).

In August 1998, the World Water Vision participatory exercise was officially launched in Stockholm with approval of the work plan and establishment of the World Water Commission. The main objective of the commission was to develop knowledge and raise awareness of issues among the general population and decision-makers so as to foster political will and leadership; develop a vision of water management in year 2025 that was shared by water sector specialists and civil society and provide input to the vision implementation strategy for which the Global Water Partnership would take the lead.

In March 2000, the Government of the Netherlands, in partnership with the World Water Council, hosted the second World Water Forum and convened a parallel Ministerial Conference. The overall theme that emerged from the World Water Vision and the Ministerial Conference is "Water Security in the 21st Century". It is an idea that links water resources management issues to wider development and environmental concerns. This means that water should be available to everybody with a good quality to meet their needs and that is done in a secured and sustainable manner that does not damage the ecosystems and that protects them from the hazards that storms, floods and droughts can bring. A key issue is how decisions are made, who makes them, and whose interests are represented in these decisions. The institutional reform of water resources sector is as important as the technical aspects of managing water resources.
These issues are reflected in the seven challenges identified in the Ministerial Declaration. The challenges reflect the international consensus on water security and provide a structure in which the key themes for future support to the water sector can be identified. The seven challenges are the following: meeting basic needs, securing the food supply, protecting ecosystems, sharing water resources, managing risks, valuing water, and governing water wisely.
The Government of Egypt (GoE), represented by the Ministry of Water Resources and Irrigation (MWRI), is working towards the promotion of comprehensive water resources management measures to secure water for all sectors. MWRI is the main authority in charge of water resources development, allocation and distribution. Newly developed water resources management strategies has become more integrated in the sense of looking at the water scarcity from all its different sides. Current policies of water resources management look at the whole set of technical, institutional, managerial, legal, and operational activities required to plan, develop, operate, and manage the water resources system on both the national and local scales while considering all sectors of economy which depend on water. Not to forget, sustainability is a major objective of these policies in the sense that the utilization of resources by future generations should not be limited by the use of current generations in any way. Suggested projects and programs do not necessarily have to serve only one sector. Conversely, by better understanding the system and better cooperation between all stakeholders, projects can be multi-purpose; it can serve reclaiming new lands, build new communities and industries, and generating hydropower for these activities while conserving the ecological system for both humans and habitats.

This paper will highlight the Government of Egypt's efforts to achieve water security for all uses. It will present the new policies and programs that were implemented in the water resources management sector. These efforts will be categorized based on the Ministerial Declaration's seven challenges where all the projects and programs that were implemented to meet a certain challenge will be described briefly to demonstrate the Egyptian experience in meeting these challenge and achieving water security and sustainable development. ■

Egypt's water supply and demands

Egypt's water resources system is characterized by its complexity and uncertain nature (Tawfik et al., 2001). It is composed of many interacting components and intermingles with social, economic and environmental systems, which are also complex and uncertain.

Egypt's water **supply and demand**

Rainfall in Egypt is very scarce except in a narrow band along the northern coastal areas, where an insignificant rain-fed agriculture is practiced. Rainfall occurs in winter in the form of scattered showers. The total amount of rainfall may reach 1.5 BCM per year. This amount cannot be considered a reliable source of water due to its spatial and temporal variability. Sparse flash floods also occur in the Sinai Peninsula and in Upper Egypt.

Egypt receives about 98% of its fresh water resources from outside its international borders. This is considered to be a main challenge for water policy and decision makers in the country as the River provides the country with more than 95% of its various water requirements. The Nile River is the second longest river in the world, being about 6800 km. Its basin covers an area of about 3000000 square Km. the river travels through ten African countries: Burundi, Democratic Republic of Congo, Egypt, Eritrea, Ethiopia, Kenya, Rwanda, Sudan, and Tanzania.

The Average annual yield of the River Nile is estimated at 84 BCM at Aswan. The discharge of the Nile River is subject to wide variation. Figure 1 shows the average monthly variation of the Nile flows at the different tributaries as well as at Aswan. The natural flow of the river can be divided into two periods 1) a short 3 month long high muddy flow season from July to September, and 2) A longer 9 month long flow clear season from October to June. The figure shows that the Nile flow at Aswan is main influenced by Khartoum flow representing the Blue Nile and Atbara flows representing Atbara River during the flood season, while for the rest of the year, the Nile flows are affected by the White Nile flows represented by Malakal.

The demand on water for the country is ever increasing as a result of population growth and increased economic activities as well as escalating standards of living. Egypt is approaching an era where these growing demands for water can no longer be met by the developed renewable Nile water supply. Currently, water resources development is constrained by the technical viability, economic feasibility, and environmental concerns. Thus, the need for the development of additional water supply and/or demand management must be addressed in addition to addressing the implications regarding water allocation, particularly as the government has taken a major shift towards a market driven economy.

Previous water policies in Egypt were not flexible enough to cope with uncertainties in defining the country's priorities with respect to water resources development as well as addressing future changes in water demands. They have been characterized as being resource development policies aiming at merely satisfying current and future requirements. Water management also suffers from fragmentation among different institutions. Although the Ministry of Water Resources and Irrigation (MWRI) is responsible for water management, linkage and coordination with other stakeholders are not strong enough to eliminate conflicts. Recently, MWRI has adopted new integrated water resources policies focusing on three major aspects: demand management, resources development, and environmental protection. Presently, water resources planning focuses on increasing the water availability for all uses from various sources in addition to saving and conserving water quantity and quality, while at the same time sustaining the environment as well as protecting people from water related hazards.

Efficient and effective use of all water resources in Egypt both in time and space requires the formulation and implementation of appropriate water sector policies (Attia and Tawfik, 1999). Recent water resources policies include different structural measures such as irrigation structures rehabilitation, improvement of the irrigation system, installation of water level monitoring devices linked to the telemetry system, expansion in the tile drainage system, etc. There are also several non-structural measures that have also been implemented including expansion of the water users association (WUAs) for ditches and mesqas, establishment of the water boards on branch canals, promotion of public awareness programs as well as the involvement of stakeholders. Laws and legislation are also considered as non-structural measures.

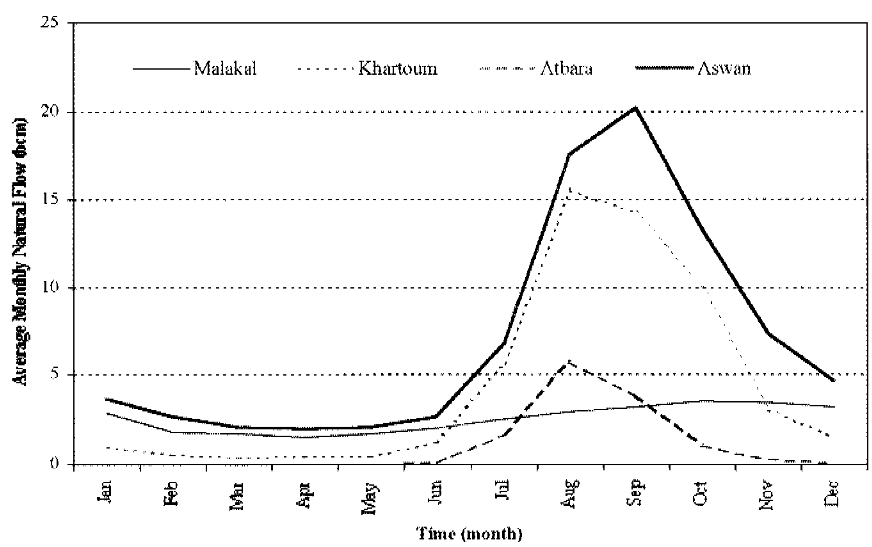


Figure 1. Average monthly flows at the main Nile tributaries and at Aswan

Egypt's water requirements increase with time due to the increase in population and the improvement of living standards as well as the government policy to reclaim new lands and encourage industrialization. The cultivated and cropped areas have increased over the past few years and will continue to increase due to the government policy to add more agricultural lands. The largest consumers of irrigation water are Rice and Sugarcane because they have high water requirements in addition to occupying considerable areas. The average annual crop consumptive use is estimated to be 41.441 billion cubic meters (BCM). The total diverted water to agriculture from all sources (surface, groundwater, drainage reuse, and sewage reuse) that includes conveyance, distribution, and application losses is estimated to be about 60.731 BCM per year. The water policies of the 1970's and early 1980's gave a significant advantage to new land development. However, recent changes in price and other policies particularly the reduction/elimination of government fertilizer and energy subsidies place farmers in the new land at a disadvantage.

Annual evaporation from open water surfaces is estimated to be about 3.0 BCM per year using the total water surface area of the river Nile inside Egypt and the irrigation network (canals and drains) and an average annual rate of evaporation. This amount varies slightly from one year to another according to climatic conditions (temperature, humidity, wind speed and solar radiation) as well as the rate of infection of canals and drains with aquatic weeds.

Municipal water demand including water supply for major urban and rural villages is estimated as 4.6 BCM per year. A part of that water comes from the Nile system and the other part comes from groundwater sources. A small portion of the diverted water (about 1 BCM) is actually consumed while the remainder returns back to the system. The major factor affecting the amount of diverted water for municipal use is the efficiency of the delivery networks. The studies showed that the average efficiency is as low as 50%, and even less in some areas. The cost of treating municipal water can be reduced significantly as the efficiency of the distribution network increases.

There is no accurate estimate for the current industrial water requirement especially with the new government policy to encourage private sector participation in industrial investment. The estimated value of the water requirement for the industrial sector is about 7.53 BCM/year. A small portion of that water is consumed through evaporation during industrial processes (only 0.79 BCM) while most of that water returns back to the system in a polluted form. ■

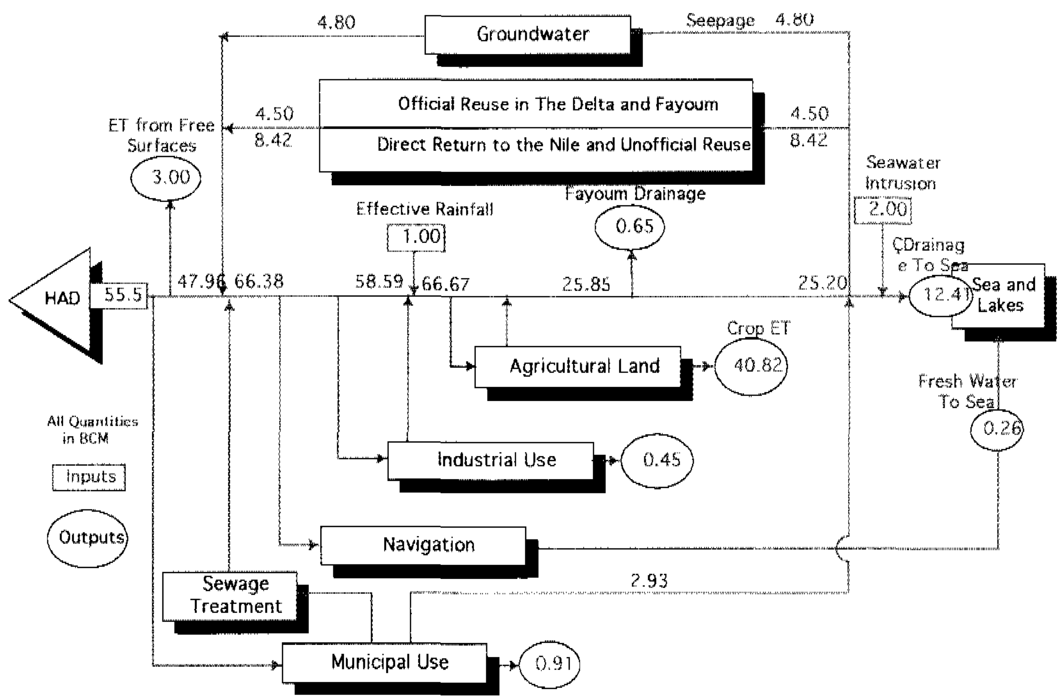


Figure 2. Egypt's national water balance for the year 1995/96

Source: The Planning Sector, MWRI

The Nile River main channel and part of the irrigation network are being used for navigation. Water demand specifically for navigation occurs only during the winter closure period when the discharges to meet other non-agriculture demands are too low to provide the minimum draft required by ships. This water goes directly to the sea as fresh water. After changing the winter closure system by dividing the country into 5 regions instead of two, the amount of water released for navigation is considered to be insignificant.

Determinant factors for water resources development in Egypt

There is a wide range of factors that might have either a positive or a negative relationship with water resources. Some of these factors affect water supply, others affect water demand, while others have effects on the pattern of use of these resources that could be reflected in the return flows.

The first determinant for water resources development is the population growth where population count tripled during the last 50 years from 19 millions in 1947 to about 65 millions in 2000 and it is expected to be about 95 millions by the year 2025. Thus, the future water policy should consider this population as the targeted users of these resources. The per capita share of Nile water will drop sharply under all standards of water poverty within the next two decades unless a strong and very ambitious plan is undertaken to develop Egypt's water resources.

The attitude of farmers and other population sectors is the second determinant for water resources development. It determines the practices of their use of water. Regardless of all expenditures paid for the new irrigation systems in new lands, most farmers tend to ignore the existence of these systems and use surface irrigation instead. They do not know much about crop water requirements to restrict themselves to provide each crop with only its actual needs. Thus, all components whether knowledge, beliefs, or experience should be changed through an effective scientific approach that affects these practices. However, this should go hand in hand with other changes needed in the water distribution system to ensure fair, timely, and efficient distribution process. Rational practices of water use and the high economic value of water were found closely related to the farmer's educational status and the type of irrigation system applied. Right knowledge is a prerequisite for positive attitudes and rational practices of water use. The awareness campaigns about the value of water should be undertaken to impose rational use of water on all users whether in the agricultural, industrial, or other sectors.

The third determinant is the institutional schemes of irrigation water use where farmers in the old land have established their own informal social organizations to formulate their network of relationships during interaction for irrigating their lands. The main task of such organization is to avoid any source of conflict that might occur within the distribution process of irrigation water. These organizations are powerful enough to impose themselves on all individuals through a variety of social means, social control methods, and social norms. Hence, there are some well-established patterns of relationships amongst farmers to organize their interactions concerning this specific scarce resource. It would be rather wise to plan for the development of existing social organizations as sub-systems related to the whole irrigation system but to be reconstructed on different basis.

A new dynamic and handy information system for irrigation and water use should be introduced to farmers and be accessible. New technical arrangements and technologies should be offered to these organizations. In the newly reclaimed lands, there are no such well-established social organizations in the irrigation process. The social organization of irrigation should be viewed and analyzed fully as a complete and open social system that needs urgent and rational intervention. A well-designed task analysis, organizational and managerial scheme, formulation of a dynamic structure of hierarchy to ensure its effectiveness, and the legislative background of such kind of organizations should be given careful attention prior to wide expansion of any recommended organizational formula. The participatory approach should be intensively utilized in the preparatory and planning stages.

