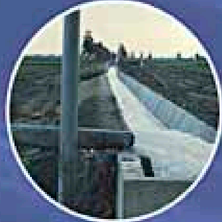
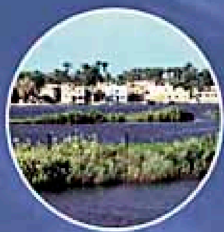
National Water Resources Plan Egypt

NWRP PROJECT

Arab Republic of Egypt

Ministry of Water Resources and Irrigation





Water *for the* Future

National Water Resources Plan 2017

January 2005

NWRP PROJECT

Arab Republic of Egypt

Ministry of Water Resources and Irrigation

Planning Sector

National Water Resources Plan for Egypt - 2017

Cairo, January 2005

Photographs

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Mediterranean Sea
Libya
Edfina Barrage
Farascour Dam
Alexandria
Port Said
Marsá Matruh
Israel/ Palestine
Zifta barrage
El-Salam Canal
Delta Barrages
Cairo
Suez
Jordan
Lake Qarun
Nile
Siwa Oasis
Al Fayoum
Sinai
Beni Suef
Gulf of Suez
Saudi Arabia
Bahr Yousef
Bahariya Oasis
Ibrahimia Canal
Sharm el Sheikh
Asyut Barrage
Hurghada
East Naga Hammadi Canal
West Naga Hammadi Canal
Farafra Oasis
Red Sea
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Naga Hammadi Barrage
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Asfoun Canal
Esna Barrage
1 Nasser Canal
2 Beheira Canal
3 Rosetta branch
4 Menufia Canal
5 Damietta branch
6 Tawfiki Canal
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Preface

The National Water Resources Plan (NWRP) has been developed within the framework of the NWRP project, carried out by the Ministry of Water Resources and Irrigation (MWRI) with support of the Government of the Netherlands. The main objective of NWRP is to describe how Egypt will safeguard its water resources in the future, both with respect to quantity and quality and how it will use these resources in the best way from a socio-economic point of view. The planning horizon for the NWRP is the year 2017.

NWRP is based on an Integrated Water Resources Management (IWRM) approach and considers all components of Egypt's water resources system and all functions and water user sectors. This means that NWRP includes also the policy areas of other ministries and that this document is 'owned' by all stakeholders involved. To this end there has been an intensive interaction between the NWRP project and the stakeholders, in particular within the inter-ministerial Technical Committee for Water Resources Management. The resulting plan and policies have been discussed and agreed upon in the inter-ministerial Technical and High Committees for the National Water Resources Plan project.

This National Water Resources Plan is one of the results of the NWRP project. Other important results are the Policy Document and the supporting Technical Reports. Actually these documents are complementary in the sense that:

- the Policy Document presents the broad policy guidelines for the development and the management of the water resources in Egypt;
- the National Water Resources Plan describes the specific actions to be taken to implement the policy and provides the necessary background information; and
- the supporting technical reports contain the detailed information and data underlying the plan and describe also the analysis process that has been followed to develop the policy and the plan.

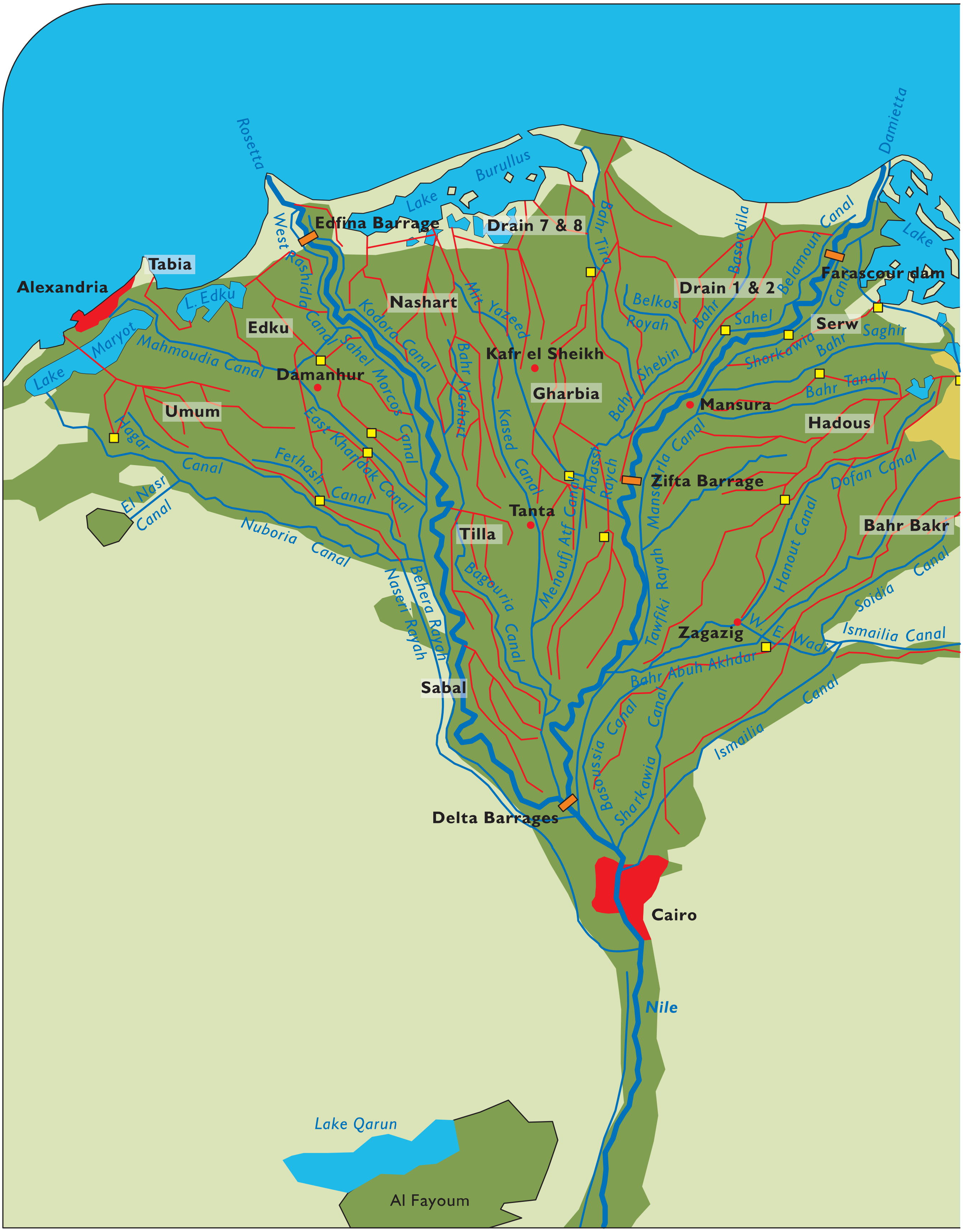
The core of the National Water Resources Plan consists of the strategy "Facing the Challenge" that has been discussed extensively with all stakeholders. This strategy is included as Chapter 5 of the plan.

I would like to thank the Dutch Government and the Netherlands Embassy for their cooperation and for providing the needed financial support.

Finally, I would like to thank all representatives of the different stakeholders inside and outside the MWRI, the Egyptian and the Dutch team for their great efforts in developing this plan.

Dr. Mahmoud Abu-Zeid

Minister of
Water Resources and Irrigation



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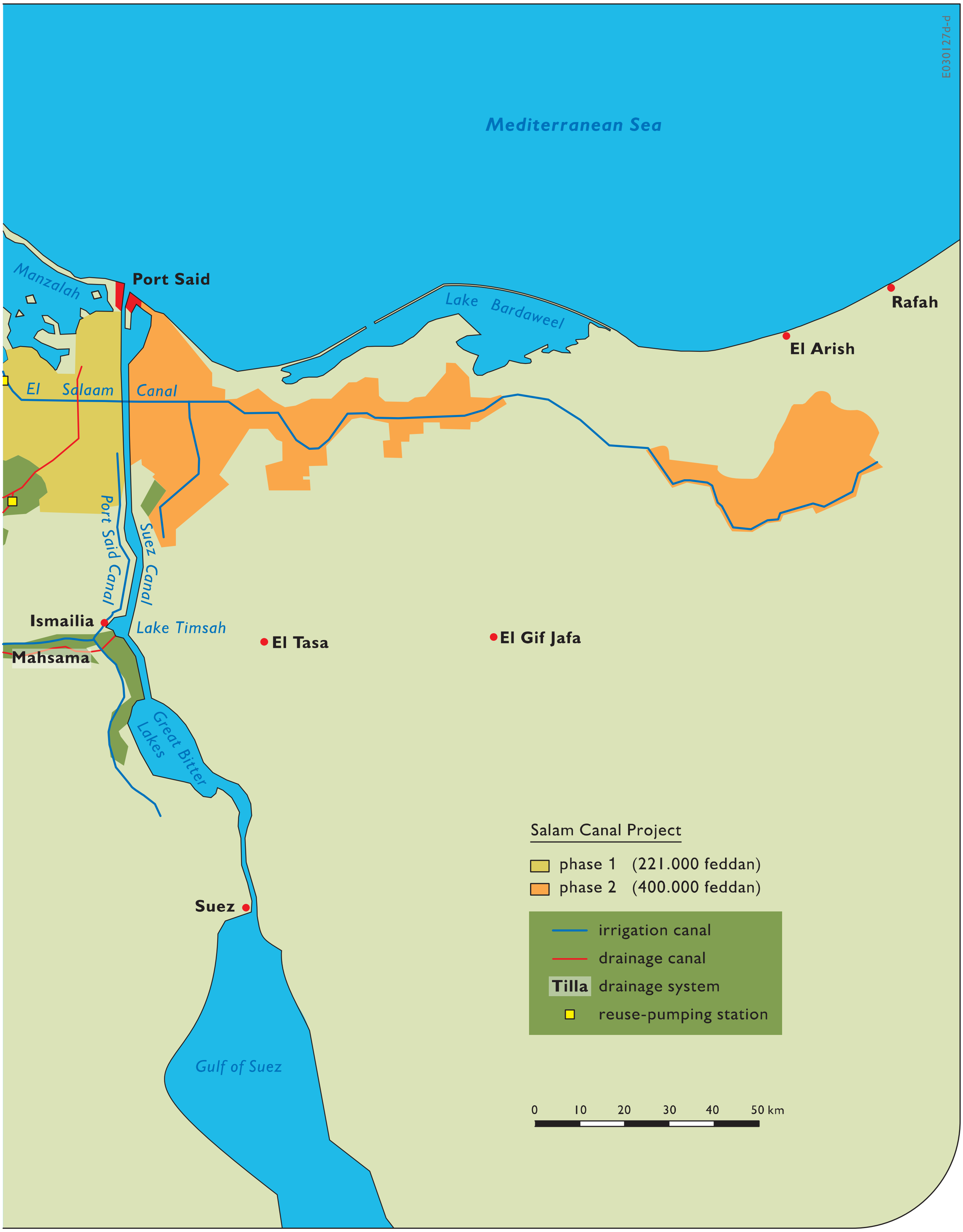
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Manzalah
Port Said
Lake Bardaweel
Rafah
El Arish
El Salaam Canal
Port Said Canal
Suez Canal
Ismailia
Lake Timsah
El Tasa
El Gif Jafa
Mahsama
Great Bitter Lakes
Suez
Gulf of Suez
Salam Canal Project
phase 1 (221.000 feddan)
phase 2 (400.000 feddan)
irrigation canal
drainage canal
Tilla drainage system
reuse-pumping station
0 10 20 30 40 50 km

Contents

Acronyms and abbreviations

AC	Advisory Committee (for the NWRP project)
APRP	Agricultural Policy Reform Project
ARC	Agricultural Research Centre (MALR)
ARE	Arab Republic of Egypt
ASME	Agricultural Sector Model for Egypt
BCM	Billion Cubic Metres
BCWUA	Branch Canal Water User Association
BOD	Biological Oxygen Demand
BOT	Build, Operate and Transfer
CAPMAS	Central Agency for Public Mobilisation and Statistics
DCE	Darwish Consulting Engineers
DRI	Drainage Research Institute (NWRC)
DSS	Decision Support System
EEA	Egyptian Electricity Authority
EEAA	Egyptian Environmental Affairs Agency
EMU	(Governorate) Environmental Management Unit
EPADP	Egyptian Public Authority for Drainage Projects
EPIQ	Environmental Policy and Institutional Strengthening Indefinite Quantity Contract
ET	Evapotranspiration (in crops)
EWP	Egyptian Water Partnership
FtC	Facing the Challenge (proposed IWRM strategy in National WR Plan)
FWMP	Fayoum Water Management Project
GAFRD	General Authority for Fish Resources Development
GCM	Global Climate Model
GDP	Gross Domestic Production
GoE	Government of Egypt
GOFI	General Organisation for Industrialisation
GWP	Global Water Partnership
HAD	High Aswan Dam
HC	High Committee (Inter-ministerial committee for the NWRP project)
IAS	Irrigation Advisory Service
IBRD	International Bank for Reconstruction and Development (World Bank)
IIIMP	Integrated Irrigation Improvement Management Project
IIP	Irrigation Improvement Project
IFPRI	International Food Policy Research Institute
IMF	International Monetary Fund
IRU	Institutional Reform Unit (of MWRI)
IWRM	Integrated Water Resources Management
KfW	Kreditanstalt für Wiederaufbau (= German Overseas Development Agency)
lcd	litres per capita per day
LE	Egyptian Pound
LNFDC	Lake Nasser Flood and Drought Control project
M&I	Municipal and Industrial
MAC	Maximum Allowable Concentration

MADWQ	Monitoring and Analysis of Drainage Water Quality project
MALR	Ministry of Agriculture and Land Reclamation
MCM	Million Cubic Metres (Mm3)
MHUNC	Ministry of Housing, Utilities and New Communities
MoHP	Ministry of Health and Population
MoLD	Ministry of Local Development
MSL	Mean Sea Level
MWRI	Ministry of Water Resources and Irrigation[1]
NAWQAM	National Water Quality and Availability Management project
NBI	Nile Basin Initiative
NOPWASD	National Organisation for Potable Water and Sewage Disposal
NPK	Nitrate, phosphate and potassium (fertiliser)
NWC	National Water Council (proposed)
NWRC	National Water Research Centre (MWRI)
NWRP	National Water Resources Plan
O&M	Operation and Maintenance
ppm	parts per million
PWS	Public Water Supply
RBO	Regional Branch Office (of EEAA)
RIGW	Research Institute for Ground Water (NWRC)
RTA	River Transport Authority (Ministry of Transportation)
SES	Socio-Economic System
SIWARE	SImulation of Water management of Arab Republic of Egypt
SPS	Strengthening the Planning Sector (project)
SWERI	Soil Water Environment Research Institute (ARC)
TC	(Inter-ministerial) Technical Committee (for the NWRP project)
TDS	Total Dissolved Solids
UFW	Unaccounted For Water
WPRP	Water Policy Reform Project
WRRI	Water Resources Research Institute (NWRC)
WRS	Water Resources System
WUA	Water Users Association
WWTP	Waste Water Treatment Plant

[1] *Till December 1999: Ministry of Public Works and Water Resources (MPWWR)*

Explanation of typical Egyptian terms

Berseem	Egyptian clover
Feddan	Area unit (0.42 ha)
Governorate	2^{nd} government level (province)
Horizontal expansion	Governmental programme to reclaim desert for agriculture
Khor	Cove in Lake Nasser (submerged old wadi)
Lower Egypt	Cairo and Delta
Markaz	3^{rd} government level (administrative)
Mega projects	Major projects undertaken by Egyptian Government, e.g. Toshka (New Valley Development) and El Salaam Development
Mesqa	Lowest (tertiary) level of irrigation canals, receiving water from a branch canal for distribution to several farm holdings
Middle Egypt	Nile Valley from Asyut to Cairo
New lands	Farmlands reclaimed from the desert by horizontal expansion projects
Old lands	Existing farmland in Nile Valley and Delta
Upper Egypt	Nile Valley upstream of Asyut
Wadi	River bed in desert area, only carrying water after rainfall

Egypt from high above

EXECUTIVE SUMMARY

Water is life. Water is also a limited resource that mankind should cherish. Water management aims to develop and protect the resource. In Egypt, being an arid country with hardly any rainfall, water management is of particular importance. Without a proper management, water will become a constraining factor in the socio-economic development of the country.

The government of Egypt is committed to develop and manage its water resources in the interests of all Egyptians. To this end the Ministry of Water Resources and Irrigation (MWRI) has since many years developed water policies and guidelines for this management. These policies and guidelines are dynamic in nature to allow for changing conditions. The underlying **National Water Resources Plan** provides an update of earlier policies and plans. The intention of this plan is to guide both public and private actions in the future for ensuring optimum development and management of water that benefits both individuals and the society at large. It is based on an Integrated Water Resources Management approach, which makes this plan a real national plan and not only a plan of the MWRI. The policy aspects involved in this plan are highlighted in a separate **Policy Document** which will be discussed in Parliament and which will provide binding objectives and guidelines for all ministries and other governmental agencies.

Integrated Water Resources Management

In common with current global thinking on how to solve present water resources problems, Egypt has adopted an Integrated Water Resources Management (IWRM) approach. IWRM is defined as a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resulting economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems. IWRM is based on several principles. Implementation of these principles is situation and culture dependent. In the context of Egyptian water management the following principles are in particular important:

- fresh water is a **finite and vulnerable resource**, essential to sustain life, development and environment; it should be considered in a holistic way, simultaneously taking into account quantity and quality, surface water and groundwater; and
- water development and management should be based on a **participatory approach**, involving users, planners and policy-makers at all levels.

Adopting an IWRM approach means that this National Water Resources Plan is oriented towards the socio-economic development goals of Egypt and, besides direct water needs, addresses also issues such as health, employment and general well-being of the people. Representatives of relevant stakeholders have been involved in developing this plan, both at a horizontal level (the various ministries involved) as well as vertically (governorates, water boards, various user groups, etc.).

The challenge

The growing population of Egypt and related industrial and agricultural activities have increased the demand for water to a level that reaches the limits of the available supply. The population of Egypt has been growing in the last 25 years from a mere 38 million in the year 1977 to 66 million in 2002 and is expected to grow to 83 million in the year 2017. The present population of Egypt is strongly concentrated in the Nile Valley and the Delta: 97% of the population lives on 4% of the land of Egypt. To relieve the pressure on the Nile Valley and Delta, the government has embarked on an ambitious programme to increase the inhabited area in Egypt by means of horizontal expansion projects in agriculture and the creation of new industrial areas and cities in the desert. All these developments require water.

However, the water availability from the Nile River is not increasing and possibilities for additional supply are very limited. Up till now Egypt had sufficient water available and the current management is very successful in distributing the water over all its users. Thanks to the enormous capacity of Lake Nasser to store water, the supply of water to these users is every year guaranteed and nearly constant. Now that Egypt is reaching its limits of available water this will not be possible anymore and Egypt will have to face variable supply conditions.

Moreover, the population growth and related industrial developments have resulted in a severe pollution of the water. This pollution is threatening public health and reducing the amount of good quality water even further. Major programmes are already being implemented to provide good drinking water to the population and to treat domestic and industrial sewage water. Still, those programmes are not sufficient yet and water quality in many areas is below standard.

The government of Egypt has to face these challenges. It will have to further develop its activities to improve the performance of the water resources system, to ensure that the national economic and social objectives are achieved and that environment and health are protected.

The Ministry of Water Resources and Irrigation plays a key-role in the development and management of the water system in the country. This plan tries to achieve the national objectives by developing new water resources, improving the efficiency of the present use and to protect environment and health by preventing pollution and by treatment and control of polluted water. Many of these activities are carried out in co-operation with other ministries such as the Ministry of Agriculture and Land Reclamation, the Ministry of Housing, Utilities and New Communities, the Ministry of Health and Population and the Ministry of Environment.

The main issues

The main issue involved is how Egypt can safeguard its water resources in the future under the conditions of a growing population and a more or less fixed water availability. Assuming that all available additional resources will be developed, the main questions with respect to water quantity that have to be answered are:

- how can the efficiency of the various uses be increased?
- how can the agricultural expansion policies of the government be supported and what are the priorities and limitations in this expansion, given existing water resources, optimum

efficiency and priority for drinking and industrial water use?
- how should Egypt manage its water resources system under variable supply conditions?

With respect to water quality, health and environmental aspects the key questions to be answered are as follows.
- what is the best mix of prevention, treatment and protection measures that results in a water quality that complies with reasonable standards?
- what is the level of investment needed to provide all people with safe drinking water and adequate sanitation facilities?

Implementation of the answers to these questions leads to the following institutional question:
- what institutional mechanisms should be developed that can best cope with the increased pressure on the water resources in the country?

The strategy Facing the Challenge

The National Water Resources Plan is based on a strategy that has been called 'Facing the Challenge' (FtC). FtC includes measures to develop additional resources, make better use of existing resources, and measures in the field of water quality and environmental protection.

The possibilities to develop **additional resources** are limited. Deep groundwater withdrawal in the Western Desert can be increased to 3.5 BCM/year, but, being fossil water, this is not a sustainable solution and should be carefully monitored. Small amounts of additional resources can be developed by rainfall and flash flood harvesting and the use of brackish groundwater. Co-operation with the riparian countries of the Nile Basin is expected to lead to additional inflow into Lake Nasser.

Measures to make better use of existing resources aim at improving the efficiency of the water resources system. They include a careful evaluation of planned horizontal expansion projects and a scheduled implementation of the projects in relation to the availability of required water. The water use efficiency in agriculture can be improved by many measures, in particular by continuing the Irrigation Improvement Project (IIP), by implementing the Integrated Irrigation Improvement and Management Project (IIIMP), by continuing the Drainage Improvement (EPADP) activities and by reviewing the present drainage water reuse policy, e.g. by applying intermediate reuse and by allowing the use of water with a higher salinity content. Moreover, a different water allocation and distribution system that will be based on equity will decrease the losses in the system. To implement such a system and to improve operation and maintenance (O&M) it will be required to have a good institutional structure with strong Water Boards and Water Users Associations. The municipal and industrial water use efficiency can be improved by a mix of infrastructural and financial incentives or measures. Various research topics are formulated to identify further options to increase the efficiency of the system.

The strategy on **protecting public health and environment** includes several packages in which infrastructural, financial and institutional measures are combined. Priority is given to measures that prevent pollution. This includes reduction of pollution by stimulating clean products and relocation of certain industries. Agriculture will be encouraged to use more environmentally friendly methods and products. If pollution can not be prevented, treatment is the next option. The plan includes a considerable increase in treatment of municipal sewage and wastewater. Domestic sanitation in rural areas requires a specific approach. In both cases cost recovery is needed to maintain the services. The last resort will be to control the pollution by protecting the people and important ecological areas from direct contact with this pollution. Additional attention is required to protect sensitive areas, e.g. around groundwater wells and intakes of public water supply.

The strategy also includes a number of general **institutional measures**. The initiated process of decentralisation (to Water Boards) and privatisation will be strengthened, including a restructuring of the role of MWRI, e.g. by establishing Integrated Districts at local level. Cost-sharing and cost-recovery mechanisms will be implemented to make the changes sustainable, in particular with respect to operation and maintenance. The planning process at national level will be continued as an ongoing exercise, including the improvement of data and information exchange among different authorities and the co-ordination of investments. Finally, the role of the real stakeholders in water resources management, i.e. farmers and citizens should be enhanced by involving them better in the various water management tasks but also by strengthening their 'ownership' feelings towards public property. The specific role of women in water management issues is acknowledged and recieves special attention.

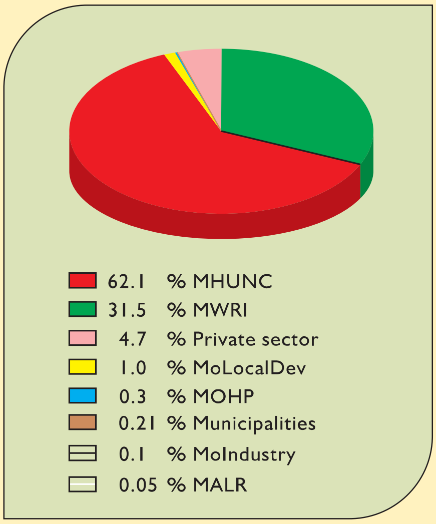
Expected results of the new National Water Resources Plan

Implementing the strategy 'Facing the Challenge' will improve the performance of the water resources system. More water will be available for the various uses and the water quality will improve significantly. The agricultural area will increase by 35% as a result of horizontal expansion and the two mega projects in Toshka and the Sinai. Living space in the desert will be created for more than 20% of the population as a result of these projects. The implementation of the strategy will support the socio-economic development of the country and provide safe drinking water to its population. The access of the population to safe sanitation facilities will double from the present 30% to 60%. Summarizing and as stated in the objectives, the strategy will safeguard the water supply up to the year 2017.

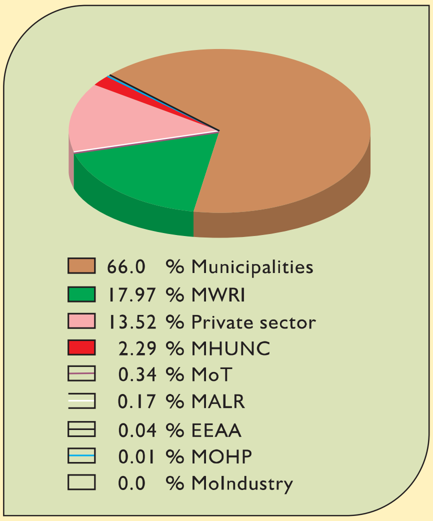
However, at the same time it should be realized that by implementing all these measures, in particular all the planned horizontal expansion projects, the water resources system has reached its limits of what it can support. Water availability per feddan and average cropping intensity are already decreasing. The management of the system will be adapted to cope with this situation.

The strategy FtC follows an integrated approach to cope with this increasing pressure on the water resources system in Egypt and contains a wide range of measures and policy changes up to the year 2017. It is a real challenge to implement this strategy. Further development of the system after 2017 may require that some drastic policy decisions are made at the national level, e.g. accepting some limitations in growth of the agricultural sector and increasing the developments and corresponding employment in the industrial and services sectors. An increase in the Nile water supply will ease the situation somewhat and should be pursued. A limited increase is not unrealistic, either as a result of water conservation projects in Sudan, changes in reservoir operation of Lake Nasser or (in the very long run) as a result of climate change.

The integrated approach of FtC assumes that all measures are indeed implemented. Failure to implement some measures may have severe consequences for the overall strategy. This is in particular the case for the expected improvement of the water quality. An insufficient improvement of the water quality will mean that the increase in reuse of water will be much less than expected with the consequence that there will be less water available for agriculture, leading to less water available per feddan and a further lowering of cropping intensities.



Investment by stakeholder category



Recurrent costs by stakeholder category

The implementation of the strategy

The strategy FtC will be implemented in the period till 2017. Many stakeholders are involved in this implementation process and the National Water Resources Plan provides the guidelines for this process. The actual implementation will be done by the various stakeholders. Their roles are clearly specified in a matrix in the implementation plan. They will translate FtC into concrete actions to be included in their regular 5-year and annual planning cycles. A National Water Council will monitor the progress and coordinate activities where needed.

The total investments needed in FtC amount to BLE 145 for the period 2003-2017. The major shares in this investment are taken by the Ministry of Housing, Utilities and New Communities (63%) and the Ministry of Water Resources and Irrigation (32%). The private sector will take care of about 5% of these investments. Most of the investments required by ministries are already included in their planning and the required additional investments above their budgets are limited.

The total recurrent costs in the same period 2003-2017 are estimated at BLE 44. These costs include the operation and maintenance costs of the system but exclude the personnel costs of the government agencies. The municipalities take by far the biggest share of the O&M costs (70%) for the operation and maintenance of the drinking water treatment plants and the waste water treatment plants. The Ministry of Water Resources and Irrigation will cover 12% while the private sector will take care of about 15%.

Required institutional and social setting

Implementing the strategy FtC is much more than just applying some technical measures. Technical measures are needed and are very essential. Drinking water purification plants and wastewater treatment plants have to be built, the Irrigation Improvement Project (IIP) and the IIIMP have to be continued and many other technical and managerial actions should be taken. However, these actions will only be effective and sustainable if they are placed in an institutional and social setting that supports these measures.

First of all a proper **enabling environment** is needed. This enabling environment is basically formed by the national and regional policies and legislation that enable all stakeholders to play their respective roles in the development and management of the water resources; and the fora and mechanism, including information and capacity building to facilitate and exercise stakeholder participation. The role of the government is crucial in this respect. The traditional prescriptive, central approach should be replaced by the creation of a framework within which participatory and demand-driven sustainable developments can take place. This includes decentralisation and privatisation while the national government would act more as regulator and controller. Water legislation should be developed to enable this changing role. Further development of Water Boards and Water Users Associations is important and will be pursued. Finally, the political will should be there to enforce these developments.

Second, the **institutional roles**. In such a changing institutional environment the role and functions of the organizations at different levels should be clearly described. This includes the creation of effective co-ordination mechanisms between the different agencies and the development of financial structures that enable these agencies to perform their task efficiently. The Institutional Reform Unit established within MWRI will play a major role in this respect.

Third, the more traditional **management instruments** will have to be developed further. This includes the technical and economic measures described above for developing new resources, making better use of existing resources and measures to protect health and environment. In addition this includes a continuous assessment of supply and demand and the further development of advanced research and a water resources knowledge base in the various ministerial research institutes.

Finally, there is a need for a new mechanism for integrating water policies and activities on the national and local levels. This can be effected by establishing a **National Water Council** (NWC) that will be assisted by a technical secretariat and Water & Environment units within the different ministries and organisations. At the governorate level **Regional Management Committee**'s (RMC's) will be established in which representatives of all stakeholders will participate, chaired by the responsible regional MWRI official.

1 INTRODUCTION

- Why a new plan? To cope with the increasing demand an Integrated Water Resources Management approach is required, involving all interests and stakeholders and finding a balance between the use of the system and the protection of the resource
- The challenges: securing water for a growing population with requirements for safe water, food and employment while protecting the environment

1.1 Water Resources Management in Egypt

The National Water Resources Plan presented here describes how Egypt will safeguard its water resources in the future, both with respect to quantity and quality, and how it will use these resources in the best way from a socio-economic and environmental point of view. The time horizon of the plan is the year 2017.

Governments all over the world pay more and more attention to fresh water resources because these either become increasingly scarce or they are a threat due to flooding. At the same time there is a growing awareness that the quality of water resources should be protected. Water of good quality and without risks for public health is nowadays considered to be a major asset.

In this field Egypt has its own particular position. It covers a very arid region situated between the Sahara and Arabian deserts. Egypt is extremely dependent on the River Nile, being the most downstream country in the Nile basin. This makes co-operation with other Nile basin countries indispensable. The country hardly has any other fresh water resources. Rainfall is very rare, except for a very small strip along the coast of the Mediterranean. Fossil groundwater is available in parts of the Western and Eastern Deserts and the Sinai.

There are many water-related challenges facing Egypt. The first and most important challenge is Egypt's expected population growth: from 63 million in 2000 to 83 million in 2017) and related water demand for public water supply and economic activities, in particular agriculture. To relieve the population pressure in the Nile Delta and Nile Valley, the government has embarked on an ambitious programme to increase the inhabited area in Egypt (from 5.5% living outside the Nile Valley and Delta to about 25%). Industrial growth, the need to feed the growing population and hence a growing demand for water by agriculture, horizontal expansion in the desert areas, etc. cause a growing demand for water. At the same time the available fresh water resources are expected to remain more or less

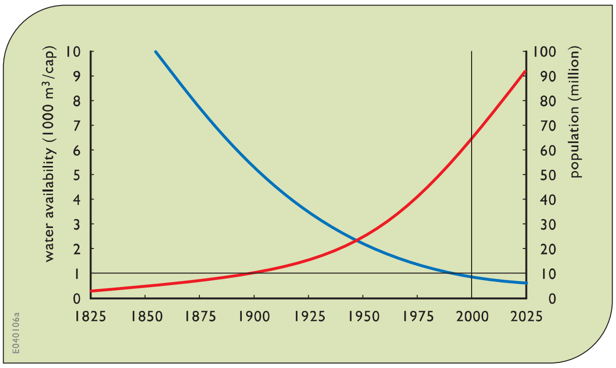


Figure 1-1 Population growth and water availability

Cairo; a city of millions and still growing

the same. This urges to make a more efficient use of present resources and, if possible, to develop additional Cairo; a city of millions and still growing water resources. As a rough global indicator of water sufficiency the annual amount of water available per capita is often mentioned in the literature. This amount includes water for all purposes, including water for food production. If less than 1000 m^3 per capita per year is available, water scarcity occurs. In Egypt this critical value was reached around 1997 as indicated in Figure 1-1. Due to further population increase the per capita amount of water is expected to decrease to 720 m^3 per year in 2017. Although the 1000 m^3 criterion for water scarcity may be debatable, it seems safe to conclude that water is becoming a scarce commodity by the year 2017. If no protective measures are taken, the increasing scarcity in terms of good quality water is expected to be even more severe, because of increased domestic and industrial pollution.

The second challenge is to improve the environmental quality. The increase in population and industrial and agricultural activities has resulted in a rapid deterioration of the quality of the water resources, in particular in the Nile Delta. This low water quality threatens public health, reduces its use for economic activities and damages the natural ecology of the water systems. Massive expenditures are needed to reduce the pollution loads and to provide the population with adequate drinking water and sanitary facilities.

The third challenge is that it has become clear that above issues can only be solved if the institutional setting of water management is improved. This includes aspects of co-operation, decentralisation and privatisation. Major elements in this respect are a participatory approach in planning, development and management and the inclusion of cost-recovery aspects. MWRI has already embarked upon a major programme of institutional reform, among others by setting up water boards and transferring water management tasks to them. This process has to be continued.

1.2 Why a National Water Resources Plan

Above considerations are not new. The Government of Egypt has since long recognised the vital role of water for the economic and social development of the country and has initiated major programmes to improve the performance of the water system. Examples are the ongoing horizontal expansion projects, the Irrigation Improvement Project (IIP) and the many drinking water and sewage treatment plants that have been and are being built.

The current Water Policy (of January 2000) of the Ministry of Water Resources and Irrigation (MWRI) covers many of the aspects mentioned and follows already an 'integrated' water resources management approach. The policy tries to achieve those objectives by:

- improving the efficiency of the present use of the water resources;
- developing new water resources,, e.g. deep groundwater; and
- protecting environment and reducing water related health hazards.

The expanding economy of Egypt, the limitations in developing new water resources and above described 'challenges' necessitate the development of a new policy. This new policy is building upon the present (2000) policy but extends it and includes new aspects. In particular the new policy:

- extends the approach of integrated water management, not only by taking all policy objectives into account, but by making the plan a 'national' plan and not a plan of MWRI only;
- hence, is based on the involvement and co-operation of all stakeholders;
- includes institutional change;
- pays specific attention to the implementability of proposed measures;
- includes an update of the water availability assessment and an update of the demand projections by 2017; and finally,
- is based on tools (including computational tools) that enable a trade-off between the various aspects involved.

The 2000 policy of MWRI was an important step towards integrated water management. Problems were identified in a wide variety of sectors and many of them are now on the way of being solved. Unfortunately, there has not always been sufficient recognition of the inter-relationships between the various sectors. The new policy is making further steps in this direction. It is advocated that water management is not an aim in itself but that it should support the achievement of other governmental goals like social, economic and environmental goals. This means that integrated water management should consider all interests, such as the interests of agriculture, ecology, industrial development, transport, recreation, fisheries and public water supplies. In the 2000 policy these interests were only weakly taken into account or were considered as boundary conditions. In the new policy they are reconsidered as policy objectives that deserve to be achieved. This is a major step in the direction of integrated water management. This step can now be taken because simulation models have become available by which the quantitative effects of actions can be calculated, enabling a trade-off between different objectives.

The integration of water management with related socio-economic policies requires co-operation between representatives of different groups, i.e. stakeholder involvement. These stakeholders are not to be restricted to organisations of public administration, like other ministries and governorates. The private sector has its own responsibility as water user. This sector should also have a task and role in an efficient use of water resources, the development of new water resources and the protection of water quality. The new strategy contains proposals to enhance the involvement of representatives of all stakeholders' organisations.

Another major step forward towards achieving the policy objectives is the overall government's policy of improving the performance of the public sector by enhancing the participation of the private sector. The new policy will elaborate further the institutional reform policy in water management that aims at an improvement of the performance of the irrigation and drainage system by transferring public responsibilities to the private sector. The present vision is that the government should remain fully responsible for the main parts of the irrigation and drainage system while the private sector should be more involved in the operation and maintenance of the lower parts of the system, such as the branch canals and the district canals. This new policy advocates some further steps towards such an involvement.

Policies, strategies, measures and scenarios - Definitions

- **Policy:** governmental (political) statement on objectives, goals and priorities in IWRM (i.e. where do we want to go)
- **Strategy:** logical combination of technical, managerial, ecological, economic, institutional and legal measures (i.e. how do we want to get there)
- **Measure:** any single action to improve the performance of the water resources system (i.e. what are we going to do)
- **Scenario:** developments exogenous to the water system under consideration, i.e. set of assumptions with respect to uncertain future developments or situations, which affect the functioning of the system considered, but which are not determined by or controlled within the system.

Implementability is a key characteristic of the new policy. Chapter 5 describes the strategy 'Facing the Challenge' (FtC) that will be followed to reach the policy objectives. The strategy includes many individual measures. During the process of selecting measures special attention was given to the question whether the measures could be implemented in terms of costs, necessary institutional capacity and public support. It is expected that the described measures not only have an effect on the policy objectives but that they indeed can be implemented.

The water sector has experienced rapid developments, and demands for water have changed significantly. New tools have become available to estimate the demands and assess the availability of water. The new policy will take the new insights in these aspects into account.

A final reason for a new policy is that choices have to be made. The new policy will address various kinds of governmental objectives. It is impossible to achieve all objectives at the same time, either due to financial limitations or because different objectives may require contradictory measures. This implies that choices have to be made with respect to the strategy orientation and the related measures. The new policy will address the trade-offs involved and put them forward in the discussions with the stakeholders.

1.3 Integrated Water Resources Management approach

The concept of Integrated Water Resources Management (IWRM) has been developing since the beginning of the nineties. IWRM is the response to the growing pressure on our water resources systems as a result of growing population and socio-economic developments. Water shortages and deteriorating water quality have forced many countries in the world, in developed and developing countries alike, to reconsider their options with respect to the management of their water resources. As a result water resources management (WRM) has undergone a drastic change world-wide, moving from a mainly supply-oriented, engineering biased approach

Definition of IWRM

IWRM is a process which promotes the co-ordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems.

GWP, 2000

towards a demand-oriented, multi-sectoral approach, often labelled Integrated Water Resources Management. In the international fora opinions are converging to a consensus about the implications of IWRM. The concept of IWRM let us move away from 'water master planning', which focuses on water availability and development, towards 'comprehensive water policy planning' which addresses the interaction between different sub-sectors, seeks to establish priorities, considers institutional requirements, and deals with the building of capacity.

A key aspect of IWRM is that the management and development of the resources should take place in interaction with the users (the socio-economic system), the environment and the institutions involved. IWRM applied in this way considers the use of the resources in relation to the social and economic activities and functions. These also determine the need for laws and regulations for the sustainable use of the water resources. Infrastructure, in relation to regulatory measures and mechanisms, will allow for effective use of the resource, taking due account of the environmental carrying capacity.

IWRM practices depend on the context of the specific application. This means that IWRM as applied in Egypt will have to take into account the particular situation of Egypt with respect to the geographic and hydro-meteorological conditions as well as the social and cultural values of the country. IWRM should not be seen as a 'model' that has to be enforced upon the country. IWRM is much more a process as indicated in the definition in the text box.

1.4 IWRM challenges for Egypt

The growing population and related socio-economic activities require an increasing amount of water. The Nile River is an abundant source of water but also this source has its limitation and at some point in time demand will outgrow the available supply. Efficiency improvement may delay that point in time but sooner or later Egypt will have to face that situation, and decisions have to be made now on how to deal with this. What are the challenges involved?

Agriculture, accounting for 95% of the water demand in Egypt

Securing water for people

Water is essential for life and access to safe drinking water is the first requirement that has to be met. Quantity is not the problem in this case. The challenge is to take care that the quality is according to health standards and to provide the necessary facilities such as drinking water plants and distribution systems.

Securing water for food production

Agriculture is a major economic activity in Egypt. Although the agricultural sector represents only 17% of the GDP nowadays (down from 40% in 1960), it still provides employment for about 40% of the labour force and plays an important role for many people as sustenance farming. However, agriculture is a major water consumer, especially in an arid country as Egypt where nearly all agriculture depends on irrigation water. Agriculture accounts for about 95% of the total net demand in Egypt (with 4% for municipal and industrial water and 1% for fish ponds). Population growth in combination with the horizontal expansion plans of the government will increase the demand for irrigation water. A considerable increase in efficiency is needed to make this additionally needed water available. Such an efficiency improvement will have important social as well as economic impacts, e.g. when changes in the cropping pattern are required (shift from crops with a high water demand to less sensitive crops).

Securing water for industry, services and employment

To improve the welfare of the people and given the limitations in the water supply for agriculture, Egypt will have to give priority to the development of other livelihood opportunities than agriculture, in particular in the industrial and services sectors. Also in this case the challenge is not quantity but quality and to provide adequate facilities not only for the supply of the water but also with respect to the sewage water that will be produced.

Developing a strong institutional framework

Water resources management in Egypt, like in many other countries in the world, has historically been very centralized, fragmented and sector oriented. The concept of iwrm stimulates cooperation between stakeholders, decentralisation and privatisation. This requires a different set-up of the institutional system around water management and appropriate ways to co-ordinate policy making, implementation and management across sectoral, institutional and professional boundaries. It also requires that the institutions involved have sufficient legal and financial means to carry out their tasks. To this end it will be needed to apply cost-recovery and cost-sharing principles.

Creating popular awareness and understanding

The limitations in the supply of water and the urgent need for water quality improvement require public awareness of these issues. This awareness is needed to mobilize effective support for sustainable water management and induce the actions required to achieve changes in behaviour. Additionally, public awareness and subsequent pressure for action may help in stimulating the political will to act.

They also need water of good quality

Protection and restoration of vital ecosystems

The aquatic ecosystems in Egypt are seriously threatened by the deteriorating quality of the water. The remaining systems are limited and fragile and in dire need to be protected. Moreover, polluted systems as the coastal lakes should be restored to their original states. Not only will this benefit the ecosystem involved, also the socio-economic 'use' of these systems will improve considerably (fishing, recreation, etc.).

Co-operation with Nile Basin countries
Egypt, being the most downstream country of the Nile river, will be influenced by developments upstream, in particular in Sudan and Ethiopia. Co-operation with Nile Basin countries is needed to ensure an equitable development of the Nile Basin as a whole. Egypt has a major interest in this co-operation. Many opportunities exist for the further development of the Nile water resources system, among others resulting in more water available for the riparian countries.

Stimulating the political will to act.
Finally, it is necessary to have political attention and commitment to ensure good decision making and the necessary investments in the development of the water resources in Egypt. Bringing water resources issues to the top of the political agenda is fundamental to the long-term success of sustainable water resources management.

1.5 Outline of this document

This document presents the National Water Resources Plan of Egypt. An overview of the contents is given in Figure 1-2. The next chapter (Chapter 2) contains a description of the water resources system of Egypt which consists of the natural water resources system and its infrastructure (the river, lakes, groundwater, etc.), the socio-economic system (the users and uses of the water) and the institutional system involved in the management.

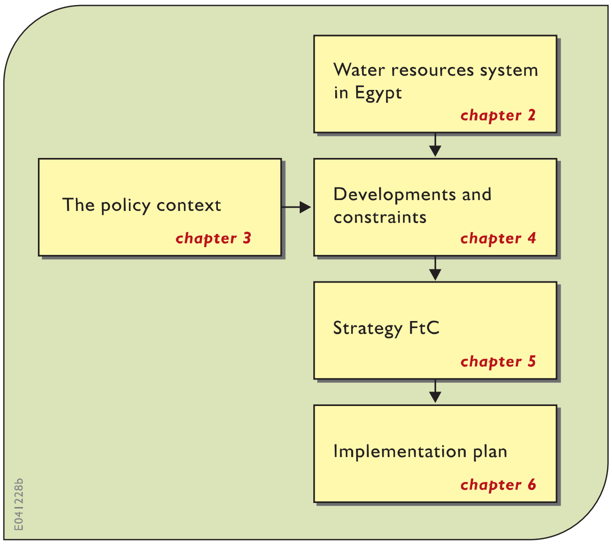


Figure 1-2 Content of National Water Resources Plan

Chapter 3 describes the context of this plan, in particular with respect to the national development goals and policies. That chapter also includes a description of the institutional and legal setting in which the NWRP will function.

The expected developments in the water sector in Egypt will be analysed in Chapter 4. It includes the expected developments in demand as well as the supply with respect to both quantity and quality aspects of surface and groundwater. Supply and demand are combined in the water balance of Egypt that will be the base for a description of the problems and constraints that can be expected in 2017 if no new actions are taken.

Chapter 5 presents the strategy 'Facing the Challenge' that will be followed to improve the performance of the water resources system. This is the most important chapter of this document because it contains the actual 'plan', i.e. the activities that will be carried out, including institutional and legal measures. The chapter also describes the consequences of the plan in terms of the evaluation criteria related to the development goals of the government.

The final Chapter 6 describes how the plan will be implemented. The two main components of that chapter are the Investment Plan (the amount of investments involved and who will pay) and the Implementation Plan (who will do what and when).

The annexes contain supporting information. The first annex (Annex A) gives an overview of the technical documentation of the NWRP project, underlying this National Plan. In Annex B background information is given, e.g. on the planned urban, industrial and agricultural developments, including the governmental plans for horizontal expansion of agricultural area. Annex C contains detailed information on the required Investments and operation and maintenance (O&M) costs involved in this Plan.

The Nile near Cairo

2 WATER RESOURCES SYSTEM

- The Water Resources System – combining the natural system with the socio-economic and institutional systems
- The Natural system comprising:
  - the Nile – source of life in Egypt
  - groundwater – a resource to be used and protected
  - good and safe water quality – needed for human health and environment
- The Socio-economic system, demanding water – a demand that will continue to increase under pressure of a growing population and socio-economic activities
- The Institutional system – providing the governmental environment in which the management of the water resources system takes place

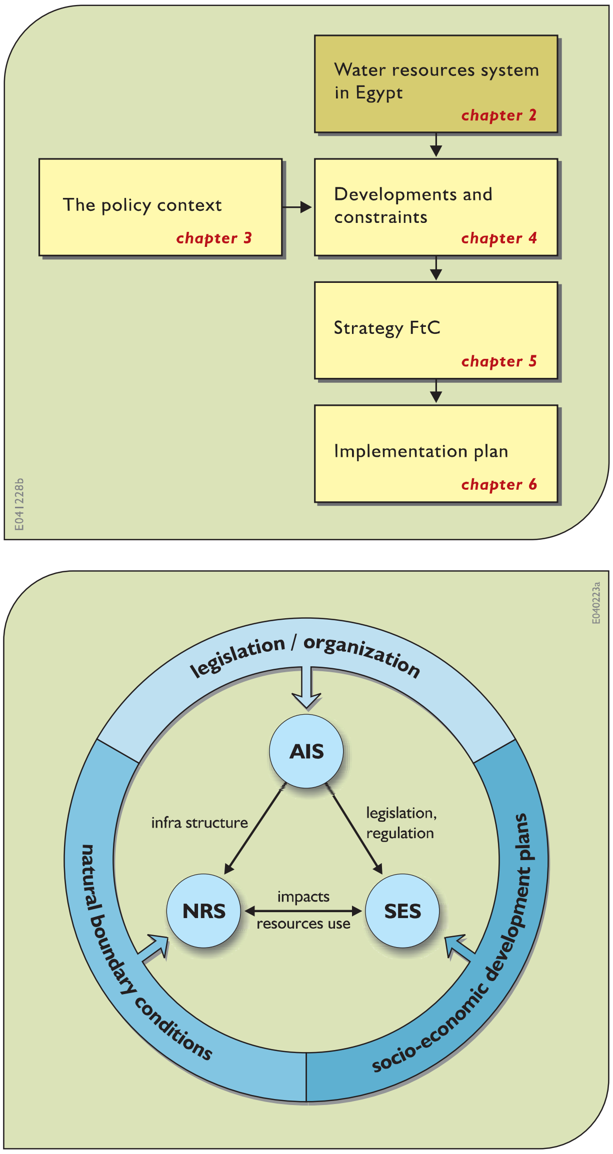


Figure 2-1 The Water Resources System in its environment

2.1 General

The holistic approach of Integrated Water Resources Management as described in Section 1.3 requires water managers to look beyond the physical aspects of the water system and to take into account also the users and uses of the water and the institutions involved. In fact, they have to consider these users and institutions as part of their Water Resources System. The Water Resources System can be defined as consisting of three components:

1. the *Natural Resources System* (NRS), being the system of rivers, lakes, groundwater aquifers and its related infrastructure; it includes both quantity and quality aspects of the water;
2. the *Socio-Economic System* (SES), the water using and water related human activities;
3. the *Administrative and Institutional System* (AIS), the system of administration, legislation and regulation including the authorities responsible for the management of the WRS and the implementation of laws and regulations.

The Natural Resources System (NRS) stands for the supply side of the system (resource base). The demand side of the system is made up of the Socio-Economic System (SES). The Administrative and Institutional

System (AIS) controls the supply as well as the demand of the resources as illustrated in Figure 2-1.

This chapter provides a description of the Water Resources System of Egypt. In Section 2.2 the Natural Resources System will be described followed by the Socio-Economic System in Section 2.3 and Administrative and Institutional System in Section 2.4. These descriptions will form the basis for the analysis that is carried out for the NWRP (Chapter 4) and of which the results are given in Chapters 5 and 6.

2.2 Natural system and its infrastructure

2.2.1 The Nile – source of Egypt's water

The Nile supplies nearly all water in Egypt. Being one of the largest rivers in the world, it is approximately 6,700 km long. Its basin covers an area of approximately 3 million km^2 and is shared by ten countries as illustrated in Figure 2-3. Its two main tributaries are the White Nile which originates from the Lake Victoria basin, and the Blue Nile which has its sources on the Ethiopian Plateau. The two rivers join at Khartoum, the capital of Sudan. The Nile river basin includes a wide range of climatological conditions and land-use, from tropical rainforest in the Lake Victoria area, the wetlands in southern Sudan, pastoral plains and rough mountains in Ethiopia till the extreme aridity of northern Sudan and Egypt. The rainfall distribution in the Nile Basin is illustrated in Figure 2-2.

Compared to many other major rivers in the world the Nile has not undergone major 'developments' yet, except the lower reach in Egypt which has been brought under nearly full control by the construction of the High Aswan Dam. The main structures in the White Nile are the Owen Falls dam (1953) that controls the outflow of Lake Victoria and some minor dams in the tributaries. Presently the release of Lake Victoria more or less follows the 'natural' outflow as specified in the so-called "agreed curve". All lakes in this upstream region are natural lakes, including Lake Edward, Lake Albert and Lake Kyoga. A major feature of the White Nile tributary is the swamps of the Sudd where much water is lost through evaporation. The outflow from the swamps is only about half the inflow and has little seasonal variation. The large volumes of water evaporated from these swamps gave rise to the proposal in 1904 for the construction of the Jonglei Canal that would bypass the swamps and reduce these losses. The construction of that canal started in the 1970's but was abandoned because of political instabilities in Sudan. Just above the confluence with the Blue Nile the Jebel Aulia Dam (1937) has been constructed, to maintain downstream flows and for irrigation purposes.

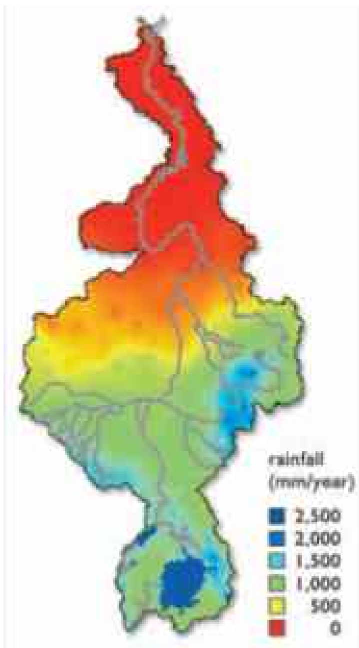


Figure 2-2 Rainfall in the Nile Basin

The water entering Lake Nasser originates for about 85% from the Ethiopian highlands, through discharges of the Blue Nile, the Sobat River and the Atbara River. The Blue Nile drains a major part of the western Ethiopian highlands with a small part of its basin subject to storage in Lake Tana.

Figure 2-3 Nile and Nile basin

Relatively small dams have been built at Sennar (1925) and at Roseires (1966) in order to provide water for irrigation and to generate some hydroelectricity. In the Atbara a dam is constructed at Khashm el Girba (1964) for the same reasons. Under construction in Sudan is the Hamdab dam at Merowe, between Khartoum and Wadi Halfa. This dam is expected to be completed in 2010 and will mainly be used for hydropower generation. Another dam has been commissioned recently in Ethiopia in the Tekeze river. This Tekeze dam will serve irrigation and hydropower purposes. Table 2-1 gives an overview of the capacities of the reservoirs mentioned above. The table shows that Lake Nasser is by far the largest reservoir in the system.

Reservoir	Design capacity (BCM)	Estimated actual capacity (BCM)
Roseires	3.00	1.50
Sennar	0.93	0.46
Khashm El Girba	1.30	0.65
Jebel Aulia	3.50	1.75
Merowe*	12.50	-
Lake Nasser	100.30**	90.00***

* reservoir under construction– mainly for hydropower
** active storage and flood control volume
*** based on very rough estimate of a reduction of 10%

Table 2-1 Capacities reservoirs in the Nile

2.2.2 Major water related infrastructure in Egypt

Dams and barrages

Major control structures on the Nile in Egypt include the High and Old Aswan Dams, and a number of downstream barrages. The Old Aswan Dam was completed in 1902 with a storage volume of about 1 BCM. By increasing the height of the dam the storage capacity was increased to 5 BCM in 1934. The High Aswan Dam (HAD), upstream of the (Old) Aswan Dam, was completed in 1964; the Lake Nasser reservoir created by this dam drastically improved the regulation of Nile water. The reservoir has a large annual carry-over capacity and is partitioned into different storage zones as shown in Table 2-2.

High Dam at Aswan

Storage zone	Level (above MSL)	Volume (BCM)	Cum. volume (BCM)
Dead storage	<147	31.6	31.6
Active storage	147 – 175	89.7	121.3
Flood control storage	175 – 178	16.2	137.5
Maximum surcharge storage	178 – 183	31.4	168.9

Table 2-2 Storage zones of Lake Nasser

Downstream of Aswan, the water levels and water distribution are controlled by a number of barrages (Figure 2-4). These barrages have locks to allow the passage of boats. The first barrage was the Delta Barrage at El Kanater, built as early as 1861.

Canal system

The major canals that divert just upstream of the barrages and the Irrigation Directorates that are served by these canals are given in Table 2-3. These canals have regulators or weirs at intervals depending on their slopes and the locations of the lower order canals. The canal system in Egypt is very extensive, in particular in the Delta area. Figure 2-5 shows the main features of the irrigation canal system in the Delta.

Branch canals that take off from the main or lateral canals deliver the water to smaller distributary canals, which in turn deliver water to the mesqas. Because the water level in the system is below field level in most of the area, the water has to be raised through diesel pumps or the traditional water wheels. In some areas the farm intakes are directly from the distributaries.

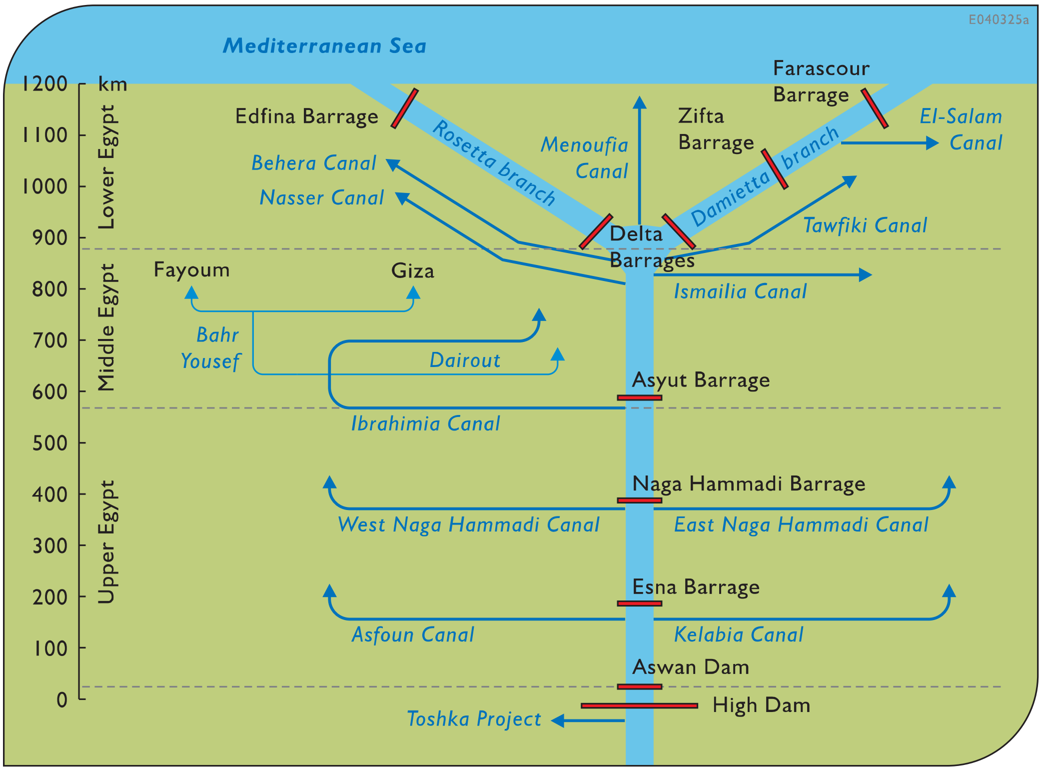


Figure 2-4 Schematic diagram of major control structures on the Nile in Egypt

Barrage	Main canal	Directorates served
Esna	Asfoun Kelabia	Qena
Nag-Hammadi	East Naga Hamadi West Naga Hamadi	Sohaq Asyut
Asyut	Ibrahimia	Asyut (small area), East and West Minia, Beni Suef, Fayoum and Giza, Ismailia, Salhia
Delta (Damietta)	Ismailia Sharkawia Tawfiki Basusia Darawa	Sharkia Kalubia Kalubia, Sharkia and East Dakahlia Kalubia Menufia
Delta (Rosetta)	Menufi Rayah Nagail	Menufia , Gharbia, West Dakahlia and Kafr El Sheikh
	Beheira Rayah Nasiri Rayah	Menufia Beheira, West Beheira, Nubaria and Nasr
Zifta	Mansouria Zaglula	East Dakahlia and Damietta East Dakahlia
	Abbasi Rayah Omar Bey Dahtura	Gharbia, West Dakahlia and Kafr El Sheikh Gharbia Gharbia
Edfina	El-Mahmodia El-Rashidia East El-Rashidia West	El-Behera Kafr El -Sheikh
Farascour	El-Sharkawia El-Salam canal	Damietta West Dakahlia

Table 2-3 List of main canals and areas served

Pumping stations

Besides the gravity diversion of Nile water, water is also diverted by more than 100 major pumping stations along the Nile and its branches (Table 2-4).

Nile reach	Number of pumping stations
Aswan – Esna	60
Esna – Naga Hamadi	8
Naga Hamadi – Asyut	4
Asyut - Delta Barrage	33
Damietta Branch	4
Rosetta Branch	4

Table 2-4 Major pumping stations

Drainage system

The drainage water from agriculture and the effluents from municipalities and industries are collected and transported by an extensive drainage network. This system comprises field drains (open drains or sub-surface drains), collector drains, and main drains which either convey the water back to the Nile or discharge into coastal or inland lakes, or directly to the sea. The drainage system is largely by gravity flow, except for a number of pumping stations in the Northern Delta. The main drainage system in the Delta is given in Figure 2-6. To cope with increasing shortage of irrigation water, reuse pumping stations pump drainage water into irrigation canals where it mixes with fresh water for further downstream use. These pumping stations are located in the Fayoum and the Delta.

Hydropower

Hydropower is generated at the High Aswan Dam, the Old Aswan Dam and the Esna and Nag Hamadi Barrages (Table 2-5).

Hydropower station	Capacity (MW)
High Aswan Dam	2,100
Old Aswan Dam	615
Esna Barrage	90
Nag Hamady	5

Table 2-5 Hydropower stations

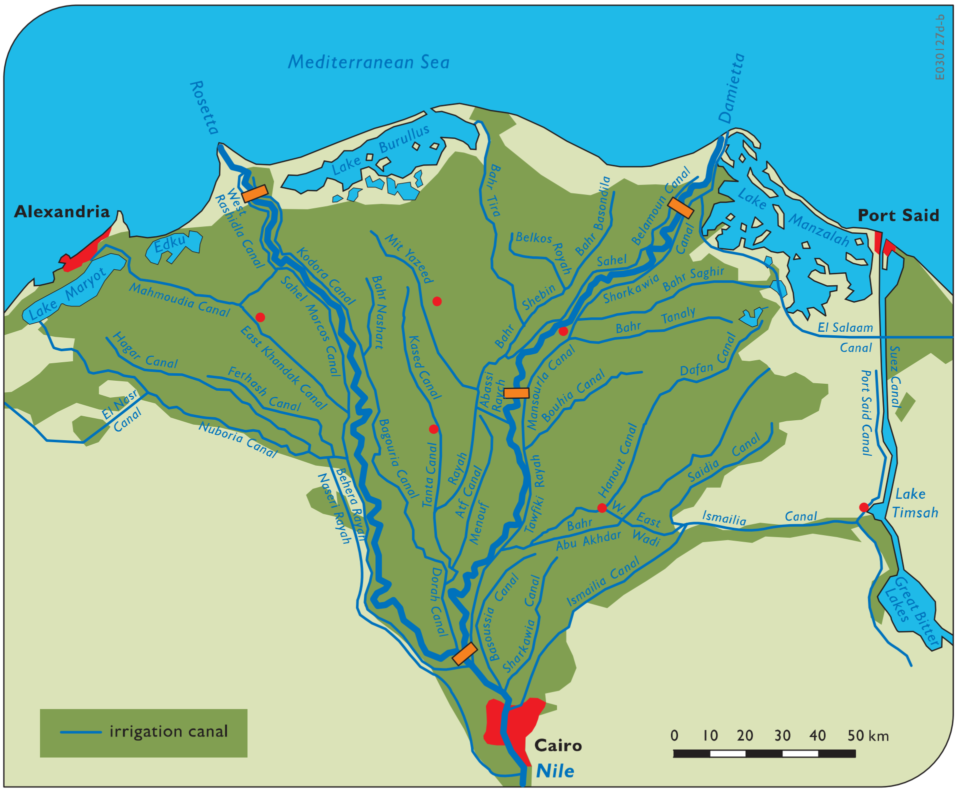


Figure 2-5 Irrigation canals in the Delta

Figure 2-6 Main drainage canals in the Delta

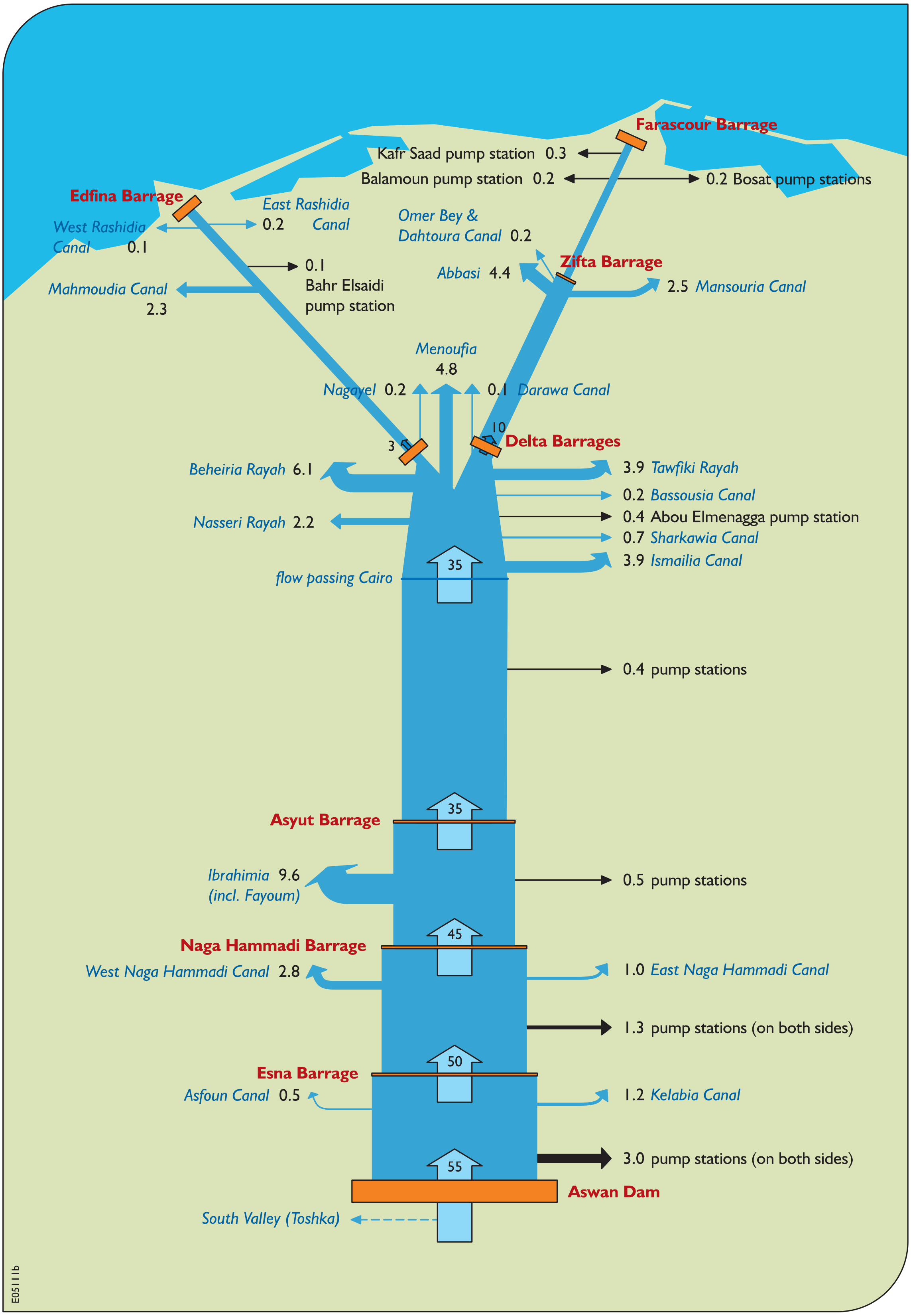


Figure 2-7 Water distribution Nile System (source: NAWQAM project)

Water distribution

Figure 2-7 illustrates a typical water distribution through the Nile System for a Nile discharge of 55 BCM/yr. It shows the order of magnitude only.

2.2.3 Climate in Egypt

Egypt has two seasons: a mild winter from November to April and a hot summer from May to October. In the coastal regions, temperatures range between an average minimum of 14° C in winter and an average maximum of 30° C in summer. Temperatures vary widely in the inland desert areas, especially in summer, when they may range from 7° C at night to 43° C during the day. During winter, temperatures in the desert fluctuate less dramatically, but they can be as low as 0° C at night and as high as 18° C during the day.

The average annual temperature increases in the southward direction from the Delta to the Sudanese border, where temperatures are similar to those of the open deserts to the east and west. Throughout the Delta and the northern Nile Valley, there are occasional winter cold spells accompanied by light frost and even snow. At Aswan June temperatures can be as low as 10° C at night and as high as 41° C during the day when the sky is clear.

Most rain falls along the coast as indicated in Figure 2-8, but even the wettest area, around Alexandria, receives only about 200 millimetres of precipitation per year. Moving southward, the amount of precipitation decreases drastically. Cairo receives a little more than one centimetre of precipitation each year. The areas south of Cairo receive only traces of rainfall.

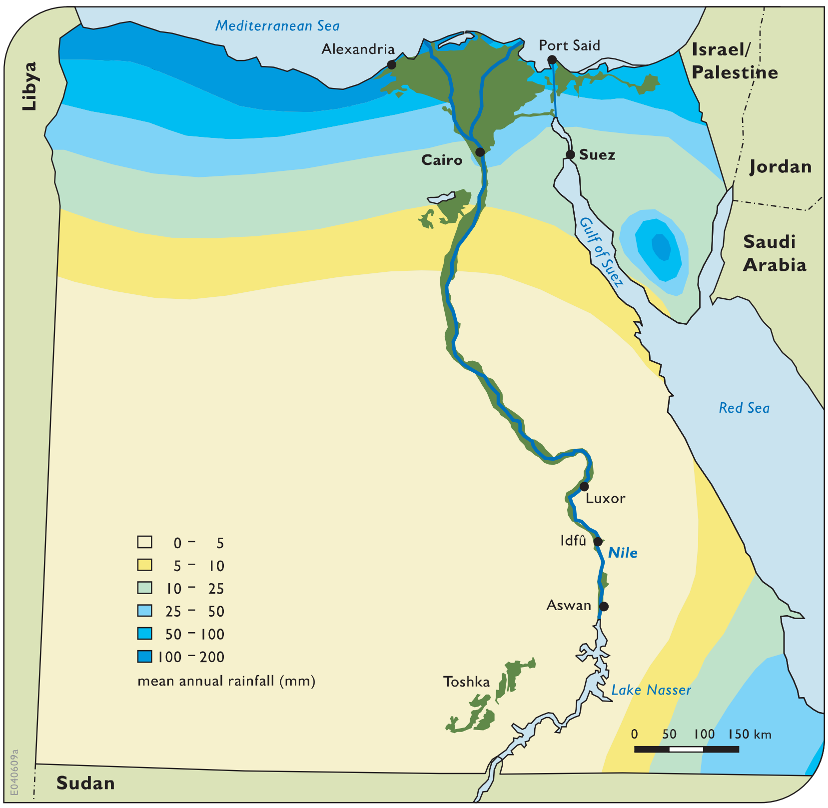


Figure 2-8 Average annual rainfall in Egypt

Some areas receive no rain at all during a number of years and then experience sudden downpours that result in flash floods. Sinai receives somewhat more rainfall than the other desert areas (about twelve centimetres annually in the north), and the region is dotted by numerous wells and oases, which support small population centers that formerly were focal points on trade routes.

A phenomenon of Egypt's climate is the hot spring wind that blows across the country. The winds, known as the *khamsin*, usually arrive in April but occasionally occur in March and May. The winds originate from small but vigorous low-pressure areas in the Isthmus of Suez and sweep across the northern coast of Africa. Unobstructed by geographical features, the winds reach high velocities and carry great quantities of sand and dust from the deserts. These sandstorms, often accompanied by winds of up to 140 kilometres per hour, can cause temperatures to rise as much as 20° C in two hours. The winds blow intermittently and may continue for days, cause illness in people and animals, harm crops, and occasionally damage houses and infrastructure.

2.2.4 Nile water resources at Lake Nasser

Figure 2-9 shows the natural flows of the Nile from 1870 onward. These natural flows are the flows at Aswan, corrected for upstream diversions. Hence, they present the situation in which the Nile were still pristine, without constructions and diversions. It appears that the average natural flows before 1900 where significantly larger as compared with the flows after 1900. The driest sequence of years occurred in the 1980s, when the level in Lake Nasser approached the dead storage level.

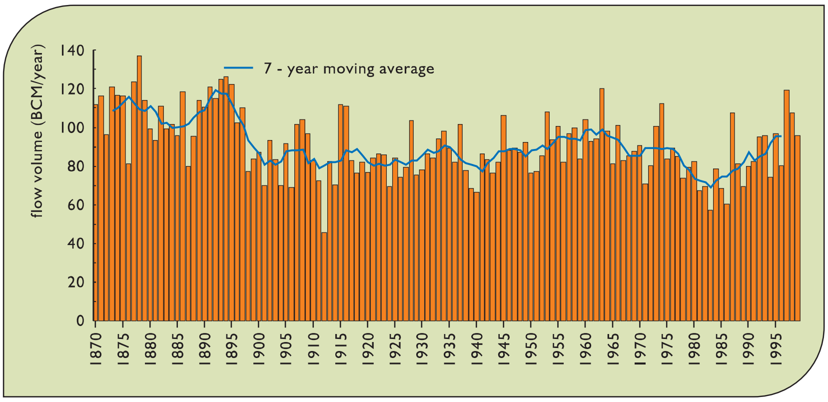


Figure 2-9 Natural flows of the Nile at Aswan (source: Nile Water Sector)

According to an Agreement with Sudan signed in 1959, Egypt's share of the water available from the Nile is 55.5 BCM/yr whereas Sudan's annual share is fixed at 18.5 BCM. These allocations are based on an average natural inflow into Lake Nasser of 84 BCM/yr (period 1900 - 1959) and an estimated 10 BCM/yr of reservoir losses. However, the actual use of Nile water by Sudan during the past period was about 14.5 BCM/yr. Because of this lower abstraction and the higher than average flows of the Nile in recent years, the level in Lake Nasser rapidly rose and significant volumes of Nile water were spilled to the Toshka depression through the Toshka spillway.

The reservoir operation is based on a simple rule: the maximum reservoir level on the 1st of August should not exceed 175m above mean sea level. Any water that has to be released from the HAD to avoid higher water levels is not to be considered as part of Egypt's share of the Nile water.

Toshka Spillway

In case of persistent years with low flow, when the reservoir level drops below about 160m above MSL, corresponding to a reservoir storage of 60 BCM, a sliding rule is applied to reduce the release below the 55.5 BCM/yr. This reduction in release was only applied once during a prolonged dry period in the 1980s. The lowest reservoir level occurred in 1987 and the corresponding release during the 1987/88 season was 52.9 BCM.

2.2.5 Groundwater

Although in terms of quantity the contribution of groundwater to the total water supply in Egypt has been very moderate, groundwater is the sole source of water for people living in the desert areas. Because of limited options to increase the Nile water availability, there has been an increasing interest during the last decade to further develop the groundwater resources.