Employment generation and development policies constitute the fourth determinant in the water resources development. The high proportion of young population sectors under 15 years represented about 34.9% of the whole population in 2000. This shows the potential incoming labor force within the next two decades, which means that there will be a higher demand on employment opportunities in the next 20 years. New job opportunities should be generated depending on the use of all natural resources available including water as the scarcest resource. Agriculture is considered one of the most capable sectors to absorb the incoming young labor force. However, generating new jobs in agriculture depends directly on the availability of water resources for reclamation of new lands and the establishment of new settlements.

The fifth determinant is the land resources where the total area of Egypt is 1,001,450 km2, the majority of which is desert lands. Most cultivated lands are located close to the Nile banks, its main branches and canals. Currently, the inhabited area is about 12.5 million feddans and the cultivated agricultural land is about 7.85 million feddans.

The per capita cultivated land declined from about 0.23 feddans in 1960 to about 0.13 feddans in 1996. The per capita crop area declined from 0.4 feddans in 1960 to about 0.2 feddans in 1996. The sharp decline of the per capita of both cultivated land and crop area resulted in the decrease of the per capita crop production. This affects directly the food security at the individual, family, community and country levels. Accordingly, the government has committed itself to undertake huge projects for transferring water to potentially reclaimable lands located out of the narrow strip of the Valley and Delta to absorb the population increase and to offer new job opportunities for youth.

The land tenure system is considered to be the sixth determinant of water resources development. The current system resulted from the limited growth rate of arable lands along with the high growth rate of population. The average holding size of lands dropped to about 1.5 feddans in 1995 with a large number of holders and tiny farms to irrigate. That resulted in: a) rendering part of these lands uncultivated for the purpose of digging canals, drains, roads and border limits, b) losing part of the water resources during the irrigation process to reach each small tiny plot, c) increasing costs of operating and maintaining of irrigation canals and drainage system, and d) suffering from the management problems and lack of coordination among the large number of users during the operation of the water distribution system. MWRI has adapted the project of irrigation improvement to increase the efficiency of irrigation and alleviate the waste of water during the operating of the irrigation system. It is quite clear that, under the trend of rapid population growth and the limited land resources along with the inheritance laws, the number and percentage of tiny and fragmented farms will gradually increase. Hence, there is a need to observe the trends of fragmentation and amalgamation closely.

The seventh determinant is the cropping pattern, which has been freed due to the liberalization process of the agricultural sector. The cropping pattern should provide farmers with completely free choices regarding crops they prefer to cultivate. The only limitation of this free choice is the area to be cultivated with rice due to its high water requirements. Within the liberalization process, other economic measures can be taken to encourage cultivation of alternative high cash, value added, and export crops that may decrease the cultivation of water hungry crops such as rice and maize.

The policy of food security is the eighth determinant of water resources development. The food gap for some main crops is expected to increase widely within the next two decades. Unless a very ambitious and serious plan to expand land resources, rationalize the use of limited water resources, and increase the efficiency of using both land and water in agricultural production to its maximum, food security in basic crops can never be achieved.

The ninth determinant is the costs of water and its recovery where recent studies showed that the cost of 1,000 m3 of water ranged between 10 and 20 Egyptian pounds. The approach of irrigation water pricing is not acceptable by the majority of farmers. However, the idea of cost recovery may be adopted and investigated on a small scale. It requires further in depth socio-economic studies to identify the approach to be used under the different conditions. In general, those who tend to accept the idea of cost recovery are more educated, large farm holders who tend to use modern irrigation methods. ■

Egypt's experience in meeting the water challenges

Egypt is an arid country with rapid population growth and crescent living standards. The natural and geographical conditions of Egypt are not auspicious in terms of fresh water resources availability (Abu-Zeid, 1997).

The Nile, which is the main source of water for the country, originates outside Egypt's international borders. It has no other tributaries within the Egyptian borders and it penetrates the Sudanese–Egyptian borders as a single channel. The Nile morphology and the barren desert, that bounds the Nile Valley and Delta, constitute a geographical barrier that prevents the Egyptians from fully utilizing their territories. Nevertheless, there are very few opportunities for increasing the current Nile water supply by implementing the Upper Nile conservation projects. On the other hand, most of the available groundwater in the desert is non-renewable and associated with a high development cost.

MWRI has launched several policies that aiming to have better utilization of the limited water resources and increase the efficiency of water use in all sectors. The implementation of these policies is one the major achievements of MWRI in meeting the World Water council seven challenges for water security. It is expected that in the near future the water supplies available from both conventional and non-conventional resources will not be enough to satisfy the increasing demands for water. Also, more concern is now given to water quality issues rather than water quantity. Therefore, MWRI has recently shifted its long going policy paradigm of water resources development to water demand management. It has launched several projects to contribute to the demand management paradigm as well as water quality conservation measures. There are also several programs for cost recovery, institutional reforms, laws and legislations, stakeholders' participation. ■

First challenge : meeting basic needs

Access to safe water and sanitation are everybody's needs and basic human rights. They are vital for health and well-being. Although there were tremendous efforts in the last two decades to provide improved water and sanitation services for all people, there are still more than 1.1 billion people worldwide who don't have an adequate supply of clean water and about 2.4 billion people do not have any acceptable means of sanitation.

There are three main stakeholders in Egypt who are involved in municipal water supply and sanitary drainage. This report provides an overview for the role of each of these agencies in providing adequate quantity and quality of municipal water at the national level.

Ministry of Water Resources and Irrigation (MWRI)

R. Khouzam (1995) summarized the efforts of MWRI concerning the projection of future needs of municipal water in Egypt. These efforts can be summarized as follows :

- **A leading comprehensive work** is that made by Water Master Plan (WMP) team in 1981. Based on the 1976 population census, WMP developed 8 scenarios for future municipal water use: an initial scenario, a revised scenario and six alternatives to forecast the municipal water use in the years 1982 and 2000. WPM focus was variation in the per capita use.

- **In 1990,** the Planning Studies and Models Component (PSMC) of the Irrigation Management System (IMS) project within the Planning Sector/MWRI presented a document on "Water Demands: Present and Future Estimates". Chapter III of that document paid special attention to the time past of reducing the high water losses *in the municipal distribution network. It adopted two scenarios for* improving the efficiency of the distributing system. It estimated a forecast of the municipal water needs for the years 2000, 2010, 2020, and 2030 at the main canal level.

- **In 1992**, the Water Security Project within the Water Distribution and Irrigation Systems Research Institute of MWRI presented a study, which, like WMP, paid attention to the growth of the rate of per capita use of municipal water. It presents rich database on monthly municipal water use. Forecasts are made for the years 2000, 2005, 2010 (Mankarious and Shibiny 1992).
- **PRIDE (PRoject In Development and the Environment)**, being concerned with the assessment of water quality in Egypt, dedicated a section to municipal issues for the purpose of reaching an estimate of associated wastewater (Welsh et al. 1992).

- **IIMI, (International Irrigation Management Institute)** in 1995, provided a study concerning the cost allocation among non-agricultural water uses. The study addressed new topics such as water pricing and quality of returning used water (Cesti 1995:11-12).

- **The National Water Resources Plan** (NWRP) for Egypt in 2001 provided a study about the stakeholders involved in municipal water and sanitary drainage, industrial wastewater and fish farms. The study aims at describing these stakeholders and analyzing them from the organizational and institutional perspectives. The purpose of the study would in actual terms serve as a mean for MWRI in its endeavor to draw a National Water Resources Plan. MWRI added recently two units to its organization structure, the Groundwater Sector and the Irrigation Improvement Sector to have efficient water resources management. The ministry also added another unite to the organization structure for Water Quality Management Unit (WQMU) working directly under the H.E. the Minister's supervision to strengthen the water quality management aspects.

On the other hand, MWRI launched a NAtional Water Quality and Availability Monitoring (NAWQAM) *program for improving the water* quality in the Nile River to reduce the health risks from water-borne diseases. The Water Availability Component of the NAWQAM project is to develop improved national water resources management policies. These policies are obtained through improved water quantity and quality data, better analysis of supply and demand variables, and increased consultation among water users and distributors. Demand models are developed to provide the tool for prediction future water demands base on historical use patterns. These predictions are updated as new data become available. A framework that uses hydrologic, municipal, industrial, agricultural, demographic, social, meteorological and economic as well as environmental data and information has been developed to predict future water demands for various uses. Different use trends are also analyzed through the model. The framework was applied on Gharbia Governorate data to demonstrate its applicability. MWRI takes in all its water policies, the allocation of water for municipalities as a first priority over all other uses where the ministry operates the water distribution system to maintain adequate water levels at the upstream of all municipal water treatment facilities all over the year.

Ministry of Housing and New Settlements (MOHNS)

The Ministry of Housing and New Settlements (MOHNS) is implementing a national strategy to expand the capacities of the municipal water treatment facilities and provide adequate sanitation facilities. The level of implementing this national strategy based mainly on the availability of funds needed for constructing the new facilities. The National Organization for Potable Water and Sanitary Drainage (NOPWASD) is a national authority having a legal personality within the MOHNS. Some of the major tasks and responsibilities of this organization can be briefly summarized as follows:

- **Lying down plans on the national level** in relation to drinking water and sanitary drainage works and preparing their execution programs as a prelude towards including them in the state general plan and monitoring their implementation(as shown in Table 1).

- **Specifying conditions and standard specifications** for sewage and sanitary drainage projects and potable water projects as well as household and public uses in productive firms and to observe them and operate in accordance with these specifications.
- **Assisting governorates** in the field of required research, preparing and making designs for large scale projects or those of special nature and when requested supervising their implementation. This assistance is extended in return for fees to be fixed by the board of directors in a form of a by-law.

- **Helping governorates in preparing contracts** pertaining to the above mentioned projects and in accordance with the specifications and conditions prepared for them and already announced in bids, local and foreign negotiations, in addition to analyzing and examining offers (bids). NOPWASD is entitled to hire specialized local or foreign consulting firms for the purpose of implementing its duties and tasks.

Table 1: Investments and capacities of drinking water and sanitary drainage projects in Million LE

Fiscal Year	No. of Projects		Production Capacity (100 m3/day)		Per Capita (l/d)		Development of Investments		Total
	Drinking Water	Sanitary Drainage	Drinking Water	Sanitary Drainage	Drinking Water	Sanitary Drainage	Drinking Water	Sanitary Drainage	
Before 1952	252	8	1,269	363	55	15	86	84	170
1952-1981/2	605	28	4,476	632	75	10	827	237	1,064
1981/2-2000	1,803	220	12,541	7,288	145	85	17,667	22,844	40,511
2000-2017*	806	923	12,056	11,900	25	90	4,722	23,927	38,649

Source: The National Water Resources Plan (Rep #17)

* Proposed Projects

NOPWASD has an independent annual budget comprising all investments in potable water and sanitary drainage at the national level excluding those investments appropriations of economic public authorities for drinking water and sanitary drainage. NOPWASD is the official entity for making decisions regarding distribution of investments for large-scale drinking water and sanitary drainage projects in governorates. Figure 3 displays the increase in the annual design capacity of the treatment plants for the water supply, the annual actual production, and the annual consumption from 1981/82 till 1997/98. Figure 4 presents the daily per capita treatment capacity during the same period. The figure exhibits a significant increase from about 110 liter per capita per day in 1981/82 to about 190 liter per capita per day in 1994/95 and to about 235 liter per capita per day in 1997/98.

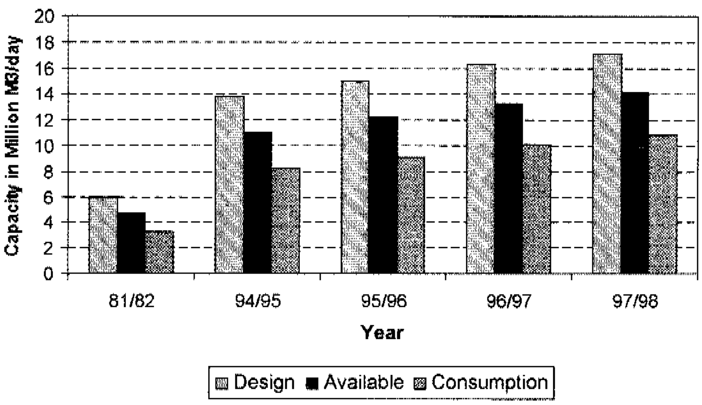


Figure 3. Capacity of municipal water treatment plants

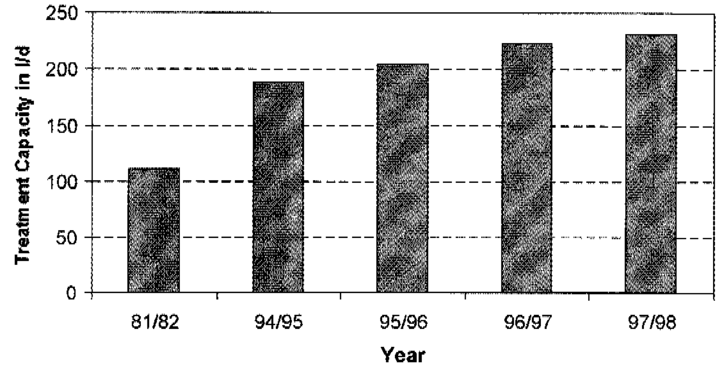


Figure 4. Available capacity of municipal water treatment plants per person

Ministry Of Health and Population (MOHP)

The department responsible for the environmental protection within the Ministry of Health and Population (MOHP) is the general department of environmental health. In the following a description of the tasks of this department is briefly summarized:

The general department of environmental health has been established and is functioning in accordance with the Presidential decree No. 2703 of 1966 concerning the establishment of the Water Higher Committee in the MOHP.

- The Minister of Health's decrees No. 569 of 1979 and No. 93 of 1987 and the "Preventive Medical Care Instructions Manual" issued in 1965 summarize the tasks and responsibilities of the General Department of Environmental Health as follows :

- **Planning to secure basic requirements**: in this regard the General Department suggests the general policy, from the technical point of view, needed to improve the environmental health in towns and villages. It coordinates in this respect with concerned agencies in: methods of making potable water available for human use; methods of disposing waste (human, animal, industrial and solid wastes) and healthy households and other matters related to securing healthy environment for citizens

- **Combating and minimization of pollution:** in this regard the General Department is responsible for: setting the optimal criteria permitted for the pollution of water, food, soil and air; setting criteria for watercourses and shores; setting plans and programs for controlling pollution, abiding by criteria, and monitoring their implementation and discovering the pinpointing sources of pollution.

- **Controlling and Monitoring activities,** which includes monitoring of health control on drinking water, sanitary drainage, solid waste, and human, industrial and animal wastes. It includes also monitoring all activities related to the supervision of health utilities to ensure that they abide by specified health regulations. ■

Second challenge : securing the food supply

The water requirements of the agricultural sector represent the largest component of the total water demand in Egypt. Agriculture consumes more than 85% of Egypt's share of Nile water annually. The rapid growth in population and changing diets as incomes increase mean that these demands will grow in the future.

The World Water Vision and framework for action highlighted the challenge of achieving water demands for food and environmental security as one of the most pressing conflicts of the coming decades.

A major threat to sustainable food production is the availability of water resources, which are limited and the rate of increase these resources is much less than the rate of growth in the demand side. MWRI initiated a long-term strategy for the optimum use of all available water resources. This strategy includes long term programs that all focus on the reduction of losses and better allocation of water to produce more with less volume.

Rice is a strategic crop that is used locally and part of the production is exported. There have been several changes in the area cultivated with rice as well as the per feddan production. Table 2 shows the changes in the annual area cultivated with rice and the total production. The table exhibits an increasing trend in the production per feddan of rice. It should be noted that water consumption of the rice is extremely high with respect to the other grain crops grown in Egypt. Nevertheless, due to the high floods occurring in the recent years since 1996, about 1.5 million feddans of rice have been cultivated yearly.

Table 2 : Total area and production of rice crops during the period 1985-2001.

Year	Total area (1000 fed.)	Total production (tons)	Average Production (Ton/fed)
1985	924.92	2311.29	2.50
1986	1,008.71	2,444.68	2.42
1987	982.66	2,405.85	2.45
1988	838.07	2,131.62	2.54
1989	983.57	2,677.32	2.72
1990	1,037.46	3,167.42	3.05
1991	1,100.65	3,447.81	3.13
1992	1,215.70	3,909.71	3.22
1993	1,282.99	4,160.76	3.24
1994	1,378.44	4,583.01	3.32
1995	1,400.72	4,789.14	3.42
1996	1,407.47	4,899.43	3.48
1997	1,549.87	5,480.01	3.54
1998	1,232.44	4,474.11	3.63
1999	1,559.40	5,816.96	3.73
2000	1,569.77	6,002.76	3.82
2001	1,340.63	5,227.45	3.90

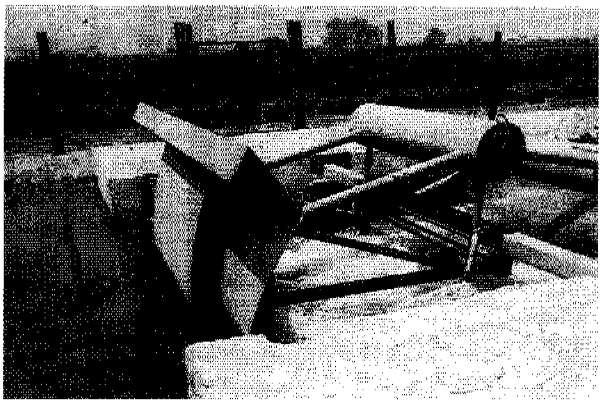


Figure 5. IIP modern gates and new raised mesqa construction

The Irrigation Improvement Project (IIP)

The main objective of the Irrigation Improvement Project (IIP) in the old lands is to improve the efficiency of water use at the mesqa (irrigation ditches) and farm levels. It also initiates the user participation and involvement in the operation, maintenance, and management of the irrigation system. Figure 5 exhibits two of the main structural works associated with IIP. The first one is the modern radial gates that close automatic when the water levels rise at the downstream side of them. The second is one type of new mesqas (field ditches) that is elevated to ensure water adequacy along the mesqa. The other type is the pipe mesqa to reduce field distribution losses.

The framework of IIP includes rehabilitation and renewal of water distribution structures, use of pipeline and raised mesqas, use of one-point collective pumping from branch canal into mesqas, and land leveling using modern techniques. It also includes the redesign the field irrigation systems and, most importantly, the formulation of Water User Associations (WUAs) that expresses the new vision for the water distribution management process.

Surface and Subsurface Drainage Network

The total area provided with subsurface drainage network reached about 4.5 million feddans, which represents more than 70% of the agricultural area nation-wide. Also some 6.6 million feddans were covered by main surface drainage network representing 90% of the total area to be covered. The maintenance activities for both surface and subsurface drainage systems are carried out by MWRI to prevent soil salinity and water logging. Cleaning open drains from weeds and removal of silt is also carried out regularly for open drains while for the subsurface drains, the annual maintenance plan includes gravity flushing for collectors and high or medium flushing for the laterals.

New changes have been made to the organizational structure of the Egyptian Public Authority for Drainage projects (EPADP) to enhance and improve its performance. Drainage Advisory Service Directorates were established to increase the awareness of farmers about importance of subsurface drainage networks and to demonstrate how simple maintenance works could be done. The establishment of these directorates is the starting steps to achieve the long-term strategy of privatization of operation and maintenance (O&M) works policy.

Figure 6. Subsurface drainage system installation

Cropping Pattern Shift

Economic analyses showed that there are substantial differences in the total economic returns to different crops grown in Egypt. It was indicated that water productivity in some regions is low according to the high water consumptive crops that has low value added. The following policies will be implemented to reduce the agriculture water consumption :

- **Gradually replace sugarcane** with sugar beets especially in Upper Egypt taking into account the lifetime of current sugar factories, which were designed to process sugarcane.
- **Reduce rice cultivated area** to about 900,000 or one million feddans at most which be sufficient to satisfy national demand, provide some potential for export, and prevent soil salinization and seawater intrusion.
- **Replace currently used varieties of rice** with the new shorter-life rice varieties, which have higher productivity, and less water requirements due to their shorter lifetime.
- **Develop new crop varieties** using genetic engineering that have higher productivity and less water consumption.
- **Narrow the gap between net revenues** of similar seasonal crops to enable MWRI to encourage less water consumptive crops.
- **Design an indicative cropping pattern** for each region in the country based on climatological conditions, soil characteristics, and water resources availability in terms of quantity and quality. Farmers should be advised to follow the indicative cropping pattern or pay for excess water if they deviate.

Figure 7 exhibits the increase in the total cropped area of wheat, rice and vegetables during the period from 1981/82 till 1997/98. The figure shows an increase in the cultivated rice areas, which has resulted due to the increase in the Nile flows during the 90ies. Figure 8 displays the total production for the same crops during the same period. The figure exhibits an increasing trend in the total production for the three crops.

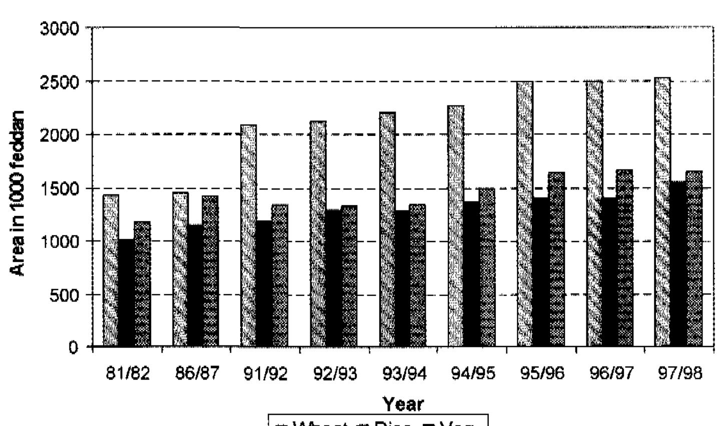


Figure 7. Cropped area for major crops during 1981/82 – 1997/98
Source: The Plan for Economical and Social Development

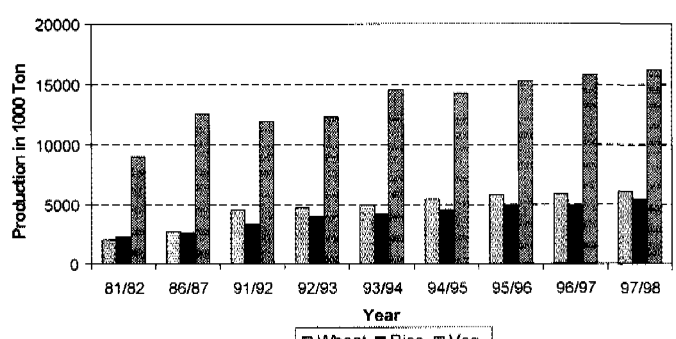


Figure 8. Agriculture production for Major Crops during 1981/82 – 1997/98
Source: The Plan for Economical and Social Development

The Agricultural Horizontal Expansion

The Ministry of Agriculture and Land Reclamation (MALR) reviewed the horizontal expansion plan and updated it using intensive survey to create the soil characteristics maps for parts of the Western Desert and Sinai and to locate new areas suitable for reclamation. The new updated plan for Horizontal Expansion of Agricultural Land, to be completed by 2017, aims at adding 3.4 million feddans (MF) to the existing agricultural area. The Egyptian government has already started the development of three mega projects (North Sinai, Toshka and North-west Delta) to expand the agricultural land with more than 1.5 million feddan in the coming decade. MWRI took into consideration the new horizontal expansion plan in designing the national water policy till year 2017. The policy estimated the additional volume of water needed to meet this plan and identify the sources for it. The policy also included a set of initiatives that must be implemented in order to meet the water demands for the new lands.

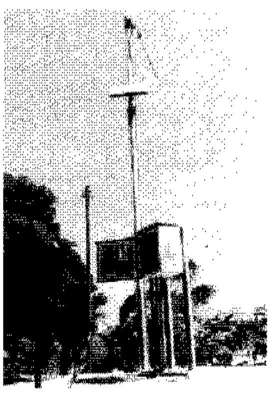


Figure 9. Field measurement site of the telemetry system

Figure 10. Main control room for the telemetry system showing the MIMIC Board and the monitors

Main System Management (Telemetry) Project

The value of information about water quality and quantity has always been recognized for better water management, but now there are tools available to manage large quantities of data in comprehensive forms enabling decision makers to focus on the actual decisions to be made. These tools include telemetry/SCADA systems, Geographic Information Systems (GIS), expert systems, scheduling systems, and many more (Schulte and Wright, 1997).
The Main System Management (MSM) project was launched by MWRI to assist decision makers and system operators in raising the efficiency of managing the Nile River irrigation system through providing timely information about water flows along the irrigation network. There are 800 remote units located along the irrigation network where water levels are recorded and transmitted to 24 stations in all irrigation directorates on a real time basis to monitor the system performance. The system allows water managers to diagnose excess water supplies in some locations and/or water deficits in other locations (Tawfik et al., 1997). Flow data provide the basis for changing flows along a certain channel, or modifying the operation of a specific hydraulic structure. This would control water losses at locations where excess water is monitored.
Figure 9 displays one telemetry field measurement site where the different parts of the station are present including the photocell, the antenna, and the recorder. The level sensor is lowered down the canal. Figure 10 exhibits the main control room of the telemetry system at MWRI headquarters. The MIMIC Board shows all monitored locations along the irrigation network. The user can select any location and displays all information related to that location on the monitors situated up the MIMIC Board.

Third challenge : protecting ecosystems

There are many ways in which human use of water resources is impacting the ecosystems. Traditional conservation approaches can work in some settings but will have only a limited impact on the overall degradation of ecosystems. These systems can only be protected through approaches that take into account the whole system in an integrated way.

The national program for protecting the Nile River from industrial pollution

MWRI in coordination with the State Ministry of Environment launched a national program to stop industrial wastewater effluent to the Nile River main stem. The program targeted in its first phase the major 34 facilities that were dumping their industrial wastes directly into the Nile River. The program provided technical support to the industries in order to minimize their wastes and improve the efficiency of water use in these facilities. It also provided technical and in some cases financial assistance to these facilities in order to establish treatment facilities for their effluent.

The program succeeded in convincing these industries to invest about 350 million L.E. in treatment facilities to treat their effluent before dumping it into the river. The program will consider in the coming phase, the industrial facilities that dump their wastewater into the main canals, then in a later stage it will consider the facilities that dump their water into the agricultural drains.

Another step to conserve the Nile River downstream the High Aswan Dam (HAD) from pollution sources, the Government of Egypt declared all the islands in the Nile River downstream HAD and its two branches as natural protected areas. This declaration helps MWRI to have better management and control over these islands and define clearly the environmental impacts of any new development plans for these areas and stop any activities that may threat the ecosystem of the River Nile. Figure 12 displays the average BOD concentrations in mg/lit in some of the major rivers around the world. The figure shows that the Nile has almost similar BOD concentrations like the European rivers of Rhine, Seine, and Thames. However, BOD concentration of Tama River in Japan is much higher than the other rivers as well as the Nile.

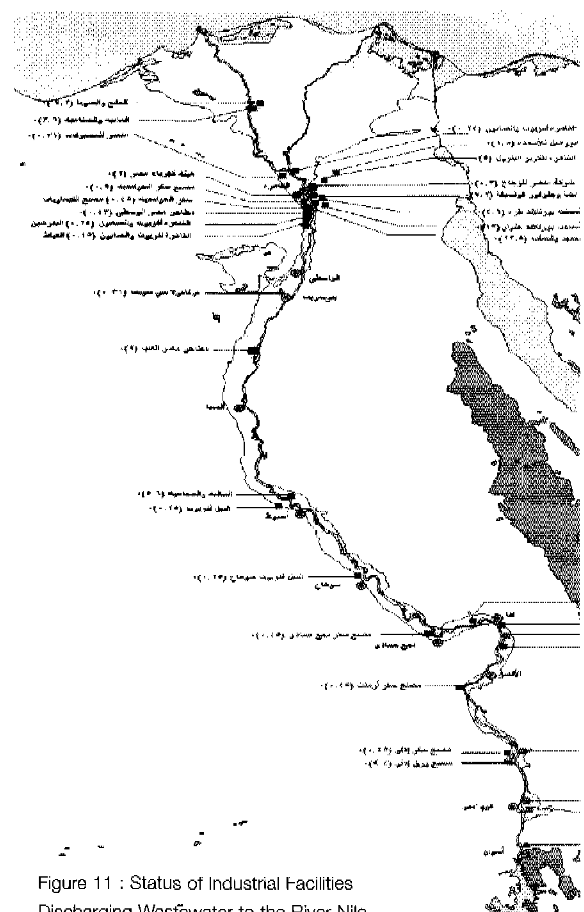


Figure 11 : Status of Industrial Facilities Discharging Wastewater to the River Nile

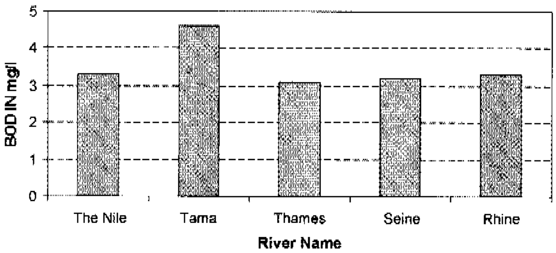


Figure 12. Average BOD concentration in some of the main rivers around the world
Source: The State Ministry Of Environment. Study for Nile Water Quality, 1999

Lake Manzala Engineered Wetland Project

A major environmental and economic concern in Egypt is the poor water quality of the north flowing drainage water. Much of the heavily polluted drain water enters large coastal lakes before flowing into the Mediterranean Sea. Engineered wetlands provide an economically and environmentally sound alternative to traditional wastewater treatment facilities.