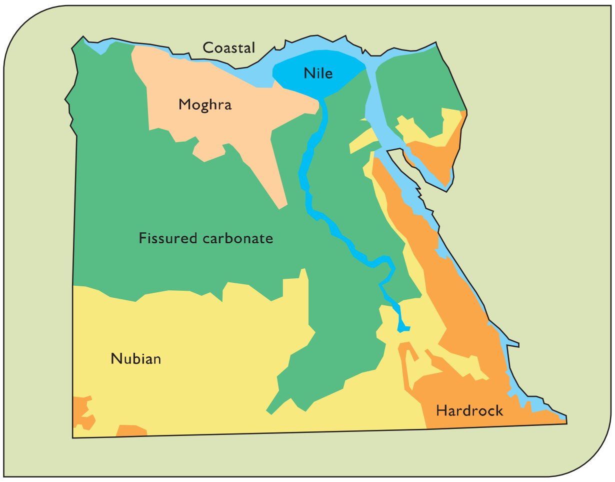


Figure 2-10 The major aquifer systems in Egypt

The major groundwater systems in Egypt are the following (see Figure 2-10):

- Nile aquifer
- Nubian sandstone aquifer
- Fissured carbonate aquifer
- Moghra aquifer
- Coastal aquifer
- Hardrock aquifer

The characteristics of these aquifers are described in more detail in NWRP Technical Reports 15 and 16 (NWRP 2001g and NWRP 2001h). Some major features are summarized below.

Nile aquifer

In terms of abstraction the most important aquifer in Egypt is the Nile aquifer (about 87% of the total groundwater abstraction in Egypt). However, since the aquifer is recharged by infiltration of excess irrigation water, and since the source of this irrigation water is Nile water released at Aswan, the groundwater in the Nile aquifer is not a separate resource.

The aquifer is composed of a thick layer of sand and gravel with clay intercalations. The sediments are covered by a clay cap of varying thickness, up to 50 m in the northern part of the Delta. The high productivity of the wells and the shallow depth of the groundwater table allow the abstraction of large quantities of water (100-300 m^3/hr) with relatively shallow wells at relatively low pumping cost. In some areas the groundwater is used by farmers in conjunction with surface water, especially during periods of peak irrigation demands.

Nubian Sandstone aquifer

Besides the Nile aquifer, by far the most important groundwater body is the Nubian Sandstone Aquifer which covers a total area of roughly 2 million km^2 and extends into Libya, Chad and Sudan. Its northern boundary is a fresh/salt water interface that follows a fault line north of Siwa oasis, crosses the Nile Valley between Minya and Beni Suef and bends north-east into the Sinai. The aquifer is phreatic in the south-western part of Egypt; elsewhere it is confined by a thick cover of carbonate rocks. The saturated thickness of the fresh part of the aquifer ranges from 200 m in East Oweinat to 3,500 m in the Great Sand Sea north-west of Farafra (see Figure 2-11).

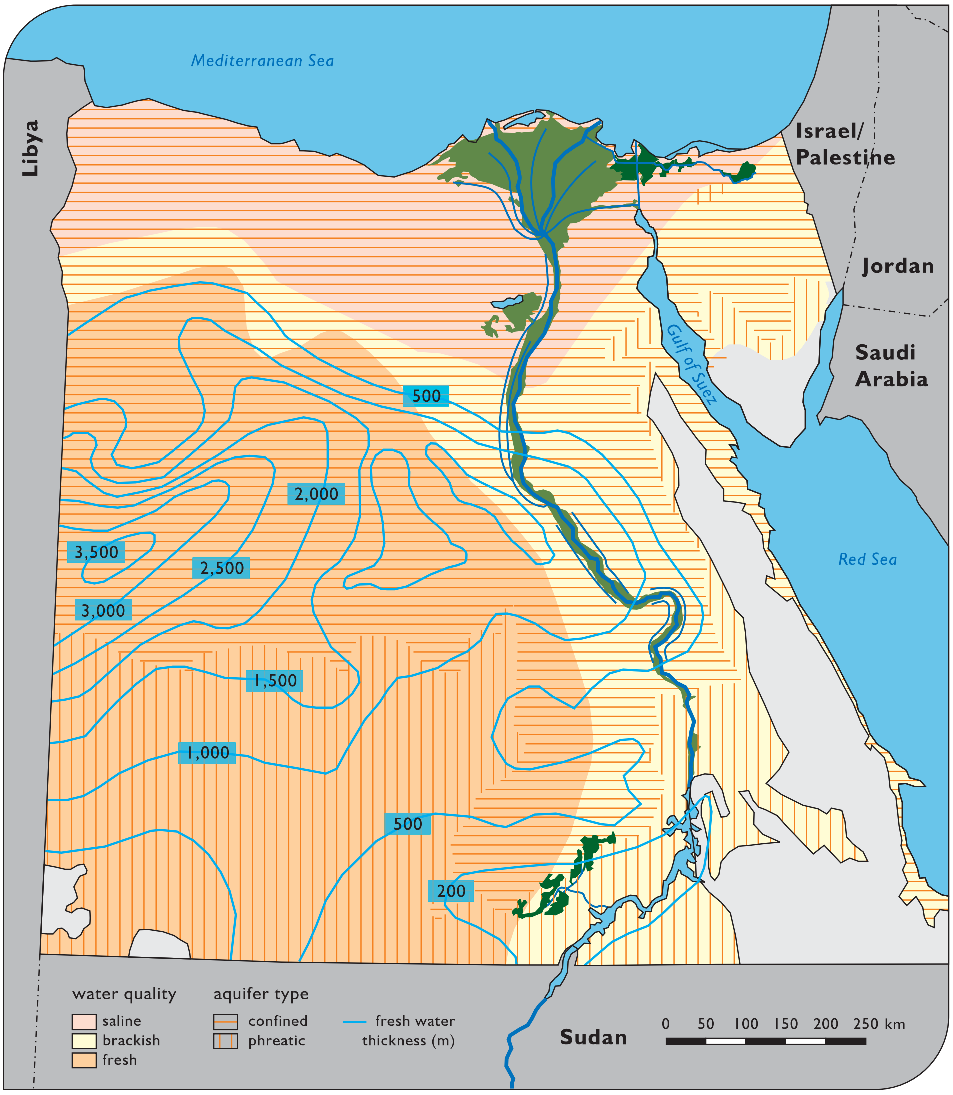


Figure 2-11 Extent and main characteristics of the Nubian Sandstone Aquifer in Egypt

Discharge takes place in the oases in the Western Desert through artesian wells and pumping. The total volume of fresh water stored in the aquifer has been subject of many studies and probably exceeds 150,000 BCM. However, this value merely is of academic interest since development in large areas will not be viable because of the large depth of the groundwater table (up to 2000 m).

The groundwater is of fossil origin and flows in a northern direction. The flow velocity in the aquifer is about 1 m/yr. This means that the travel time from the Sudanese border to the Qattara depression, over a distance of 800 km, would be roughly 800,000 years. During this time many climatic changes have taken place, including wet periods during which the aquifer system has been replenished. The transition to the current arid conditions has started some 8,000 years ago. The age of the groundwater in the central part of the Western Desert varies between 20,000 and 40,000 years which indicates that the aquifer has indeed been recharged by local rainfall.

Fissured carbonate aquifers

The fissured carbonate rocks occupy more than 50% of the surface area of Egypt and act as a confining layer on top of the Nubian Sandstone Aquifer. This aquifer system predominates in the northern part of the Western Desert and is also present in the Eastern Desert (with negligible recharge) and large areas of the Sinai (with recharge from rainfall). The aquifer has not received enough attention as regional aquifer system, irrespective of the fact that many natural springs occur. The aquifer recharge is unknown but is expected to be limited. Because of its low porosity, groundwater occurrence is restricted to isolated pockets of sedimentary deposits, fissures and fault systems. No reliable figures are available about the total groundwater potential. In Siwa the productivity of wells shows a large variation: from 5 to more than 300 m^3/hr.

Moghra aquifer

The Moghra aquifer is found at the surface from Wadi Natrun and Wadi Farigh towards the Qattara depression. It consists of coarse sand, gravel and sandstone with clay and silt stone intercalations. The groundwater flow is in general directed towards the Qattara depression. The aquifer is recharged by rainfall and lateral inflow from the Nile aquifer; the total yearly recharge of the aquifer is unknown. The aquifer contains fresh groundwater only near its eastern border (Wadi El Farigh). The salinity increases rapidly towards the north and west.

Due to the sharp increase in abstractions for groundwater-based reclamation projects and industrial and municipal supply, notably in the western fringes of the Nile Delta, the water quality and sustainability of this resource is at risk. Water levels are dropping and the water quality has deteriorated due to salinization and pollution.

Coastal aquifer systems

The coastal aquifer systems occupy the northern and western coasts. These aquifers are recharged by rainfall. Quantities that can be abstracted are limited due to the presence of saline water underneath the fresh water lens.

Fissured and weathered hard rock aquifer system

This Pre-Cambrian aquifer system, predominates in the Eastern Desert and the Southern Sinai. The aquifer system is recharged by small quantities of infiltrating rainwater.

2.2.6 Other water resources

Other water resources in Egypt are very limited in amounts and often of local importance only. They include water from local rainfall and flash flood harvesting schemes along the Mediterranean and in the Sinai and the use of desalination in the tourist areas along the Mediterranean and the Red Sea. There is some potential to further develop these resources. This will be described in Section 4.3.

2.2.7 Quality of surface water

The water quality of the Nile is affected by agricultural drainage water, containing salts, nutrients, pesticides, herbicides, and industrial and municipal effluents from all towns and villages of Upper Egypt that drain either directly or indirectly into the river. The major quality parameters that are available to assess the water quality in all monitoring points in the Nile system and a number of drains are:

- BOD5
- Dissolved Oxygen
- Suspended Solids
- NH_4-N, NO_3-N, NO_2-N, Total-N, Organic-N
- PO_4-P, Total-P, Inorganic-P
- Chloride
- Faecal Coli Bacteria
- Algae and Diatoms, Chlorophyll
- SiO_3

Water pollution by solid waste

Water quality surveys carried out along the Nile (NWRP, 2001a) showed that the distribution of the values of quality parameters is nearly uniform from Aswan to Cairo. The suspended sediment concentrations increase gradually along the Nile in the downstream direction. Total Dissolved Solids (TDS) ranges from 130 mg/l in Lake Nasser to 200-250 mg/l at the Delta barrages. The pH increases from 7.7 at had to 8.5 in the Nile Delta. The BOD as a result of human activities mainly shows a variable distribution but only occasionally exceeds the standard (especially in the downstream sections) of 6 mg/l. The variability is the result of point discharges and self-purification of the river. As a result the dissolved oxygen drops below the limit of 5 mg/l in exceptional cases only. Nitrate and ammonium hardly exceed the current standards, except for ammonium at one location in Upper Egypt. The spatial distribution of faecal coliform varies strongly. The standard is significantly exceeded during the summer months at a few locations in Upper as well as Lower Egypt.

So far the Nile maintained its self-purification capacity. However, enormous loads of matter are released to the system. To what extent the Nile sediment is contaminated with accumulated constituents is not known.

In the Nile branches the water quality deteriorates in a northward direction due to disposal of municipal and industrial effluents and agricultural drainage as well as decreasing flow. The Rosetta branch receives high oil and grease loadings, nutrients, organic loads, and solids. This is a result of discharging a part of the wastewater of Greater Cairo through the Muheet/Rahawy drain as well as discharges of pesticides and toxic chemicals from other sources. Also, salts, suspended matter and herbicide residues reach the river from agricultural drains.

The Damietta Branch receives nutrients, organic loads, grease and oils as a result of discharge from the Talkha fertiliser industry and drainage of herbicides and pesticides from agricultural drains especially near the Farascour dam. TDS increases in the branches up to approximately 500 mg/l.

Irrigation canals have hardly been covered by water quality monitoring since they are supposed to have a quality similar to that at the point of diversion from the Nile. Most of these canals are major sources for downstream drinking water treatment plants. However, many canals are suffering from the following inputs:

- Industrial and domestic waste (liquid and solid) from canal banks as is the case in for example the Mahmoudia and Ismailia canals.
- Residuals from fertilisers, molluscicides (snail killer, for instance for the control of Bilharziasis) and herbicides which find their way to the irrigation water system.
- Agricultural, domestic and industrial wastewater at locations where reuse pump stations add drainage water to the canals.

The open drain system receives the excess irrigation water that flows through the soil or via sub-surface drainage systems. The quality of drainage water is affected by the type of soils, toxic substances used for pest or herb control and domestic effluents from the banks. Most of the drainage system of Upper Egypt discharges the wastewater into the river Nile, while most of the drains in the Delta ultimately discharge into the Northern Lakes and the sea.

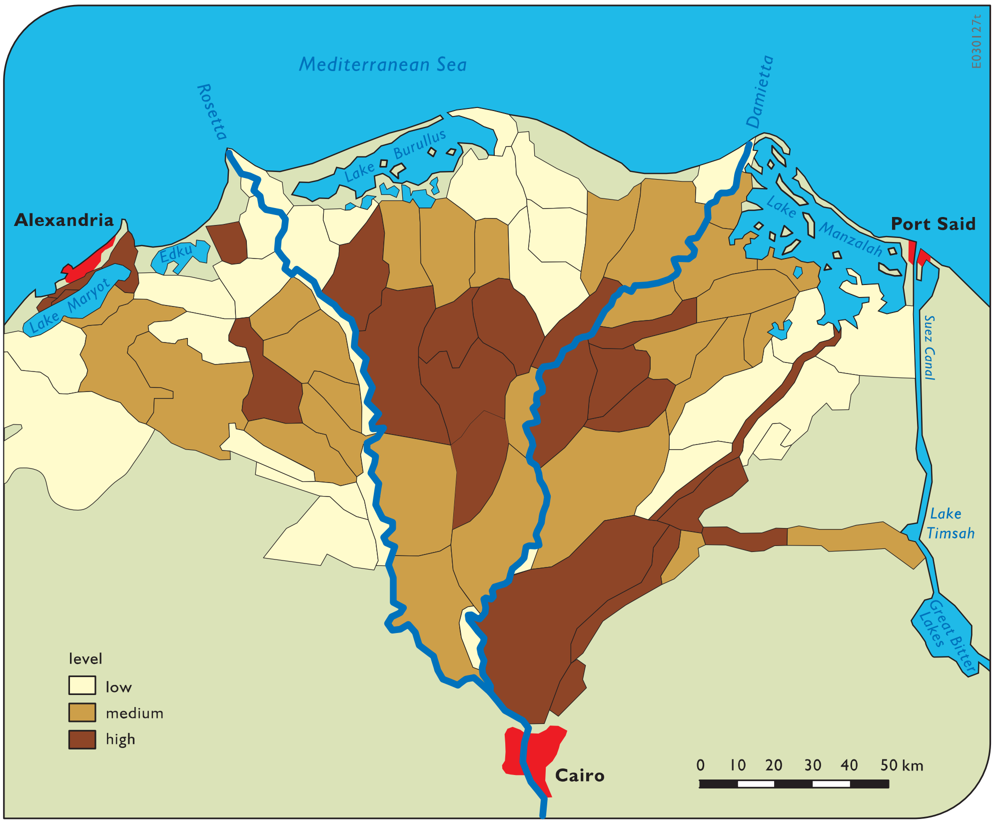


Figure 2-12a Drainage catchments in the Delta with pollution problems

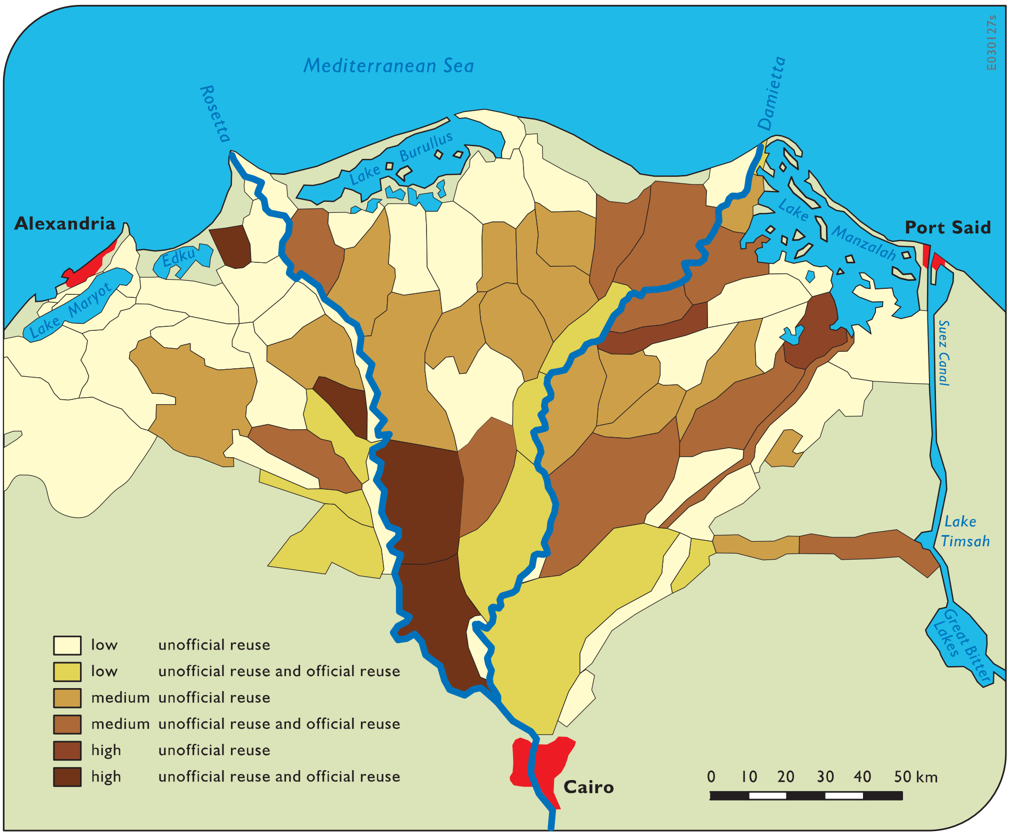


Figure 2-12b Drainage catchments in the Delta with official and un-official reuse

The Task Force on Water Quality Priorities and Strategies of MWRI (MWRI, 2000) has identified priority issues, areas, and actions with respect to water quality in Egypt. In this study groundwater, irrigation water, Nile water as well as drainage water were taken into account. Two priority issues were identified: health and safe reuse. For each a logical set of criteria was developed to assess a risk situation based on (i) the existence of polluted surface or groundwater and (ii) a direct or indirect contact mechanism between the water and human beings.

Geographical maps were prepared to present areas with high, medium or low pollution levels (based on the monitoring data for indicator parameters) and areas with low, medium or high contact mechanisms (Figure 2-12). By combining the geographic distribution, it was possible to identify problem areas based on the criterion that health or reuse has priority (Figure 2-13). This method identifies areas where there is an acute problem because there is both pollution and a contact mechanism. If for example, surface water is highly polluted, but no risk of (in)direct contact exists, then this area will not receive priority from a health point of view. The areas identified by this method are the areas that require priority pollution control action. However, to reduce the pollution levels in the identified problem areas, the action may involve an area upstream from the contact area. Sometimes there is more than one option for action. If, for example, an area is threatened by the use of polluted drain water for reuse, there is the option to stop reuse and the option to reduce the pollution in the drain. Often it will be necessary to choose the least sustainable one (stop reuse) until the more sustainable option (reduce pollution) is achieved, after which the reuse can be resumed. From this assessment the urgency of addressing large urban conglomerates as a priority has become evident.

2.2.8 Quality of the groundwater

The quality of groundwater in the Nile system is generally still fairly good. However, in some shallow groundwater bodies, pollution has reduced its suitability for raw drinking water (presently, about 20% of the groundwater in the Nile aquifer does not meet the standards for drinking water production). Especially in the fringes of the Nile Valley and Delta, where there is no protective clay cap, the groundwater is highly vulnerable to pollution (RIGW, 1999).

Untreated groundwater in the reclaimed desert fringes of the Nile Valley often does not comply with the standards for drinking water due to the following processes:

- Natural halite and gypsum dissolution in the soil
- Gypsum addition to lower the Sodium Absorption Ratio (SAR)
- Nitrate leaching from fertiliser.

In the old lands of the Valley, where the groundwater is protected by a clay cap, the groundwater quality is much better. However, due to reducing conditions, high manganese concentrations are found.

Based on FAO standards (FAO, 1985), groundwater in the newly reclaimed areas will usually exhibit slight to moderate restrictions when used for irrigation. However, the water quality in the reclaimed areas is expected to improve; dissolved salts will be leached out and the application of gypsum will be reduced. Nitrate leaching from fertiliser, however, will continue. The

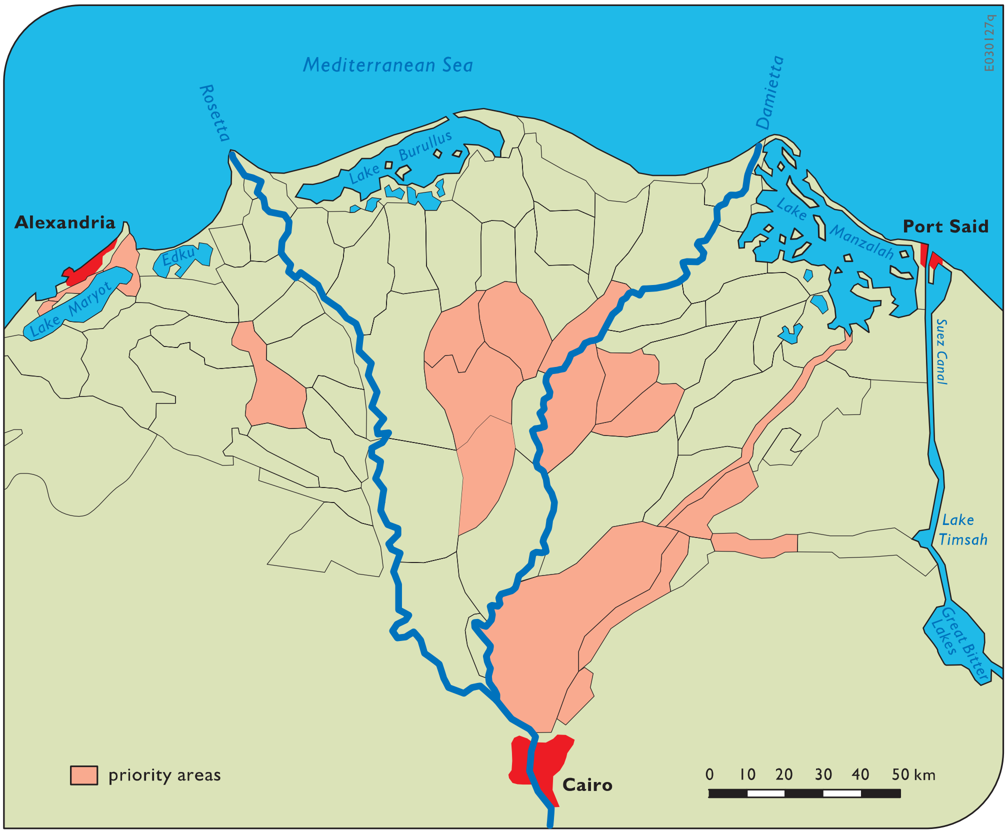


Figure 2-13a Priority areas in the Nile Delta based on health criteria

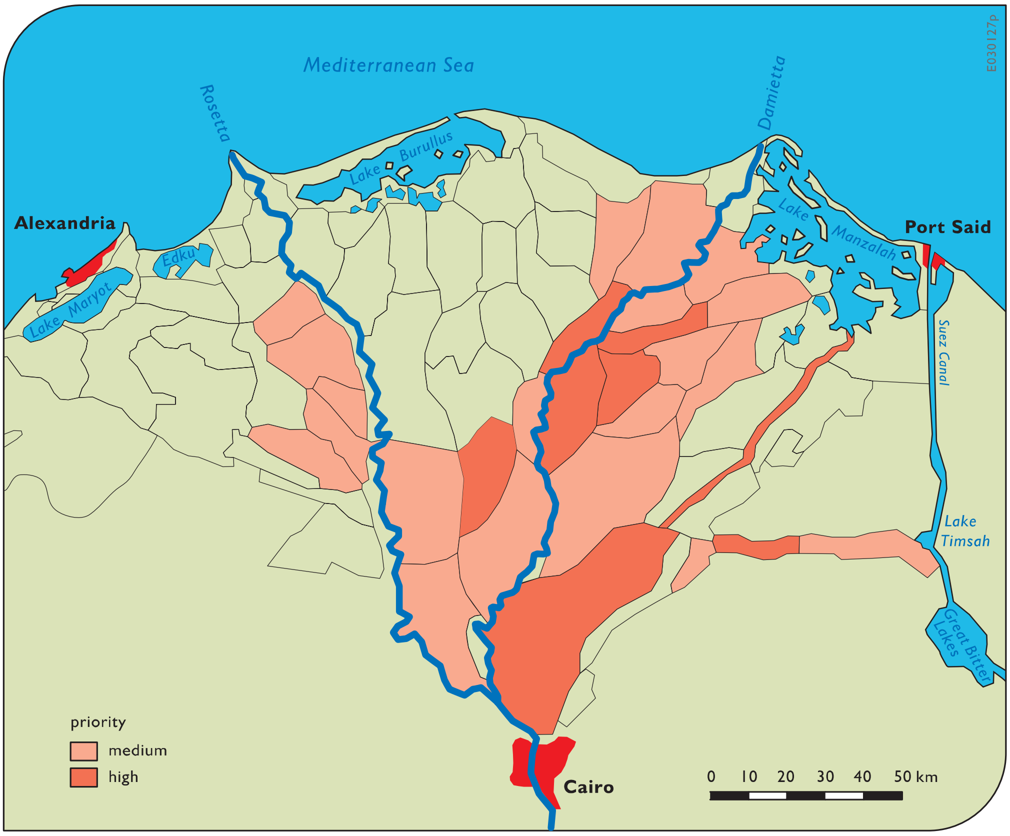


Figure 2-13b Priority areas in the Nile Delta based on the official reuse criteria

contamination plumes below the reclaimed areas will mix with the groundwater below the old lands and ultimately reach the Nile.

The groundwater quality in the Nile Delta is generally better than in the Nile Valley. In about half of the reclaimed areas in the fringes, the critical values for drinking water are not exceeded and groundwater in these areas can be used directly for drinking without further treatment. In the old lands of the Delta, where the groundwater is protected by a clay cap, also relatively high manganese and iron concentrations are found.

Fresh groundwater with a TDS less than 1,000 ppm is dominant in the upper zone of the Nile aquifer occupying the old floodplain of the Valley and the southern part of the Delta. Brackish groundwater (up to a TDS of 5,000 ppm) is found in the lower zone of the Nile aquifer, in the fringes of the Valley and in the northern half of the Delta. Saline groundwater occurs in some isolated pockets in the Valley and Delta and is abundant in the northern Delta. The presence of saline water in the northern part of the Delta is not caused by seawater intrusion. This part of the Delta was submerged around 4000 years ago when extensive lagoons developed, thick muddy clay beds were deposited, and seawater intruded the aquifer. In addition a number of other processes probably occurred (see NWRP Technical Report 16 (NWRP 2001g)).

It is not clear how far inland the deeper aquifer is saline, but up-coning saline groundwater has been reported around larger well fields at a depth of 100 m as far inland as Tanta. On the other hand, data from oil wells suggest the presence of low saline water (TDS 2,500 ppm) at larger depth in the coastal zone as well as offshore. Flowing low saline wells (2,300 to 4,500 ppm) of 100 to 150 m depth have been reported along the coast where the shallow groundwater has a TDS of 35,000 ppm or more.

The water quality in the Western Desert is usually very good, especially in the Nubian Sandstone. The salinity of the fresh part of the Nubian sandstone aquifer varies both vertically and horizontally. South of the latitude of Beni Suef (29°N) the salinity ranges between 100 and 500 ppm. In Kharga and Dakhla the salinity decreases with depth from 1,000 ppm in the upper horizons to 200 ppm in the deepest layers. In Siwa, near the salt water interface, the upper layers of the Nubian sandstone contain fresh water (200-400 ppm), while deeper layers contain hypersaline water (up to 100,000 ppm). The fresh groundwater from the Nubian sandstone is highly corrosive due to the presence of free CO_2 and H_2S and a low redox potential which causes corrosion of well casings, screens and pumps. The common high iron content (2-20 ppm) in most of the aquifer adds to the problems causing clogging of well screens. Incidentally higher nitrate concentrations occur and iron and manganese concentrations sometimes exceed the drinking water standards, notably in Farafra.

The outcropping carbonate aquifers contain brackish water. Fresh water occurs only in areas where the aquifer is recharged, either through infiltration from wadis or seepage from the underlying Nubian Sandstone Aquifer.

In the Eastern Desert and the Sinai the groundwater shows high TDS concentrations. Shallow wells in the Quaternary and the wells in the deeper aquifers have a high salinity which makes the water unfit for human consumption and irrigation. The same holds for the shallow hardrock aquifers in Southern Sinai and the Eastern Desert, which are recharged by infiltrated rainwater. Deeper hardrock aquifers are expected to contain brackish water.

The coastal aquifers in the Mediterranean and Red Sea littoral zone usually contain brackish water. Along the Mediterranean coast, where rainfall replenishes the shallow aquifers, a thin lens of fresh water is found floating on top of brackish or saline water. This thin lens has been exploited on a small scale for thousands of years by the local population. The fragile balance between recharge and discharge should not be disturbed by larger scale developments.

Vulnerability	Pollution load		
	low	medium	high
Low	low	low	medium
Medium	low	medium	high
High	medium	high	high

Table 2-6 Pollution risk classification

The pollution risk of groundwater resources depends on the vulnerability, the type of pollutant and the pollution load (Table 2-6). The RIGW has mapped the intrinsic vulnerability for the main aquifers in Egypt and constructed pollution risk maps for the Nile Delta and Valley based on this table.

Egypt's most vulnerable areas are the fringes of the Nile Valley and Delta where a protecting clay cap is absent and where the aquifer is directly exposed to high pollution loads. This is reflected in the current groundwater quality. The intrinsic vulnerability of the phreatic part of the Nubian Sandstone is also very high. However, this part of the aquifer is located in remote, uninhabited areas in the south of Egypt where the pollution risk is low. In the oases in the Western Desert the Nubian Sandstone aquifer is found at greater depths, covered by carbonate rocks and the pollution risk is low. All wadi and hardrock aquifers are extremely vulnerable and the pollution risk in inhabited wadis is very high. The coastal aquifers are also very sensitive to pollution, mainly from upconing saline water or intrusion of sea water.

Dumping waste in surface water

2.2.9 Sources of pollution

Water pollution is defined as the change in the physical, chemical, radiological, or biological quality of the water resource caused by man or due to man's activities, that is harmful to existing, intended, or potential uses or functions of the resource (Novotny & Olem, 1994). According to this definition, water with natural or background concentrations is not considered polluted, even though the quality does not meet our needs. This could be described as contamination, but not as pollution. On the other hand, if through human activities like irrigation, naturally existing salts are flushed to drains, this can be classified as pollution. Pollution is a side effect of human activities and is therefore subject to control.

Pollution is not always a result of an increased input of matter, but can also result from a decrease in the quantity of diluting water. An example is the increase of salt concentration in irrigated agriculture by evapotranspiration. The expression 'pollution causes' is therefore better than 'pollution sources'. However, as the latter is most commonly used, it will be applied in this section to indicate activities that cause or induce pollution. Major sources of water pollution in Egypt originate from the domestic, agricultural and industrial sectors.

Domestic sources

The total amount of domestic wastewater has been estimated at 4.3 BCM for the year 1997. In a number of cases, municipal and rural domestic wastewater is discharged directly into waterways, often without treatment or with insufficient treatment. The discharge increases year after year due to the construction of water supply networks in many villages. Also, the present expansion of water networks in several towns without parallel construction of new sewerage systems or rehabilitation of the existing ones aggravates the problems and leads to pollution problems of the water bodies and increasing public health hazards. The constituents of domestic and urban input to water resources are pathogens, nutrients, suspended solids, salts, and oxygen demanding material. Pathogens are the main problem for public health.

Direct use of waterways for laundry, cleaning and bathing adds to the impact of the pollution problem, as does the direct disposal of solid waste on the banks of the waterways.

Agricultural sources

Salt is one of the most prominent pollutants that results from irrigated agriculture. Salt is accumulated in the soil or transported to the drainage water. Excess irrigation water can also mobilise salts that were already present in soils and underlying layers. This can result in significant salt fluxes to canals or drains (e.g. in the fringes of the Western Delta).

In addition to salts, the agricultural drainage water contains agrochemical residues (from fertilisers, pesticides, herbicides, etc.) that are serious contaminants for downstream water users. Part of this pollution results from the cleaning in the waterways of equipment or storage vessels that were used to store or spray agro-chemicals. The disposal of liquid animal waste pollutes both surface and groundwater. In groundwater, agricultural nitrate is a notable problem.

In summary the following major impacts of agricultural activities on water quality can be identified:

- increased salinity

- deterioration due to chemical fertilisers and pesticides
- eutrophication of water bodies due to increase in nitrogen and phosphorus nutrients from fertilisation

Type of industry	Potential pollutant
Food production	BOD/COD, ammonia, suspended solids
Textile	Hydrocarbons, heavy metals
Paper and graphical industry	BOD/COD, hydrocarbons, phenols, heavy metals
Chemical plants	Hydrocarbons, chlorinated hydrocarbons, heavy metals, phenols, cyanide, etc., BOD/COD
Oil and soap industry	BOD/COD
Metal and machinery industry	Heavy metals, acids, hydrocarbons
Energy production	Hydrocarbons, polycyclic hydrocarbons, heat
Construction	Hydrocarbons
Small scale urban activity	BOD/COD, hydrocarbons

Table 2-7 Overview of some potential pollutants per type of industry

Industrial sources

Although modern industry has existed in Egypt since the early 19th century, industrial growth rapidly expanded in the second half of the 20th century. Food processing, textile manufacturing, and cement and fertiliser production traditionally were the main industries. Industrial development in the early 1950s took a new course, shifting away from the traditional agrarian base to heavy industries such as steel, machinery, and chemicals. An important feature of Egypt's industrialisation at that time was the concentration of new industries in the metropolitan areas in the Nile Delta, north and south of Cairo, particularly in Helwan and Shoubra El Kheima, Kafr El Zayat, Talkha, and in the Alexandria metropolitan area. Extension of industry has been mainly planned in new industrial areas in the desert adjacent to the Nile Valley and Delta.

Many industries in Egypt use older and heavily polluting technologies. Few industries are equipped with appropriate treatment facilities. Many of the small industries and even some of the larger ones are discharging untreated wastewater to a public sewer system. Industrial

Industrial pollution

wastewater with toxic components may negatively affect the treatment efficiency of municipal treatment plants. Many other industrial facilities still discharge their wastewater only partially treated or not treated at all to the surface water system. This means that a large number of organic and inorganic substances can impair the water quality in the Nile system. The main groups of industries and their potential pollutants are shown in Table 2-7.

The new industries in the desert areas tend to apply cleaner technologies to protect the environment. The new industrial cities are mostly supplied with water from the Nile system; their effluent flows, however, do not return to the Nile system. Part of these new cities have been facilitated with sedimentation or evaporation ponds for primary treatment. These ponds might become environmental hazards, because part of the waste load is toxic and can easily leak into the groundwater system because of prevailing light soil types.

Contamination by natural substances

Although not classified as pollution, natural contamination of the water resources may limit the various user functions. Measures are possible to reduce the impact or to prevent the use of the contaminated water. Two examples of natural contamination in Egypt are:

- *Brackish to saline groundwater in the Northern Delta.* As a result of different sea levels and climatic conditions in the past, there are shallow aquifers in the Delta (but also elsewhere) that contain brackish or even saline water. This water will flow to the drains or to groundwater wells.
- *Dissolution of iron and manganese from sedimentary formations released to groundwater under reducing conditions.* This is a natural process that over millions of years caused the iron deposits in Baharia Oasis for example. The same process still causes high concentrations of iron and manganese in groundwater in different parts of the country, which is considered undesirable by the users.

2.3 Socio-economic system

2.3.1 Population

Population growth is certainly among the most pressing challenges that Egypt is facing in its development. Concerns about the rapid population growth have been raised at the policy level since the 1930s. After the 1952 change of government this official concern was expressed in the National Charter, where high population growth was seen as a major impeding factor to raise the living standard.

The country has a long history of population censuses. In modern times, the first census was held in 1800, recording a population of 2.5 million. The next census was held around 1850, finding 4.5 million. From 1882 onwards population censuses were held with 10-year intervals until 1947. The Central Agency for Public Mobilisation and Statistics (CAPMAS) held its first census in 1960, followed by the second one in 1966. Since then the Population, Housing and Establishments censuses are carried out at 10-year intervals, the latest in 1996. In that year the total population in Egypt was 59.3 million. By mid-2003 it has increased to 72.5 million (irrespective of nationality, not counting the more than 2 million Egyptians living abroad).

The annual population growth rate decreased from 2.8% in the period 1976-1986 to 2.1% in the period 1986-1996, and has decreased further to 1.9% (2003 estimate). In relation to arable land and water, Egypt's population density is among the highest in the world: 97% of the population lives in the Nile Valley and Nile Delta, which covers only 4% (40,080 km^2) of the total area of Egypt, resulting in an average population density of 1,435 persons per km^2. According to the 1996 census, Greater Cairo had a population of 10.7 million (CAPMAS, 1998) and, overall in Egypt, urbanisation had reached 43% by 1996, according to official figures.

Life expectancy at birth has increased from 42 years in 1950 to 70 years (male 68, female 73; 2003 estimate). Infant mortality dropped dramatically from 200 per 1,000 births to 44 during the same period and was estimated at 35 in 2003. With 34% of the population being younger than 15 years, changes in fertility encouraged by population policies will have effect in the long run only.

The total fertility rate peaked at more than 7 in the early 1960s, but has decreased to 5.28 in 1979/80, to 3.63 in 1993/95 and is estimated at 3.0 in 2003. There are large differences per region: in 1993/95 the urban areas in Lower Egypt had a TFR of 2.66 only, whereas rural Upper Egypt still had 5.19 (CAPMAS, 1999).