Global Environmental Facility (GEF) is funding a five-year demonstration project at Lake Manzala, one of the major coastal lakes. The project will address ecosystem restoration, sustainable development and engage local community and NGO's in research, training and other national capacity building activities. The wetland will demonstrate innovative low-cost approaches for improving water quality that will lead to Egyptian self-sufficiency in this form of biotechnology. Wetland and terrestrial plant biomass will be cultured, harvested and processed into marketable products. The clean effluent water from wetland cells will be supplied to an aquaculture facility that will produce juvenile fish for restocking the lake and for other aquaculture ventures. The low cost and potential income from aquaculture operations will provide an incentive for extending wetland biotechnology to other highly polluted areas.

Protecting Lake Nasser Ecosystem

The Aswan High Dam (AHD) was built to fulfill water security provisions through strategic storage of Nile water, protection from ravages of floods, and allowing year- round cultivation of crops to cope with the growing national needs of food and fiber. Lake Nasser storage capacity is approximately 130 BCM at elevation 175 m (amsl). The water arriving at the reservoir inlet is about 84 BCM per annum. The annual water losses include seepage, bank storage, and evaporation with an estimated value of approximately 10 BCM. During the flood season the river carries large amounts of sediments that typically deposit in Sudanese part of the reservoir. Sediment deposited in the reservoir is considered to be the main environmental concern for the water quality and ecosystem. Some 100-130 million tons of sediment deposition inside the reservoir occurs annually. According to Makary et al. (2001) Figure 13 displays the accumulated sediment volume in Lake Nasser following the equations of Lane and Koelzer (1943) and Miller (1953) from 1964 to 2000. The average accumulated volume of sediment during that period amounted to more than 3 million cubic meters. The Nile Research Institute (NRI) within the National Water Research Center (NWRC) is carrying an environmental monitoring program for Lake Nasser water quality. Based on the analysis of the collected results from that monitoring program, the institute concluded that in order to preserve the unique domain and the invaluable virgin nature with all-original rural conditions of the Lake Nasser in Egypt. A program of applying integrated reservoir management is vital. The policy involves a comprehensive assessment, setting of objectives, planning and management of the reservoir system and availability of resources, taking into account traditional, cultural and historical perspectives and conflicting interests and uses. The program is meant to be a continuous and evolutionary process for achieving sustainable development. Corrective measures have to be formalized to stop the environmental deterioration under the persistent ambitious development plans. Lake Nasser and a strip 20 km wide (on both sides) should be announced a natural protectorate.

Attenuation of contamination by means of dilution caused by the large reservoir water contents applies only to chemical pollution. However, biological pollution increases exponentially regardless of the volume of the ambient. Solid and liquid wastes of any development activity in the Lake Nasser vicinity, including agricultural drainage, should be disposed safely away from the reservoir. If not practical, at least secondary treatment should be imposed before any wastewater is allowed into Lake Nasser.

MWRI realized the importance of protecting Lake Nasser from pollution, as it is almost the sole source of fresh water to the country. The ministry is coordinating with all the concerned ministries to formulate a strategy for sustainable development of the area around the lake taking into consideration all the mitigation measures that ensures the prevention of the lake water pollution.

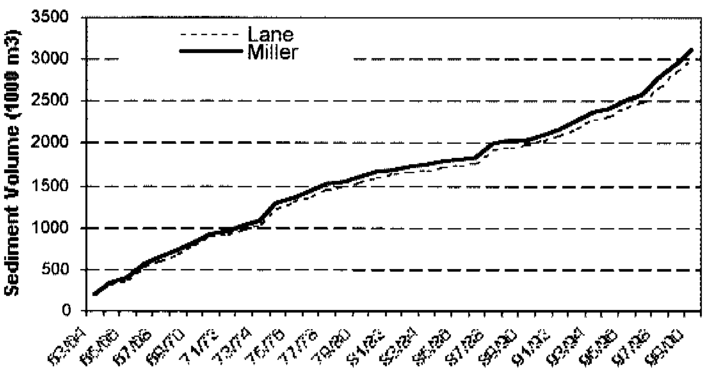


Figure 13 Accumulated sediment volume in Lake Nasser from 1964 till 2000

Establishment of the Central Laboratory for Environmental Quality Monitoring

The Central Laboratory for Environmental Quality Monitoring (CLEQM) was established with the assistance of the Canadian International Development Agency (CIDA) within the organizational structure of NWRC. It was established to offer solutions to a wide range of environmental problems. Chemical and biological analyses are performed at CLEQM according to the highest international standards. The staff of CLEQM has been trained at several international laboratories to gain the experience for handling different types of analysis for solving complex environmental problems.

CLEQM includes five major analytical departments; ecotoxicology and environmental indicators, organic chemistry, inorganic chemistry, microbiology, and soil. Each laboratory houses a number of up-to-date and fully automat4ed analytical instruments that are capable of handling large number of environmental parameters. CLEQM assists in the development of regulations and standards for pollution control measures as well as the development of water quality protection guidelines. CLEQM runs an advanced QA/QC program. Figure 14 shows parts of the several labs available within CLEQM and the trained staff working there.

Currently, CLEQM is responsible for the analysis of water quality samples collected from the different water bodies through the National Water Quality Component (NWQC) of the NAtional Water Quality and Availability Monitoring (NAWQAM) project.

Figure 14. CLEQM staff working in the different chemical and biological labs

Water Quality Monitoring Component (WQMC)

Drainage water reuse has been adopted by MWRI as a national policy since the mid 80ies to expand irrigated areas and increase irrigation water. Drainage water quantity and quality have been monitored at most of the drainage lifting and mixing pump stations as well as at the outfalls of the drains into the Mediterranean and the northern lakes.

Table 3 reports the amounts of drainage water pumped into the sea in the three delta regions and the average salinity of them represented by EC. The table shows that there is no significant change in the amounts of water pumped into the Mediterranean except in the recent years of 1998/99, 1999/2000, and 2000/2001. This is mainly due to the high Nile flows during these years that led to more water released downstream AHD, resulting finally in more drainage water collected and pumped into the sea. The table also shows an increasing trend in EC values during the period 1987/88–1997/98 except for year 1992/93. Nevertheless, the salinity decreased with more drainage water in the last three years.

Table 4 displays the amounts of drainage water that have been reused in the three Delta regions during the period 1984/85 – 1999/2000. The table also reports the average salinity of this water in each region. A significant increase is observed in the reused quantities only in 1989/90, 1990/91 and 1998/99. The table also shows slight differences between salinities within the three regions as well as through the years. Nevertheless, a national drainage water quality monitoring program is currently implemented and operating to maintain the permissible levels for reuse and to ensure sustainability of the drainage reuse program in the future.

The Water Quality Monitoring Component (WQMC) is initiated as one of the three components of the National Water Availability and Quality Management (NAWQAM) project. The main objective of WQMC is to rationalize water quality monitoring activities into a national monitoring program for all water bodies and to strengthen the capabilities and raise the institutional capacity of the of NWRC staff in water quality monitoring and analysis. The specific outcomes from the WQMC are as follows:

- **Improved timeliness** and reliability of relevant and accurate water data as generated by NWRC,
- **Improved water data storage,** retrieval and analysis by NWRC through greater capacity for database and GIS management,
- **Improved implementation and dissemination** of water information by NWRC to/from stakeholders in forms suitable for influencing policy dialogue and formulation.

There has been a comprehensive survey carried out to determine the location, frequency, and sampled parameters for the different water bodies. An extensive network of monitoring station has been established and the part of it lying within the Nile Delta region is shown in Figure 15.

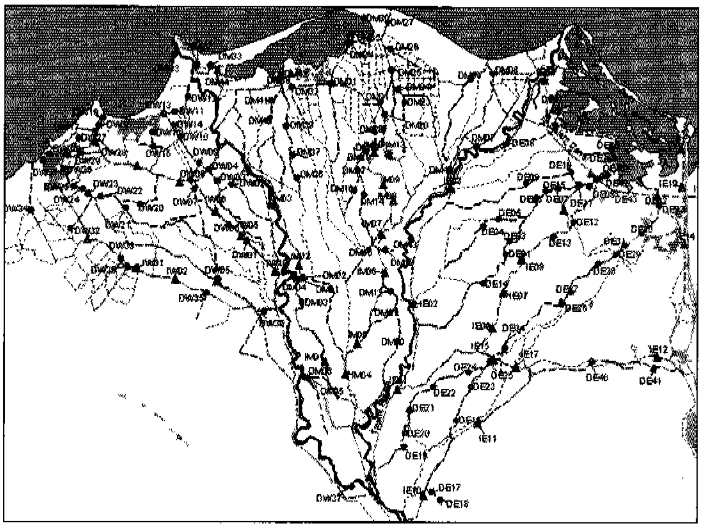


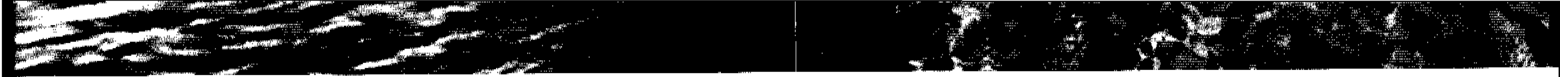
Figure 15. Water quality monitoring sites on the Nile branches, canals and drains in the Delta

Table 3 Drainage Water Flowing to the sea in the three Delta regions during the period 1984/85 - 2000/2001
Q : Drainage water discharge (billion m3 year) / EC : Drainage water salinity (ds/m)

Year	Eastern Delta		Middle Delta		Western Delta		Total flowing to the sea	
	Q	EC	Q	EC	Q	EC	Q	EC
84/85	4,391	2,21	5,013	3,35	4,231	5,76	13,726	3,82
85/86	4,219	235	4,883	3,71	4,339	5,02	13,442	3,71
86/87	3,815	2,43	4,900	3,72	3,955	4,72	12,670	3,65
87/88	3,513	2,64	4,291	3,96	4,030	5,65	11,835	4,14
88/89	3,181	2,76	4,142	3,88	4,168	6,00	11,491	4,34
89/90	3,651	2,85	4,159	3,99	4,574	5,75	12,384	4,31
90/91	3,726	2,72	4,032	4,06	5,116	6,24	12,873	5,54
91/92	3,795	2,40	4,092	4,22	5,118	5,46	13,005	4,18
92/93	4,094	2,45	3,740	4,09	4,312	3,97	12,146	3,49
93/94	4,129	2,71	3,632	4,32	4,613	5,50	12,463	4,21
94/95	3,829	3,26	3,966	4,18	4,252	5,68	12,047	4,42
95/96	3,790	3,20	4,127	4,16	4,491	5,67	12,408	4,41
96/97	7,891	3,26	4,506	4,24	4,044	5,87	12,441	4,46
97/98	3,813	3,27	5,054	4,14	4,343	7,38	13,211	4,95
98/99	4,146	3,06	6,198	3,45	3,944	6,22	14,289	4,10
99/00	4,133	2,71	6,167	3,51	4,996	5,07	15,295	3,80
00/01	4,130	2,49	5,476	3,41	4,467	5,18	14,073	3,70

Table 4 Reuse of drainage water in the Nile Delta During 1984/2000

Year	Eastern Delta		Middle Delta		Western Delta		Total reuse	
	Q	EC	Q	EC	Q	EC	Q	EC
84/85	1300,50	1,28	763,47	1,29	814,08	1,53	2878,05	1,36
85/86	1262,84	1,30	474,64	1,21	788,49	1,51	2798,97	1,33
86/87	1419,75	1,34	766,43	1,24	806,77	1,53	2992,95	1,36
87/88	1381,12	1,44	692,60	1,41	628,90	1,49	2702,62	1,44
88/89	1400,02	1,53	704,03	1,46	554,67	1,62	2658,72	1,53
89/90	1503,65	1,57	1505,92	2,24	62,53	1,49	3635,00	1,83
90/91	1584,88	1,59	1999,17	1,70	639,03	1,57	4223,07	1,64
91/92	144,59	1,46	2057,66	1,80	617,45	1,46	4119,70	1,63
92/93	1460,37	1,41	1841,15	1,69	560,72	1,28	3862,24	1,52
93/94	1120,04	1,58	1691,22	1,76	586,45	1,12	3397,71	1,59
94/95	1389,74	1,64	1842,65	1,86	684,53	1,24	3916,92	1,67
95/96	1745,88	1,89	1814,59	1,79	705,86	1,42	4266,32	1,77
96/97	1843,21	1,94	1947,86	1,85	642,48	1,31	4433,56	1,81
97/98	1736,34	1,66	1801,32	1,77	632,41	1,35	4170,06	1,66
98/99	2126,90	1,48	2168,30	1,52	738,27	107	5033,47	1,43
99/00	1661,80	1,64	1891,41	1,64	1183,61	1,97	4736,82	1,72



Strengthening of the Water Quality Management Unit

During the eighties, water resource management was mainly concerned with quantitative water management and salinity control, the latter in respect to the planned re-use of drainage water for irrigation purposes. In the early nineties, it was realized that the quality of water in the surface water bodies and some shallow groundwater aquifers was rapidly declining, due to the rapid urbanization and industrialization, increased use of agrochemicals and pesticides in agriculture, and absence of a coordinated approach for prevention and treatment of wastes and wastewaters polluting these systems. Health hazards and increased environmental concerns have called for an active policy in the field of water quality management.

In satisfying the growing users' demands for sufficient and good quality water, MWRI is increasingly confronted with crucial water quality aspects. There was an increasing need to develop an active policy for prevention and control of pollution, in view of the deteriorating water quality and its impact on human health and environment. Both the growing water demands and increased pollution threat are a direct consequence of rapidly growing population, socio-economic development leading to increased urbanization and industrialization, and a further expansion of the cultivated and inhabited area outside the Nile Valley and Delta.