A population of more than 72 million

Family planning poster

Variant	1996 census	2002	2007	2012	2017
Low			71.0	76.2	81.0
Medium	59.3	65.8	71.8	77.5	83.1
High			73.1	80.1	86.9

source: CAPMAS, excluding Egyptians living abroad

Table 2-8 Population projections for FYP (million)

Variant	1996 -2001	2001 -2006	2006 -2011	2011 -2016	2016 -2021
Low		2.6	2.3	2.1	2.0
Medium	3.1	2.8	2.5	2.3	2.2
High		3.1	2.9	2.7	2.6

source: CAPMAS

Table 2-9 Total fertility rate projections 1996-2021

Family planning programme

In 1966 Egypt established a national family planning programme, which aimed at reducing fertility and thus a reduction in population growth. A national population policy, however, was not formulated until 1973. In 1995 this policy was articulated further to recognise the simultaneous importance of the four interrelated dimensions of Egypt's population problem: growth, spatial distribution, characteristics (literacy, etc.) and structure. This refined policy stressed the need to improve population characteristics within the context of overall socio-economic development. The family planning and maternal and child health services are executed by the Ministry of Health and Population (MoHP) as part of a broader women's reproductive health programme. The prevailing religion in Egypt, Islam, does not discourage family planning.

Population projections

On behalf of NWRP, the CAPMAS Population Studies and Research Centre prepared in 1999 an expected/medium, high and low population forecast for the period 1999-2017, based on their latest census data. These three variants exclude Egyptians living abroad and are presented in Table 2-8 and in Figure 2-14. The 2003 population estimate of 72.5 million suggests that even the high estimate was conservative.

The Total Fertility Rate is expected to decline further, as indicated in Table 2-9. Fertility can be influenced by policy measures and is therefore the focal point for population policies and strategies. Its change over time is the main factor in population growth projections. The changes in fertility and mortality, however, can only be expected to be gradual, making population forecasts rather accurate on the short term.

The resulting average annual population growth rates for the period 1996-2017 are 1.88% for the high variant, 1.66% for the medium variant and 1.54% for the low variant. In the medium variant, life expectancy at birth would increase from 66 years now to 77 in 2050. Infant mortality and mortality of children under 5 years of age would further drop from 51 and 65 per 1000 births to 10 and 11 respectively.

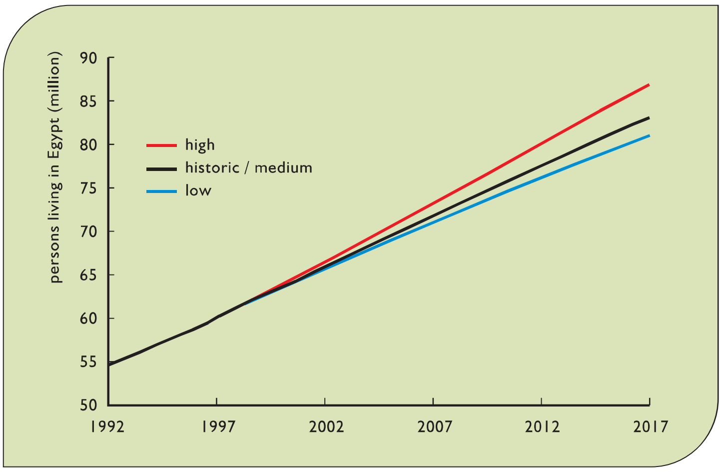


Figure 2-14 Population projections

Markas-level population figures were obtained from CAPMAS, showing the 1996 census results. The totals per governorate were compared with the 1986 census data, both urban and rural. From these data *Markas*-level population projections (urban and rural) have been prepared for the low, medium and high scenario, taking the difference in growth in the governorates into account. The results were adjusted to accommodate the planned expansion of existing new cities from 0.96 million inhabitants in 2000 to 8.8 inhabitants by 2017, as provided to NWRP by the Ministry of Housing, Utilities and New Communities. Similar calculations have been made for 2000 to enable the Survey on Municipal and Industrial Water and Wastewater, executed for the NWRP project, to extrapolate the collected 2000 data to 2017.

It has been assumed that the expansion of the agricultural areas in Toshka and El Salam would attract 1.75 million persons, mainly from other Governorates. For the purpose of water resources planning, assumptions had to be made at governate level about the reallocation of people. This included estimates of the number of inhabitants for the planned expansion of the new cities and assumptions for the population density in the rural areas, taking into account the differences between governorates with respect to population characteristics. The analysis resulted in an estimated total reallocation of 5.52 million persons between governorates and furthermore a net shift from rural to urban of 4.4 million persons was assumed. The proportion of the rural population has been lowered slightly from 57% in 1996 to 52% in 2017 because of the rural to urban reallocation. Detailed population projections are presented in (NWRP 2001d).

Labour force and employment

The labour force is estimated at 20.6 million (2001), with 29% engaged in agriculture, 22% in industry and 49% in the services sector including government. Unofficial estimates place Egypt's jobless rate in the 15%-25% range, about twice the official unemployment rate of 12% (2001 estimate). Some 800,000 new people enter the work force every year. Unemployment in Egypt is therefore concentrated amongst young people. From these unemployed young people 90 percent have a university or high school diploma. Many of them are from farming backgrounds but lack land.

Government services account consistently for 8% of GDP, a level believed to be too high to be sustainable in the long run. The resulting large bureaucracy is a legacy of four decades of nationalisation from the 1950s.

Macro-economic effects of population growth

At Cairo University (Khorshid, 1996) an attempt has been made to quantify the effect of population growth on economic development. The model analysis shows an increase of real per capita GDP in 2009/10 of 8% for the low population projection compared to the high projection. Based on historic family planning costs, the cumulative extra costs between 1993 and 2015 to lower the total fertility rate sufficiently to meet the low population projection are estimated at less than LE 1 billion, making the investment in family planning extremely worthwhile economically.

Investments and exports would be positively affected by the change from the high to the low population scenario, while total public and private consumption and imports would decline. Costs of education and other social services including food subsidies, government housing expenditures, water and sewerage, would be much lower in the low population scenario, since in the high scenario, households are larger and there are 24,000 more of them by 2015. In terms of agricultural area, there is only 0.13 feddan (500 m^2) per capita available now, which would decrease to 0.09 feddan (380 m^2) by 2017 due to population growth if there would be no expansion of agricultural area. In terms of water, the situation is also critical, with less than 900 m^3 available per capita per year for all purposes today, which will decrease to 670 m^3 per capita per year by 2017 if no additional water is made available.

2.3.2 Macro-economic conditions

The Egyptian economy has made remarkable progress in the 1990s, as the government has implemented reforms under an IMF stabilisation programme. The government also has accelerated the privatisation of state-owned enterprises, whose losses were a major drain on the state treasury, and liberalised rules for foreign investment, resulting in greatly increased foreign business interest in Egypt. Subsidies have been cut (except for a few basic items such as staple foods). Budget deficit almost disappeared in 2000, but is expected to rise to 6.7% in 2004, lifting domestic debt to a high level of 71% of the Gross Domestic Product (GDP).

GDP 2001-2002	Total	Public	Private
in billion LE	**299**	**71**	**228**
GDP (in %)	**100**	**24**	**76**
Agriculture	**17**	**0**	**100**
Industry	**32**	**26**	**74**
• petroleum & derivates	5	79	21
• electricity	2	1	99
• construction	5	41	59
• mining & other	20	11	89
Services	**51**	**30**	**70**
• transport & communication	7	16	84
• Suez canal	2	100	0
• trade	18	3	97
• finance	4	67	33
• insurance	0	56	44
• hotels & restaurants	1	2	98
• government	8	100	0
• other	11	6	94
source: CAPMAS 2003			

Table 2-10 GDP per sector (in billion LE and %)

The structure of the Egyptian economy is presented by sector in Table 2-10, showing also the distribution over public and private sector. The agricultural sector, which represented 40% of GDP in 1960, now only produces 17% of GDP and is almost completely in private hands. The industrial sector produces 32% of GDP of which 26% is still in public hands, including most of the power sector. The services sector (including government) is, at 50%, the largest sector.

The economic growth has been stable in the period 1996 till 2000 and increased in real terms from 5 % in 1995/96 to 6 % in 1998/99. Economic growth slowed down after 2000 due to global economic recession to a five-year low of 1.6% for the fiscal year ending 2002. In 2003 a growth of 2.9% was achieved and for 2004 a growth of 3.6% is expected with an upward trend towards 5.5% by the end of this decade. Real GDP growth is rather unevenly distributed over the sub-sectors and between the public and the private sector. In 1998/99 the Agriculture sector showed the same growth as in the previous year which is (at least in value terms) larger than the population growth. The private part of the Industrial sector was doing well, whereas the public part showed a decline. This may partly be due to the ongoing privatisation. The Mining sector was affected by low oil prices; the Tourist sector (Hotels & Restaurants) showed a strong recovery from the Luxor (1998) incident and again from the 'September-11' (2001) incident. The Suez Canal revenues increased slightly.

The GDP per capita (expressed in 1996/97 LE) increased 4% from le 4,126 in 1997/98 to LE 4,297 in 1998/99. The corresponding values in terms of USD/day are 3.3 and 3.5. In terms of purchasing power parity the Egyptian GDP per capita is almost USD 11/day (2002 estimate). While looking at these data on GDP one should bear in mind that there is an extensive informal economy in Egypt. This informal economy comprises all small street vendors, cleaners, gardeners, etc. who's economic activities are not registered by the official statistics.

The government's economic plans for the coming years largely follow the same pattern as for the previous years regarding investment levels, revenue allocation and growth expectations. The medium term objective is to achieve a consistent GDP rate of growth of 6%.

From May 1991 to mid 2000 the exchange rate of the Egyptian Pound against the United States Dollar was (kept) stable at about USD 1 = LE 3.4, but was lowered to about USD 1 = LE 3.8 at the end of 2000 and to LE 4.6 in 2002 and reached LE 6.2 in May 2004. Inflation (consumer price index) was in double digits in 1993, but has been largely controlled since then and was 4.2% in 1998 and below 4% in 1999 but up at 4.3% in 2002. The government intends to keep inflation around 4% over the next few years and will not attempt to reduce it further, as this could run the economy into recession.

Egypt's oil export revenues declined by about one-third in 1998 due to a fall in world oil prices, contributing to a deterioration in Egypt's current account balance. These prices made a strong recovery in 2000. Due to major recent discoveries, natural gas is likely to be the primary growth engine for Egypt's energy sector for the foreseeable future. Natural gas production was about 93 million m^3 per day in 2003 and is expected to rise to 140 million m^3 per day in 2007, with much of the increased volume being exported as liquefied natural gas (LNG).

The private sector is expected to contribute 76% of GDP, up from 65% in 1996/97 due to the comprehensive deregulation programme (simplified registration and customs procedures). The level of investment will, at 19%, remain below the level generally considered necessary to generate sufficient employment. This low investment will be caused by a slowing-down in privatisation and a less than ideal business environment (still high tariff and transaction costs, low investment incentives, complicated tax administration, inefficient dispute settlement, overcrowded ports, etc.). The private sector is still predominantly active in the small and medium enterprises, leaving the large enterprises mainly to the public sector.

Egypt's long-term macro-economic prospects look favourable, with progress set to accelerate on such structural issues as privatisation, trade liberalisation, and deregulation. Egypt's main challenge is matching employment growth to the estimated 800,000 new job seekers coming into the labour market each year. To lower unemployment, Egypt needs to maintain a high rate of GDP growth and to bring in more foreign investment.

For the Government to achieve its aim of sustainable annual GDP growth of 6%, driven by exports and private sector initiatives, much more effort will have to be made to improve the environment for investment. Still low savings and investment rates (16% and 19% respectively) mean that significant levels of growth cannot be generated domestically, and therefore foreign investment has to be attracted.

The manufacturing sector expects rising economic growth, higher productivity, increased sales to domestic and international markets and stable inflation, according to the Industrial Barometer, a survey conducted by the independent Centre for Economic Studies. In the NWRP an economic growth of 6% is assumed in the most likely scenario. In the light of more recent developments, this seems to be slightly on the optimistic side.

2.3.3 Agriculture

Agriculture in Egypt is almost entirely dependent on irrigation from the Nile since there is no significant rainfall except in a narrow strip along the Mediterranean coast. The agricultural land base consists of old land in the Nile Valley and Delta, rain fed areas, several oases, and lands reclaimed from the desert since 1952 (the New Lands). The total irrigation area in 1997 was

Rural area in the Delta

	Old lands (6.2 mln feddan)			New lands (1.6 mln feddan)			Total (7.8 mln feddan)		
	Area 1000 fed	Prod. 1000 t	Value mln LE	Area 1000 fed	Prod. 1000 t	Value mln LE	Area 1000 fed	Prod. 1000 t	Value mln LE
Total crops	**11,982**	**51,693**	**33,605**	**2,898**	**11,980**	**9,340**	**14,880**	**63,673**	**42,946**
Grains	5,650	17,187	11,012	845	1,546	1,001	6,495	18,733	12,013
Pulses	401	533	618	74	82	99	475	615	717
Fibres	823	754	2,074	0		0	823	754	2,074
Oil seeds	137	654	227	89	92	142	226	746	369
Sugar	360	14,823	1,543	25	438	57	385	15,261	1,600
Vegetables	1,138	13,220	7,658	820	6,625	3,953	1,958	19,845	11,611
Fodder	2,905	72	5,717	448	7	775	3,353	79	6,492
Tree crops	500	4,450	4,264	550	3,190	3,194	1,050	7,640	7,458
Other crops	68		493	47		119	115		613
Cropping intensity		1.93			1.43			1.90	

source: Ministry of Planning, Annual Plan 1999/2000

Table 2-11 Cropped area, production and value, 1997/98

	Old lands			New lands			Comparison new / old		
	Area 1000 fed	Yield t/fed	Value LE/fed	Area 1000 fed	Yield t/fed	Value LE/fed	Area %	Yield %	Value %
Total crops	**11,982**	**4.31**	**2,805**	**2,898**	**4.13**	**3,223**	**24**	**96**	**115**
Grains	5,650	3.04	1,949	845	1.83	1,184	15	60	61
Pulses	401	1.33	1,540	74	1.11	1,344	18	83	87
Fibres	823	0.92	2,520						
Oil seeds	137	4.78	1,656	89	1.03	1,593	65	22	96
Sugar	360	41.18	4,286	25	17.52	2,278	7	43	53
Vegetables	1,138	11.62	6,729	820	8.08	4,821	72	70	72
Fodder	2,905	0.02	1,968	448	0.02	1,731	15	65	88
Tree crops	500	8.90	8,528	550	5.80	5,807	110	65	68
Other crops	68		7,255	47		2,538	69		35

	Proportion per crop, area and value				Relative proportions (> 1 indicates more on new lands)	
	Old lands		New lands			
	% Area	% Value	% Area	% Value	Area	Value
Total crops	**100**	**100**	**100**	**100**		
Grains	47	33	29	11	0.62	0.33
Pulses	3	2	3	1	0.76	0.58
Fibres	7	6	0	0		
Oil seeds	1	1	3	2	2.69	2.25
Sugar	3	5	1	1	0.29	0.13
Vegetables	9	23	28	42	2.98	1.86
Fodder	24	17	15	8	0.64	0.49
Tree crops	4	13	19	34	4.55	2.69
Other crops	1	1	2	1	2.86	0.87

source: Ministry of Planning, Annual Plan 1999/2000

Table 2-12 Comparison of agricultural production in New and Old Lands, 1997/98 about 8 million feddan and the rainfed areas along the Mediterranean coast cover about 0.12 million feddan. Egypt's land is generally highly productive and, in combination with good climatic conditions (maximum sunlight, cool winters) ideally suited for intensive cultivation with a large variety of crops. The cropping areas, productions and values of the major crops are summarized in Table 2-11.

In terms of water use, an important issue is whether the expansion of the New Lands comes at the expense of less water being available for the Old Lands. As can be seen in Table 2-12, (columns upper right), productivity per crop is much lower in the New Lands than in the Old Lands. Grains in New Lands produce about 60% of the yields of grains in Old Lands; vegetables, tree crops and fodder 65%-70%; sugar less than half; pulses and old seeds around 85%. This is expected to improve with time, but initially, newly reclaimed lands do not achieve the yields of the older lands. Expansion into New Lands is considered necessary for agricultural expansion and to accommodate the growing population. To the extent that the high productivity of the Old Lands has not yet been met in the New Lands, this represents a chance for expansion of output, even without massive additional investment.

In spite of the lower productivity for each crop (both in ton/feddan and in LE/feddan), the overall average value of production per feddan is higher for the New Lands. The only way this can be true (assuming roughly equal prices for any given crop produced) is that the mix of crops produced in the two types of areas is different, with the New Lands favouring the higher value crops. This is, in fact, the case as can be seen in the lower part of Table 2-12.

The higher-value crops favoured in the New Lands are particularly tree crops (fruits) and vegetables (together a little less than 50% of the planted area, but 75% of the value of production). Tree crops and vegetables together amount to less than 15% of the area and about 35% of the value produced in Old Lands.

Food self-sufficiency

Since 1987, the Ministry of Agriculture (MALR) does not interfere with the farmers' crop choice, except for rice and sugar cane. Egypt currently imports about 50% of its wheat and varying proportions of other agricultural commodities and proces-sed food, whereas rice, potatoes, cotton and citrus are exported. Although Egypt is one of the world's largest food importers, this import accounted for only about 27% of the total import bill in 1997 (NWRP, 1999a).

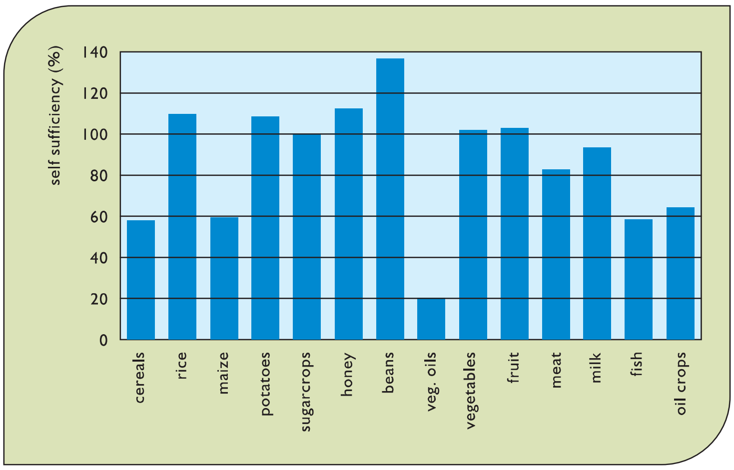


Figure 2-15 Self-sufficiency in major food items (2001) Source: FAO (food balance), 2001

Food self-sufficiency is the ratio between the production and con-sumption. The present agricultural strategy is not based on self-sufficiency but on food security, using Egypt's competitive advantages (APRP, 1998). Maximising food self-sufficiency in 2017 through measures would result in the production of large quantities of basic staple grains, which are relatively low-value in the international market.

Egypt is increasingly in a position to produce higher value food crops (e.g. fruits and vegetables) and non-food crops (e.g. flax and cotton) and trade them to purchase staples and have additional revenue and employment as well. Maximising national income is therefore considered a more reliable approach to food security than self-sufficiency. The large discrepancy in the balance of payments between the import bill and export proceeds is probably a larger threat to economic sustainability and thus to food security. This trade imbalance could best be tackled by promoting exports rather than by curbing (food and fodder) imports. Thus, food policy should focus on making the best use of all productive resources, which for agriculture include: land, water, labour, climate and the proximity to vast export markets by growing crops for which it has a comparative advantage (NWRP, 1999a). Figure 2-15 shows the self-sufficiency in major food items in 2001.

Other policy developments in agriculture

The agricultural sector has already implemented more reforms in terms of privatisation and liberalisation than any other sector in the economy, thereby generating jobs, investments and increased exports. Yet there is scope for further policy reform that would increase domestic production, export revenues and private sector jobs.

This scope for policy reform in the agricultural sector has been the subject of a Vision Workshop organised by APRP (RDI, 1999). In this workshop representatives of various ministries, APRP and USAID discussed their vision on the agricultural and agribusiness sector in 2003, and worked out a common view about the desired direction of change. The items in that vision that are important for NWRP are briefly presented below, including how these points are taken into account in NWRP.

Land

Full property rights on lands should be established as this will mean the possibility for buying, selling, leasing, etc, which is essential for maximizing the use of the land. It would also allow access to medium and long-term credit, increase investment and agriculture and create jobs. In the new lands, especially of Toshka, private sector large scale investment in horticultural production for export is envisaged.

Institutions

Liberalisation and privatisation of agricultural institutions would lead to overall employment increase after an initial transition. Private associations and rural organisations remain crucial to public/private policy dialogue and to information management and dissemination, as well as to efficient technology transfer. Cooperatives, Water User Associations and Community Development Associations will use their great potential to empower their members. The regulatory environment currently restricting the development of these institutions will be adapted.

Centre Pivot irrigation system on the New Lands

Pest management

Pesticides are an integral part of the input package for all crops. The full liberalisation of pest management services to all crops, including and especially cotton, will eliminate the more than LE 125 million in subsidies that the GoE currently provides for cotton pest control. Paying the full costs of pest control will move farmers towards using pesticides more judiciously. The degree to which agricultural drainage water can be reused depends also on its content of pesticides. Inland fisheries are presently severely affected by pesticides. Although there are attempts to use integrated pest management on a larger scale, pesticides will remain to be applied in agriculture. It is therefore imperative that the GoE vigorously regulates their production, import and use. Registration of pesticides, consistent with international standards, will make it easier for Egyptian farmers to export while maintaining a high degree of protection for people and the environment.

Horticulture

Agriculture exports account for almost 25% of total exports, yet only 5% of horticulture production is now exported. As improved systems and knowledge allow for increase in horticulture exports, the total impact on exports could be substantial. Horticulture is labour-intensive, capable of creating large numbers of new jobs on small farms and large farms, and in marketing and processing. Horticulture uses irrigation water efficiently, producing the highest value of output per unit of water input. The horticulture sub-sector is clearly under-exploited. Egypt has the comparative advantage of fertile soils, favourable climate, skilled farmers, and proximity to major markets. The country now needs to develop a dynamic and significant horticulture industry. By specialising in a few high-valued horticultural products, Egypt will be able to use its comparative advantage to its fullest potential. The NWRP expects for 2017 a significantly expanded horticultural sector.

Rice cultivation in the Delta

Rice

Rice production is critical for the environment of the Northern Delta. The MWRI estimates that 700,000 feddan of rice cultivation are required annually in order to prevent salt-water intrusion and to maintain soil quality. Rice is the third largest crop in terms of cultivated area and total production after wheat and maize. Total area amounted to 1,550 million feddan and total production was 5,480 million tons in 1997. Rice yields are with 3.5 tons/feddan among the highest in the world. Per capita consumption reaches about 40 kg (1997) and the country exported 470,000 tons in 2002.

Rice is particularly important for the NWRP because of its extensive use of irrigation water. On a per feddan basis the gross irrigation requirement of rice is 76% more than that of cotton and 126% more than that of maize. If hybrid varieties are introduced, rice could become one of Egypt's important export commodities. For the NWRP Reference Case 2017 (the situation without new measures, see Section 4.1.1) a rice area of just above 1 million feddan is assumed, the majority of which to be located in the downstream Delta areas.

Cotton

Cotton production employs over one million people during most of the year and constitutes the principal source of cash income for many farming households. The textile industry provides direct employment to half a million workers, and indirectly to several million more. It constitutes the principal Egyptian manufacturing sector in terms of employment. Egypt needs to focus on regaining its competitive advantage in cotton. Egyptian cotton has lost market share due to high prices, poor quality, and competition from new varieties of cotton grown overseas. Removing the constraints of the cotton industry on production, marketing and processing, will regain the market share of Egypt and increase productive employment. The NWRP expects for 2017 a revitalised cotton export sector.

Cotton field

Sugar

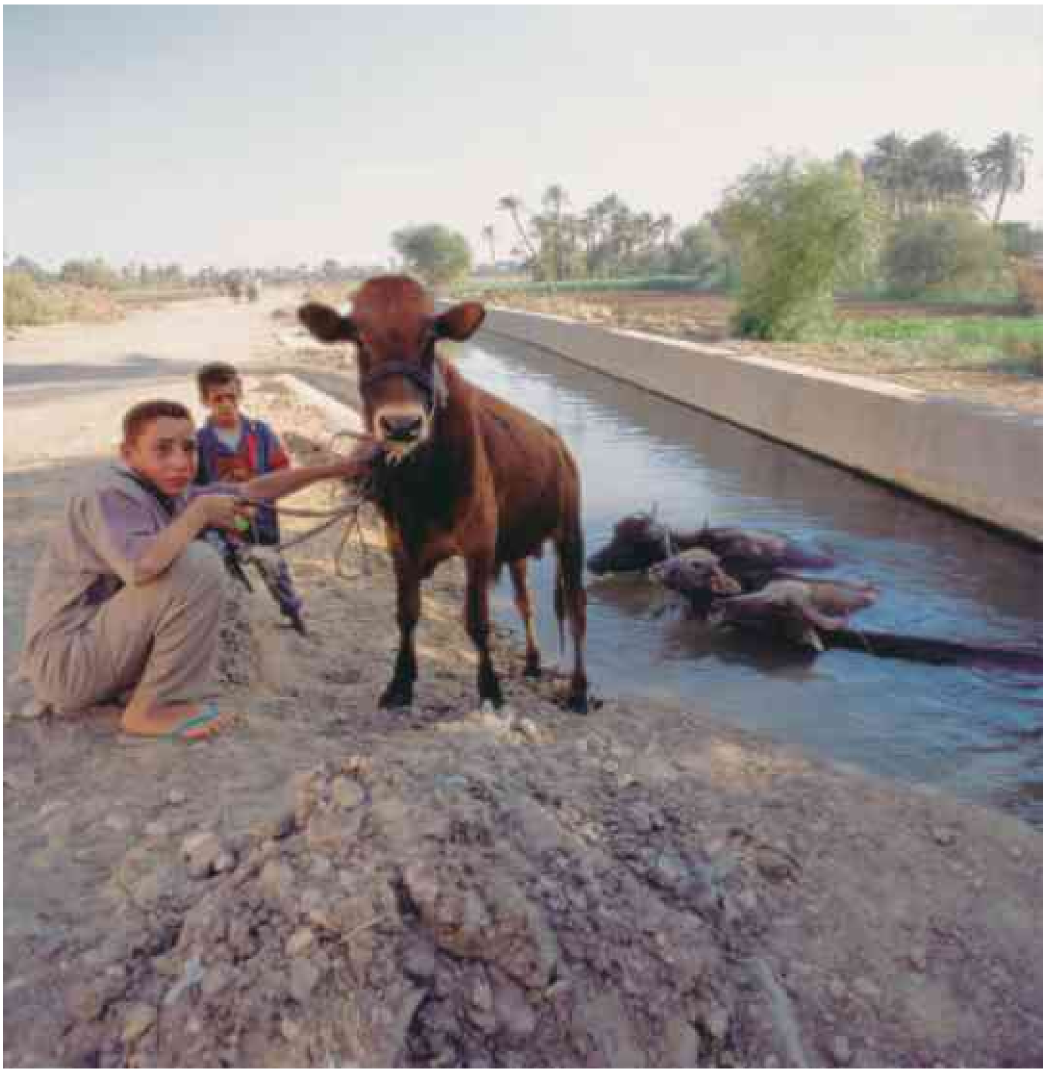
Sugarcane and sugar beets are grown on a contract basis, so the area planted to these crops depends on the processing capacity, and the yield. The area with sugarcane is planned to remain at the present level of 300,000 feddan (25,000 in Sohag, 170,000 in Qena, 80,000 in Aswan and 25,000 in Menya). Cane yields are the highest in the world (on a production per day basis) because of ideal conditions for this C_4 plant in Upper and Middle Egypt: plenty of light and water. Through the use of new high yielding varieties the present yield of about 46 tons/feddan could become as high as 56 tons/feddan, so total production would rise to 17 million ton. Laser land levelling has been completed on 90% of the sugarcane land. A second round of levelling will follow. This has improved field irrigation efficiency and has resulted in a reduced water demand

Sugar cane

by 10-15%. Further reduction of 10-15% is possible through the use of perforated pipes for irrigation water distribution. The 1998 sugar production was 1.35 million ton, with 1 million ton from cane and 350,000 ton from beet.

Sugar production is important for NWRP because of the high water use of sugar cane. From a water management point of view the growth of sugar beet is preferred but this is constrained by the invested capital in processing factories for sugar cane. The plans for cane and beet sugar have been incorporated in the NWRP strategy for 2017.

Animal husbandry
The animal husbandry sector is divided into a small scale, largely subsistence oriented sector catering for the farm family and its direct surroundings, and a modern sector catering to the urban consumer. The urban milk market again is divided in one for raw buffalo milk, produced by semi-intensive buffalo farms, and cow milk, produced by semi-intensive and commercial cattle farms. The local milk processing industry processes milk from commercial cattle farms and relies further on imported milk components. Beef and milk production in Egypt is still underdeveloped, and the country is therefore not self-sufficient in these commodities.



Cattle in the Delta

Egypt has considerable scope for increasing its livestock activities, thereby adding value to crop residues, generating considerable direct and indirect employment and substituting imports. The historic livestock composition has been collected from the Economic Affairs Sector of MALR and from the Statistical Year Book. Trends in production include semi-intensive cattle and buffalo milk production and commercial (large scale) dairy production for industrial processing.

2.3.4 Domestic and Municipal sector

The supply of sufficient water of good quality is an important element of the national water policy in Egypt. Compared to the agricultural water demand the municipal water demand is small, but given the health aspects involved, this supply will receive priority over all other users. The health aspects are in particular important in the urban centers that will grow as a result of the growing population and the increase in urbanization (from 43% in 1996 to 48% in 2017). Already in 1950 Cairo ranked 25th among urban agglomerates in the world with 2.4 million inhabitants, moving up to 17th in 2000 and 14th by 2015 (e.g. before Los Angeles). Directly related to the supply of drinking water is the collection and treatment of the municipal wastewater.

Public Water Supply

The Demographic and Health Survey of 1995 (El Zanaty, 1996) surveyed some 15,000 households and recorded their source of drinking water. It was found that more than 80% of those households have access to piped water, mainly within their dwelling. Urban households and households in Lower Egypt have a somewhat better access to piped drinking water than rural households do. Rural households without piped water supply mostly use well water (Table 2-13). Since then, the proportion of the population served by piped water has risen to 95% (90% into the residence and 5% from standpipes).

The governmental policy with respect to drinking water is to have full coverage of both urban and rural areas by 2007, including a further improvement of the quality of the services. Reference is made to Section 4.2.2 for further information on public water supply.

Sanitation

The Government of Egypt has made a significant effort towards providing sanitary and wastewater services for its people. However, according to official figures, the coverage rates for sanitary facilities are much less than those for water supply (see Table 2-14). Just over 50 percent of the urban population has access to sewerage services, while the corresponding value for rural areas is less than 10 percent.

Domestic and municipal wastewater collection (sewage systems) and treatment facilities are limited to the main urban centres. In 2000 approximately 28% of the population was connected to a sewerage system, based on an interpretation of data collected during a national survey (NWRP, 2001c). Highest coverage was in the larger urban conglomerates Cairo, Giza, Alexandria and the Canal Cities. Towards 2017 the coverage rate is expected to increase significantly in areas outside these large urban areas (Table 2-15). The low coverage, in combination with a sub-optimal treatment, results in severe water quality problems around municipal areas.

Source of drinking water	Total urban	Total rural	Urban govern'tes	Lower Egypt			Upper Egypt			Frontier govern'tes	Weighted average
				Total	Urban	Rural	Total	Urban	Rural		
Piped water	96.6	69.5	99.0	85.9	98.3	79.8	68.0	90.9	55.7	50.4	83.3
In residence	92.5	53.3	94.7	71.6	94.5	60.2	58.8	86.7	43.8	49.5	73.2
Public tap	4.1	16.2	4.3	14.3	3.8	19.6	9.2	4.2	11.9	0.9	10.1
Well water	1.1	25.5	0.1	11.2	0.5	16.5	26.2	4.0	38.1	4.3	13.1
In residence	0.7	13.3	0.1	6.8	0.3	10.0	12.6	2.7	18.0	1.3	6.9
Public	0.4	12.2	0.0	4.4	0.2	6.5	13.6	1.3	20.1	3.0	6.2
Nile/canal	-	0.3	0.0	0.1	-	0.1	0.3	-	0.5	0.1	0.1
Other	2.3	4.7	0.9	2.8	1.2	3.6	5.5	5.1	5.7	45.2	3.5
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

source: El-Zanaty, 1996: Demographic and Health Survey, 1995

Table 2-13 Source of drinking water according to location of residence (%)

Sanitary facility	Total urban	Total rural	Urban govern'tes	Lower Egypt			Upper Egypt			Frontier govern'tes	Weighted average
				Total	Urban	Rural	Total	Urban	Rural		
Flush toilet	50.5	6.2	57.8	21.7	47.5	8.9	14.7	37.4	2.6	39.1	28.7
Trad. w/tank fl.	1.9	1.4	1.1	2.0	2.6	1.7	1.7	3.1	1.0	3.0	1.7
Trad. w/bucket fl.	44.9	63.3	40.1	63.0	47.7	70.6	53.3	52.5	53.6	42.1	54.0
Pit toilet/latrine	1.6	17.8	0.4	9.8	1.7	13.8	16.5	4.2	23.1	8.6	9.5
No facility	0.9	9.6	0.5	2.9	0.5	4.1	11.9	2.4	17.0	1.0	5.2
Other	0.2	1.7	0.1	0.6	-	0.9	1.9	0.4	2.7	6.2	0.9
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

source: El-Zanaty, 1996: Demographic and Health Survey, 1995

Table 2-14 Source of sanitary facilities according to location of residence (%)

Service area	2000	2017 ref. case
Average Cairo, Giza, Alexandria and Canal Cities	74%	72%
Rest of the country	11%	54%

Table 2-15 Coverage rate of sewage systems

New cities

In an effort to stop the conversion of fertile agricultural land into urban and industrial use, a development started in the mid 1970s to create new cities and industries in the desert. Another reason for this policy was to move polluting industries away from the existing cities.

Sixteen New Cities are presently under development, housing almost 1 million people in 2000. By 2017, the time horizon of NWRP, these cities are expected to be fully developed, housing some 8.8 million people. Thirteen of these cities depend on Nile water; the other three use groundwater. All these new cities use the desert as destination of wastewater and are assumed to have waste water treatment plants by 2017. The urbanisation plan of the government includes the type of industries that are planned to provide employment for the inhabitants of the new cities. In addition to these developments, 41 New Cities have been proposed, planned to house 6.7 million people by 2017. The location of the existing new cities and proposed new cities is given in Figure 2-16. An overview of these cities is given in Annex B. The growth of the population in rural and urban areas has been forecasted as part of the population forecast, taking the planned new cities into account.

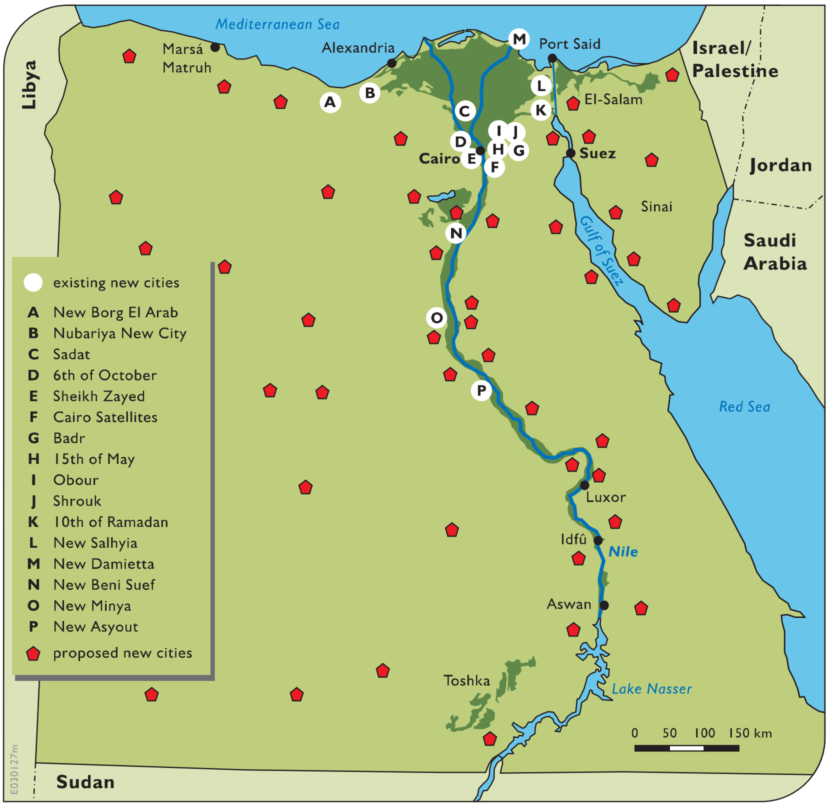


Figure 2-16 Location of new cities

2.3.5 Industry

Industry is a growing sector in the national economy of Egypt. Further industrial development is expected to play a major role in the socio-economic development of the country, providing employment for a large part of the growing population.

Measured in terms of value of public and private industrial output, the petroleum sub-sector is with 35% the largest, followed by the food industry (24%), the textile industry (13%) and the engineering and electrical industries (13%), see Table 2-16. The regional distribution of the various industrial sectors is given in Table 2-17.