Recently MWRI has adopted a strategy towards integrated and partly decentralized water resources management in cooperation with stakeholders. Therefore, water resources management aspects of water quantity and quality for surface and groundwater resources are integrated into one national water management policy and strategy through the establishment of the Water Quality Management Unit (WQMU).

The unit will contribute to the development and implementation of a national policy and approach of water quality management and pollution control in order to protect the countries vital water resources and to halt/reverse the deteriorating water quality situation build up during the last decades.

The unit's major objective is to set up a sustainable institutional capacity for water quality management within MWRI, which is involved in policy preparation, outlining strategies and action planning in close cooperation with ministries/agencies and other stakeholders. WQMU will assist in the following activities:

- **Standardizing and institutionalizing** the monitoring of water quality and pollution data, very close to different sectors and organizations within MWRI;
- **Repairing and updating the legislation issues**, criteria and standards for various water uses and functions.
- **Finding and proposing mechanisms** for water quality protection (at national and regional level) together with stakeholders;
- **Coordinating arrangements with other departments** and sectors to carry out joint activities;
- **Increasing public awareness for the need of protection** of water resources and prevention/control of pollution with planners, water management engineers, decision makers and the public (opinion leaders);
- **Testing in two pilot areas strategies** of water quality management;
- **Providing training programs** for the staff with management, communication and technical skills to implement water quality management at a full scale in the Ministry. ■

Fourth challenge : shared water resources

Support at the international level will be given to the regional initiatives on international river basins that emerge in response to the challenge of the ministerial declaration on sharing trans-boundary water resources.

This challenge is to promote peaceful cooperation and develop synergies between different uses of water at all levels through sustainable river basin management approach. These issues present a significant political challenge. Addressing these issues not only requires political will, but also technical solutions. One of the fundamental solutions to meet this challenge is to develop, strengthen and enforce agreements as appropriate, on bilateral, basin wide, regional or global. Building the trust between basin countries is another key issue to meet this challenge. Sharing information, improve understanding of common water resources, and technical cooperation could promote confidence between the basin countries.

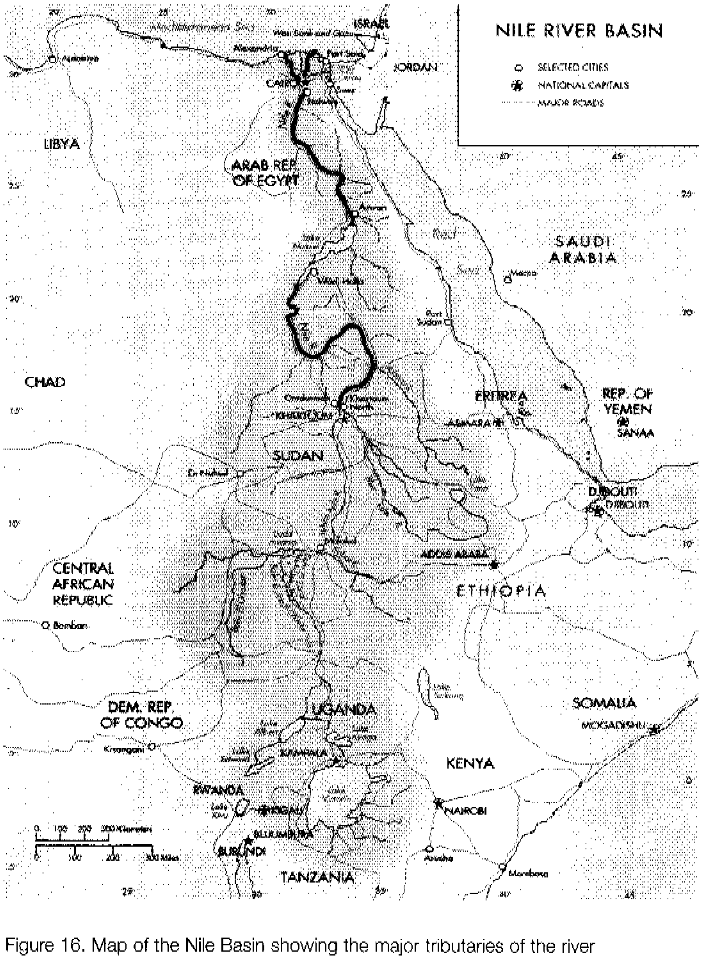


Figure 16. Map of the Nile Basin showing the major tributaries of the river

The Nile Basin Initiative

The Nile River is shared by ten African countries: Burundi, Democratic Republic of Congo (DRC), Egypt, Eritrea, Ethiopia, Kenya, Rwanda, Sudan, Tanzania, and Uganda (shown in Figure 16). The river serves as home to world-class environmental assets, such as Lake Victoria (the second largest fresh water body, by area, in the world) and the vast wetlands of the Sudd region. It also serves as home to an estimated 160 million people within the boundaries of the Basin, while about twice that number -roughly 300 million- live within the ten countries that share and depend on Nile waters.
Despite the extraordinary natural endowments and rich cultural history of the Nile Basin, its people face considerable challenges. Today, the Basin is characterized by poverty, instability, rapid population growth, and environmental degradation. Four of the Nile riparian countries are among the world's ten poorest, with per capita incomes in the range of USD 100-200 per year. Population is expected to double within the next 25 years, placing additional strain on scarce water and other natural resources. Yet the Nile holds significant opportunities for 'win-win' development that could enhance food production, energy availability, transportation, industrial development, environmental conservation, and other related development activities in the region.
The future will bring opportunities as well as serious challenges. One of which is climate change. The 1995 report of the Intergovernmental Panel on Climate Change came to the conclusion that, as a result of man's interventions in the biosphere, the climate of the earth will change considerably over the next 100 years, with important consequences for man. The consequences of these climatic changes will be felt through impacts on human health, agriculture, forests, coastal zones and species and natural areas. Intimately linked to all of the above will be changes in the distribution and quality of the earth's water resources.

Evolution of Cooperation in the Nile Basin

Cooperation started in the form of bilateral agreements since the beginning of this century. However, countries of the Nile Basin have been engaged in regional cooperative activities over the past thirty years. One of the early regional projects in the Nile Basin was Hydromet, which was launched in 1967, with the support of UNDP. It was followed by the Technical Cooperation Committee for the Promotion of the Development and Environmental Protection of the Nile Basin (TECCONILE) started by 1993, which was formed in an effort to focus on a development agenda. Also in 1993, the first in a series of ten Nile 2002 Conferences commenced with the support of CIDA. In 1998, recognizing that cooperative development holds the greatest prospects of bringing mutual benefits to the region, all riparian countries, except Eritrea, joined in a dialogue to create a regional partnership to facilitate the common pursuit of sustainable development and management of Nile waters.
The transitional mechanism was officially launched in February 1999 in Dar Es-salaam, Tanzania by the Council of Ministers of Water Affairs of the Nile Basin States under the title of Nile Basin Initiative (NBI).

NBI Vision and Actions

The shared vision of the Nile Basin Initiative (NBI) is: "To achieve sustainable socio-economic development through the equitable utilization of and benefit from, the common Nile Basin water resources". To translate the Shared Vision into action, the riparian has developed a Strategic Action Program that focuses on two complementary ideas 1) a shared vision and 2) an action on the ground. The ideas are mutually reinforcing. A common vision provides a framework for activities on the ground and, in turn, these activities realize the vision. These ideas are being translated into actions through two complementary programs: (i) a basin-wide Shared Vision Program (SVP) to create an 'enabling environment' for cooperative action through building trust and skill, and (ii) Subsidiary Action Programs (SAP) to plan and implement investments and activities 'on the ground' at the lowest appropriate level, taking into account the benefits from, and impacts of, these activities in all riparian countries.

The International Consortium for Cooperation on the Nile

The first meeting of the International Consortium for Cooperation on the Nile (ICCON), took place from June 26-28, 2001, in Geneva, Switzerland, to celebrate cooperation between the ten countries of the Nile Basin and to establish partnerships that will lead to sustainable development and management of the Nile River for the benefit of all. The ICCON 1st meeting was a major milestone for the Nile Basin Initiative. The meeting, for the first time, brought together Ministers and senior officials from Nile Basin countries with broad range of bilateral and multilateral donors and other interested parties, such as civil society , professional organizations, media and NGOs. The meeting also offered an avenue for raising and coordinating funding from a variety of sources. As a first step, around 140 Million US Dollars were raised to support both programs of SVP and SAP for the Basin. ■

Fifth challenge : managing risks

The discussions at the Second World Water Forum provided an increasing exposure to the management of risks resulting from climate change and climate variability. The challenge is to provide security from floods, droughts, pollution and other water-related hazards. The hazards of natural origin cannot be prevented and in most cases there is no 100% protection. Prevention measures are the key to reduce risks and are far more cost-effective than post-disaster responses.

MWRI through modifications and improvements in its organizational structure has established new entities to assist in the development and implementation of the different measures to manage risks and reduce its negative impacts whether they are social or economic impacts.

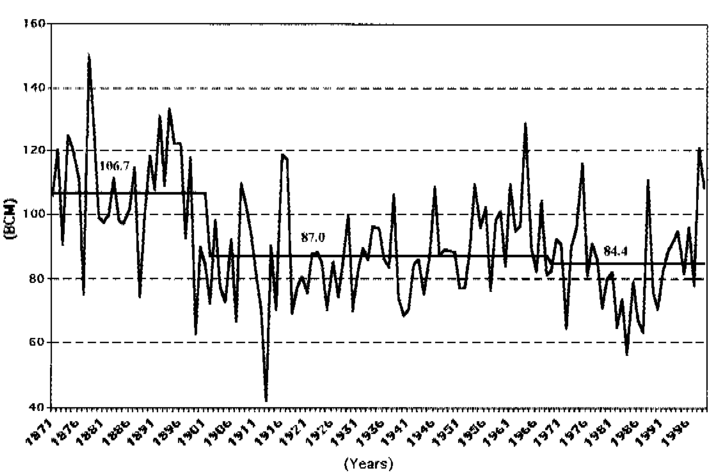


Figure 17. Nile River natural inflows at Aswan during the period 1871-2000
Source: The Planning Sector, MWRI

Lake Nasser Flood and Drought Control Project

Egypt is situated in the arid belt in Northeast Africa and is extremely dependent on the Nile for its water needs and security. There are increasing indications worldwide about possible climate change with wide ranging effects on the environment, societies and economy and to which human activities have contributed considerably (CO_2, greenhouse effect). One of its implications is that rising sea levels could directly threaten the Nile Delta in Egypt, a situation that is exacerbated by great uncertainty about the effects of changing inflows (quantity and quality) from the Nile. Figure 17 exhibits the variations in the natural annual inflow at Aswan during the period 1871 – 2000. The figure demonstrates the decreasing trend in the annual inflow average from 106.7 bcm during the period 1871-1900 to 87.0 bcm from the beginning of the century till the start of operation of HAD when the average annual flow was determined by 84.4 bcm.

The vital element for Egypt's Nile water security is provided by the water supply and adequate management of the storage of HAD reservoir (Lake Nasser). Over the past three years water levels in Lake Nasser have been high, caused by a sequence of wet years and limited use of water in Sudan.

The discharges through the Nile have been low since the HAD has been put into operation and the construction of physical infrastructures built in the flood plain is based on that condition. Higher discharges may lead to flood damages such as damage to constructions, existing land use, degradation of riverbeds, instability of riverbanks and threats to human settlements. In turn, reduced inflows and drought will directly affect drinking water supply and food production, as well as threaten human population downstream. Risk assessment then becomes important to anticipate such threats. Mitigation of such risks can be proposed by setting up different scenarios for the operation of HAD and its spillways in combination with scenarios external to HAD operations. Figure 18 demonstrates the previous relationship between the lake elevations and the operating policies represented by the DAH releases.

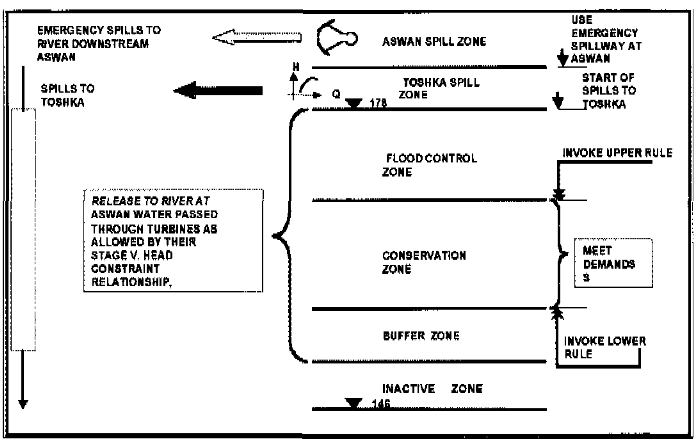


Figure 18. HAD reservoir elevation and storage zones in relation to the release policies

There has been several efforts to determine the optimal reservoir release policies in relation to reservoir inflows and storage levels. Many of these efforts dealt with the HAD reservoir only. However, Figure 19 presents a logical framework for the system operation. The figure shows the three main components of supply, demand and control (operating rules).

Figure 19. Elements of the Aswan Complex to determine the optimal operating policies for the reservoir

Supply	Control	Demand
Main sources Equatorial lakes Ethiopian plateau	**Aswan Complex** Lake Nasser High Aswan Dam (HAD) Pond of 6 km. bet. HAD and LAD Low Aswan Dam (LAD)	**Consumption** Agriculture Municipalities Industry Navigation

Climate change effects and instability of its foremost natural resource base will put a great strain on Egypt's development perspectives at long term. As the Egyptian society and economy vitally depend on the Nile, there is an urgent need to integrate uncertainties of future climate change into its water policy, planning and operation, and set it within the condition and dynamics of the Nile Basin as a whole. This would in turn include risk assessment and mitigation from an integrated perspective.

One aspect of climate change is the impact on sea level rise. Several climatological studies expected a sea level rise that could submerge a considerable part of the Egyptian Delta resulting in a great loss to the Egyptian economy.

Egypt is currently undertaking large land reclamation projects to meet the escalating demands for food and to help redistribute the crowded population away from the Nile Valley and Delta. Thus, losing any part of the old fertile land would cause Egypt to reclaim more lands to compensate for such loss, which may be beyond the economic capability of the country. In addition, more resettlement programs will be required which is not an easy option. However, no accurate assessment exists of the environmental, social, and economic impacts of such change on Egypt.