Sub-sector	mln LE	%
Petroleum industries	6,640	9
Food industry	23,351	33
Textile industies/wood/paper	17,201	24
Engineering, electrical industries	2,464	3
Chemicals, pharmaceutical industries	4,476	6
Cement/building materials industries	17,203	24
Mining industry	320	0
Total	**71,655**	**100**

source: CAPMAS 2003

Note: excludes governmental workshops, military production of militairy factories, ginning and grinding industries, bakery, tea packing, press and publishing

Table 2-16 Value of production of main industrial sub-sectors (2000/2001)

Governorate	Food	Fabric	Wood	Paper	Chemical	Building	Mineral	Machinery	Others	Total
Cairo	1,040	2,814	459	753	625	391	195	1,920	471	8,668
Giza	539	371	155	183	360	257	59	571	13	2,508
Kalupia	229	546	84	63	447	97	105	395	9	1,975
Alexandria	409	704	109	148	353	116	62	348	23	2,272
Behera	215	83	30	11	40	69	3	61		512
Marsa Matrouh	6		1		2	2				11
Domietta	156	43	562	10	19	67		57		914
Kafr EL Sheikh	133	69	19	14	6	31		62		334
Monofia	161	51	29	21	97	63	12	105	4	543
Sharkia	877	248	515	125	308	286	49	775	16	3,199
Gharbia	279	640	93	71	109	116	19	226	2	1,555
Dakahlia	323	140	133	28	91	120	14	485	2	1,336
Port Saied	91	23	29	18	14	19	3	70		267
Ismailia	54	12	15	8	23	16	1	21		150
Suez	23	4	6	8	13	13	5	17	1	90
EL-Fayoum	55	10	6	23	10	17		15		136
Bani Suef	45	4	11	8	9	24		11		112
EL Menia	104	6	44	13	8	39	2	46		262
Asyout	187	23	101	27	30	44	5	129		546
Suhag	101	15	46	15	28	28	2	50		285
Qena	75	5	10	11	14	18	1	31		165
Aswan	63		24	10	5	22	1	29		154
New Vally	4		1			1		1		7
Red Sea	17		9			9		8		43
North Sinai	16		10	4	3	7		12		52
South Sinai	1				2	1				4
Total	5,203	5,811	2,501	1,572	2,616	1,873	538	5,445	541	26,100

Table 2-17 Number of industries by sector and governorate (2003)

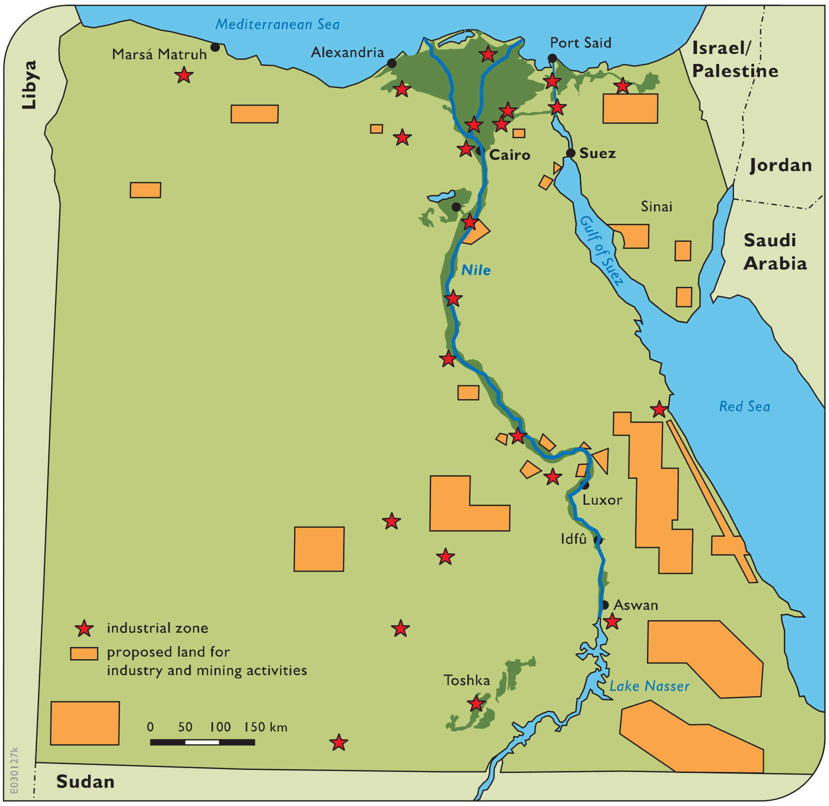


Figure 2-17 Location of new industrial areas

Industrial policy

The industrial policy is to create new cities and industrial zones outside of the Nile Valley and Delta. To achieve this policy objective, the industrial areas Borg Al-Arab and Al Sadat have been completed. The Aswan Industrial Area, Asyout Industrial Area and the Sohag Industrial Area are under implementation. Contracts have been signed for the Ismailia Industrial Area and the Asafraa Industrial Area. Studies are ongoing for additional industrial areas in Beni Suef, Menia, Wadi El Natroun, New Valley (El Dakhla and El Kharga), Fayoum (Kom Oshim). A project for the relocation and development of leather tanneries is located in Badr City. Foundries will be relocated to a new industrial area on the Qattamiya – Ain Sukhna road. An overview of the locations of the new industrial areas is shown in Figure 2-17.

2.3.6 Fisheries and aquaculture

Fisheries are under the responsibility of the General Authority for Fish Resources Development (GAFRD) of the Ministry of Agriculture and Land Reclamation. The aquatic resource base in Egypt is extensive and includes fresh, brackish and marine waters. A concise description of the resources is given below. More information is provided in (NWRP, 2000a).

Marine resources

A large part of the fish production in the Egyptian sector of the Mediterranean Sea has always depended on the discharge of nutrients from the Nile system. This inflow decreased after the construction of the High Aswan Dam but was partly compensated by increased drainage of domestic waste nutrients. Increased reuse of drainage water in agriculture will result in less drainage to the sea and will result in a decrease of sardine catches. Treatment of wastewater will result in a further production decrease, but the value of the remaining yields will be higher if toxicants are removed as well.

The Red Sea fishery traditionally includes the fisheries of the Gulf of Suez, the Suez Canal, and the Great Bitter Lake. Also, the development of aquaculture along the Red Sea coast has often been suggested. However, production inputs will be expensive, and would focus on high-valued species (sea bass, sea bream) for export and the luxury tourism industry.

Areas of the Egyptian Red Sea coast are threatened by oil pollution as well as by sewage and waste disposal (rubbish dumps). Without intensified control, this will pose serious problems for the welfare of the natural resources of the sea, including fisheries. Small amounts of oil may already result in "bad taste" of fish.

Northern Delta Lakes

The Northern Delta Lakes (see map 2 in the Preface of this document) are shallow, and have a rich aquatic life. Large parts of the lakes are overgrown with aquatic vegetation, speeding up the process of land reclamation. The open water area of the lakes rapidly declined during the last decades due to land reclamation, the formation of in-lake reed islands, and also due to the development of fish farms along the shores.

The characteristics of the lakes changed considerably due to the construction of the High Aswan Dam. Nowadays, the lakes are largely fed by agricultural drainage water, mixed with effluents from municipalities and industries. Towards the seaside there is some increase in salinity. In the past, the lakes were more saline (with periodic flushing in the flood season). The present situation is more stable and different aquatic species flourish in different parts of the lakes. The more stable, slightly brackish situation also has led to extensive development of

Aquaculture in the Delta

aquatic vegetation, providing the fish species with spawning and nursing areas, and providing an extended substrate for fish feed organisms.

The planned increase in reuse of drainage water will increase salinity. This is not considered a problem since good fish production is also possible at higher salinity, and suitable brackish water species are generally of higher value. Moreover, higher salinity would provide a natural mechanism for control of weeds. However, there should be no sudden flushes of fresh water, and at least one open connection to the sea should be maintained for recruitment.

Of much more concern is the pollution of the lakes, caused by inflow of heavily polluted drainage water. Lake Burullus is the least polluted of the northern coastal lakes, but also here residues of agrochemicals are still substantially higher than the maximum allowable concentration according to the FAO guidelines of 1989 (FAO, 1989). Lake Burullus is a Ramsar site, (RAMSAR, 2004), with recognised importance for migratory birds. The birds add to the already existing fishing pressure.

Lagoons

There are two lagoons in the Sinai peninsula: *Lake Bardawil* and the *Port Fouad* depression. They are deeper than the Delta Lakes. Lake Bardawil is also a Ramsar site and one of the most important water bird wintering areas in North Africa. The lake is connected to the sea by two openings, which need regular maintenance to prevent large portions of the lake to become hyper-saline. Except for scarce winter rain, the lake is not fed by any fresh or brackish water. But this could change because of the Northern Sinai agricultural development. Any drainage water inflow into the lake will lower salinity and add nutrients and pollutants. In principle this may have a positive effect on production as long as pollutant levels in the drainage water remain low.

The Port Fouad Depression, or Lake Malaha, is a hyper-saline lagoon in the north-west corner of the Tina plain. It is connected to the sea and the Suez Canal, resulting in some water circulation, but not enough to bring salinity down. Apart from its importance for fisheries, the depression is also an important water bird wintering and breeding area.

Inland lakes

A substantial part of *Lake Nasser* is deep (up to 130 m). Since the area below 20 m depth is hardly of interest for fisheries, the total production is strongly dependent of the surface area of the lake which varies with the level of the reservoir. In Lake Nasser the production has always been lower than in comparable lakes in the world. This is due to the fact that most other lakes were constructed on substantially more fertile soils than under Lake Nasser. As far as fish quality is concerned, the picture is incomplete

Lake Qarun in the Fayoum depression is entirely fed by drainage water. Since the lake has no outflow its salinity and pollution level has been steadily increasing. Around

Cage Cultures in the Nile

1980 the salinity reached the level of seawater and presently it is reported to be in the order of 40,000 ppm. With the increase in salinity the freshwater species were replaced by species from the Mediterranean: mullets, sole, shrimps. If future salinity exceeds 70,000 ppm, the lake might only become suitable for production of brine shrimp, used as a protein base for fish and livestock feed.

Wadi Rayan is a depression south of Fayoum. Since 1973 excess drainage water was transferred to this depression, resulting in two interconnected lakes. Fishing activities started in 1983. The lakes are yearly stocked with mullet fry collected from the Mediterranean. With almost no precipitation and a very high evaporation rate, an increase in salinity takes place in the lower of the two lakes, similar to Lake Qarun. Fish from Wadi Rayan shows high levels of some heavy metals and pesticide.

The Nile, its branches and canals

The Nile and its branches, and the extensive system of irrigation and drainage canals together form a substantial fisheries resource. The Nile waters are presently rather rich in nutrients, because of the inflow of agricultural drainage water, supplemented by domestic and industrial effluents.

Fish farming

Fish farming has been practiced in Egypt through the ages. Currently, fish farming in Egypt ranges from the traditional village type ponds and the *hosha* system (enclosed low-lying areas), to modern governmental and private fish farms. The future of aquaculture is rather uncertain. Fish farms are presently only allowed to use drainage water, which is a risky source because of pollution.

Fish in rice fields

After the introduction of high yielding (and shorter duration) rice varieties that require a more shallow water depth and higher inputs of pesticides, the fish yields in rice fields decreased strongly. However, with adequate fisheries stocking and management, and with adequate selection of rice pesticides, the production could easily be increased.

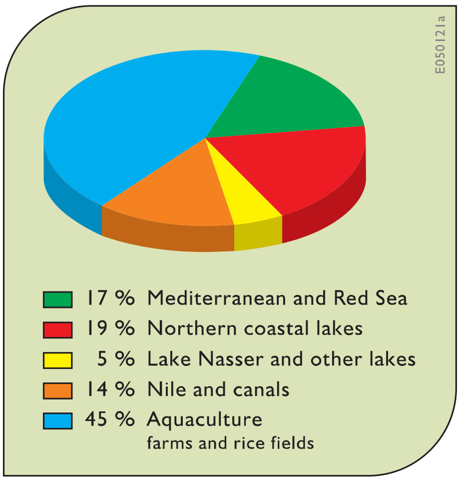


Figure 2-18 Fish production, 2001
(source: CAPMAS 2003)

Production

From the official GAFRD statistics for the year 2001, the combined marine and inland waters of Egypt are reported to produce some 770,000 tons of fisheries products (Figure 2-18). With the addition of 175,000 tonnes of imported fish products, the per capita consumption would be about 10 kg/year. The accuracy of these official statistics is not high and the numbers seem a bit at the high side. A different estimate of total sustainable production would point at some 400,000 tons.

Data show stable productions or even upward trends for most areas. In Lake Qarun production declined from 1992 to 1994 but improved since then. The most striking reduction is seen in fish from rice fields, where production went down from 21,200 ton in 1996 to 6,900 ton in 1997. The statistics of the year 2001 mention again a production of 18,300 ton.

Virtually all Egyptian water bodies are fished to the maximum and some are overexploited already. To maintain per capita consumption levels at 10 kg seems not realistic, unless production levels of existing resources are preserved, and strong expansion of aquaculture and/or import takes place. Expansion of aquaculture is limited when only drainage water may be used, and unless more massive investments in modern production farms take place. Subject to feasibility studies and pilot farms, the development for aquaculture of the huge brackish water aquifers in the Western Desert, along the Nile Valley, and in the Sinai Peninsula may prove to be viable. Another aquaculture potential exists in cage culture in Lake Nasser and the Nile. The present ban on this type of activities is not based on sufficient scientific evidence and should be reconsidered, based on adequate research.

Quality of fish

Official statistics on the quality of fish is limited. Reported average amounts of heavy metals, organochlorine pesticide residues and PDB's in fish meat are substantial, and often well above the Maximum Allowable Concentration (MAC) standards. These high levels indicate an increased health risk for people that consume much inland fish.

2.3.7 Inland navigation

The main inland waterways consist of the Nile (Aswan-Qanater) and the Beheira/Nuberia canal (Qanater-Alexandria) and Ismailia canal (Cairo-Suez). The secondary system includes the Rayahs (except the Nasiry Rayah) and a number of other navigable canals and drains. Inland waterways are used by traditional sailing boats (*feluccas*) for the transport of building materials, river barges and hotel boats (cruise ships), which mainly ply between Luxor and Aswan.

The Damietta Branch is being transformed into a navigable waterway. There also are ideas about transforming the Rosetta Branch into a year-round navigable waterway and to connect this waterway with the Beheira Rayah at Kafar Boleen. A plan to improve the navigation conditions in the Ismailia canal reportedly has not yet been approved, because of fears by the Suez Canal Authority that the connection with the Suez Canal may interfere with the traffic of marine vessels in the canal.

Major bottlenecks for inland navigation are presently the condition of some shipping locks (Nag Hamady and Sariaques on the Ismailia canal), shoals in the Nile and the shallow depth of the Nubaria canal between km 60 and km 100. The lock at Nag Hamady will be replaced with a larger and deeper one. The shallow depth in the Nubaria canal has to be removed through dredging and bank protection.

For navigation on the Nile especially the low flow period November to February is critical. A safe navigation criterion for the water depth according to the River Transport Authority, is 2.3 m (1.8 m draft plus 0.5 m clearance). As a minimum, a depth of 1.45 m is required (minimum draft of 1.20 m plus 0.25 m clearance). At a water release from Aswan of 75 million m^3/day there are about 16 to 18 locations between Aswan and the Delta Barrage where the water level in the navigation channel is less than the minimum depth.

There is no exclusive release of water from Lake Nasser for navigation. There only is a guaranteed minimum release of 60 million m^3/day, which is also required for some municipal intakes along the Nile. Therefore, the shallows that affect the navigation on the Nile have to be removed through dredging.

According to the River Transport Authority 300 hotel boats (cruise ships) are registered, on 256 of which draft and passenger capacity information was available or could be estimated.The draft of these boats ranges from 0.65m to 2.3m and the capacity from 17 to 464 passengers. Total capacity is 30,674 passengers. As can be seen from Figure 2-19 and Figure 2-20, most of the hotel boats, including the largest one with 464 passengers, have a draft not exceeding 1.5m. Only 35 boats (with a total capacity of 4,700 passengers) exceed this limit. If for some reason the draft in a relevant river stretch would be limited to 1.5m, these 35 boats could not operate here. It is assumed in this NWRP that all new hotel boats will have a draft not exceeding 1.5m. The majority of the hotel boats use the bottleneck stretches, especially during the busy winter season.

In addition a feasibility study on the use of barges for the transport of ISO-containers (SWECO, 1999) between the Mediterranean coast (Alexandria and Damietta) and Cairo has been analysed. By 2015 between 60,000 and 170,000 TEU (twenty feet equivalent unit) containers are expected to use the planned Cairo container terminal at Ather El Nabi. Transport is expected to take place in convoys of a pusher barge and a dumb barge that together can transport 44 TEU. As this container transport takes place outside the bottleneck stretches of the Nile, it will not be affected by different NWRP strategies.

NWRP assumes that the distribution of river transport over the year is even, hence half taking place during the winter. It also assumes that river transport will grow at the same rate as industry. The occurrence of bottlenecks for navigation will be discussed in Chapters 4 and 5.

Inland water transport on the Nile

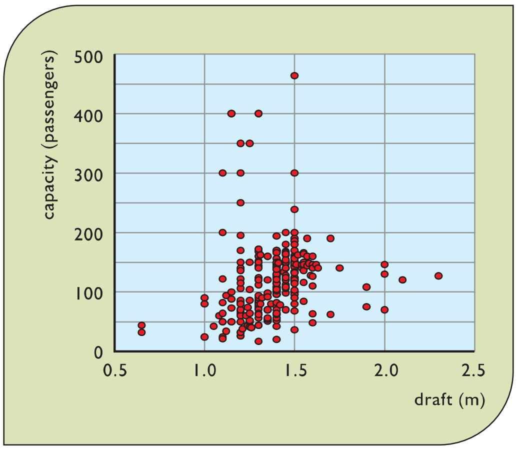


Figure 2-19 Capacity versus draft of hotel boats

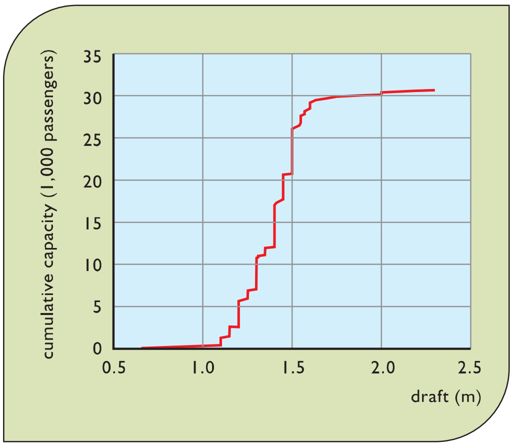


Figure 2-20 Cumulative capacity versus draft of hotel boats

2.3.8 Hydropower

Information about existing hydropower as provided by the Egyptian Electricity Authority (EEA) is presented in Table 2-18. The total existing hydropower capacity is 2.81 GW, producing 12,222 GWH in 1997/98 or 16% of the gross national generated electricity. The table shows clearly that the two Aswan dams provide by far most of the hydropower generated.

	Unit	HAD	Aswan Dam 1	Aswan Dam 2	Esna	Nag Hamady
Capacity	MW	2,100	345	270	90	5
Commissioned in	Year	1,967	1,960	1,986	1,995	1,998
Discharge	BCM/y	57	57	57	51	52
Discharge rate	m^3/kWh	6	21	18	81	103
Average head	m	70	22	22	5	4
U/s water level*	m (+MSL)	175	111	111	79	65
D/s water level*	m +(MSL)	110	90	90	75	62
Efficiency	%	85	78	90	82	83
Maximum load	MW	1,980	265	270	79	5
Generated energy	GWh	8,949	1,196	1,673	394	9
Max. gen. energy	GWh/d	44	6	7	2	0
Min. gen. energy	GWh/d	7	1	2	0	0

source: Egyptian Electricity Authority * at end of the year

Table 2-18 Hydropower data (1997/98)

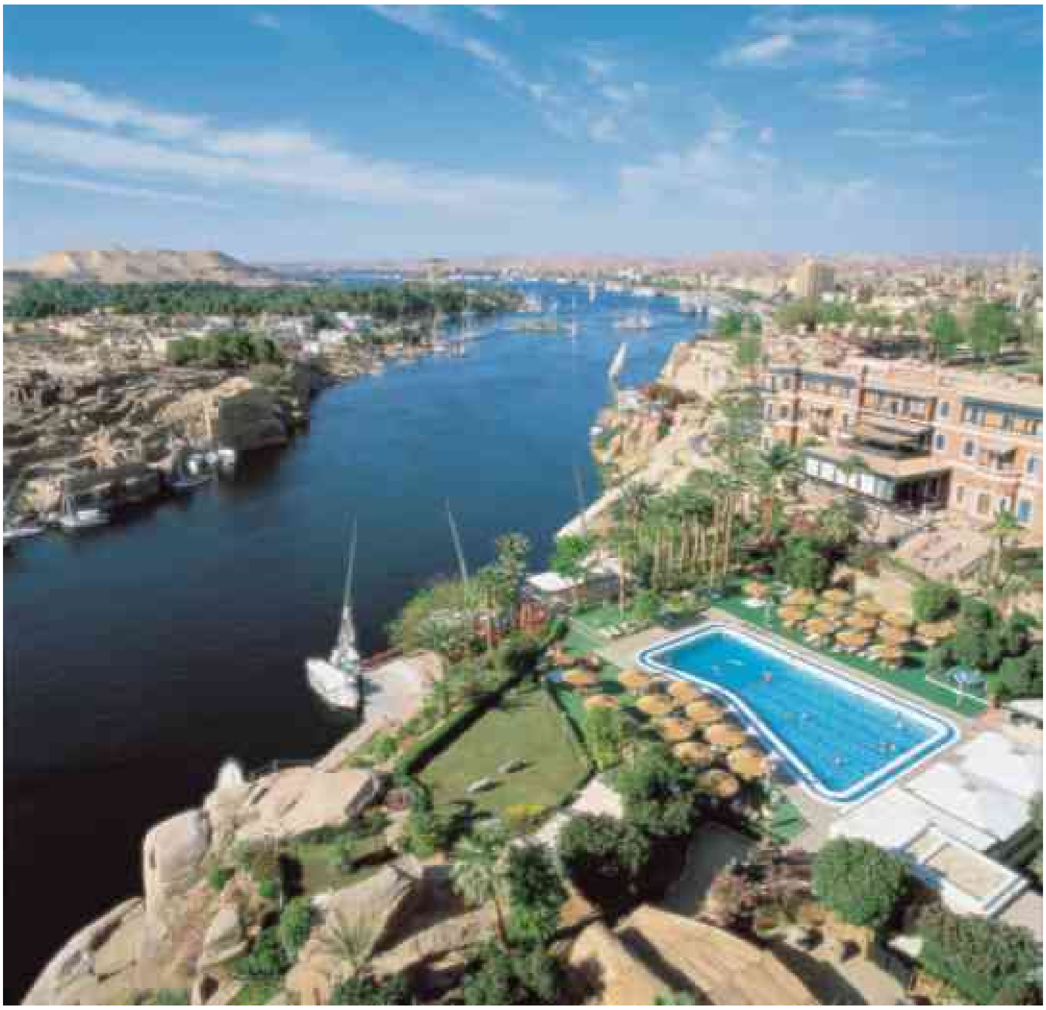
Plans for further hydropower development exist. A small hydropower station in El-Lahoon (0.8 MW) is under construction as well as an extension of the Naga Hamady power station of 80 MW (to be operational in 2005). Further possibilities for hydropower development till 2017, with a total of 70.5 MW, are being studied. At Gabal Atakaa (Suez), a 2.1 GW pump-storage scheme is being studied.

Demand projections by the Egyptian Electricity Authority up to 2017 are based on an expected GDP growth rate of 5% and an income elasticity of 0.9-1.0, meaning that electricity consumption is expected to increase almost at par with economic growth over the medium term.

Because of the increasing water shortages, hydropower generation has a low priority in water allocation. No releases from HAD take place exclusively for hydropower generation. Hence, the production of hydropower can be considered to be a by-product of the releases for irrigation and municipal and industrial water supply and does not need to be taken into account as a separate water demand sector. There is no water loss (consumptive use) in the hydropower generation, contrary to thermal power generation where large amounts of cooling water are lost through evaporation.

2.3.9 Tourism

Tourism is among the country's five main sources of hard currency inflows (the others being remittances from Egyptian workers abroad, oil exports, Suez canal tolls, and foreign aid). The tourist sector creates considerable direct employment, and also stimulates employment in



Tourism in Aswan

other sectors such as construction, transport, food production and processing, textiles and handicrafts. Direct and indirect employment is estimated at around one million jobs. On a global level, Egypt's share in the tourist market grew from 0.39% in 1986 to 0.55% in 1995.


Tourism development along the East Coast

There is considerable potential to further develop the tourist sector, especially in the leisure and adventure segment (diving, desert trips) along the Red Sea and in Sinai. Tourist arrivals have been subject to remarkable fluctuations, with peaks in 1990, 1992, 1997 and 1999, and dips in 1991, 1993, 1998 and 2001. The fluctuations were mostly in the European arrivals. 2003/04 was a good tourist year and trends are upward.

Along the Red Sea, fresh surface water is virtually absent, and good groundwater is only available in limited amounts. Where no piped water from the Nile Valley is available, a considerable part of the hotel development depends on desalinated sea water for drinking, swimming pools, cleaning and gardening.

For water resources planning, the number of tourist-nights is more important than the number of arrivals. In 1999 the thirty million tourist-nights were equivalent to a resident population of 85,000. This equivalent is in terms of annual water use. As far as water quality is concerned, tourism on one side demands clean water for drinking, swimming and cruising, but at the same time puts extra pressure on this resource. Proper management is therefore of paramount importance to keep this important sector healthy and growing.

Due to seasonal fluctuations in tourist inflows, the locally required capacity for drinking water supply has to be based on the peak rather than the average number of tourist nights.

The Ministry of Tourism has ambitious expansion plans, especially along the Gulf of Aqaba (Taba, Nuweiba, Dahab, Wadi Keir and Sharm El Sheikh), along the Red Sea coast (Hurgada and Safaga) and for the Nile Cruises. A continuation of the average 5% per year growth of the last 20 years would result in tourist-nights to the equivalent of 140,000 residents in 2017; whereas a linear projection would result in a population equivalent of some 110,000 capita. Although the water use per tourist-night will be higher than for the average Egyptian, the national impact of the tourists on the water demand is insignificant. However, as the coastal tourist resorts are all located in areas with limited groundwater resources, the local impact of tourism will be significant, and would require major investments in water supply and sanitation. More detailed projections of tourism development are presented in (NWRP, 2001d).

2.3.10 Social Aspects of water management

In 1996, about 15.7 million persons, or about 26.5 percent of the population, were classified as poor in Egypt by an IFPRI study (IFPRI, 1997). This estimate relies on the 1996 CAPMAS census population estimates and a poverty line based on food and non-food consumption. In monetary terms (LE per month per capita), the poverty line ranges from LE 83 in rural Upper Egypt to LE 129 in metropolitan areas (1997 price level). Of these, 5.1 million were deemed to be ultra poor. (This estimate is based on the same population numbers and uses a lower poverty line that corresponds to the same caloric norms, but makes a more restricted allowance for non-food expenditure.) In monetary terms (LE per month per capita), the ultra-poverty line ranges from LE 53 in rural Upper Egypt to LE 75 in metropolitan areas.

Poverty rates are significantly higher in the rural sector, and about 63 percent of the poor live in rural areas. The study results do not indicate a significant difference in poverty between Upper and Lower Egypt, which differs from the conventional wisdom that Upper Egypt is substantially poorer than Lower Egypt. This is perhaps because this study allows for regional differences in cost of living and basic non-food needs and therefore reflects real purchasing power, which many earlier studies did not do.

Female-headed households are more likely to be poor. In the urban sector, 33 percent of female-headed households are living in poverty, while about 22 percent of male-headed households are poor. In the rural sector, the indices are 36 percent for female-headed and 28 percent for male-headed households. The poor and the non-poor tend to have similar rates of labour force participation, but female participation rates are only about one-fourth to one-third of the male participation rates. The differences between the male and the female unemployment rates are also striking, the latter being more than four times higher, despite the already low female participation rates.

Women's roles in agriculture and irrigation were investigated as part of the national survey (EL Zanaty, 1998). Of the 355 interviewed farmer's wives, 43% said that they helped in agriculture. There was a substantial disparity between Upper Egypt (9%) and the rest of the country (47%). Almost all wives who help in agriculture (an average 22 hours per week) assist in cultivation, over half help with livestock and almost a third help in irrigation, but fewer than 10% of farmer's wives reported that their suggestions on agriculture and irrigation are taken serious by their husbands. Male migration to the Arabian Gulf and internal migration to urban areas have placed a heavy burden on rural women. They shoulder the responsibility for a large portion of farm work, thus their attitudes towards irrigation water use are becoming important for water planning too.

In the context of irrigation, men are generally assumed to best represent the water related interests and needs of the household at the level of the community. Women, however, must also often use water for additional purposes other than irrigating the main field crop: watering livestock, irrigating the homestead or for domestic purposes. For women, as for the poor, to formally claim a right to a limited resource and take an active role in its management, challenges the status quo and the interests of those who now make the decisions.

The survey mentioned above also investigated farmers' attitude toward the Ministry of Water Resources and Irrigation, by asking the sampled farmers what they would like to discuss with a senior ministry official. Eight in ten male and female farmers said that they would tell the official that they need more water. Second, a quarter of the male and 12% of the female farmers would mention that the canal needs cleaning. Third, 16% of the male farmers and 7% of the female farmers would request water to arrive on schedule. Only 6% of the male and 8% of the female farmers said they had nothing to discuss with the Ministry. The interviewed male and female farmers mentioned the following as specific problems:

- There is not enough water in the mesqa, especially in the end of the mesqa and in the summer;
- Water not available on schedule;
- Water salinity;
- Crowded pumps;
- Blockages of the mesqa;
- Contamination of mesqas because of household wastewater and soap residue, sewage and dead animals;
- Drainage problems.

Water Users Associations exist in parts of the country and function as follows: farmers on one mesqa select a representative to the association, which meets regularly with the district irrigation engineer to determine the major repairs that need to be made. The association is also responsible for organizing regular mesqa maintenance and resolving conflicts. Over the last years successful pilots have been carried out with the establishment of user organizations above the mesqa level (Branch Canal WUA, Water Boards). These organizations show potential in coordinating local water management, in resolving water use conflicts, in planning for irrigation and drainage improvement and in enhancing service delivery efficiency.

2.4 Institutional system

The governmental structure of Egypt consists of three levels. The first level is the central government (Ministries). The de-central government is structured in Governorates (2nd level) with districts and some cities as 3rd level units (*markaz* level). The Ministry of Water Resources and Irrigation is the prime responsible ministry for water resources management.

2.4.1 National level - MWRI

The Ministry of Water Resources and Irrigation has a central organization in (and around) Cairo. The Ministry has strategic and operational tasks. The operational tasks include both national activities (such as the implementation and operation of the Nile related infrastructure, the irrigation and drainage canals and the coastal lakes) and activities at district level.

The central organisation of the Ministry includes various departments and sectors. From the point of view of NWRP the most important are:

- Planning Sector;
- Nile Water Sector;
- Irrigation Department, including
  - Irrigation Sector
  - Groundwater Sector
  - Horizontal Expansion Projects Sector
  - Irrigation Improvement Sector
  - Nile Protection Bureau
- Egyptian Public Authority for High Dam and Aswan Dam
- Egyptian Public Authority for Drainage Projects (EPADP)
- Mechanical and Electrical Department (pumping stations)
- Water Quality Management Unit (established during preparation of this NWRP)
- Institutional Reform Unit (established during preparation of this NWRP)
- National Water Research Centre (NWRC)

At de-central level MWRI distinguishes 22 Irrigation Directorates, subdivided into 62 Inspectorates and about 206 Districts. An inspectorate covers about 4 districts. The area of a district is between 20,000 and 60,000 feddan (about 40,000 – 100,000 farmers). Other organisation units used in the management of irrigation are:

- Feeder Canal level (between 10,000 – 100,000 feddan / 15,000 – 150,000 farmers)
- Branch Canal level (between 1,000 – 12,000 feddan / 1,000 – 15,000 farmers)
- Mesqa level (between 10 – 100 feddan / less than 100 farmers)

The management of the drainage system is set-up in a similar way as the irrigation system with about the same Directorates, Inspectorates and (145) Districts. However, the organisation was separate. The Ministry is in a process to integrate the irrigation, drainage and groundwater management into 'Integrated Water Management Districts' (IWMD). Two pilot IWMD's have been established in December 2001. The further development of IWMD's will be part of the Integrated Irrigation Improvement and Management Project (IIIMP), that will also include the formation of Branch Canal Water Boards /WUAs and possible scaling up of the Branch Canal Water Boards to District Water Boards.

The Ministry is in a process to turn over part of its management responsibilities at district and lower level to Water Boards and Water User Associations (WUA). WUAs operate at *mesqa* level. At this moment there are some Water Boards that operate at Branch Canal Level. There are plans to upgrade these Water Boards to District level.

2.4.2 National level – other ministries

For the other Ministries involved in water management reference is made to Section 3.1. As stakeholders these Ministries have taken part in preparation of this NWRP, each with a specific interest. In Section 3.2.2 a description of these Ministries and their specific objectives with respect to water management is given.

Similar to MWRI, some of these Ministries have operational tasks at a de-central level, also organized through districts and inspectorates. From the point of view of Integrated Water Resources Management it is unfortunate that the districts and inspectorates of the different Ministries do not coincide.

2.4.3 De-central level

The public administration at the de-central level is divided in 26 Governorates (or *Mohafz*a) as illustrated in Figure 2-21, and one special status city (Luxor). There are two types of Governorates. The first type consists of the four one-city Governorates of Cairo, Alexandria, Port Said and Suez. These four Governorates are further divided into urban quarters (or *hais*). The second type consists of complex, multi-city Governorates, which are divided into 156 districts (or *markaz*), and cities, urban quarters and villages (or *qaria*).

Twelve national Ministries have Directorates at Governorate level with de-centralised functions and budgets, amongst others the Ministry of Health and Population and the Ministry of Housing, which play an important role in the local planning of water resources. Fourteen Ministries have (some) decentralised functions but no de-centralised budgets. Among this second category is the Ministry of Water Resources and Irrigation.

Between the central government and the local administration conflicts may arise in terms of budget, (complexity of) regulations and staffing. Financial competencies are split over national ministries and agencies on the one hand and the Governorates on the other hand. A second main issue is the hierarchical relation of departments at Governorate level that have to report both to their national ministry or agency and to the Governorate. This complicates horizontal coordination of policies at local level.

It is clear, that - together with the local branches of the Ministries and Authorities, who are technically responsible - the Governorates exercise administrative control and are an important stakeholder for water resources planning and management. For the development of the NWRP a working relationship has been established with the Ministry of Local Development that facilitates:

- The Council of Governors, chaired by the Prime Minister and meeting monthly
- The Round Table of Governors in each of the seven planning regions, chaired by the Minister of Local Development.