The foreseen climate change would also affect Egypt in another way by changing the Nile inflow to Lake Nasser in quantity as well as in quality. Although some studies have indicated a positive effect of such climate change with respect to the quantity of Nile inflow (Strzepek at al., 1996), there is great uncertainty of quantity and quality shifts. Even such increase in inflow will require preparation as the outflows downstream HAD will have to be increased. As the Egyptian economy relies heavily on Nile water resources, there is an urgent need to integrate the uncertainties of future climate change into water policy in order to be able to adapt to changes more easily.

This calls for a planning and forecasting system that integrates future Nile River basin flows and sea level rise for this century on the basis of the state-of-the-art climate based information. Such a system with its scenarios will assist decision-making by the Egyptian Government to sustainable development alternatives for long term. It will also serve as a base for anticipating and defining disaster management scenarios. Despite the increased number of studies about global warming impacts, very few studies exist that assess these impacts on developing countries and the measures to be taken.
The project is a research project of which the general objective is to determine scenarios, assess risks and identify mitigation measures due to variations in the Nile River regime and climate leading to floods, droughts and land use changes in the Nile Basin (upstream and downstream HAD) and to integrate its findings in Egypt's national water strategy, planning and operations.
The prime objective is to enhance the existing facilities within the Nile Forecast Center (NFC) to aid MWRI in setting scenarios for risk assessment due to floods, droughts and climate change.

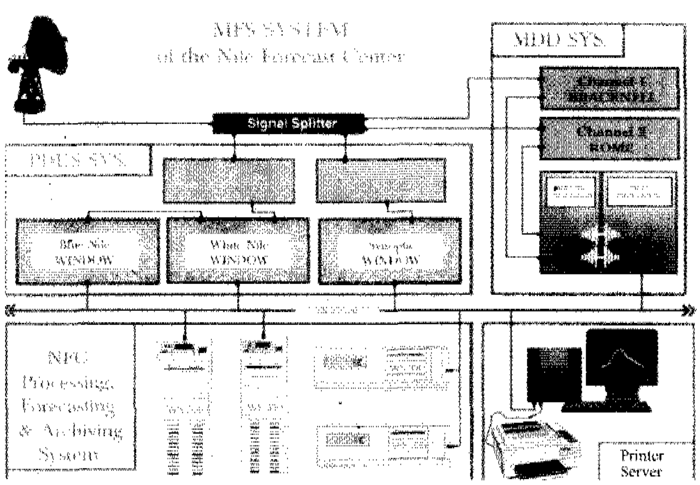


Figure 20 : MFS system of the Nile Forecast Center

Flash Flood Early Warning System

The Water resources Development Institute (WRDI) with assistance of the Main Systems Management project in MWRI initiated a joint project to establish an early warning system for the flash floods using the modern technologies of telecommunication. The system was applied in Sinai Peninsula where a number of water level sensors were installed on the major stream flows on the flood plains in Sinai. These sensors were linked via VHF communication system to a central monitoring room in the WRDI. The sensors detect any water flow that may run in the flood plain streams and transfer these data to the central room. The room is equipped with simulation models and GIS systems to simulate the water flow along the catchment's area and predict the expected water hydrographs and calculate the expected volume of water and maximum water velocities at the major bottlenecks along the flood plain. The system also draws a risk map for the vulnerable areas along the flood plain.

Preventive Maintenance Project

The Preventive Maintenance Project aimed at replacing old and non-functional small and medium sized structures in the irrigation system; intake and head regulators, weirs, tail-escapes, spillways, bridges, and crossing structures on branch and distributary canals. It also aimed at improving the quality of construction to assure that the replacement structures were built according to MWRI specifications. Executive equipment and workshop facilities have been established in six governorates where the project was implemented. The project covered more than 20,000 irrigation structures. Rehabilitation of these structures yielded better operation and control over the water distribution process (Abu-Zeid et al., 1996). Figure 21 shows two examples of channel maintenance activities.■

Figure 21. Examples of activities in relation to channel maintenance project

Sixth challenge : valuing the water

The challenge is to manage water in a way that reflects its economic, social, environmental and cultural values for all its uses. Water should be treated as a basic human right but it should not be provided free of charge. A balance should be struck between pricing of water as commodity and the cost of providing it in a good quality and sufficient quantity. Growing recurrent costs for O&M of irrigation services and facilities are creating huge budgetary demands in Egypt. In addition, public irrigation is heavily subsidized and has become an enormous fiscal drain. In 1995, the public subsidy to irrigation services was almost LE 670 Million. Greater emphasis is now put on cost recovery mechanisms whereby the resources for O&M, minimally, must come from the direct beneficiaries, the water users.

Cost Recovery of Irrigation System

A package of demand-oriented measures have been prepared and applied to the Egyptian agricultural sector under the Irrigation Improvement Project (IIP). Water users' associations that were established under the IIP project serve as an excellent example of the effect of user involvement and cooperation on the system management. Although all the users here are farmers who belong to the same economic sector, it is the concept of stakeholder involvement in decision making during the various stages of planning and implementation, which is emphasized. When the user is involved from an early stage, it is evident that he will accept the proposed improvements and will be able to operate and maintain them easily afterwards. Moreover, they resolve conflicts between themselves automatically as they have to share a common resource.

In order to achieve the user involvement objective, a department for water advisory service was established under the irrigation improvement sector. One of the main functions of this department is to help in the transfer of the management of the mesqa to farmers and help them resolve conflicts and problems.

The success of the IIP project in forming water users' associations forced the parliament to issue a legislation of such associations in which it was defined as private organizations owned and operated by its members of the water users of the water course for their own benefit, and work in the field of water use and distribution and all the related organizational activities for the purpose of raising the agricultural productivity.

Repayment of the full capital cost of improved mesqa, excluding interest, over a period not more than twenty years and establish a special fund within the MWRI to finance future mesqa improvement beside recoveries from farmers, the fund would be financed from budgetary transfers and foreign grants and loans.

The payment for mesqa investment expressed as a proportion of incremental income attributed to irrigation improvements varies between 15-25%. This shows the ability of beneficiaries to pay, it also shows there is strong incentive for farmers to participate in the irrigation improvement program.

Subsurface Drainage Cost Recovery

Irrigated agriculture represents 98% of the Egyptian agriculture. Typical adverse impacts of perennial irrigation are soil salinity and water logging.

Egypt in 1970 launched a large-scale drainage program. The program was planned to cover the entire old agricultural land in the Nile Delta and Valley. After finishing the installation of the national drainage system, EPADP will continue to operate and maintain it in addition to rehabilitation and replacement of the old drainage systems. Egypt's drainage program is considered to be one of the largest, if not the largest drainage program in the world. It has been extremely successful preserving Egypt's soil and allowing for high crop production. An increase in crop yield by more than 20% due to installation of the drainage system has encouraged farmers to participate in the program and pay for it.

A similar approach of recovery the investment costs for mesqa in IIP is followed in the case of subsurface drainage investments, which have been made over more than five million feddans during the last 30 years.

Cost Recovery in the New Lands

In the new lands, farmers are also responsible for investment costs for all infrastructures including downstream of the booster pumps that draw from distributary canals, serving areas in the order of 100-200 feddans. Such investment may either be undertaken independently at farmers expense or by government with cost recovery according to the rules set out above.

Thus, the policy of the government with respect to capital cost recovery is to recover no charges above the delivery point (mesqa head in the old land, booster pump in the new land) and a proportion of the investment costs below the delivery point. Thus, the subsidy on capital investments is in the order of 80 to 90%. The existing policy for capital cost recovery should be reviewed in the light of the very high subsidy resulting from present procedures.

Cost Recovery for Operation and Maintenance

Operation and maintenance (O&M) costs are the responsibility of farmers below the delivery point. Failure to fulfill this obligation results in the work being undertaken by MWRI and charged to the farmers on average general, farmers pay L.E. 18 per feddan per year for mesqa maintenance in the old lands, either to the government or as a contribution of labor cost recovery for O&M above the mesqa from farmers has been through land tax.

Farmers in Egypt today pay very little in taxes relative to their incomes. Under the present system, as agricultural incomes rise in response to liberalized market conditions, tax revenues do not automatically follow. Farmers with 3 feddans or less of land and who have no other source of income are exempt from land tax and additional taxes attached to agricultural land tax. In all cases, these exemptions do not apply if taxpayer has other sources of family income. However to obtain an exemption, farmers must apply to their local authorities each year and go through an enormous bureaucratic process, as a result most farmers seem to pay their land tax whatever the size of their holding. Settlers on new lands, being newly graduates, farmer landless peasants, or investors, are given a grace period of ten years before they are subject to any taxes. Total land tax collections for year 2000 came to LE 133 million at an average of 20 LE/feddan/year. In addition most farmers pay an additional 15 % of the land tax to their local administrative authorities. Other taxes paid by farmers in addition to land tax for other local services, fees, stamp duties, etc. The average payment is about 15 LE/feddan/year.

Most farmers pay land tax based on a valuation done in the late 1980's. This tax ranges from less than 10 L.E/feddan to no more than 35 LE/feddan in no case does it seems an excessive burden on the farmers. The government has frozen the land tax for five years at its current rates as a measure to palliate the impact of the implementation of the new land law which took effect on 1 October 1997. Farmers are aware of this and appreciate it.

Cost Recovery on Mega Projects

The Egyptian government has started the development of three mega projects (North Sinai, Toshka and North-west Delta). These projects will mostly attract investors although some parts are set-aside for graduates. Privatization is introduced from the start and thus already included in the planning process of these projects. GOE sets up holding companies to invest in the main system to provide water to the main gate of a lower level on the basis of cost recovery.

GOE has set a maximum level of cost recovery. This concept is already issued by presidential decree. From the main gate onwards, private parties take over the development and O&M including investments in the water system infrastructure. In areas with relatively small landowners, water boards are set up at branch and district level. ■

Seventh challenge : governing water wisely

The challenge was brought by the World Water Vision to ensure good governance, so that the involvement of the public and the interests of all stockholders are included in the management of water resources. Transparent and flexible national laws are a prerequisite for integrated water resources management policy development. Better coordination and institutional strengthening is highly needed to overcome fragmented responsibilities in the field of integrated water resources management. More involvement of women in water management as important stockholders will also be needed.

Despite country specific variations, the institutional changes observed at the international level evince certain common trends and patterns. With globalization and an increasing integration of the world economic system, countries began to realize that learning from mutual experiences is an important means for improving their mutual performance in various areas including water management (Saleth and Dinar, 1999). Water institution falls in the domain intersected by economics, law, and public policy, and is strongly influenced by resources endowment, demography, and science and technology (Saleth and Dinar, 1999). The key issue is no longer resource development and water quantity but rather resource allocation and water quality. The old development paradigm centered on centralized decision making, administrative regulation, and bureaucratic allocation is fading fast to pave way for a new paradigm rooted in decentralized allocation, economic instruments, and stakeholder participation. The main concern in the water sector is the inherent limitations of the existing institutions in dealing effectively with the new set of problems that are not related to resource development but to resource allocation and management. The water administration and water sector decision process have to accommodate now an increasing role of users organizations and non-governmental agencies, as well as to identify the ways in which information technologies can be gainfully utilized in resolving water problems.

Institutional Reform Unit (IRU)

MWRI proposes to set-up an Institutional Reform Unit to carry out and co-ordinate decentralization and privatization activities. This Unit should become the driving force for institutional reform. The main task of IRU will be to provide further detail of the Vision for Future Water Management and to initiate and monitor its implementation, with due involvement of the various water stakeholders :

- **In old lands :** establishment of Water Boards
- **In old new lands :** establishment of Water Boards and various modes of public-private partnership
- **In the new lands and the mega projects :** various modes of public-private partnership
- **Privatization of some parts of MWRI** (e.g. factories) into enterprises (asset sale).

The output of the Unit includes :

- A detailed vision, strategy, and work plan for reform of the Water Sector
- An assessment of the prospects for public-private partnerships in relation to policy goals of the government (MWRI) and the private sector
- Execution through third parties of studies and researches for preparation of privatization actions.
- Review current legislation and propose changes
- A priority-list of both public-private partnerships and enterprises to be privatized.
- Preparation of ToRs for privatization and decentralization activities according the vision. The ToRs include the approved decentralization and privatization models and related transfer processes.

These outputs are a mixture of policy development and execution.

During a detailed appraisal of the establishment of IRU, an assessment should be made whether these elements should be combined in one Unit or undertaken by two Units. The proposed characteristics of IRU :

- IRU is directly attached high in the Ministry.

- IRU should work in close co-operation with related Departments and Sectors of MWRI.

- IRU will be steered by a Reform Steering Committee that should function as a "Board of Change". This Steering Committee should include persons from MWRI and from outside the MWRI (from Government-side and private sector site).
- IRU should co-operate with other concerned Ministries (such as Ministry of Finance, Ministry of Economic Affairs, Ministry of Agriculture and Land Reclamation, Ministry of Industry, Ministry of Planning, etc.)
- The staff of IRU is drawn from diverse backgrounds as water, finance, economy and law. IRU will be a small Unit with several members coming from the related Departments and Sectors.
- IRU should analyze and take advantage of the lessons learned from previous experiences (both national and international).
- IRU will set up working committees with members from other Sectors and Department and the private sector. Consultants will assist the working committees and IRU on specific assignments.
- IRU should not duplicate the work of other committees such as the User Participation Committee but work in close co-operation with these committees.

Figure 22 presents the general organizational structure of MWRI including most of the new entities established.