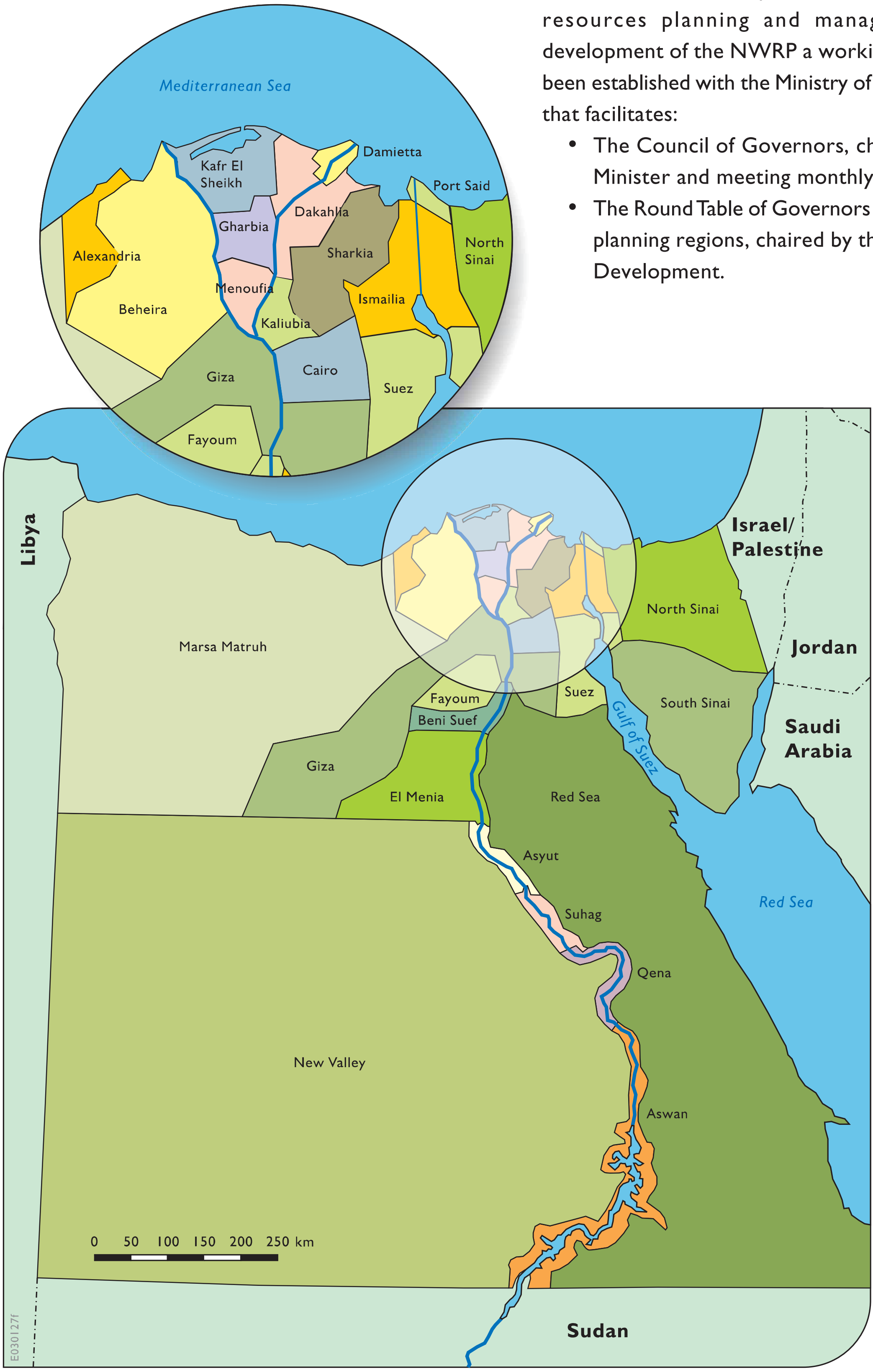
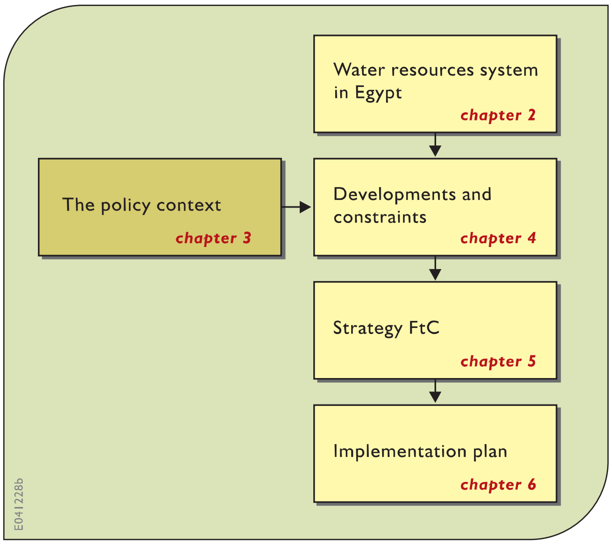


Figure 2-21 Governorates in Egypt

3 THE POLICY CONTEXT

- Water Resources Management - a multi-stakeholder activity
- Objective WRM: to support the socio-economic development of Egypt on the basis of sustainable resource use, while protecting and restoring the natural environment.
- The legal framework - laws on water and environment
- The international context - cooperation with Nile Basin countries



This chapter will describe the context for the new National Water Resources Plan. First a brief overview will be given of the stakeholders involved in water resources planning and management in Egypt (Section 3.1). Section 3.2 will describe the national development goals and policies, both from a national point of view as well as the sector policies of the various ministries. In Section 3.3 the legal framework related to water will be given. Finally, Section 3.4 will summarize some aspects of international co-operation in the Nile Basin.

3.1 Institutional setting and stakeholders

Water resources are of great economic significance for the population of Egypt. Water is an important input for agriculture and industry and other sectors in the economy. Investments in water management will contribute to the development of the country. The need to feed the population and to strengthen the economy requires an anticipatory and proactive role, not only by the public administration but also by other stakeholders. Water resources also play a key role with regard to social objectives. In fact, water resources are of importance in increasing employment in all sectors of society and in creating an acceptable distribution of the national income. Possibilities to safeguard the national food security fall within the social objectives of the government's policy.

Public health threats and environmental degradation are a major concern for the Egyptian government. Deterioration of surface water quality and groundwater quality can cause serious problems for public health and ultimately it can cause economic damage. Public administration and all other stakeholders have a shared responsibility to face these challenges.

On the national level various Ministries have responsibilities related to water resources management (see text box). Through their policies these ministries influence the national water resources. Occasionally other ministries are involved as well such as the Ministry of Electricity (hydropower) and the Ministry of Tourism (tourist related navigation on the Nile, water quality along Northern Coasts). Co-operation between all relevant ministries is necessary to strengthen water resources related policies.

Main stakeholders at Ministerial level

- Ministry of Water Resources and Irrigation
- Ministry of Planning,
- Ministry of Agriculture and Land Reclamation,
- Ministry of Industry,
- Ministry of Environment,
- Ministry of Health and Population,
- Ministry of Transportation,
- Ministry of Housing, Utilities and New Communities,
- Ministry of Local Development

In addition to these national actors, IWRM has to incorporate the policies and views of the regional and local stakeholders, i.e. the governorates, districts, water supply and sanitary drainage authorities, water boards, water users associations, and, of course, the general public.

Different kinds of stakeholders are the upstream Nile Basin countries. Although the national water resources plan focuses on the national aspects of Egypt's water resources, a continuation of the co-operation between the Nile Basin states both on a bilateral and regional basis is of utmost importance to safeguard the water resources. Moreover, by co-operation additional resources for Egypt and other riparian countries can be made available.

3.2 National development goals and policies

3.2.1 National development objectives

The national objectives for Egypt's development in the period 1997 - 2017 have been described in the document "Egypt and the 21st century" (Cabinet ARE, 1997). Essential elements in the policy are the central role of the private sector in Egypt's development, human resources development, the transition to an information-based community, conservation of the environment, and a water conservation culture. Water conservation is considered to play an essential role in the development of natural resources. Conservation should include water use for domestic purposes, in irrigated agriculture and in industry. A proper scientific and economic basis has to be developed for effective water resources management.

Non-ministerial stakeholders

- Governorates
- Local Units and / or Local Councils
- Economic General Authorities
- Investors Associations
- Water Users Associations
- Farmers Co-operatives
- NGO's
- The Public

General objectives of the national policy related to water resources development include:

- To increase the economic growth to 6.8% in the period 1997 - 2002 and to 7.6% in the period 2003 - 2017, to

increase the per capita GDP from 1,250 USD to 4,100 USD in 2017 and to increase employment to 97-98%.
- To increase the inhabited space of Egypt (5.5% of the population living outside Nile Valley and Delta to be increased to 25%). The present policy of developing new cities outside the Nile Valley will be expanded by developing areas in Sinai and the Western Desert.
- The development of Northern Egypt concentrates on El Salam Canal in the Eastern Delta (220,000 feddan) and Sinai (400,000 feddan). Other plans include the development of 250,000 feddan in Middle Sinai and the development of harbours, industry and tourism.
- The basis for the development of Southern Egypt is the construction of the New Valley Canal that will irrigate some 500,000 feddan, and the expansion of oases where 447,000 feddan are planned to be irrigated using groundwater resources. Support will be given, besides to agriculture, to the development of industry and tourism.
- Protecting the Nile and other fresh water resources from pollution.
- Promotion of integrated pest control and limitations on the use of agro-chemicals.
- Extension of sewage networks and wastewater treatment plants.
- Promotion of water conservation in domestic use, in agriculture and in industry.

These long-term national objectives are translated into Five-Year plans. The Five-Year Plan 2002-2007 has taken into account the slowing-down of the world economic growth of recent years and has somewhat reduced the growth objective. On the other hand public spending is likely to increase.

3.2.2 Sector policies

Based on the national policy all ministries have developed their own sector oriented policies and strategies. The goals and objectives for those sectors that are related to water resources management can broadly be described as follows:

Agriculture – source of life

Ministry of Water Resources and Irrigation (MWRI)

- Objective: reach best possible benefits of available water resources in terms of the supply of good drinking water, the support of the development in various economic sectors and the protection of the inland aquatic environment.
- Strategy elements:
  - increase of supply (rainfall and flash flood harvesting, groundwater development, reuse, desalination)
  - support horizontal expansion goals of the government
  - improved water management by user participation, new technologies and privatization
  - improving water quality by monitoring and evaluation
  - improved co-ordination with other agencies
  - increased public awareness
  - international agreements

MWRI

Ministry of Agriculture and Land Reclamation (MALR)

- Objective: to improve food security and increase national agricultural production through maximizing the net return per unit of water.
- Strategy elements:
  - to continue the policy of liberalisation and demand management
  - to increase the irrigation area with 3.4 million feddan up to the year 2017, depending on the availability of water
  - to improve food security
  - to increase farmers participation in the management of irrigation systems

Ministry of Housing, Utilities and New Communities (MHUNC), in particular NOPWASD

- Objective: provide sufficient drinking water of good quality to the population and to treat the municipal wastewater in such a way that the discharge of the effluent does not pose any health and environmental risk.
- Strategy elements:
  - to increase the number of water treatment plants and to increase the capacity of existing plants
  - to increase the number and capacity of wastewater treatment plants and to reuse treated wastewater
  - to use the potential of groundwater for municipal water supply in view of its lower costs
  - to give priority to municipal and industrial water supply in the allocation of Nile water and groundwater
  - to minimize the losses in the distribution system through leak detection and network upgrading

Above Ministries are all directly and actively involved in the management of Egypt's water system. Several other Ministries have a more indirect role, e.g. with respect to law development and enforcement, and monitoring and inspection. The most important are:

Ministry of the Environment (in particular EEAA)

- policy formulation and plan preparation for the protection of the environment
- water quality monitoring (pollution loads from industry, waste water from Nile ships and coastal monitoring)
- definition of 'natural protectorates' such as Lake Bardawil, Lake Qarun and Wadi El Rayan, all affected by water resources management

Ministry of Health and Population (MoHP)

- establishment and enforcement of drinking water standards
- monitoring and protection of surface water quality
- inspection of wastewater treatment plants
- population control programmes (affecting an important scenario assumption of the NWRP)

Ministry of Industry (MoI) in particular GOFI

- coordination between MWRI, NOPWASD and MoI to ensure the availability and sustainability of water supply
- protect water resources from pollution through the implementation of cleaner technologies, recycling of process and cooling water and wastewater treatment prior to discharge
- involve scientific community in developing low-cost methods for the analysis and treatment of water

Ministry of Transportation (MoT) and River Transport Authority (RTA)

- expand navigation possibilities on the Nile and its branches
- maintain minimum depth of 2.5 m for tourist and transportation vessels on the Nile

Ministry of Local Development (MoLD)

- responsible for sustainable development of rural areas and small cities, including water supply and sanitation

Ministry of Electricity (MEE)

- responsible for the generation of hydropower at the High Aswan Dam and other hydropower stations

Ministry of Planning (MoP)

- prepares the annual and 5-year plans in co-operation with the ministries and governmental authorities and monitors their implementation
- involved in the prioritization of the allocation of investments

3.2.3 WRM objectives and performance indicators

The objective of water resources development is derived from the national development goals and policies mentioned in the previous section. The National Water Resources Plan is 'national' and, hence, can and should integrate the sector policies from the various ministries. On this basis the National Water Resources Plan has adopted the following objective (text box):

Objective of Water Resources Development in Egypt

To support the socio-economic development of Egypt on the basis of sustainable resource use (surface water and groundwater), while protecting and restoring the natural environment. Specific policy objectives are:

- the supply of drinking water for domestic uses and the provision of sanitation services, according to the standards and targets of MoHP, NOPWASD and MoLD, on a cost recovery basis but taking into account the right on basic requirements of all people
- the supply of water for industrial purposes and the provision of sewage treatment facilities on a cost-recovery basis
- the supply of water for irrigation based on a participatory approach and cost-recovery of operation and maintenance
- the protection of the water system from pollution, based on a polluter-pays principle and the restoration of water systems, in particular the ecological valuable areas

This objective is still rather general and has to be made specific (see also Figure 3-1). Economic development and social objectives as defined by the national government are the starting points. The objectives can be further specified for the water sector as 'Meeting Water Needs' and 'Protecting Health and Environment' as indicated in the second layer of Figure 3-1. In order to achieve these objectives, specific institutional reform and financial objectives are formulated in the third layer.

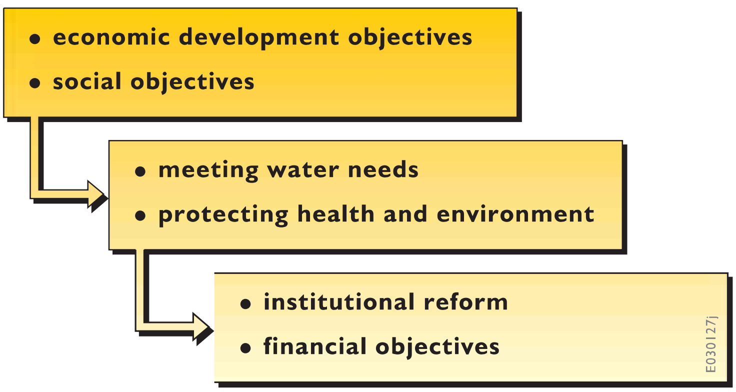


Figure 3-1 Objectives of the NWRP

Economic development

The development and use of the available water resources in general should contribute to the national economic growth. For the different economic sectors the aim is to use the water resources in an optimum way, enabling an increase in production (industry, agriculture, aquaculture) and an improvement of the conditions for other water using sectors (such as navigation and tourism). Some important water related indicators that describe to what extent these policy objectives will be achieved are:

- For agriculture:
  - increase in irrigation area
  - increase in production value in agriculture
  - crop intensity
- For industry
  - wastewater treatment cost industry
- For fisheries
  - production value fisheries
- For tourism
  - navigation bottlenecks in the Nile
  - water quality along North Coast (coliform index)

Social objectives

Major social objectives where water plays a direct or indirect role are related to access to safe drinking water, the increase in employment, equity in water distribution and farmers income, and some minimum level of food self-sufficiency. Another major government objective is to create more living space in the desert areas, outside the heavily populated Nile Valley and Delta. Some important water-related indicators that describe to what extent these policy objectives will be achieved are:

- General:
  - population living in desert area
- Employment, income and equity
  - employment in agriculture
  - average income farmers
  - equity water distribution in agriculture
- Drinking water and sanitation
  - coverage drinking water supply systems
  - coverage sanitation systems
- Self sufficiency in food production
  - percentage of self-sufficiency in cereals

Meeting water needs

Because of population growth, industrial growth and developments outside the old lands (horizontal expansion in the Nile fringes and desert areas, and development of New Industrial Cities in desert areas), the demand for water of good quality is increasing. Since the potential for development of new water resources is limited (mainly limited to groundwater development in the Western Desert), water is becoming an increasingly scarce commodity. This urges a more efficient use of water. It also urges attention for the sustainability of the water resources system in areas where this resource is not replenished. Important indicators that describe to what extent this policy objective will be achieved are:

- Water resources development
  - available Nile water
  - abstraction of deep groundwater
- Water use efficiency Nile system
  - outflow to areas outside the Nile system ('sinks')
  - overall water use efficiency Nile system
- Water use in agriculture
  - supply-demand ratio
  - water availability per feddan
- Public water supply
  - Unaccounted-for losses
  - supply-demand ratio

Access to canal bank

Protecting health and environment

Poor water quality has a direct impact on health and environment conditions. Reduction in pollution loads entering the water system will improve the water-related public health conditions, improve the sustainable use of groundwater resources, and contribute to meeting the water quality requirements of the various functions of the water system. Important indicators that describe to what extent this policy objective is achieved are:

- Pollution and health
  - violation of water quality standards (e.g. E-coli)
  - water quality of shallow groundwater
- Ecology and sustainability
  - use of non-renewable groundwater
  - condition Ramsar site Bardawil
  - ecological condition coastal lakes

Supporting 'objectives'

The Government of Egypt aims to promote sustainable growth through enhanced private sector involvement in production and in public services. The assumption underlying this aim is that less government involvement in production and public services allows those to function with greater economic efficiency. Likewise, the water sector's economic efficiency is expected to increase through attributing a greater role to water users in the management of Egypt's waters. Or in other words: the same (or higher) levels of service and production would be achieved at less cost. The institutional reform that is needed to achieve this goal is often seen as an 'objective' by itself. In an analytical sense institutional reform actions are considered to be measures and not an objective; measures which have been included in the water resources management strategy as strategy components.

The same applies to the financial 'objectives' of the government. To reduce the financial burden for investments, operation and maintenance of the water-related infrastructure, the government aims to recover (part of) the cost involved in these activities. Cost recovery and the use of other financial incentives will be included as strategy components.

In Chapter 4 a description will be given what the present situation is with respect to above objectives, expressed in the related indicators, and what can be expected in the year 2017 under the present scenarios and policies.

3.3 Legal framework

Water management needs the support of an adequate legal framework that provides the water managers with guidelines and instruments for the planning of new developments, for the allocation of water, for the operational management and maintenance of the irrigation and drainage system, for the management of water quality and for financing all these activities.
The most important laws in this respect are:

- Law 12 (1982), "Concerning the Issue of the Law on Irrigation and Drainage";
- Law 213 (1994), "Regarding Farmer Participation";
- Law 48 (1982), "Concerning the Protection of the River Nile and Waterways from Pollution", implemented by Decree 8/1982 of MPWWR; and
- Law 4 (1994), "Law for the Environment."

The main characteristics of these laws are summarized below.

3.3.1 Law 12 (1982): Irrigation and Drainage

Irrigation and drainage are regulated by Law number 12 of 1982 "Concerning the Issue of the Law on Irrigation and Drainage". The Law defines public properties related to irrigation and drainage, for example the River Nile, the main canals, public feeders and public drains and their embankments. It also defines the use and maintenance of private canals and field drains and specifies arrangements for the recovery of costs of drainage works. The rules for water allocation, for example the winter closure, rotations and the planting of rice are provided, as well as rules for the construction of water intakes along the Nile and public canals and the need for consultations with land owners before making changes to water intakes.

The Law regulates the use of groundwater and drainage water (construction of wells or the use of drainage water and water pumps). It provides the regulations for the development of new land and the price that has to be paid for the irrigation and drainage of land. The Law regulates the protection against flooding, navigation and coastal protection, the authority to recruit people to guard and protect the banks of the river Nile (and irrigation establishments) against flooding, as well as measures to protect the irrigation system against damage. Section VII of the Law describes the penalties for violations (for example growing rice in areas without a license can be punished with 30 to 100 LE per feddan) and gives the irrigation engineer the right to demand repairs of damages to irrigation or drainage works. Finally some provisions are given to settle disputes and a fund for the repair of irrigation works is established.

Law 12/1982 is primarily aimed at irrigation as the dominant water user and the Ministry of Irrigation (now MWRI) as the water manager that has to give permission for all abstractions of water. Other water users are not mentioned in particular. No priority rules are given in case there might be conflicts between various categories of water users.

The Law does not provide an adequate legal basis for water resources management in a era of scarcity, which demands the involvement of stakeholders in the water sector in the planning and allocation of water resources. A revision of Law 12 has been drafted and submitted to the Cabinet, which enables user organizations to play a role in the management of irrigation water at the levels of *mesqa* and above in all categories of irrigated land in Egypt.

3.3.2 Law 213 (1994): Farmer Participation

Law 213/1994 (FWMP, 1996) provides MPWWR (now MWRI) the legal basis for the establishment of farmer participation at the mesqa level for *improved* irrigation systems. It also establishes a fund to finance projects related to the development and maintenance of improved mesqas and to promote awareness with respect to the use of water. The Law originally only concerned water users organisations on *new lands*. Recently the Law has been adapted to include organisations on *old lands* (such as IIP WUAs, branch canal WUAs and Water Boards) as well. The Law enables the recovery of costs in case the landowner neglects his duties with respect to the maintenance of the irrigation or drainage system or if he violates the authorisation for irrigation of new land.

Although Law 213/1994 enables farmer participation in the management of improved irrigation systems at the mesqa level and provides the legal basis for water users organisations on new lands, organisations on old lands can only acquire a legal personality in conformity with Law 32/1964 on Private Associations and Unions (FWMP, 1996).

Meeting of Water Users Association

3.3.3 Law 48 (1982): Protection of Nile from Pollution

Law 48/1982 provides the basis for the protection of surface and groundwater against pollution. In the law a distinction is made between the Nile and the irrigation canals which are referred to as 'potable', and the drains, lakes and ponds, which are referred to as 'non-potable'. MPWWR (now MWRI) is made responsible for the licensing of wastewater discharge, whereas the Ministry of Health is responsible for monitoring effluents. Only discharge of treated wastewater is permitted, while treated wastewater from animal or human sources can only be discharged to "non-potable" water. In addition, the reuse of drainage water is regulated, as well as weed control and waterway pollution by agro-chemicals. It establishes a fund from the revenues of levies, fines and costs recovery, which can be used for administration, donations, research and rewards.

The executive regulations of Law 48 provide water quality standards for (1) the Nile river and canals), (2) treated industrial discharges to the Nile, canals and groundwater; (3) domestic and industrial discharges to drains, brackish lakes and ponds, (4) reuse water to be mixed with Nile river or canal waters, and (5) the drains, lakes and ponds themselves.

Law 48 of 1982 and its executive regulations have been reviewed in a number of studies. Comments are related to the nature of the standards and their strictness, which hampers compliance and enforcement, the distribution of responsibilities and the relation between this Law and Law 4/1994, which was established for the protection of the environment in general.

Strict enforcement of the present regulations would mean very large investments by industry and municipalities, which are in the present situation not realistic and even counterproductive. It would also forbid the reuse of treated municipal wastewater. The application of Law 48 needs to become more flexible; adaptations of the Regulations are necessary to convert it into an effective tool in an overall action plan for pollution control. A revision of Law 48 is in preparation within MWRI for submission to the Cabinet.

3.3.4 Law 4 (1994): Environment

Law 4/1994 concerns the environment in general. During the preparation of the law it has been decided not to integrate Law 48/1982 into this new law. Instead, Law 4/1994 refers to Law 48/1982 for specific regulations on water quality. An important element of Law 4/1994 is the establishment of the Egyptian Environmental Affairs Agency (EEAA). From the viewpoint of Integrated Water Resources Management Law 4/1994 provides regulations for the protection against pollution of sea shores, ports, etc that are not covered by Law 48/1982.

The co-existence of Law 4/1994 and Law 48/1982 makes that the division of responsibilities between various agencies with respect to the management of the water quality in the river Nile, the canals and the groundwater is not always clear.

3.4 International co-operation

The Nile River is an international river and is shared by ten countries: Burundi, Congo, Egypt, Eritrea, Ethiopia, Kenya, Rwanda, Sudan, Tanzania and Uganda. From its major source, Lake Victoria, the White Nile flows north into Sudan. At Khartoum it meets the Blue Nile, which rises in the Ethiopian highlands. From the confluence of the White and Blue Nile, the river continues North, enters Egypt through Lake Nasser and terminates in the Mediterranean Sea. The river is approximately 6,700 km long and the basin covers an area of approximately 3 million km^2 (see also Figure 2-3 in Chapter 2).

Egypt, being the most downstream country in the basin, has been cooperating with the other countries for many years through agreements. These agreements aim to secure Egypt's share in the Nile Water. The first agreement between Nile Basin countries was signed in 1891. The most important agreements are listed in the text box.

Main agreements between Nile Basin Countries

1929: Egypt and Great Britain (repr. Sudan, Kenya, Tanzania and Uganda)

- no works to be undertaken on the Nile, tributaries and lakes which would reduce the volume of the Nile waters reaching Egypt
- Egypt has the right of inspecting the implementation of projects
- all agree on Egypt's ancient rights of the Nile water
- Egypt has the rights of investigating along the whole length of the Nile, to the remote sources of Nile tributaries in these territories

1959: Egypt and Sudan

- interrelated with the agreement of 1929
- earlier acquired rights: 48 BCM/yr for Egypt and 4 BCM/yr for Sudan
- utilization of Nile waters after construction of the High Aswan Dam to be shared by Egypt (7.5 BCM/yr) and Sudan (14.5 BCM/yr)
- construction of Roseiras reservoir in Sudan
- projects to minimize losses in Gabal and Zaraf lakes, Ghazal lake and its branches, Sobat river and its branches, and the White Nile Basin
- technical cooperation between both countries and with other Nile Basin countries
- establishment of the Permanent Joint Technical Commission (PJTC) of the Nile waters

1993: Egypt and Ethiopia

- both countries should not embark on any works on the Nile that could harm and affect other countries
- importance of safekeeping and protecting the Nile water
- compliance with international laws
- consultation and cooperation between both countries for utilization of the Nile water to increase water flows and to reduce losses

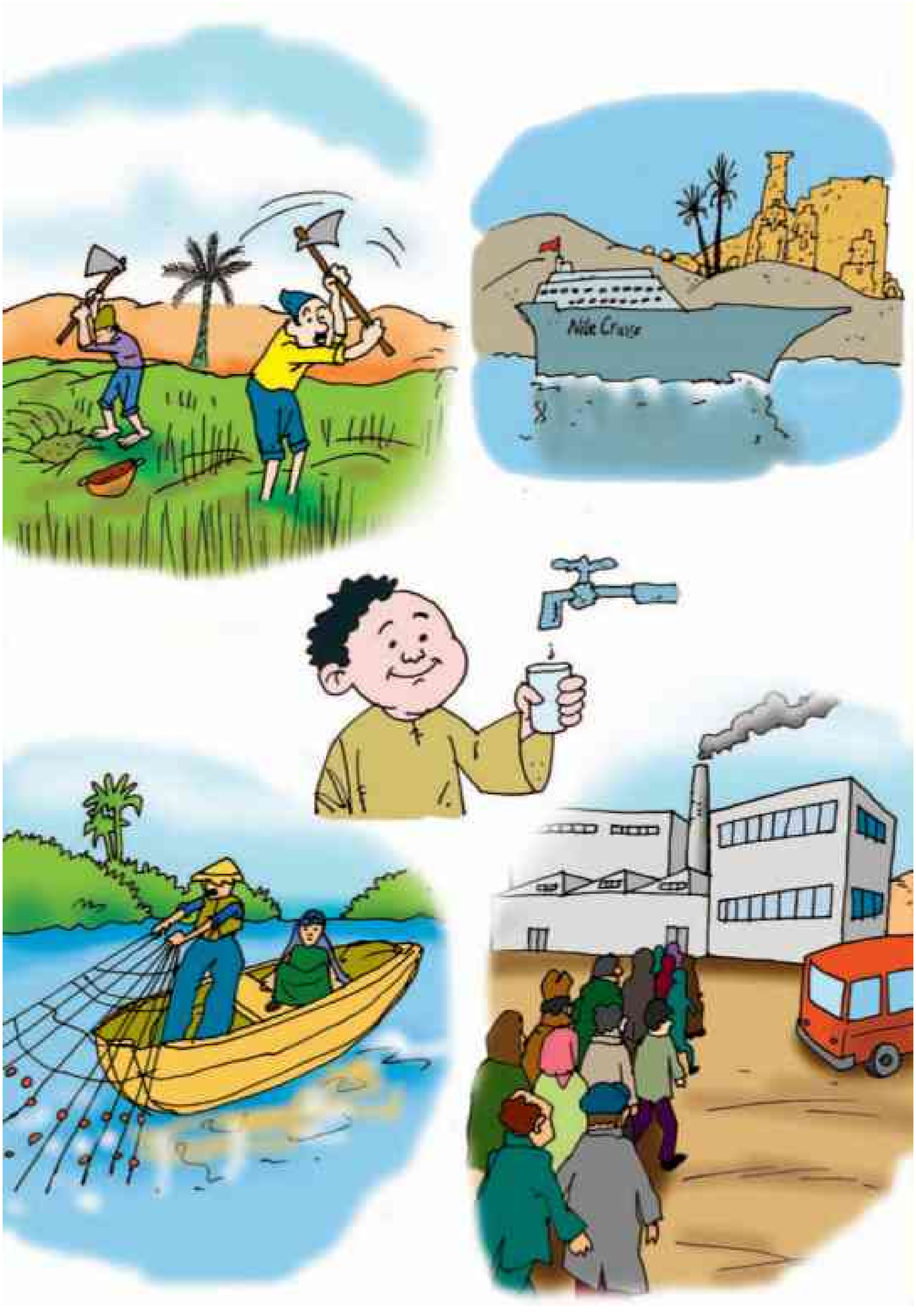
An important step for the cooperation has been and still is the technical cooperation. This started in 1967 in the form of a joint project of Egypt, Sudan, Uganda, Kenya and Tanzania on hydrological and meteorological studies in the basin. The project was joined by other countries at a later stage. In 1992 the ministerial council of the Nile Basin countries initiated the technical committee TECCONILE (Technical Cooperation Committee for the Promotion of the Development and Environmental Protection of the Nile Basin) to investigate and study all technical aspects related to the Nile Basin. TECCONILE continued until 1999 when it was replaced by Nile Basin Initiative (NBI) as a wider framework with different operating organs aiming at paving the way for a final installation of legal and institutional arrangement. Egypt has been a strong supporter of the work of the Nile Basin Initiative and will continue to do so.

Nile Basin Initiative

Blue Nile

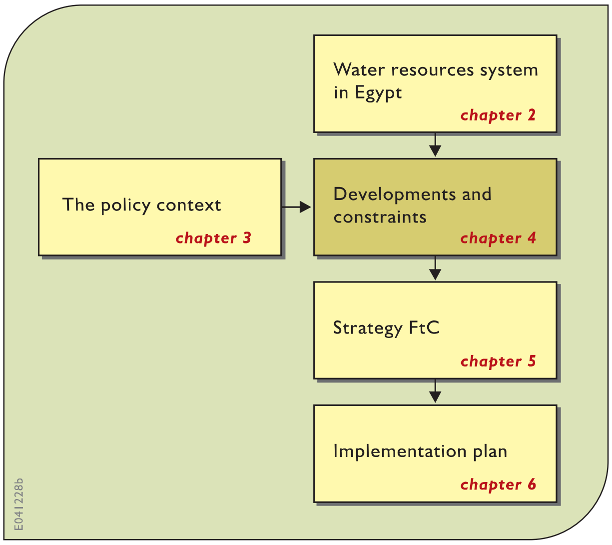
Owen Falls, Uganda

Confluence of Blue and White Nile, Sudan


Nile Cruise

4 DEVELOPING AND MANAGING THE SYSTEM – AN ANALYSIS

- Looking into the future – a growing demand requires Egypt to look for options to improve the performance of the water resources system
- The growing demand – more people and more economic activities in agriculture and industry
- Finding solutions:
  - more water
  - increase the efficiency of use
  - improve the quality of the water
- The water balance – where demand and supply should meet
- Problem analysis 2017 – what will happen if no new actions will be taken



The water resources system as described in Chapter 2 has to support the socio-economic development goals as stated in the previous chapter. This requires management, both with respect to the day-to-day operational activities as well as planning to deal with the present issues and anticipated developments. The National Water Resources Plan addresses this planning need. An analysis has been carried out to identify the present state of the water resources system, how this will develop between now and the next 20 years and what kind of actions and measures can be taken to improve the performance of the system.

This chapter will describe the analysis that has been carried out. The results of the analysis will form the basis on which the strategy Facing the Challenge has been developed and which will be presented in the next Chapter 5. The first step was the definition of scenarios about future developments that the water resources system has to cope with (Section 4.1). The time horizon for NWRP has been set at the year 2017. Predictions are made on the demand (Section 4.2) and supply (Section 4.3) in future situations. In Section 4.4 the approach to pollution control is described. Comparing demand and supply and taking into account the quality aspects involved leads to a description of the expected problems in 2017 of which the water balance is a major component as this water balance will indicate if Egypt will have sufficient water to support its development goals (Sections 4.5 and 4.6). Finally, in Section 4.7 an inventory is made of all possible measures that can be taken to further improve and develop the water resources system. That inventory will be the real basis upon which the strategy Facing the Challenge will be developed in the next chapter. Figure 4-1 illustrates the content of the analysis steps and corresponding sections.

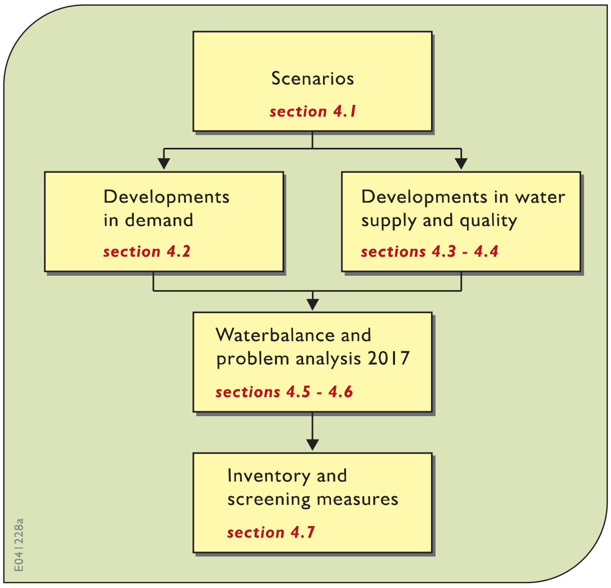


Figure 4-1 Structure of NWRP analysis

4.1 Scenarios – how to deal with an uncertain future

4.1.1 Why scenarios - definitions

NWRP deals with the future and this future is by definition uncertain. NWRP has to support the socio-economic development objectives of the government of Egypt, e.g. provide its inhabitants with access to sufficient drinking water of good quality, provide water to farmers to irrigate their lands and provide water to industry. But how many people will there be in future, how much land will need to be irrigated and how much water industry may need? And what about climate change? Will the Nile provide in future more or less water to be distributed among the riparian countries? All these uncertainties that are beyond the control of the water resources planners are captured in scenarios. By developing alternative scenarios different possible futures can be analysed, trying to find the best strategy to deal with that future and the uncertainties involved.

NWRP has taken the year 1997 as the starting point of the analysis at the start of the NWRP project in 1998. For that year all required data was available. A planning period of 20 years was assumed which brings the time horizon at the year 2017. This year 2017 coincides with the planning horizon that was used in several recent planning studies of MWRI as it is the start of another 5-year planning cycle. The analysis carried out for the present situation is called the Base Case. It describes the present performance of the Water Resources System.

Definitions in NWRP

- **Base year** ('present' situation): 1997
- **Time horizon** (future situation): 2017
- **Base case**: performance WRS in 1997
- **Reference case**: performance WRS in 2017 if no additional measures are taken

The performance of the Water Resources System in the year 2017, under the assumption that no additional measures are taken apart from those that are firm, is called the Reference Case. This case will be used as a reference to compare the impacts of the new strategy Facing the Challenge, i.e. how much the performance of the system will improve when this strategy is implemented. The Reference Case is not a do-nothing case; besides the predicted autonomous developments it does include all measures that are presently already being implemented or planned to be implemented. Since it is not unusual that the realisation of plans lags behind the planning, the Reference Case may be slightly optimistic. The assumptions made for the Reference Case introduce an additional uncertainty in the analysis.

4.1.2 Scenario elements

Scenarios represent visions of what may happen in the future, particularly with respect to those factors that are likely to be important in determining the demand-supply conditions of the various users, but which are outside the control of the water resources planners.

Demand related scenarios elements

Many socio-economic developments will influence the demand for water and the performance of the water resources system. The most important socio-economic scenario variables from the perspective of NWRP seem to be:

- Population growth, determining the demand for drinking water but also the demand of related economic activities such as (irrigated) agriculture and industry.
- The general economic growth and welfare, influencing the per capita consumption, labour costs, prices of commodities, etc.
- Industrial growth, including not only an increased demand by a growing industry but also a decrease in demand caused by technological improvements in water use in the industry.
- The increase in per capita income, again influencing the demand for water but also the ability to pay for that water and the increased demand for other products (e.g. from agriculture) that also consume water.
- The loss of agricultural land due to growth in residential areas, decreasing the demand for irrigation water.

Supply related scenarios elements

Supply related scenario elements are rainfall, evaporation and the inflow in Lake Nasser. These elements are stochastic by nature and vary year by year. Global warming and related climate change will influence these variables, both with respect to their absolute value as well as their variability. What climate change will mean for Egypt is still very uncertain and can not be taken into account in our analysis. In a kind of what-if analysis a very first indicative impression can be derived of the impacts for Egypt. That will be described in Section 5.6.

Water conservation projects upstream of Lake Nasser can have important impacts on the supply of water for Egypt. The co-operation in the framework of the Nile Basin Initiative (NBI) is promising but not sufficiently developed to take these conservation projects into account as ‘measures’ in Egypt’s water resources strategy. Instead, these conservation projects can be included in the scenarios. The most realistic conservation project is Jonglei Phase I. The construction of the Jonglei Phase 1 canal, which by-passes a large portion of the Sudd swamps, was started in the mid 1970s. This scheme would save an estimated annual amount of 4 BCM of evaporation losses in the swamp. However, the construction was halted in 1983 due to political instability in Sudan. Its future completion seems far from certain due to a number of reasons. Jonglei Phase I has been included in the more favourable scenario. When implemented the scheme will increase the Nile flow by some 4 BCM/yr. This will equally be shared between Sudan and Egypt.

4.1.3 How has NWRP dealt with these scenario elements?

The main analysis of the strategy 'Facing the Challenge' (see Chapter 5) is carried out for the 'most likely' scenario. This 'most likely' scenario is constructed on the basis of best estimates for the relevant variables: a population growth of 1.62 %/yr, a loss of agricultural land due to urbanization of 26,000 fed./yr, and a supply from Lake Nasser of 55.5 BCM/yr. In addition two other scenarios were developed: a 'more favourable' and a 'less favourable' scenario, based on a positive or negative view on how the future will develop. For a full description of those three scenarios reference is made to NWRP Interim Report No.1 (NWRP, 2001a).

Analysis has shown that most measures included in the strategy Facing the Challenge appear to be independent of the chosen scenario as they contain policy decisions that do not depend on the scenario variables. Moreover, the inaccuracies in a lot of data and the models used to make the predictions do not justify additional calculations using changed scenario elements, in particular the demand related ones.

On the other hand it is apparent that the scenario element 'Supply available from Lake Nasser' is a very important factor for the management of the water resources system in Egypt. Recent analysis indicated that global climate change might increase the discharge of the Nile (LNFDC, 2004). At the other hand, political developments in Sudan make it highly unlikely that the Jonglei canal will be completed in the near future.

Combining all uncertainties it was concluded that a formal scenario analysis based on above scenario elements would not be carried out for the NWRP. Only the 'most likely' scenario has been used for the overall analysis and the strategy 'Facing the Challenge' is based upon that scenario. However, after completing the analysis of 'Facing the Challenge' a 'what-if' analysis has been carried out on the most important uncertainties. The results of that analysis will be described in Section 5.6. Included in the analysis are:

- changes in drinking- and industrial water demand of -20% till +20% (more or less combining the demand related scenario elements described in Section 4.1.2);
- availability of water at Lake Nasser in the range 54.5 (less favourable scenario), 55.5 (present), 57.5 (more favourable scenario), 59.0 and 63.0 BCM/yr (extremely favourable results of climate change); and
- a reduction in water reuse because of insufficient water quality (an implementation risk related to a delay of installing treatment facilities and/or insufficient performance of the facilities).

4.2 Developments in demand and use of water

The demand for water in Egypt will increase. In particular the planned Horizontal Expansion programme of the government will result in a major increase in the demand for water. Other sectors of which the demand will grow are the municipal and domestic water use and the industrial use. The developments in water demand will be described in this section. The section will also pay attention to the social aspects of water management and the various cost recovery, tax and subsidy aspects involved.

4.2.1 Agriculture

Agriculture is by far the largest user of water in Egypt. It accounts for 95% of the total consumptive use, compared to consumptive uses of 4% for municipal and industrial water and 1% for fishponds. Hence, developments in the agricultural sector will have a strong influence on water management. These developments include the increase in irrigated area as a result of horizontal expansion, the loss of irrigated area due to urbanisation and developments in crop yields.

Horizontal expansion

Horizontal expansion is one of the major policy instruments of the Egyptian government to relieve the population pressure in the Nile Valley and Delta. The original 1982 Horizontal Expansion Plan was based on a national survey on land suitability of areas near the Nile Valley and Delta, performed in the 1970s. According to the results of this survey and a study of water availability it was agreed by MALR and MWRI to reclaim 2.68 Mfeddan (2.18 Mfeddan irrigated with Nile water, 0.30 Mfeddan with deep groundwater and 0.20 Mfeddan irrigated by reuse of treated wastewater).

Till 1997 about 0.815 Mfeddan were actually reclaimed and went into production. In 1997 a new Horizontal Expansion Plan was adopted that aims to develop 3.4 to 3.5 Mfeddan, including the reclamation of 1.2 Mfeddan from the previous (1982) plan. This plan was completed in the year 2002. A rough map of the areas developed and still to be developed is presented in Figure 4-2. Table 4-1 gives a summary of the horizontal expansion projects, including their sources of water. More detailed information is presented in Annex B2.

Region and source of water	Total area	Completed by 2004	Under impl. in 2004	To be initiated 2004-2017
Surface water and drainage reuse				
Eastern Delta	465.2	317.0	25.7	122.5
Middle Delta	124.9	115.9	9.0	0.0
Western Delta	324.0	299.0	0.0	25.0
Sinai *)	690.0	310.0	10.0	370.0
Middle Egypt	81.0	43.7	8.8	28.6
Upper Egypt	962.4	66.8	246.3	649.4
Groundwater				
Western Delta	60.0	15.0	45.0	0.0
Sinai	25.4	5.9	19.5	0.0
Western Desert	514.0	83.0	166.0	265.0
Eastern Desert	70.0	0.0	60.0	10.0
Treated waste water				
Eastern Delta	45.0	0.0	0.0	45.0
Western Delta	95.0	95.0	0.0	0.0
Middle Egypt	20.7	0.0	0.0	20.7
Total	**3,477.6**	**1,351.2**	**590.2**	**1,536.2**

*) including 250,000 feddan after completion of the Jonglei Phase I project
source: Horizontal Expansion Sector, MWRI

Table 4-1 Horizontal expansion projects (in 1000 feddan)

Figure 4-2 Horizontal expansion projects

The present rate of new reclamation is about 150,000 feddan per year by the government and some 50,000 feddan per year by the private sector. These private sector developments are part of the total targets because of water limitations. In other words, if the private sector develops more the government will develop less. Two major projects in this field are the El-Salam Canal / Northern Sinai project and the Toshka project.

El-Salam Canal / Northern Sinai Agricultural Development Project

The El-Salam canal is designed to irrigate about 620,000 feddan. It starts from the Damietta Branch of the River Nile upstream of the Farascour Dam near Damietta. It will provide the water to irrigate 220,000 feddan in the Eastern Nile Delta and 400,000 feddan in Sinai. Map 2 in front of this document gives and overview of the El-Salam Canal project. The water for this project (4.45 BCM/yr) will be derived from agriculture drainage water from Bahr Hadous and Lower Serw drains and from the river Nile (Damietta branch). East of the Suez Canal water is delivered by the El Salam Canal through a siphon. Originally some 250,000 feddan were identified in the Land Master Plan (1986); 135,000 feddan south of El Arish were added in 1990 upon the request of the North Sinai Governorate.

Crossing El-Salam Canal with Suez Canal

The El Salam Canal East will have pumping stations to lift the water to a maximum level of +45 m above MSL. Water available is estimated at 2.8 BCM/yr, whereas water requirements are estimated at 2.95 BCM/yr. Especially during the summer, water supply will show shortages. In view of the relatively high salinity level after mixing the Nile water with drainage return flows, leaching requirements will be substantial.

Toshka project (South Valley)

The Toshka Project is developed in the Western Desert as part of the policy of the GoE to increase the inhabited area of Egypt. The present plan comprises the development of irrigated agriculture on 540,000 feddan near Lake Nasser (see Figure 4-3). The water demand (4 to 5 BCM per year) is taken from Lake Nasser through pumping. In view of the variable levels in the lake (from 147.5 to 178.5 m above MSL, the (submerged) inlet has been located at about 140 m above MSL, well below the lowest expected level. The water flows through tunnels to the Mubarak pumping station, built in a deep excavated pit. The water is pumped to a level of about 200 m to reach the starting point of the canal. The capacity of the pumping station is given as 300 m^3/s. The main canal is designed for 540,000 feddan.

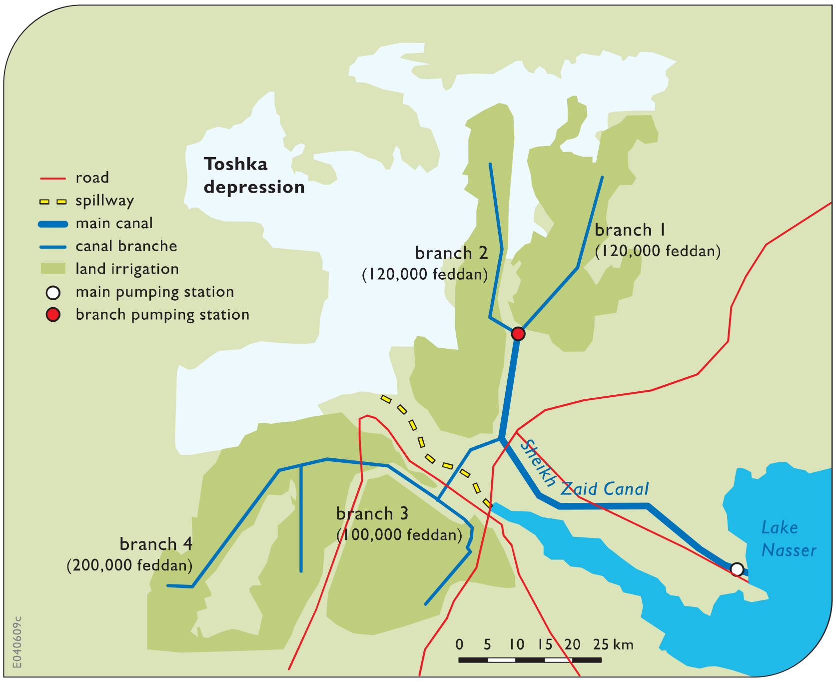


Figure 4-3 Overview of Toshka project

Lining of canal in Toskha project

Mubarak pumping station

Loss of agricultural land due to urbanisation

The loss of agricultural land due to urbanisation has been studied extensively for the 1984 Water Master Plan project and the findings have been reported in a separate volume (Ministry of Irrigation/UNDP, 1984). The study quotes 11 different sources, resulting in losses of agricultural land per year ranging from 10,000 to 75,000 feddan. The report concluded that 45,000 feddan per year seemed to be a fair estimate.

The loss of agricultural land due to urbanisation, degradation and brick making has been recorded by MALR for the period 1983-95 and described by Girgis (Girgis et al, 1997). The total land lost in this period is 81,000 feddan, and was lost mainly to urbanisation (43%) and degradation (47%). Half of the land lost to agriculture is located in the Delta Governorates Dakhalia (12%), Gharbia (10%), Menoufia (12%) and Kalyoubia (15%). There have been large fluctuations of land loss over time, varying between 8,771 (1989) and 4,465 (1992) feddan. The average area lost in the recorded period is 5,800 feddan per year, which is considerably less than the estimate used by the Water Master Plan.

Region	Irrigation area (thousand feddan) 1997 base year	2017 ref. case *)
Deep groundwater deserts	70	763
New Valley (Toshka)	0	540
Upper Egypt	1,307	1,728
Middle Egypt	1,093	1,085 **)
Fayoum	360	378
East Delta	2,131	2,446 **)
Middle Delta	1,551	1,525
West Delta	1,473	1,866 **)
Sinai (surface water)	0	695
Total	**7,985**	**11,026**

*) including all planned expansions up till 2017

**) these areas include a total of 250,700 feddan to be irrigated with treated wastewater

Table 4-2 Irrigation areas in 1997 and 2017

Based on discussion with the stakeholders involved and staff of the Remote Sensing/GIS unit of SWERI the loss of agricultural land in the old lands in the Valley and Delta is (somewhat arbitrarily) assumed to be 26,000 feddan per year. Over the 20-year time period of the plan this results in a loss of 0.52 million feddan.

Resulting irrigation area in 1997 and 2017

Correcting for the loss of land due to land-use changes, the assumed total irrigation area in the 2017 Reference Case equals about 11 million feddan (irrigation area in 1997 minus loss due to land-use changes, plus horizontal expansion). The areas in the different regions are summarised in Table 4-2.

Crop production

Future cropping patterns

The 2017 cropping pattern was estimated by the ASME model. This model determines the cropping pattern that produces the highest consumer-producer surplus, given certain constraints such as the availability of water, land, and export possibilities. Changes in the demand for agricultural commodities between 1997 and 2017 were simulated in ASME through the elasticity of the commodities, the increase in population and the change in per capita income (NWRP, 2001b).

Crop	Predicted yield increase
Wheat	35%
Vegetables, maize, rice (short variety) and flax	30%
Potato and cotton	25%
Other crops	20%

Table 4-3 Predicted increases in crop yield

Autonomous developments in crop yields and prices

To estimate future agricultural production also the expected increases in crop yield (due to improved crop varieties, etc.) have to be considered. Based on discussions with agronomists from MALR (NWRP, 2001f) crop yields up to the year 2017 were predicted to increase by 20% to 35% (Table 4-3).

To estimate the production value, the prices of internationally traded agricultural commodities have been converted into import parity farm gate prices for imported commodities and into export parity prices for exported commodities by making allowances for transport costs, taxes, etc using standard methods. The question of what price projections to use for future estimations was finally resolved by assuming that the future real prices (removing general price inflation) would be approximately equal to the prices of the baseline year. The reason to do this is that although long-run price trends have shown some decline, in recent years this decline has been more gradual, and it is projected to be even more gradual in the future. Furthermore, there is enough year-to-year variation to make the trend very unclear if only a short series of years is used. For example, in 1996, there was a price spike for wheat but 1997 prices were about the same as in the base year, 1995. In subsequent years, the trend has been slowly down. But given that the variability is significant, and that the rate at which the prices are dropping is lessening, and also given the fact that recent low prices (2000 and 2001) may be below the long term trend, it is difficult to say with certainty that prices in 2017 will be lower than in 1997 in real terms.

A second reason to avoid projecting decreasing prices is that, doing so in the NWRP analysis, this results in declining returns to agriculture overall. It seems more likely that some (real) crop prices may decline relative to others, but estimating these relative prices runs the risk

Loss of agricultural land by urbanisation that the future value of total agricultural production under different cropping scenarios will be driven by these estimates of relative prices, and these are debatable. The simplest solution is to keep prices at current real levels for the year 2017.

4.2.2 Domestic, municipal and industrial water

Within the scope of the NWRP project, a national survey was carried out on municipal and industrial water supply and wastewater treatment. The aim of this survey was to assess the sector's present status, and the ongoing and planned developments. The results of that survey are documented in Technical Report 18 of NWRP (NWRP, 2001c).

Future demands for municipal and industrial water largely depend on population growth and industrial growth. In the most likely scenario Egypt's population is expected to grow from 59.3 million (1996 census) to 83.1 million in 2017, whereas the urbanisation increases from 43% to 48% (Chapter 2). Economic growth towards 2017 has been assumed at 6 % per year. Based on the assumed population growth and growth in GDP the per capita income is expected to increase by 4.3% per year.

	Water demands (lcd)	
Category	Egyptian Code of Practice	NOPWASD
Governorate capital	220	250
Other urban	180	215
Rural > 10,000	150	125
Rural < 10,000	150	100
New cities	300	n.a.

Table 4-4 Gross unit water demands

Drinking water demand

The Egyptian code of practice for drinking water supply gives daily gross unit demands in litres per capita per day (lcd) for different types of service areas. NOPWASD uses slightly different figures for the unit demands (see Table 4-4). These are the design demands at the treatment plants and therefore include unaccounted for water (UFW) losses.

Actual demands from the public water supply system are mainly determined by:

- income and tariffs
- type of connection (house connection or standpipe)
- availability of sewer system

	Production	
Source	MCM/day	%
Surface water *)	11.92	82.6
Groundwater	2.40	17.3
Desalination	0.02	0.1
Total	**14.44**	**100**
*) about 6% is from compact treatment units		

Table 4-5 Sources of drinking water in 2000 (source: NWRP, 2001c)

In general demands increase with income and the availability of a house connection, and decrease with higher tariffs. The availability of a proper sewer system or drainage system to discharge wastewater also affects the water use. Households that are connected to a sewer system in general show higher per capita use of drinking water.

Assuming an increase in per capita income of 4.3% per year and an income elasticity of 0.1 for water demand, the annual per capita increase

Plants	Capacity MCM/day
Existing plants	
Present capacity	18.52
Ongoing construction to increase capacity	0.73
Planned capacity increase (up till 2017)	3.31
New plants	
Ongoing construction	5.76
Planned capacity increase (up till 2017)	1.33
Total (existing, under construction and planned)	**29.65**

Table 4-6 Capacity of drinking water plants (source: NWRP, 2001c)

in demand is 0.43% per year, which corresponds to an increase of 7.6% between 2000 and 2017. Combining the population increase with the per capita increase in demand, the total municipal demand (excluding industrial water) will rise by 41% between 2000 and 2017.

Drinking water production

The capacity of drinking water plants more than tripled in the last 2 decades. The total installed capacity of water treatment plants in the year 2000 was 18.5 million m^3/day and the average drinking water production was 14.4 million m^3/day (or 79% of the total capacity), which is equivalent to an annual volume of 5.31 BCM. An estimated amount of 0.62 BCM/year was used for industrial purposes. About half of the total drinking water production was for Greater Cairo and Alexandria.

By far the largest source of raw water is the surface water system (Table 4-5). Only 17% of the drinking water supply is from groundwater (some 1800 wells). The production of desalinated brackish- or seawater is only a minor part in the national drinking water supply. However, it is the main source for drinking water in tourist areas along the Red Sea coast and the Sinai Peninsula.

In the national survey also an inventory was made about ongoing and planned construction of drinking water plants (Table 4-6). Annex B3 provides an overview of existing and planned drinking water plants by governorate.

In the 2017 Reference Case all planned capacity increase is realised in 2017 and the total available capacity would reach almost 30 MCM/day.

Industrial water

The estimated industrial water use is based on the national survey carried out within the scope of the NWRP project (NWRP, 2001c). It is noted that the industrial water use data presented in their final report should be interpreted with caution, since the data is based on a limited sample survey of 312 public industries. Extrapolations were based on CAPMAS statistics on total labour in the different industrial sub-sectors, and average water-use per labour unit for the different sub-sectors in the surveyed industries. The total water use in the surveyed industries represents only 13% of the total estimated use.

Sector	Demand 1980 *) MCM/yr	Demand 2000 *) MCM/yr	Growth per year %
Power	[2,270]	[5,287]	[8.1%]
Chemical	231	675	5.5%
Food	182	1,084	9.3%
Textile	83	161	3.4%
Metal	74	153	3.7%
Others	58	139	4.5%
Total (excl. power)	627	2,213	6.5%

*) Water Master Plan 1980
**) NWRP, 2001c

Table 4-7 Comparison industrial demands in 1980 and 2000

Excluding cooling water for power plants, the total industrial water use in the year 2000 was estimated at 2.2 BCM, of which some 55% by industries in the large urban conglomerates of Greater Cairo and Alexandria. About 53% of the industrial water is abstracted directly from the Nile and irrigation canals, 28% from the public net and 19% from groundwater. Annex B4 provides an overview of the estimated industrial water demand by governorate.

This industrial water is used for the following purposes:

- Process water: 51%
- Cooling water: 43%
- Other use: 6%

From the 1980 Masterplan study (UNDP/IBRD, 1981) it appears that the water use by power plants at that time represented about 78% of all industrial water use. Since power plants were not included in the NWRP survey (NWRP, 2001c), the following text only refers to industries other than power plants.

The largest industrial consumer of water is the food sector, followed by the chemical sector. These two sectors consume almost 80% of all industrial water. The data from the M&I survey and the data from the 1980 Master Plan are compared in Table 4-7. If the data in Table 4-7 is correct, there was a large growth in industrial water demand during the last decades, with highest growth in the food sector.

One of the economic development objectives is to create favourable conditions for industry. Considering the fact that industrial water supply has a higher priority than the supply of irrigation water, no shortage is anticipated for the industrial sector.

To estimate the industrial water demand for 2017 it is assumed that the demands in the old industrial areas will increase by 20%, due to expansion of these areas. The new industrial areas in 2017 are estimated to cover 305 km^2. In the year 2000 already 102 km^2 were developed (NWRP, 2001c). The design supply to these areas equals 7,000 m^3/km^2 per day, during 300 days per year (equals 8,820 m^3/feddan/yr). This compares to 0.67 l/s/ha which is in the same order as design values in other countries (usually in the range of 0.5 to 1.0 l/s/ha). The industrial cities will be supplied from the public water supply network.

In addition to the new industrial areas also the demand for mining areas will increase in 2017. The estimated water demand for these areas is based on the same design supply mentioned above. It is somewhat arbitrarily assumed that this mining demand is covered from non-Nile resources. The estimated industrial water demands are summarized in Table 4-8. In this table the cooling water demand for thermal power plants is not included (4.7 BCM for 1997 and about 13.5 BCM for 2017).

The uncertainty about the present total industrial water use and its distribution over the different Governorates, is obviously also reflected in the forecasted demands. The industrial survey undertaken by NWRP provided useful information, but it can hardly be expected that more than indicative figures are obtained for the whole country, based on the extrapolation from a limited sample of surveyed industries.

	Demand	
Industrial areas	2000 MCM/yr	2017 MCM/yr
Old areas	1,998	2,398
New areas	214	641
Mining	pm	1,155
Total	**2,213**	**4,193**
supply from public net	624	1,132

Table 4-8 Summary industrial demand (excluding cooling water power plants)

4.2.3 Sanitation

Most of the water taken in for domestic, municipal and industrial use is being discharged again to the water system as waste water. Part of that waste water is treated.

Municipal waste water

The sanitary facilities (sewage systems) are presently mainly limited to the main urban centres (see Section 2.3.4). Correspondingly, waste water treatment is also limited to these centres. Of the total waste water discharge in 2000 of about 9 million MCM/day only 50% is treated (see Figure 4-4). The other 50% is either discharged untreated or kept in septic tanks (NWRP, 2001c). The capacity of waste water treatment plants has increased by more than six times in the last two decades. The existing capacity of 6 MCM/day presently serves about 18 million people in mainly urban areas to process about 4.5 MCM/day. NOPWASD has planned to reach a total available capacity of 15 MCM/day by 2017, serving all urban areas (about 40 million people) and processing about 10 MCM/day of wastewater. Annex B5 gives an overview of existing and planned waste water treatment plants. No reliable information is available about the performance of the waste water treatment plants. Due to sub-optimal maintenance and operation it is expected that this performance is still rather low. This means that the effluent discharge of the waste water treatment plants still contains a high pollution content.

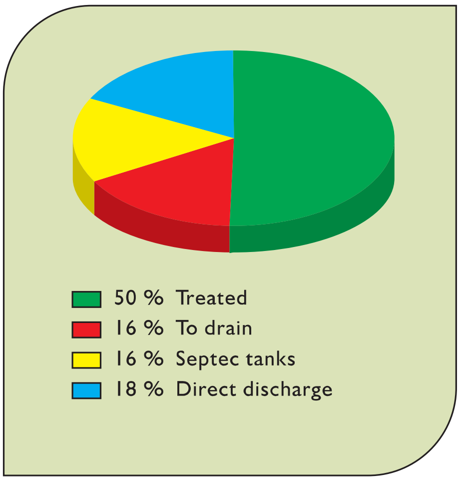


Figure 4-4 Waste water discharge in 2000

Industrial waste water

Based on the survey carried out by NWRP (NWRP, 2001c) it is estimated that about 80% of the industrial water intake is discharged back into the system as (polluted) return flow (excluding cooling water).

4.2.4 Cost recovery, taxes and subsidies

Irrigation and drainage

Investment, O&M and rehabilitation costs of irrigation and drainage infrastructure have traditionally been borne by the Ministry of Water Resources and Irrigation, hence providing water free of charge to farmers, except for the pumping costs from the *mesqa* to the field. In the pre-liberalisation period irrigation water demand management was not required since there was sufficient water, and the agricultural sector contributed indirectly to the government budget through the below world market prices the Government paid for the produce that farmers were compelled to grow.

Since cropping and prices have been liberalised in the 1980s, farmers are rather free what to grow and to whom to sell. With the increase in population, the construction of mega projects, and the increase of industrial and municipal use, irrigation water will become scarce and the costs for O&M and rehabilitation of the irrigation and drainage infrastructure will increase.

Egypt's new water strategy follows an integrated approach, combining demand management with resource development (Abu Zeid, 1997). Instituting a viable cost recovery programme would be a measure to both curtail water demand and to improve the funding for operation, maintenance and renovation. A recent study of MWRI on cost-recovery in the Irrigation and Drainage Sector (MWRI, 2004) motivates the needs and objectives of an increase of cost recovery in this sector. This will be based on an amendment of Law 12/1984 (Section 3.3.1).

Recommendations include options for recovery of O&M and capital costs of irrigation at branch canal level and of the drainage system as well as required institutional arrangements. The implementation of these programmes will require changes in the financial management structures as well as capacity building, in particular of the various water users advisory services (e.g. IAS).

For the new lands in the Toshka project, where land holdings will consist of large private sector farms, water charges have been proposed that are a combination of non-crop-based area charges and volumetric charges with an area charge of 100 USD/feddan/year. The volumetric tariff structure that has been proposed, ranges from 5 piastres per m^3 for supplies below 4,000 m^3 per feddan per year to 8 piastres above 6,000 and below 7,000 m^3, which apparently is the maximum considered (see NWRP, 2000d).

NWRP has considered crop-based water charges as a measure to curtail water use. These charges would be different per region, reflecting water quality. After extensive discussions it was decided not to select the measure. In (NWRP, 2000d) an overview is given of all previous work of water charges.

After the construction of the High Aswan Dam, the annual floods disappeared and salinisation of soils became a problem. The technical answer was a massive programme of sub-surface drainage. Farmers repay these on-farm investments, but with a extensive grace period. The same applies to the investments made under the Irrigation Improvement Project (IIP), in which individual pumping is replaced by collective pumping at *mesqa* level, using an elevated mesqa. For sugarcane there is a programme for land levelling and the use of gated pipes to improve field water application efficiency and yields. Repayment by farmers for these investments is also subject to a substantial grace period, amounting to a subsidy element.

For thousands of years, Egyptian governments (from the pharaohs to the dynasty of Mohammed Ali) used to obtain revenues by taxing agricultural land. The importance of land tax faded after the socialist reforms and the subsequent liberalisation. In 1996, total land taxes were MLE 138 (some LE 20 per arable feddan), constituting only 0.22% of the GoE's revenues. Apart from the land tax, farmers pay a sales tax of 10% on inputs and services, except for agro-chemicals, which carry only 5%. In addition, farmers pay a wide variety of small duties, licences, obligatory insurances and taxes related to machinery, the cleaning of the *mesqa* (LE 12-15/feddan), the cleaning of tile drainage and cotton marketing charge (LE 7-10/kentar of 50 kg). The total agricultural tax burden seems to be very low.

There are import tariffs for agricultural commodities. These duties in fact protect Egyptian farmers from cheap imports. The import duties for maize and wheat are 5%, for sugar 10%, for sorghum, barley, soybeans, vegetable oil 15% and for rice 25%. Especially the high rice tariff is one of the reasons this crop is overly popular with Egyptian farmers. In view of ongoing trade agreements and policy changes the NWRP will assume that import tariffs have dropped to 5% by 2017.

Municipal and industrial water supply

Cost recovery in the municipal and industrial water supply sectors is somewhat better than in agriculture but still far below full cost recovery. It is estimated that the government subsidizes the water service in the industrial sector with about 70%. It is generally acknowledged that industry should have the capacity to provide a major share, if not all, of the costs involved.

The subsidy of the municipal sector is estimated at 88%. The rate for domestic water supply in Greater Cairo is around LE 0.13/m^3, while cost of provision the raw water alone is estimated at LE 0.56/m^3. Domestic water rates have not increased since 1992, although local water companies have been authorised to institute a cost recovery programme.

4.3 Finding solutions - developments in supply

The by far easiest solution to meet the growth in demand would be to increase the supply. However, as will appear in Section 4.3.1, the possibilities to do so are limited. From a hydrological point of view the Nile has a huge potential but political, administrative and environmental constraints make it difficult to develop that source. There is potential for additional groundwater withdrawal, in particular in the Western Desert. The two other supply possibilities, rainfall / flash flood harvesting and desalinisation provide only very local solutions.

Not having many possibilities to increase the supply it will be needed to improve the efficiency of the present use. This will not actually increase the amount of water available but it will decrease the losses and, in this way, make more water available for actual use. This will be described in Section 4.3.2.

Finally, in Section 4.4 attention will be given to the quality of the water. Comparable to the increase of efficiency, improving the quality of the water will make more water of acceptable quality available for the users.

4.3.1 Increase of supply

Potential to increase Nile water availability

There are in principle four ways that Nile water availability and/or use in Egypt might increase:

- Implementation of upstream water conservation projects.
- Changes in operation of Lake Nasser to reduce evaporation and spill losses from the reservoir.
- Changes in Nile discharge as result of climate change.
- Reduction in losses to sinks from the Nile system in Egypt.

Upstream water conservation projects

A large part of the water of the White Nile is lost in Sudan through evaporation in swamp areas, notably the Sudd, Bahr El Ghazal and Machar swamps as indicated in Figure 4-5. To increase the inflow into Lake Nasser, a number of water conservation projects were proposed in the past (the Jonglei 1 and 2, The Bahr El Ghazal and Machar Marshes schemes). According to the Agreement with Sudan, any increase in available water from such conservation projects would be shared equally between Sudan and Egypt.

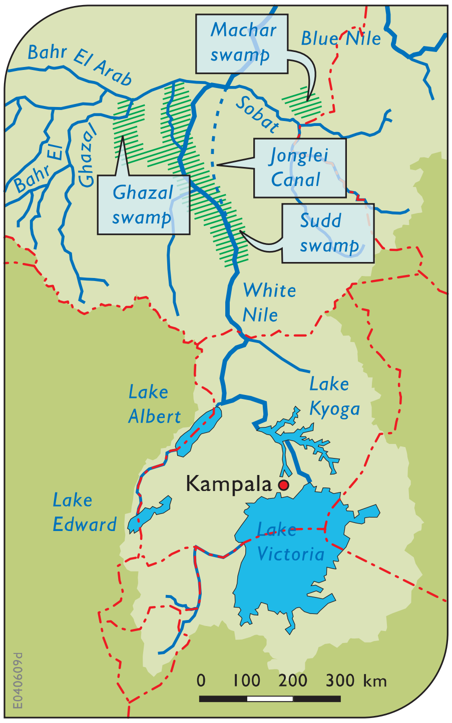


Figure 4-5 Swamps of Sudd, Bahr El Ghazal and Marchar

The construction of the Jonglei 1 Canal, which by-passes a large portion of the Sudd swamps, was started in the mid 1970s. This scheme would save an estimated annual amount of some 4 BCM of evaporation losses in the swamp. However, the construction was halted in 1983 due to political instability in the Sudan. Its future completion seems presently far from certain due to resistance from local population and environmental concerns amongst possible financing agencies. Therefore, for the 2017 planning horizon it seems justified to include the Jonglei development in an optimistic supply scenario only.

Changing operation of Lake Nasser

The average evaporation volume from Lake Nasser is about 10 BCM/year. The annual water release at Aswan is presently rather constant and not depending on the reservoir level. However, if this release is made variable in future (higher release at high water levels and lower release at low water levels) the average reservoir level and free water surface area could be reduced, and as a consequence the evaporation loss could be lowered. In addition, spill losses to the Toshka depression during high reservoir levels could be reduced. A preliminary study showed possible water saving in the order of 2 BCM/year through a change in reservoir operation.

Spill from Lake Nasser in Toshka depression December 1999

Another possibility to increase the useful discharge from Lake Nasser is to make better use of the flood storage zone of the reservoir by allowing higher reservoir levels at the first of August, thus reducing the available flood storage. Such measure should be combined with an increase in the capacity of the Toshka spillway. This measure will result in increased evaporation from the lake but this will be compensated by having more water available in the reservoir at the start of the low flow period. Moreover, it will reduce the effects of long-term dry years as experienced in the 1980 decade.

The impacts and implications of possible changes in reservoir operation are being studied in more detail in the "Lake Nasser Flood and Drought Control (LNFDC) Project" that started in 2002. These have not been taken into account in the NWRP yet.

Climate change

The same lnfdc Project has shown that the Nile discharge in Lake Nasser is extremely sensitive to changes in precipitation in the basin (LNFDC, 2004). Studies have shown that an increase of 10% in average annual precipitation would lead to an average increase in annual flow of 40%. Similarly a decrease in 10% in precipitation would lead to a reduction of the annual flow with more than 50%. Most global climate models predict an increase in precipitation in the important areas of the Nile basin. Given the high level of uncertainty involved in these predictions NWRP has not considered a possible increase in discharge because of climate change. As this increase is not unrealistic some sensitivity analysis has been carried out what this would mean for NWRP.

Reduction in losses to sinks

If the available Nile water is not increased in future, the only way to make a better use of the available water is to implement measures that are aimed at water savings in the system downstream of Lake Nasser. These measures will improve the overall water use efficiency of the Nile system, which is reflected in a reduction in outflows to sinks (i.e. outflows from the Nile system to desert areas, inland lakes, coastal lakes, the Mediterranean and the Suez Canal). Possibilities for increasing the efficiency will be described in Section 4.3.2.

Potential and present abstractions groundwater

Figure 4-6 and Table 4-9 summarise the total potential of fresh groundwater resources and their current use. In the Western Desert and Sinai the groundwater is abstracted from the Nubian Sandstone and Carbonate aquifers. These resources are non-renewable and yields are therefore non-sustainable. The groundwater potential in these areas is based on estimates using the MODFLOW groundwater model for a period of 50 years, under the assumption that the maximum allowable drawdown is 100 metres and the de-watering of the aquifer is restricted to one third of its saturated thickness. The groundwater potential in the Western Desert has been estimated for the main oases and expansion areas only. Present abstraction figures were supplied by RIGW and WRRI.

For the Nile Valley and Delta the groundwater potential has been estimated by the RIGW. In the old land, the potentiality has been defined as the actual groundwater recharge (mainly irrigation excess water). In the fringes that are irrigated with groundwater, the potentiality depends on the saturated thickness of the aquifer, the storage coefficient, transmissivity, and infiltration rate. The groundwater abstractions figures were updated by RIGW for the NWRP project (RIGW, 2000).

For the Northwest coast and Eastern Desert (including Halayeb and Shalateen) no reliable figures are available on groundwater potential and current abstractions. The figures provided in Table 4- 9 are based on rainfall data and estimated recharge of the shallow aquifers.

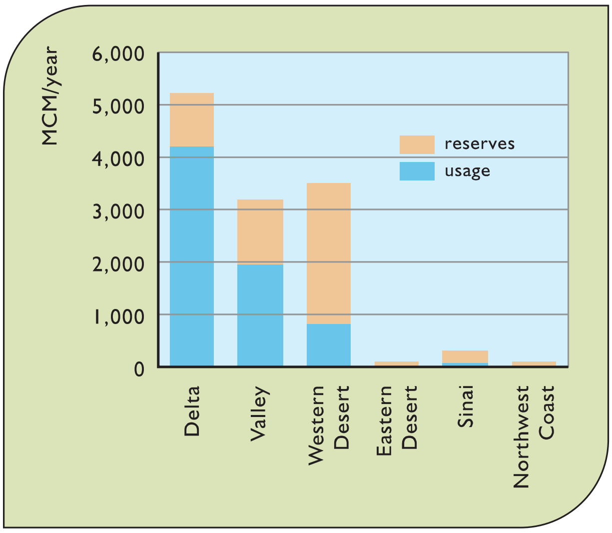


Figure 4-6 Groundwater potential and use

Region	Usage	Potential	Reserves
Delta	4,195	5,220	1,025
Valley	1,932	3,170	1,238
Western Desert	817	3,500	2,683
Eastern Desert	6	90	84
Sinai	67	294	227
Northwest Coast	5	80	75
Total	**7,022**	**12,354**	**5,332**

Table 4-9 Groundwater potential and actual use (in MCM/yr)

Rainfall and flash flood harvesting

Rainfall harvesting and runoff harvesting have been considered primarily in the Sinai, the Northwest Coast and the Eastern Desert where population density is low, groundwater potential limited and where there is no access to Nile water. In these areas rainfall has for centuries been the principal water resource and consequently there is a good tradition of small-scale water conservation practices. Figure 2-8 (Chapter 2) indicates the areas where possible locations for rainfall harvesting can be found.

Techniques that are applied are of low technology and include the construction of earth bunds to convey runoff to small depressions, contour ridging, construction of small earth check dams in depressions, etc. Also, cisterns are constructed below wadi beds, either from concrete or dug in limestone. The yield of these systems is an important source of water for small Bedouin settlements and villages. Further development of these techniques, embedded in rural development programmes, will be considered, to be implemented with a high degree of stakeholder participation and stakeholder ownership.

For the construction of somewhat larger dams (say 10 to 20 m high) to create storage of rain water, thorough hydrological, geological and topographical surveys are required. Figure 4-7 shows potential areas for flash flood harvesting. Presently, there are some 8 existing dams in the Sinai, while there is a plan to construct an additional number of dams, primarily for flood protection, on Wadi Gerafi.

The construction of such dams seems only viable for water harvesting if they also have an important flood protection function. Major aspects that negatively influence the viability of flash flood harvesting schemes are the highly erratic nature of the rainfall (see for example Figure 4-8) and the high sediment loads of larger flash floods. Smaller size reservoirs may have a more favourable yield/capacity ratio but their lifetime will be shorter due to sediment inflow, while the spillway cost will be disproportionally high. Larger size reservoirs on the other hand will have a lower yield/capacity ratio that will negatively impact the cost.

If in certain cases a multi-purpose reservoir appears viable, the water could be directly abstracted from the reservoir for use. However, considering the very irregular filling (and subsequent use) in combination with high evaporation losses, it is preferred to study options for storing this water through recharge into the groundwater system.

Figure 4-7 Potential areas for flash flood harvesting

Desalination of brackish water and sea water

Desalination has long been confined to situations where no other alternatives were available to produce drinking water (some coastal towns, islands, remote industrial sites), or where energy was abundantly available (power stations, gas and oil production fields). Today, desalination is becoming a serious option for the production of drinking- and industrial water as an alternative to traditional surface water treatment and long distance conveyance. The desalination capacity in Egypt has grown to some 150,000 m^3/day. Most of the plants treat seawater, but a growing number of installations use brackish water. The capacity of individual plants is generally small and ranges between 500 and 10,000 m^3/day.

There is unlimited potential for further development of seawater desalination in Egypt along the long shoreline. Sectors of application are the tourist sector and the industries along the coast. Considering the vast reserves of brackish groundwater in Egypt there also is great potential for brackish water desalination which can be applied at much lower cost. Desalination of inland brackish groundwater requires special attention for the discharge of the brine (the highly saline by-product of desalination). Treatment of domestic waste water and of drainage water is a potential new field of application for which vast quantities of water are available in Egypt.