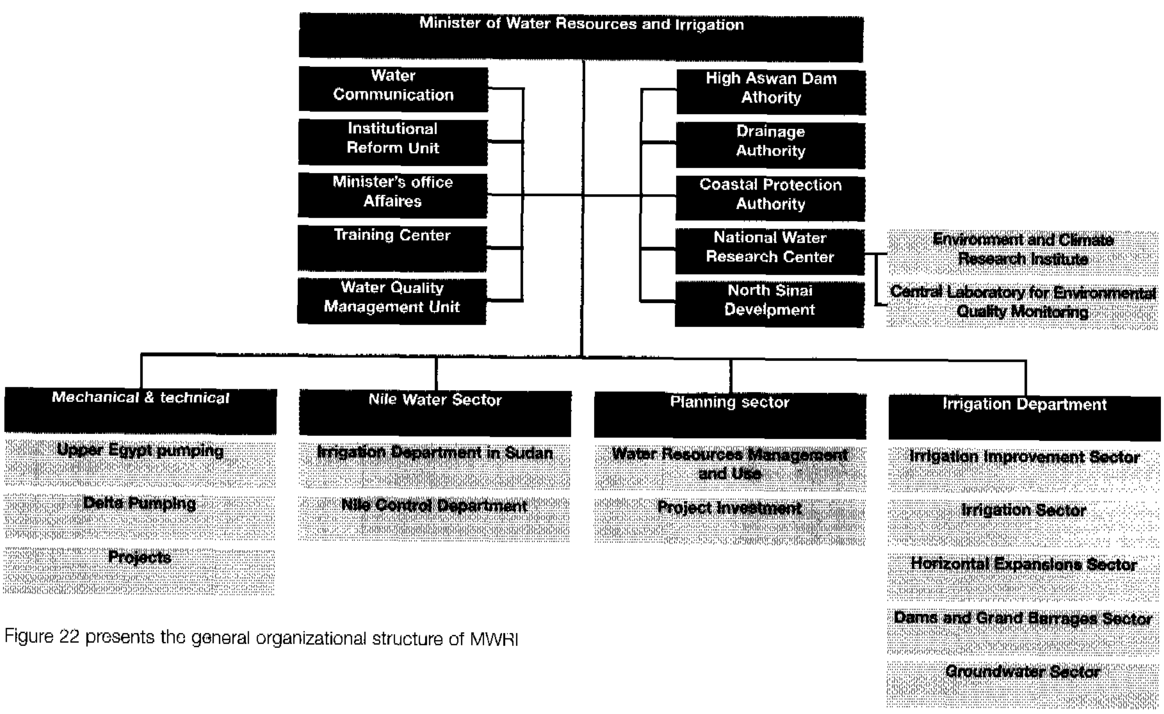


Figure 22 presents the general organizational structure of MWRI

Shift From Resource Management to Demand Management

One of the fundamentals of integrated water resources management is the involvement of all stakeholders as much as possible in the various management activities. As water is essential to all forms of life and prosperity, competition for water among users is already escalating as growing needs outstrip the limited resources. The objective should be to transform the competition between stakeholders into a form of cooperation that achieves the largest overall revenue with the least sectoral harm.

MWRI can no longer singly assess the resource, match supply to projected demand and finance, design, build and operate water resources systems. Decisions must be made on the best use of water by evaluating the economic, social and environmental costs and benefits of alternatives. As a prerequisite, these alternatives should be first considered fair when negotiated with stakeholders, who are continuously kept well informed about opportunities, limitations and viable trade-offs, including quality considerations. Accordingly, it is important to build a good partnership between water managers and a well-informed public as conflicts increase. Beyond the expectation of optimized benefits, this collaborative approach to water resources development is also considered to be more acceptable to the public.

Fortunately, the demands of most sectors are not absolute, but amenable to management, which should aim at optimizing the return from various allocations under the expected conditions of scarcity. In this respect, non-engineering demand-oriented measures, such as intersectoral collaboration, building public awareness and economic incentives will have an important role in order to match demand with available supply.

Demand-oriented approach looks at the real demand for water and tries to urge the users to make better use of water. This can be achieved by creating awareness among the users that the resource is precious; for example by letting them pay for it, or pay the costs to treat and deliver it.

Groundwater Sector

The Groundwater Sector is established within MWRI to be responsible for all activities related to groundwater resources in the renewable aquifer in the Nile Valley and Delta as well as the aquifers in the Eastern and Western Deserts and Sinai. The Sector is in charge of granting permissions for new wells after necessary studies are conducted. It is also in charge of analyzing data and information related to sustainable yield of each well in addition to acquiring and keeping water quality data.

Irrigation Improvement Sector (IIS)

It should be noted that the Nile irrigation system has tremendous physical, economic, social, and political momentum along its evolutionary path. Egypt's irrigation delivery system consists of 31,000 km of public canals, 16,700 km of private mesqas (irrigation ditches) and farm drains, 560 large pump stations, and more than 22,000 water control structures (Saad and Farid, 1996). In such a closed water system of conjunctive resources, improving the use efficiency in part of the system is expected to improve the overall efficiency as it changes the amount of water available for all users.

The Irrigation Improvement Project (IIP) is one of the large scale projects that advances the Egyptian irrigation system in the 21st century. It is the aftermath of a long term field and research experiments during the period 1978-1984. The main goal of the project was to improve the overall system efficiency through a set of technical, economic, environmental and social measures applied at the field level. The project was based on a detailed feasibility study conducted by a multidisciplinary team. Under the policy direction of demand management, the project adopted several structural and non-structural measures to improve the traditional surface irrigation (Abu-Zeid, 1997). IIP comprises improving control structures, using modern methods in land leveling/tillage, on-farm development, and rehabilitation of main and branch canals in addition to most mesqas, promoting equity of water distribution, and attaining a form of cooperation between the irrigation directorate and farmers, by forming WUAs.

The success of IIP resulted in the establishment of the Irrigation Improvement Sector on a large scale in the old agricultural areas in Egypt. The Irrigation Improvement Sector (IIS) is an example of a new entity within MWRI. IIS, through the implementation of elevated or piped mesqas, gives the farmers better, more reliable, and lower operational cost access to water. However, it is not expected that the project in the large scale will result in great water saving as had been expected. It induces farmers to increase evaporative consumption of water in improved areas by providing water short areas, at the tail ends of the mesqas, with more adequate supplies so that they can become more productive. Yet, there are many other impacts of the 1IP on both local and national levels such as cost sharing and farmers' participation in the water management process. Despite the fact that IIP has a limited impact on the overall water use efficiency, it has various other benefits in the command areas where it has been applied among which are:

- Increasing water distribution efficiency in most command areas as well as attaining equity of water distribution among all the farmers on the mesqa eliminating the tail-end problem.
- Reducing time and operational as well as maintenance costs required by reducing the number of working pumps on the mesqas and using a single-point lifting at the head of each mesqa.
- Transferring the new irrigation technologies to the farmers through Irrigation Advisory Services of MWRI.
- Initiating new spirit of cooperation among farmers with the introduction of WUAs to allow farmers schedule irrigation among themselves.

Water Users Associations (WUAs)

Water administration and water sector decision process have to accommodate an increasing role of user organizations, non-governmental agencies, and women, environmental and other self-help groups as well as to explore the ways in which emerging water and information technologies can be gainfully utilized. MWRI has adopted a policy to increase stakeholders' participation in water management and operation of the irrigation system through the formation of Water Users Associations (WUAs) that were also experimented within IIP. WUAs serve as an excellent example of the effect of users' involvement and cooperation in the system management. Although all the users here are farmers who belong to the same economic sector, it is the concept of stakeholders' involvement in decision making during the various stages of planning and implementation, which is emphasized. Moreover, farmers have better chance for resolving conflicts among themselves automatically as they have to share a common resource.
The main functions of WUAs include participation in planning, design, operation, and maintenance of improved mesqas, identification of roles and responsibilities of mesqa heads and setting up rules to resolve conflicts, establishment of linkages for coordination with other agriculture and irrigation concerned agencies as well as with other water users' associations. WUAs also help in the development of financial resources of the association in order to improve operation and maintenance.
The success of IIP in forming WUAs forced the parliament to issue a legislation of such associations in which it was defined as private organizations owned and operated by its members (users of the water course) for their own benefit, and work in the field of water use and distribution and all the related organizational activities for the purpose of raising the agricultural productivity (Attia and El-Shamy, 1998).

Irrigation Advisory Service (IAS)

In order to achieve the user involvement objective, a department for Irrigation Advisory Service (IAS) was established under IIS. This department aims at coordinating between farmers and irrigation operators for the setup of WUAs as well as helping farmers in all stages of planning, design, construction, operation, and maintenance of the improved mesqas. It also provides farmers with information about water distribution, helps transfer management procedures of the mesqas to farmers, and helps them implement new technologies such as laser leveling of fields, and new water distribution gates. It encourages farmers to develop better links with agricultural production agencies such as the agricultural extension service, agricultural investment bank, agricultural cooperatives, irrigation and drainage districts, pump maintenance companies, and local authorities.

The Water Boards Project

At the branch canal level, under the Dutch Government aided program to Egypt, the Water Boards project has been formulated to develop an approach, which has a general validity to the diverse irrigation and drainage system in Egypt. The Fayoum Water Management Project's initiative to establish experimental "local Water Boards" at the Secondary Canal was quite successful and between 1995 and 1998 a total of 10 "local Water Boards" were established. Eight of these follow a "joint management" model, whereby users and Ministry staff (District Engineers) form the Board. These are established by Decree of the Under-Secretary of State for Fayoum of MWRI. For the two remaining, the Board consists of users only and is formed under law 32/1964 on Private Organizations and Unions.
The positive outcome of this experiment first lead to the formulation of a project to expand the experiment beyond the Fayoum (the Water Boards Project) and second in expansion of the experiment to the level above the Secondary Canal during the third phase of the Fayoum Water Management Project.
The Water Boards Project was formulated to develop a viable national policy and legal framework for Water Board development. This is a clear indication that the Government of Egypt has decided that for the future the users need to be formally involved in water management. The limited impact of earlier experiments due to the absence of a legal framework for user organizations at secondary level and above has been duly recognized and this was included in the Terms of Reference of the Water Boards Project.
The Water Boards Project will base its recommendations for a national policy for participatory water management at the secondary level on existing experience and the establishment of 8 (eight) additional experimental "Water Boards" spread over the country. This combined experience will form the basis for the formulation recommendations for a national policy and a legal framework for user participation in water management at the secondary level.
The Agricultural Policy Reform Program (APRP) is a broad-based policy reform program involving five GOE ministries (MALR, MWRI, Ministry of Trade and Supply (MOTS), Ministry of Public Enterprise (MPE) and Ministry of International Cooperation. APRP has the goal of developing and implementing policy reform recommendations in support of private enterprise in agriculture and agribusiness. USAID supports the MWRI in five program activities under APRP .
These five activities are :

- Water policy analyses.
- Water policy advisory unit
- Water education and communication
- Nile River monitoring, forecasting and simulation.

APRP has formulated two important benchmarks for the Ministry of Water Resources and Irrigation. One is the Benchmark No.5: Revision of Law 12/1984 on "Irrigation and Drainage", and the other one is Benchmark No.4: on "Irrigation Management Transfer".

These Benchmarks are implemented in MWRI with the assistance of the Environmental Policy and Institutional Strengthening Indefinite Quantity Contract (EPIC). Benchmark No.5 would result in a law that recognizes Water Boards as user organizations for water management at the Secondary Canal level and above. Benchmark No.4 is an experiment to expand the concepts of participation and privatization in the water sector even further.

Parallel to this the Irrigation Improvement Project has embarked on the formation of "Branch Canal Water Users Associations", which are fashioned after the three experimental BCWUAs established under the EPIQ program in 1999. The BCWUAs are established in IIP areas where WUAs have been established and are basically Federations of Water Users Associations.

Water Communications Unit and the Public Awareness Program

The Water Communications Unit is also established within MWRI to initiate general public awareness programs for all water users and introduce saving and conservation programs. It collects information from the different departments and research institutes within MWRI and present it in an easy to understand format for different stakeholders to better manage the system parts within their jurisdiction. It is also in charge of printing and disseminating bulletins and brochures on ways to save water and protect it against different types of pollution. The unit also in cooperation with the Egyptian TV and Radio Union produces programs advising people, especially farmers, on main water issues and concerns. The unit involves staff of public relations and media communications besides irrigation and water resources engineers

The National Water Resources Plan (NWRP) and Stakeholders' Participation

The National Water Resources Plan (NWRP) will have to consider all components of Egypt's water resources system and all functions and water using sectors involved. Therefore, one of the essential elements in developing the plan is to create the necessary coordination mechanisms to develop consensus on the NWRP objectives and implementation among all stakeholders involved in the development and use of Egypt's water resources, both governmental (ministries, regional authorities) and non-governmental (e.g. industry, water users organizations).

The development of a National Water Resources Plan (NWRP) means addressing many aspects of water related issues. Water demand and water pollution are the main aspects within a wide variety of activities of the society. Dealing with these activities can only be effective in good cooperation. Because limitations have to be faced with respect to available resources (both physical and financial resources), not all demands of society can be fulfilled. In that case it is even more important to involve the stakeholders in the process leading to selection of a water management strategy, This involvement should warrant that all relevant interests are taken into account in a balanced way and is intended to create a broad acceptance of the resulting plan, at the end facilitating the implementation.

In the NWRP a distinction is made between different stakeholders based on their level of involvement in water resources planning:

- Stakeholders at Central Government level.

All ministries which have a responsibility with respect to the supply of water of sufficient quality or which have a specific task to represent the interests of different categories of water users. In Egypt this means that in principle some 12- 14 ministries are involved.

- Stakeholders at Regional Government level.

These are the Governorates (26) and in each Governorate the elected Local Council, representing the population, and the Local Unit representing the ministries concerned.

- Public and Private Water Users.

* Agriculture: farmers (sometimes organized in Water Users Associations or Water Boards) and fishermen: irrigation, drainage, desalination, environmental issues;

* Organizations responsible for providing drinking water and sanitation (General Authorities, Economic Authorities and Companies);

* Industry (public and private): water supply, environmental issues;

* Citizens: the public at large: awareness, drinking water and sanitation, leakage prevention.

At the Central Government level the stakeholder involvement in the development of NWRP has been organized through the establishment of a number of committees:

An Advisory or Steering Committee within MWRI chaired by the First Under-Secretary to ensure the embedding of the process within the ministry responsible for development of the plan.

An Inter-Ministerial High Committee, chaired by the Minister of Water Resources and Irrigation. The members of the committee represent the most important ministries involved and are of sufficiently high level to be able to take decisions on water resources planning issues.

An Inter-Ministerial Technical Committee for Water Resources Planning, chaired by the Head of the Planning Sector, MWRI. This committee consists of staff members of the Ministries represented in the High Committee, who are involved in water resources planning activities in their Ministry. This committee should prepare all proposals for the High Committee and be responsible for the actual co-operation between the Ministries.

The Water Policy Reform Project and the Benchmarking Approach

The management of water resources with the escalating population growth rates, a desire for agricultural expansion, and increasing demands on surface water supply put a great pressure on MWRI in order to meet all these growing demands with the available limited water resources. Both MWRI and USAID are cognizant of the need to develop policy reform that will effectively address these and other issues that determine the utilization efficiency, productivity, and protection of water resources in Egypt. Through this project, the Ministry developed a" water resources results policy package" to produce four major results:

- Improved irrigation policy assessment and planning process;
- Improved irrigation system management;
- Improved private sector participation in policy change; and
- Improved capacity to manage the policy process.

A water resources results package has been designed aiming at policy analysis and reforms to improve water use efficiency and productivity by specific objectives as:

- To increase MWRI knowledge and capabilities to analyze and formulate strategies, policies and plans related to integrated water supply augmentation, conservation and utilization, and to the protection of the Nile water quality.
- To improve water allocation and distribution management policies for conserving water while maintaining farm income.
- To recover the capital cost of mesqa improvement, and to establish a policy for the recovery of operation and maintenance costs of the main system.
- To increase users' involvement in system operation and management.
- To introduce a decentralized planning and decision making process at the irrigation district level.

Laws and Legislation Reform

The current applicable Law No. 12/1984 and its supplementary Law No. 213/1994 define the use and management of public and private sector irrigation and drainage system including main canals, feeders and drains. They also provide legal directions for operation and maintenance of public and private waterways and specify arrangements for cost recovery in irrigation and drainage works. Some of the articles of that law are listed in the following Tables (5) through (9).

Table (5) Article 60 of Law48/1982: The fresh water bodies in which it is permitted to discharge treated industrial liquid effluents must remain within the following (quality) standards and specifications:

Parameter	Standards & Specifications (mg/liter unless otherwise noted)
Color	Not to exceed 100 degrees
Total solids	500
Temperature oxygen	50∞ C above normal
PH	Not less than 5
Dissolved oxygen Demand	Within the range 7-8.5
Chemical Oxygen Demand	Not to exceed 6
Organic nitrogen	Not to exceed 10
Ammonia	Not to exceed 1
Oils and grease	Not to exceed 0.5
Total alkalinity	Not to exceed 0.1
Sulphate	Within the range 20-150
Mercury compounds	Not to exceed 200
Iron	Not to exceed 0.001
Manganese	Not to exceed 1
Copper	Not to exceed 0.5
Zinc	Not to exceed 1
Synthetic Detergents	Not to exceed 1
Nitrate	Not more than 45
Fluorides	Not to exceed 0.5
Phenol	Not to exceed 0.02
Arsenic	Not to exceed 0.05
Cadmium	Not to exceed 0.01
Chromium	Not to exceed 0.05
Cyanide	Not to exceed 0.1
Lead	Not to exceed 0.05
Selenium	Not to exceed 0.01

Table (6) Article 61 of Law48/1982: The standards set by the Ministry of Health for permits to discharge treated industrial liquid effluents into the fresh water bodies and groundwater reservoirs are:

Parameter	The maximum limits of constituents in treated industrial liquid effluents discharged to: (mg/liter unless otherwise noted)	
	River Nile from its Southern Egyptian border to the Delta Barrages	Nile branches, main canals, ditches & groundwater reservoirs
Temperature	35o C	35o C
HP	6-9	6-9
Color	No col. substance	No col. substance
Biochemical Oxygen Demand	30	20
Chemical Oxygen Demand (Dichromate)	40	30
Chemical Oxygen Demand (Permanganate)	15	10
Total Dissolved Solids	1200	800
Fixed (Ash of) Diss. Solids	1100	700
Suspended Solids	30	30
Fixed (Ash of) Susp. Solids	20	20
Sulphides	1	1
Oil & grease & resins	5	5
Phosphate (inorganic)	1	1
Nitrate-N	30	30
Phenol	0.002	0.001
Fluorides	0.5	0.5
Residual Chlorine	1	1
Total heavy metals	1	1
this covers:		
*Mercury	0.001	0.001
*Lead	0.05	0.05
*Cadmium	0.01	0.01
*Arsenic	0.05	0.05
*Chromium (hexava-	0.05	0.05
lent)	1	1
*Copper	0.1	0.1
*Nickel	1	1
*Iron	0.05	0.05
Manganese	1	1
Zinc	0.05	0.05
Silver	0.05	0.05
Synthetic Detergents	2500	2500
Total Coliform (MPN/100ml)		

Table (7) Article 62 of Law48/1982: Without violating the rules in Article 60 of this decree, the Ministry of Irrigation can allow discharges to exceed some of the limits set forth in the previous article in some cases where the volume of treated industrial liquid effluent discharged to fresh surface water bodies is not greater than 100 m3 /day. In such cases, the effluent quality must not exceed the limits stated in the following table:

Parameter	Maximum limit to the quality of treated industrial liquid effluent discharged in: (mg/lit unless otherwise noted)	
	River Nile from Aswan to Delta Barrage limits up	Nile branches, main canals, ditches & groundwater reservoirs
Biochemical Oxygen Demand		
Chemical Oxygen Demand	40	30
(Dichromate)		
Chemical Oxygen	60	40
(Permanganate)		
Total Solids	20	15
Fixed Ash of Solids	1500	1000
Suspended Solids	1000	900
Oils & grease & resins	40	30
Nitrate	10	10
Phenol	40	30
	0.005	0.002

Table (8): Article 66 of Law 48/1982: Sewage and industrial liquid effluents, which are licensed to discharge into brackish or saline surface water bodies, must comply with the following standards and specifications:

Parameter	Maximum limit (mg/liter unless otherwise noted)	
	Sewage effluent	Industrial Liquid Effluent
Biochemical Oxygen		
DemandTemperature	35∞ C	35∞ C
PH	6-9	6-9
Biochemical Oxygen Demand	60	60
Chemical Oxygen Demand	80	100
Chemical Oxygen		
(Permanganate)	40	50
Dissolved Oxygen	Not less than 4	-
Oils and grease	10	10
Dissolved Solids	2000	2000
Suspended Solids	50	60
Colored Substances	Free of col. sub.	Free of col. sub.
Sulphides	1	1
Cyanide	-	0.1
Phosphate	-	10
Nitrate	5	40
Fluorides	-	0.5
Phenol	-	0.005
Total heavy metals	1.0	1.0
All pesticides	nil	nil
Total Coliforms (MPN/100ml)	5000	5000

Table 9: Article 68 of Law 48/1982: The brackish or saline surface water bodies into which discharge of treated liquid effluent is permitted must comply with the following standards and specifications:

Parameter	Standards & Specifications (mg/liter unless otherwise noted)
Temperature	Not to exceed 5∞ C above normal average
Dissolved Oxygen	Not less than 4 mg/1 at any time
PH	Within the range 7-8.5
Synthetic Detergents	Not to exceed 0.5 mg/1
Phenol	Not to exceed 0.005
Turbidity	Not to exceed 50 units
Total Dissolved Solids	Not to exceed 650 mg/1
Total Coliforms (MPN/100 ml)	Not to exceed 5000

In light of prevailing and projected water supplies, demographic and ecological conditions in Egypt, the laws are in serious need of reconsideration. Law 12 and its executive regulation have been revised to take into account current Government of Egypt policies on liberalized crop, decentralization, and privatization as well as cost recovery for irrigation systems.

For this purpose, a modified law was enacted to reflect the latest developments, concepts, visions and inputs related to water use management. The modified law was intended to achieve the following objectives:

- Highlight the concept of integrated water management for different sources, types and uses considering the social and economic aspects.
- Develop new water resources.
- Define the responsibilities and authorities of governmental and non-governmental bodies at all central, regional and local levels.
- Encourage water users to participate in water resource management under the supervision of the MWRI. Private companies should be encouraged to assume this function, passing associated costs and expenses on the end users.
- Complete the tile drainage networks so they can reach all the existing farmlands and replace the old ones.
- Expand the use of drainage water for irrigation purposes.
- Expand the use of ground water resource for drinking and irrigation purposes.
- Improve and integrate surface irrigation systems modernizing them on the old lands.
- Continue to conserve the use of irrigation water and apply modern irrigation systems.
- Replace or renovate irrigation and drainage pumps at the end of their life span.

Main features of the revised law 12/1984 on cost recovery

- According to the law, the responsibility to dredge and maintain the private mesqas and drains and preserve their embankment in good conditions lie with the landlords. If the landlords fail to carry out this function, the competent manager may instruct to do so. Failing this the competent administrative department may implement such works and collect the actual costs by administrative ways from landlords in proportion to the land area each of them owns including the damages for each land occupied because of such works.
- MWRI regulates the method of participation by the farmers and water users and makes available the necessary private and government funding for irrigation and drainage-related construction, replacement, rehabilitation, operation and maintenance works.
- MWRI regulates in particular, the formation of corporate water user associations in the old and new lands in respect of private or public irrigation methods. It also regulates the formation of corporate water boards in certain lands of specific geographical borders and public water sources.
- MWRI may entrust to a specialized company or certain water user association or water board the responsibility of constructing, managing, operating and maintaining at the water users cost-parts of the irrigation and drainage networks, groundwater wells, joint reservoirs and dams or systems of improved irrigation and tile drainage.
- The costs of improving the private mesqas and their contents in the old lands are collected after MWRI determines the costs of their construction in accordance with the rules described under article (64) of the draft law.
- The article (64) of the draft law stated that MWRI should make a statement of the costs of erection of the tile field drains or improved mesqas. An amount equivalent to 10% of the erection costs is added as an administrative fee. The statement indicates the part of the cost of each feddan of the land included in the irrigation or drainage unit. The costs of the field drain or field irrigation networks are born by the landlords.
- A landlord may pay the amounts referred to under the previous paragraph either at one time or in annual installments provided that all costs must be paid within a period of no more than twenty years and that the amount of each installment must not be less than twenty pounds. The payments are collected starting from the first year following the implementation.
- No land may be allotted for horizontal agriculture expansion without the approval of MWRI to make sure that a water source is available for the irrigation as may be determined by the ministry.
- The Minister of Water Resources and Irrigation shall determine by decision:

- The terms and conditions for licensing the irrigation of new lands;
- The costs and charges for water supply and distribution;
- Establishing corporate water user associations and water boards;
- No groundwater well, deep or shallow, may be dug in EGYPT

except with license from MWRI in accordance with such conditions as may be determined by the ministry;

- The Minister of Water Resources and Irrigation shall by decision define the wells and mesqas for which charges are collected for their operation, management and maintenance
- The Minister of Water Resources and Irrigation shall by decision determine the charges to be paid for irrigating and draining water by the state's pumps and machines unless the land tax is estimated on the basis of the free charge use of irrigation and drainage facilities.
- A person licensed to use or exploit the water of the Nile, canals, groundwater, wells, reservoirs or flowing springs for purposes other than agricultural purposes whether for transportation or navigation or industrial activity or generating electricity or drinking or any other purposes shall pay a fee for maintaining, operating and managing the utility in accordance with such rules and rates as may determined by the minister of water resources and irrigation. A person licensed to drain water resulting from an activity other than the agricultural shall pay such charges as may be determined in accordance with rules and rates laid down by decision of the minister of water resources and irrigation.

Climate and Environment Research Institute (ECRI)

The Climate and Environment Research Institute (ECRI) was established within NWRC in 1995 to perform and carry out research activities in relation to impacts of climate changes on water resources as well as water quality in Egypt. ECRI was in charge of investigating these impacts on surface as well as groundwater resources. It carried out a joint research project on "CLimate Impact on WAter Resources and Dryland Agriculture" (CLIWARDA). This project was executed under an EU umbrella that selected eight African, Asian and Latin American countries where serious impacts due to climate change may affect their water resources. The project included the study of the meteorological characteristics of the Upper Nile Basin. It reviewed previous studies for predicting the Nile flows. It also investigated possible sea rise and drowning the Nile Delta.

Incorporating of Gender in MWRI

Gender is part of the whole socio-economic environment in which water management takes place. Socio-economic factors, and therefore gender, play a critical role in ensuring the success, cost effectiveness, efficiency and sustainability.

Therefore, the Advisory Panel Project (APP) on Water Management and Drainage has addressed the gender issue where several activities have been carried out. From August 1998 to March 1999, a gender consultancy had been carried out at field, institutional and policy level. Furthermore, a gender documentary film has been prepared in January 1999. Both the consultancy study and the documentary film showed that women and men of different socio- economic categories have different needs, interests and means in the development, use and management of water resources. This heterogeneity of water users and ministerial staff should be taken into consideration in planning, design, operation etc. of water management in order to reach the objective of the Ministry: an optimal and integrated management of Egypt 's water resources.

MWRI should have a clear gender policy to have a backbone for gender activities. This policy could be 'to have an equal involvement of men and \women (quantitative and qualitative) in control and benefit at all levels of water management (planning, design, implementing, operation, maintenance, monitoring and evaluation).

A gender officer has been assigned full time by H.E. the Minister of Water Resources and Irrigation to initiate, carry out and/or coordinate gender activities at field and institutional level. The gender officer has a clear ToR and is located in the Minister's technical office. The gender officer is responsible for the collection and exchange of gender data and information within the ministry as well as with other organizations.

Since many foreign projects within MWRI have a gender component, the gender officer sets directions for these projects to prevent that there will be gaps or overlaps between the gender activities of the different projects.■

Summary and conclusion

This report summarizes the main actions and measures implemented by MWRI to achieve improved water management and to face future water challenges. Re-planning of water resources and modification in the water allocation and distribution procedures are required to satisfy the increasing demands without need to increase the water supply significantly. Comprehensive water management programs are implemented to raise the water use efficiency and increase the food production.

Most of these programs included improvement and modernization of the water distribution system at both the macro and the micro levels. They also included maintenance and rehabilitation of the water control structures. Many of the measures taken were soft measures dealing with institutional reform. Several new entities have been established to achieve the overall goal of implementing sustainable water resources policies including water resources development, water demand management, and water quality conservation. Laws and legislation are also considered soft measures for protection of the environment and to achieve sustainable utilization of reused and recycled water. Cooperation and coordination among the Nile Basin countries is needed to realize sustainable and safe water resources management.

The problem of environmental degradation arose as a result of the lack of a long-term water resources management framework, the prolonged drought and the continuously increasing and uncontrolled exploitation of water resources for agricultural uses. New mechanisms have been initiated and introduced within MWRI organizational structure to allow and ease the process of water management. These mechanisms include software and hardware aspects. Institutional reform within MWRI is a hardware aspect. Proper institutional structure should be carefully set to ensure efficient coordination among stakeholders including MWRI. However, further resource development is constrained by environmental concerns, technical inadequacy, and budgetary limits while at the same time the demand for water is ever increasing due to population growth, economic development and life style changes. Stakeholders are no longer just water users waiting for their share of water adequately in time and space but they are deeply involved in the decision making process (operation and management of the water resources system). The set-up of water users' associations and water boards also assist in the policy implementation.

Emphasis is also given to resource allocation and conflict resolution. The level of awareness of the public, the acceptability and the effectiveness of economic instruments, the creation of public awareness, and the selection of those instruments that are both acceptable and effective are the main issues for the effective consideration of water as an economic good (Mylopoulos and Kolokytha, 1997). Allocation and conflict resolution mechanisms have to be either created or strengthened both in legal and policy aspects. Hydroinformatics is a new technology, which can be used for better planning and management of water resources. The Water Communication Unit and the Main Information Center provide the necessary information on the water status from both the resources and requirements sides.

From the above, this study concludes that the institution reform lies in the heart of the integrated approach adopted by MWRI for the management of its water resources. This institution reform aims to strengthen the political, technical, legal and administrative arrangements that lead to save water, and in general maximize the return from using the limited investment available to the water sector in Egypt.

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