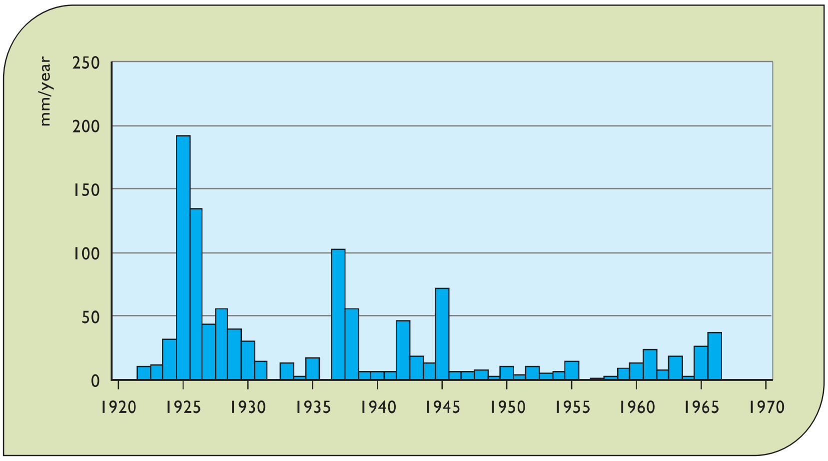


Figure 4-8 Variation in annual rainfall at Themed in the Sinai (1922 – 1966)

Reversed osmosis (RO) is currently the fastest growing technology to produce high quality water. This method seems the most cost-effective one; the unit price is about USD 0.7 to 0.9/m^3 for capacities larger than 10,000 m^3/day and depending on the salinity of the raw water. The efficiency of RO installations is critical to its operation and maintenance. A review of the operation of existing installations is recommended to define operational requirements for new plants, especially if constructed for public water supply. These type of investments are ideally suited for BOT arrangements.

Further information on the possibilities of desalination is described in Technical Report 13 of the NWRP project (NWRP, 2000f).

4.3.2 Increase the efficiency

Developments to improve water use efficiency

To maximise the total amount of water available to agriculture a number of developments started, aimed at a more efficient use of the scarce water resources by improving irrigation efficiencies and reuse of drainage water that would otherwise be lost.

Irrigation Improvement Project (IIP)

IIP is an ambitious programme that is being carried out by MWRI to a) improve the irrigation efficiencies in the Old Lands and b) improve the water distribution amongst the farmers. Major components of the IIP are:

- renovation and improvement of branch canals, including modular discharge regulators at the head of branch canals, cross regulators and downstream water control structures;
- conversion from rotational to continuous flow;
- *mesqa* improvement by conversion of low level mesqas to raised canals or pipelines;
- set-up of Water User Associations.


Irrigation at quarterly level

The total area planned to be improved under the IIP programme by the year 2017 is about 3.5 million feddan of which some 70% is located in the Delta. To attain

Elevated mesqa in IIP

maximum benefit of these measures by the farmers, the IIP developments are supported through Irrigation Advisory Services (IAS). The IAS will also support WUAs that will be established outside the areas that are considered for IIP improvements.

Considering a maximum speed of implementation of some 100,000 to 150,000 feddan per year the total area covered by IIP in 2017 will be 2.5 million feddan.

Simulations with the NWRP Decision Support System (NWRP DSS) model for a typical distribution system showed an overall increase in irrigation efficiency from 0.61 to 0.66 and an increase in field application efficiency from 0.70 to 0.75. The resulting increase in consumptive use of water was 3.5% (due to improved water supply at the tail ends of the *mesqas*) whereas the drainage flows reduced by some 10%.

Region	1997 reuse MCM/yr	2017 target [3] MCM/yr	Target increase MCM/yr
Eastern Delta	1,774 [1]	3,639	1.865
Middle Delta	808 [1]	3,159	2,351
Western Delta	637 [1]	1,670	1,033
Fayoum	241 [2]	396 [4]	155
Total	**3,460**	**8,864**	**5,404**

1) data DRI
2) 1994 data (ARCADIS, 2000)
3) data Horizontal Expansion Sector MWRI
4) not mentioned as target but as maximum capacity

Table 4-10 Drainage water reuse in 1997 and targets for 2017

Reuse of drainage water

The total official reuse of drainage water in 1997 was about 3.5 BCM. Included in this reuse are a number of gravity feeders from drains to tail ends of irrigation canals in the Middle Delta.

According to the MWRI targets, the total reuse would increase to about 8.9 BCM in 2017. A summary of the reuse targets is given in Table 4-10. Note that these are targets of MWRI; actual reuse will be less than that as will be shown in Section 4.5.2. The reuse from the Gharbia main drain outlet (Middle Delta) is not included in the table below, because this is considered unofficial reuse. A more detailed overview of planned drainage water reuse is given in Annex B6.

In 1997 a number of pumping stations, mainly located in the Eastern Delta, were closed because of high pollution levels in the drains (e.g. Wadi and Mahsama pumping stations). The new Umoum reuse scheme was not yet operational because of similar problems, although all infrastructure was already in place.

In addition to the official reuse through reuse pumping stations, drainage water is pumped directly by farmers (especially tail-end farmers) for irrigation. Simulations with the NWRP DSS model for the Delta indicate that such unofficial reuse in 1997 was as high as 2.7 BCM.

The reuse targets for 2017 mentioned in the above table are indicative only. Actual reuse will depend largely on the quantity and salinity of water in the drains. This, in turn will depend on available irrigation water and irrigation efficiencies.

Developments to improve drainage conditions

MWRI considers subsurface drainage as a main tool to improve soil conditions and to sustain the soil fertility. Reported economic returns are high. There is an ongoing programme by the Egyptian Public Authority for Drainage Projects (EPADP) to implement subsurface drainage in the Nile Delta and Valley. The total area included in the programme is about 6.4 million feddan of which some 75% is already completed.

In addition there is an ongoing drainage rehabilitation programme in areas where existing drainage systems were not properly designed to cope with very specific soil conditions. These areas are mainly concentrated in the Governorates of Menufia, Gharbia, Kalubia. Some smaller areas are located in Beheira, Sharkia, Beni Suef, Fayoum, Qena and Sohag. The total area already rehabilitated is about 0.4 million feddan. The target area to be implemented up to the year 2012 is 1.2 million feddan.

Considering the present development rates of new subsurface drainage systems and rehabilitation of older systems, it is assumed that by the year 2017 the subsurface drainage systems in the old lands are fully implemented and properly functioning.

Integrated Irrigation Improvement and Management Project (IIIMP)

The IIP, EPADP and several institutional reform programmes on water management are expected to further develop and integrate into IIIMP. IIIMP aims to achieve an integrated planning, management and execution of all interventions needed at command level. Stated objectives of IIIMP are:

- Developing a framework for integrated water management plan and programme in selected command areas, combining water quantity and quality management through inter-agency and stakeholder consensus.
- Improving the institutional, financial, and environmental sustainability of water services through decentralization of water management, intensive user and private sector participation in the investment, and operation and maintenance at the district/branch canal levels and below and improved water quality management practices.
- Establishment and expansion of WUA's and the Water Boards in line with Government policy of integrated irrigation and drainage water management. This would include support for WUA's at the tertiary level and upscaling them to branch canal level and their incorporation in the Water Boards at the district level.

The project started in 2004 with an initial coverage of 500,000 feddan in the Delta (Mahmoudia / Beheira – 196,000 feddan), Meet Yazid / Gharbayia and Kafr El-Sheikh – 124,000 feddan), and Bahr Tanah / East Daqahlayia – 87,000 feddan), Middle Egypt (Serry / Menia – 76,000 feddan) and Upper Egypt (Tomas and Afia / Qena – 17,000 feddan).

Installing Subsurface Drainage

4.4 Finding solutions - water quality

4.4.1 General

Pollution control (or pollution abatement) is a more comprehensive term to describe the efforts to improve water quality than pollution prevention or pollution reduction, which should ideally be part of pollution control. Pollution control means finding a compromise between the interests of socio-economic activities that cause pollution and the need for a good water quality to protect human health and the environment). The main pollution control activities are: prevention, reduction/treatment and impact modification.

Pollution prevention is the activity to reduce or eliminate the generation of pollutants. For many polluting substances or activities, alternatives are available. The use of less harmful agro-chemicals, the use of cleaner production technologies, the development of products that do not need certain substances (e.g. cadmium-free batteries or phosphate-free detergents), and the recycling of materials, all reduce the production of waste.


Guarding the environment

These measures can be economically attractive, but sometimes the cleaner production process may be more expensive than the more polluting alternative. In this case other measures are needed to force or encourage producers to use the cleaner technologies. Possible measures are taxes (on polluting items) or tax reductions, quality certification, subsidies, pollution charges, public awareness, etc., that make the less polluting process more competitive. In addition, legal restrictions can also be used.

Pollution reduction or treatment is applied to waste (-water) as an "end-of-the-pipe" measure. Various treatment technologies are applied to change substances into less damaging substances or to separate the undesirable substance from the waste (-water). Specific types of pollutants, especially toxicants, will require sophisticated treatment technologies. Treatment of domestic wastewater, with moderate amounts of non-toxic industrial wastewater, is generally classified in three categories:

- primary treatment, which includes physical (sometimes chemically enhanced) processes like filtration and sedimentation;
- secondary treatment, which adds biological processes, primarily based on bacteria;
- tertiary treatment in which processes are added to eliminate certain substances like phosphates or nitrogen.

Impact modification does not change the pollutant discharge itself, but channels the discharge in such a way that it causes least harm or provides additional measures to prevent contact with people. This is considered a temporary solution until suitable treatment is available. An example is the allocation of the waste carrier function to certain drainage channels, until suitable treatment is feasible.

4.4.2 Water quality policy

To be able to find a compromise between the interests of socio-economic activities, socio-economic limitations and the need for a good water quality to protect human health and the environment a set of priorities and principles have been defined by the government (the policy) to achieve the desired situation (policy objectives).

The policy objectives for the strategy on water quality are:

1. improvement of water related public health conditions.
2. sustainable use of groundwater resources (both shallow and deep).
3. meet the water quality requirements of the various functions of the waterways.

To achieve these objectives the following priorities and principles were applied:

- *Priority will be given to measures that address the emissions which most seriously exceed the standards and which have the greatest impact on the objectives.* This prioritisation gives guidance to the efforts especially when financial and human resources are limited. It aims at reaching a significant improvement on the short term, enabling maximum benefit of improvements.
- *Based on the precautionary principle, measures should preferably be aimed at preventing emissions. If this is not possible, due for example to technical or financial causes, treatment should be chosen as second best measure. Only if both prevention and treatment are not possible, controlled emission can be considered.* This order of priorities prevents wasting large amounts of resources on treatment when prevention is possible as a much more sustainable option. Also it emphasizes that even for discharges for which no feasible solution is yet available, the government has a responsibility to stimulate impact modification and to monitor the discharges.
- *Every polluter is responsible for his emissions.* This means that polluters can be charged for their actions that damage water quality. This is also known as the "polluter-pays- principle". The polluter charges can take many forms, ranging from fines to taxes and discharge levies related to permits. It can apply both to legal and illegal discharges.
- *The burden of a water quality problem that has its origin in a water system should not be passed on to a water system downstream.* This means that the region that causes a deterioration of water quality, is responsible for taking precautionary measures. It also requires an organisation that ensures that regions are made aware of their responsibilities regarding downstream users.
- *Measures that do not rely on institutional or legal changes are preferred on the short term.* This is based on the idea that certain institutional and legal changes can take a lot of time before they can come into force. By taking effective short term actions some time is available to work on the process of legal changes that are required to make the identified measures possible.

The present laws and regulations are not developed with the proposed mix of measures in mind. Law 48 of 1982 is mainly a law that imposes limits which are difficult to achieve. The present policy requires a law that stimulates improvements and enables the relevant ministries to manage the process. The change of laws is therefore an essential ingredient of the institutional measures related to the National Plan.

4.5 Water balance of Egypt

On its route from Lake Nasser to the Mediterranean the water of the Nile River is re-used several times. In the Valley water is abstracted from the river for irrigation. Part of that water is returned to the river as drainage water and can be used again downstream. The same applies to the abstractions for drinking water and industrial water. This reuse of the water makes the water balance of Egypt quite complex. The water balance including reuse will be given in Section 4.5.2. First a more simple water balance will be presented that only considers the ultimate amounts of water that are lost from the system, either through evaporation, crop evapo-transpiration or terminal drainage to the desert or sea.

4.5.1 Water balance without reuse

The water balance of the Nile system is schematised in Figure 4-9 in a simplified way. The inflow consists of the release of Nile water from Lake Nasser and effective rainfall.

There are two forms of outflow from the system: evaporative outflow and terminal drainage to sinks. The evaporative outflows include the evaporation losses from open water, evaporation from fallow lands, wet surfaces etc., evaporative losses from the municipal and industrial sectors, and consumptive use in the agricultural sector (by far the largest).

Neglecting any over-year differences in storage in the system the water balance can be simplified as follows:

Inflow = evaporative outflow + terminal drainage

Terminal drainage is drainage to sinks, which are areas outside the system, such as desert areas and the sea.

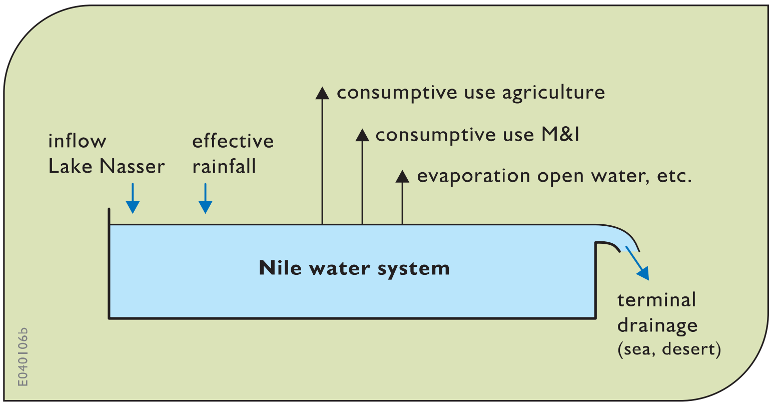


Figure 4-9 Simplified water balance Nile System

This water balance approach for the Nile system has been applied for the 14-year period from 1984 till 1998, using the modelling system of NWRP. The actual crop evaporation was used as unknown variable. The results of the models (see text box) show a good agreement with the crop evaporation as calculated by applying standard estimation methods.

To get the water balance for the whole of Egypt only the deep groundwater withdrawals have to be added. The resulting water balances for both 1997 and 2017 are given in Table 4-11. The 2017 balance refers to the 'optimistic' Reference Case conditions (see Section 4.1.1), where all planned horizontal developments are executed and some 2.5 Mfeddan of IIP improvements are implemented. For all new irrigation developments on lighter soil types outside the old lands in the Valley and Delta it is furthermore assumed that modern irrigation techniques are applied, with corresponding overall irrigation efficiencies as high as 80%. Apart from these assumptions, no additional water saving measures to reduce the outflow to sinks were assumed.

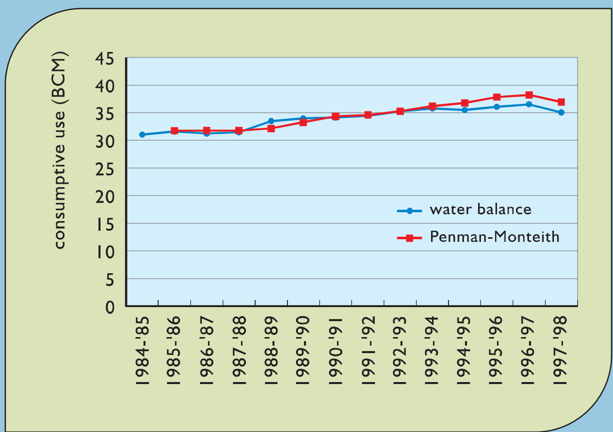
The last column in Table 4-11 gives the water balance for Egypt after implementation of the strategy Facing the Challenge. This strategy includes additional measures to increase the efficiency of the system and will be discussed in the next chapter. This last column is added here for comparison reasons and will be explained in Section 5.5.

The amount of evapotranspiration (ET) mentioned in the table suggests an accuracy of 0.1 BCM per year. Considering the accuracy in estimating the various water balance terms such accuracy is not justified. However, to estimate the differences between 1997 and 2017 the detailed figures are preserved since the water balance inaccuracies are assumed to be of similar magnitude in the two other water balance computations.

Annual Water Balances Nile system

NWRP has prepared annual water balances of the Nile system for the 14-year period 1984/'85 till 1997/'98 (NWRP, 2000b). In these water balances the crop evapotranspiration (ET) was computed as the closure term. Based on later information the balances were slightly adjusted (NWRP, 2002a). For the same 14-year period also the potential crop evapotranspiration values were computed using FAO's Penman-Monteith method and cropped areas (NWRP, 2000b). Results of the water balance computations (actual ET) and the Penman-Monteith computations (potential ET) are shown in the figure below. Both (entirely different) ET estimation methods show a good comparison in magnitude and trend over the 14-year period.

After 1992/'93 it seems that the actual ET from the water balance slightly reduces in comparison with the potential ET calculated with Penman-Monteith. Although somewhat speculative, in view of all inaccuracies involved in the estimates, this might indicate increasing stress in water availability. This conclusion would be in line with results from the NWRP models for the year 1997 from which it was concluded that already in 1997 the demand exceeded the supply of irrigation water.



Consumptive use (ET) computed from water balance and by Penman-Monteith method

Water balance Nile system expressed in BCM/yr consumptive use	1997	2017 ref. case	2017 FtC
Inflow			
Release Lake Nasser	55.5	55.5	55.5
Effective rainfall	1.3	1.3	1.3
Total inflows	**56.8**	**56.8**	**56.8**
Outflow to sinks in the desert			
Horizontal expansion areas	0	1.8	1.5
Fayoum	0.6	0.5	0.5
New cities	0	1.2	0.7
Outflow to the sea			
Nile branches	0.2	0.2	0.2
Drains (incl. fish ponds)	12.9	11.7	9.5
Evaporative losses			
Surface evaporation	2.4	2.5	2.5
Fallow lands	0.2	0.9	0.5
Fish ponds	0.4	0.2	0.2
Municipal and industrial use	1.6	2.5	2.5
ET agriculture - Nile system	**38.5**	**35.3**	**38.7**
Total outflows and losses	**56.8**	**56.8**	**56.8**

Water balance desert system expressed in BCM/yr consumptive use	1997	2017 ref. case	2017 FtC
Inflow			
Deep groundwater	0.9	4.0	4.0
Outflow			
Outflow to sink (desert)	0.05	0.3	0.3
Municipal and industrial use	0.05	0.3	0.1
ET agriculture - desert system	**0.8**	**3.4**	**3.6**

Table 4-11 Water balance Egypt

For the discussion of the water balance it is important to make a distinction between the area dependent on the Nile system and the area that will be provided by deep groundwater. The reason is that the water availability per feddan will differ significantly between the two areas. This will be explained in the next section.

For the Base Year condition 1997 the volume of evapotranspiration (ET), estimated from the water balance was 36.2 BCM. If no water saving measures are taken in future, the total volume of ET will increase somewhat (till 37.3 BCM in the 2017 Reference Case) but this is mainly due to the increase in deep groundwater withdrawal in the desert area. The volume of ET in the Nile system will decrease from 35.3 till 33.7 BCM. This is due to an increase of some 2.7 BCM/yr by 2017 of the outflow to sinks in the desert, from horizontal expansion areas and the New Industrial Cities. The M&I losses increase by 0.9 BCM/yr. On the other hand, the drainage outflow from Fayoum (to Lake Qarun and the Lower Wadi Rayan lake) and the coastal lakes/sea (from both the Delta area and the El Salam scheme) decreases by some 1.5 BCM/yr while the reduction in fishpond losses adds another 0.7 BCM/yr to the savings.

While the water availability for agriculture in the Nile system will decrease, at the same time the irrigated area will increase from 7.9 Mfeddan in 1997 to 10.3 Mfeddan in 2017. This means that the water consumption per feddan in the Nile system will decrease from about 4,800 m^3/feddan in 1997 to 3,400 m^3/feddan in 2017. It is clear that additional measures are needed. These will be described in the next chapter. For reference purposes the water balance of Egypt after these measures are taken is also included in Table 4-11 as an additional column. This last column will be explained in Chapter 5.

4.5.2 Full water balance including reuse

As explained above water can be used more than once. In fact, some of the users 'consume' only a fraction of the water they withdraw. The remainder is discharged back to the system. Examples are the Municipal Use that consumes only 0.9 BCM of their water withdrawal of 4.7 BCM in 1997, and Fishery that consumes (evaporates) only 0.4 BCM of their demand of 1.3 BCM. The water balances of Egypt for 1997 and 2017 (Facing the Challenge case) including the reuse are given in Figure 4-10 and Figure 4-11. These water balances are not different from the ones given in the previous section. They provide some more detail and show the gross demand of the various uses and their return flow.

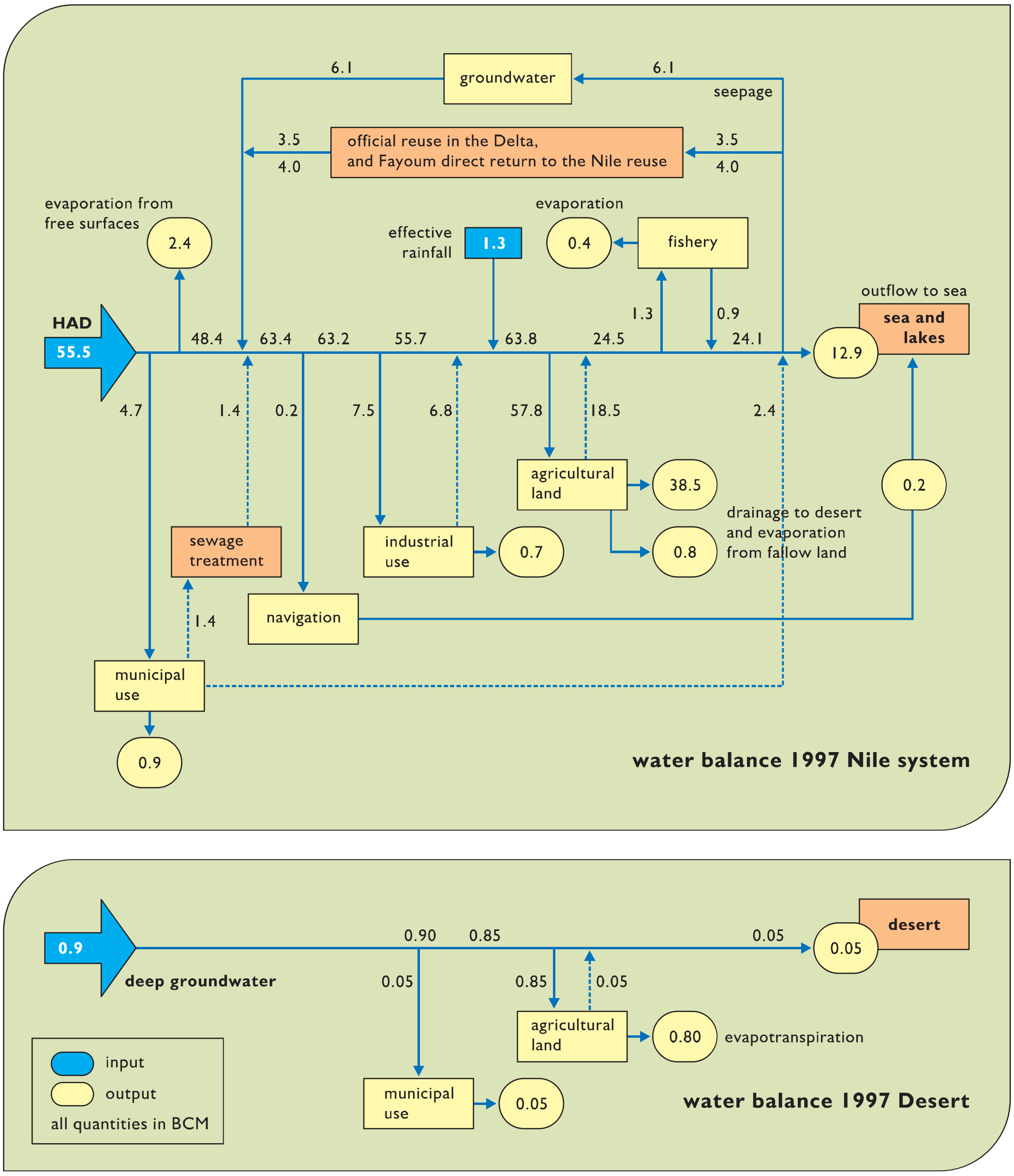


Figure 4-10 Water Balance Egypt 1997 including reuse

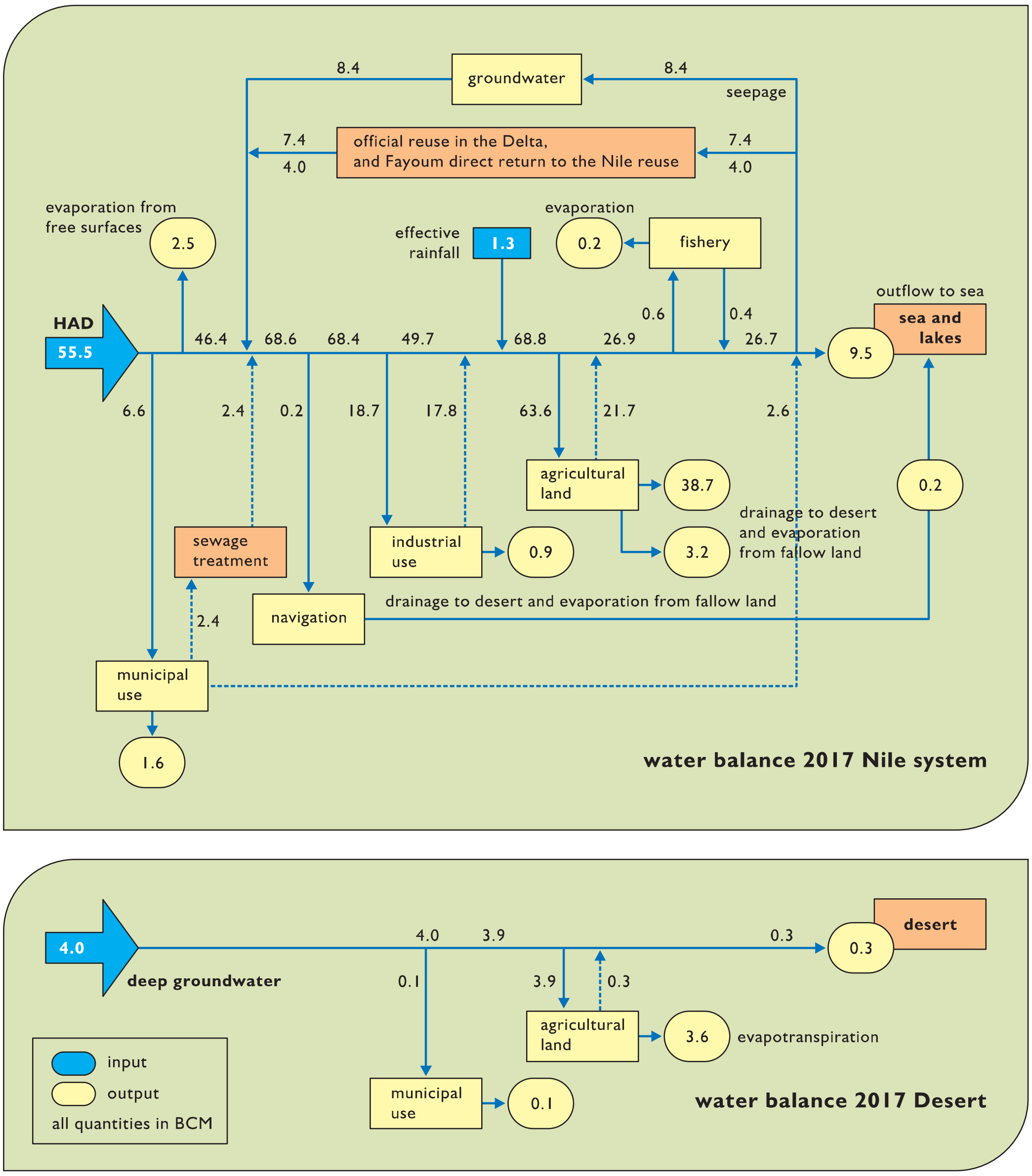


Figure 4-11 Water Balance Egypt 2017 (Facing the Challenge) including reuse

4.6 Problem analysis 2017

The information given in previous sections provide the basis for the statement of problems and issues discussed in this section. Given an estimated (most likely) development in socio-economic activities a prediction is made of the performance of the water resources system in the year 2017 (the time horizon of the NWRP) under autonomous conditions. A full problem analysis is given in some of the supporting documents of NWRP (Technical Report no. 23 - Problem Analysis 2017 (NWRP 2002a) and Technical Report no. 25 - Future water for Agriculture in the Nile system of Egypt (NWRP 2002c).

An overview of the predicted conditions in 2017 is shown in Table 4-13. As mentioned in Section 3.2.3 the conditions are expressed in performance indicators grouped under a number of general objectives that are set for the water sector in Egypt. The figures refer to the situation that no additional measures are taken, apart from those which are already under implementation (Reference Case 2017).

4.6.1 Economic development objectives

The socio-economic development of Egypt has been, and will remain, strongly dependent upon the development of its agricultural and industrial sectors that together accounted for 50% of the GDP in 1997.

Agriculture

For the water availability in agriculture it is important to make a distinction between the Nile system and the desert. The irrigation area served by Nile water in 1997 was about 7.92 Mfeddan (Table 4-2). The total horizontal expansion area that depends on Nile water and is planned to be completed by 2017 is 2.87 Mfeddan. This includes 0.25 Mfeddan that is planned to be irrigated by treated wastewater. Considering an estimated 0.52 Mfeddan loss of agricultural land due to land use changes in the Nile Valley and Delta (see Section 4.2.1), the total irrigated area by Nile water would increase by about 30% to 10.26 Mfeddan if all planned developments are implemented.

From the water balances described in Section 4.5 it appears that the total available amount of crop consumptive use in the Nile system is expected to decrease from 38.5 BCM in 1997 to 35.3 BCM in 2017. Considering the planned increase in irrigation area the average annual crop consumptive use per feddan in the Nile system will decrease by more than 25% from 4,861 m^3/feddan to 3,441 m^3/feddan in 2017 (Table 4-12). These figures refer to a situation where no additional measures are implemented for areas dependent on Nile water.

	1997	2017 ref. case	2017 FtC
ET agriculture (in BCM/yr)			
Nile system	38.5	35.3	38.7
Desert	0.8	3.4	3.6
Irrigated area (in Mfeddan)			
Nile system	7.92	10.26	10.01
Desert	0.07	0.66	0.66
Consumptive use per feddan (m^3/feddan/yr)			
Nile system	4,861	3,441	3,866
Desert	pm	5,152	5,455

Table 4-12 Annual crop consumptive use per feddan (Nile system)

Such decrease in crop consumptive use would obviously have a drastic impact on the crop intensities and the farmer's income. To maximise the water availability for agriculture, the overall

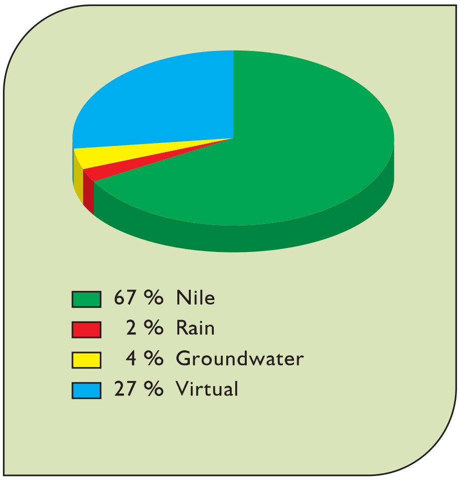


Figure 4-12 Water sources for agricultural commodities (1997)

water use efficiency should be improved through a number of measures that are aimed at a reduction of losses to sinks. This is considered a major challenge for future water management.

The export – import balance is expected to improve through more export of high-value commodities and import of low-value commodities. Membership of the World Trade Organisation and the Egypt–EU Partnership Treaty enable the increase in export. The present origin of the water required for agricultural commodities in Egypt is shown in Figure 4-12. This figure includes the agricultural imports and the "virtual water" associated with those imports.

Especially in the Delta extensive areas of irrigated land experience low crop yields because of salinity, often in combination with water logging. The problems increase towards the north due to reuse of drainage water and seepage inflow of saline groundwater. The estimated loss in crop production in these areas is about 30% of the potential yield (source: DRI). There also are some salinity problems in the northern part of the Sinai and in the Fayoum.

A special problem is the quality of water that is directly pumped from the drains for irrigation. This water often does not meet the standards for agricultural use, regarding concentrations of heavy metals (especially in the Eastern Delta) and pathogens. This not only poses a direct threat to farmers and consumers, but can also hamper exports when receiving countries are setting strict quality standards.

Industry

As water allocation to industry is given priority over agricultural use, no shortage of water in industry in 2017 is expected. However, decreasing raw water quality may have some impact on the industrial sector due to additional cost for water treatment. Another cost component for industry is the cost that the industry will have to make for treating its wastewater. In the 2017 Reference Case, no additional treatment capacity for industry is included; the conditions were assumed to be similar to 1997.

Fishery

The total inland fishery production is expected to decrease by some 14% in the 2017 Reference Case due to a smaller lake surface and the phasing out of temporary fish ponds. In the coastal lakes the inflow from polluted drains poses a threat to fisheries and tourism. The quality of fish is presently already low and problems are expected to aggravate in the future if no additional actions are taken.

Tourism

The 2017 Reference Case conditions will affect tourism in two ways. The number of navigation bottlenecks for the tourist boats in the Nile will increase due to lower Nile discharges in certain periods with corresponding decreases in water depth. The Mediterranean Coast has an important tourist function and seasonally large numbers of people reside in these areas. Where the untreated wastewater is discharged into the sea, either directly or through the coastal lakes, a health risk is created. It should be assumed that additional measures will be taken to avoid this situation.

General	Unit	1997 base	2017 ref. case
Population	Million	59.3	83.1
Urbanisation	Ratio	0.44	0.48
GDP at economic growth of 6 %	Billion LE	246	789
Economic development objectives			
• **Agriculture**			
Irrigation area	Mfeddan	7.985	11.026
Gross production value	Billion LE	34.46	35.76
Crop intensity	Ratio	2.1	1.5
Net value production per feddan	LE/feddan	2,812	2.075
Net value production per unit of water	LE/m^3	0.64	0.66
Export/import value	Ratio	0.09	0.12
• **Industry**			
Costs polluted intake water	LE/m^3	0.65 - 1.10	no change
Waste water treatment costs	LE/m^3	0.22 - 0.50	no change
• **Fishery**	Index	100	86
Production (index 100 in 1997)			
• **Tourism**			
Navigation bottlenecks (index 100 in 1997)	Index	100	114
Social objectives			
• **Create living space in desert areas**	% of tot. pop	3%	23%
• **Employment and income**			
Employment in agriculture	M pers.year	5.01	6.24
Employment in industry	M pers.year	2.18	4.99
Average income farmers	LE/yr	5,362	4,629
• **Drinking water supply**			
Coverage	Percentage	97.3%	100%
• **Sanitation**			
Coverage	Percentage	28%	60%
• **Equity**			
Equity water distribution in agriculture	-, 0, +	0	+
• **Self sufficiency in food**			
Cereals	Percentage	73%	53%
Meeting water needs			
• **Water resources development**			
Available Nile water	BCM	55.5	55.5
Abstraction deep groundwater	BCM	0.70	3.96
• **Water use efficiency Nile system**			
Outflow to sinks from Nile system	BCM	16.3	17.6
Overall water use efficiency Nile system	Percentage	70%	67%
• **Water in agriculture**			
Supply/demand ratio (relative to 1997 condition)	Ratio	1.00	0.78
Water availability per feddan Nile system	m^3/feddan/yr	4,495	3,285
• **Public water supply**			
UFW losses	Percentage	34%	34%
Supply/demand ratio	Ratio	0.67	0.76
Health and environment			
• **Pollution and health**			
E-coli standard violation (1997 = 100)	Index	100	121
Water quality shallow groundwater	-, 0, +	0	-
• **Ecology and sustainability**			
Sustainability: use of non-renewable groundwater	Abstr/pot	0.15	1.00
Condition Bardawil (Ramsar site)	-, 0, +	+	-
Condition coastal lakes	-, 0, +	0	-

Table 4-13 Indicator values for Base Year 1997 and Reference Case 2017

4.6.2 Social objectives

Living space

To enlarge the inhabited space of Egypt there is much Government emphasis on developing agricultural and industrial activities outside the Nile Valley and Delta. For the year 2017 it is expected that the population living in the desert areas will increase from less than 2% in 1997 to 23% of the total population.

Employment and income

The agricultural sector in 1997 provided 32% of the jobs, and manufacturing 14%. The official unemployment rate was 9.4% in 1997 and decreased to 7.9% by 1999. The unofficial rate was estimated as high as 17 to 20%.

Based on simulations with the ASME agro-economic model, the employment in agriculture and agro-industry is expected to increase from about 5.0 million in 1997 to 6.2 million in 2017. Employment in the industrial sector is roughly estimated to increase from 2.2 million to 5.0 million.

Although the average per capita income in Egypt is expected to increase, the average income in agriculture is likely to reduce due to the lower crop intensities.

Drinking water supply and sanitation

Sufficient and safe drinking water is considered a basic need. Although the capacity of drinking water plants more than tripled in the last decades, there still are many people in Egypt, especially in rural areas, who lack a proper water supply. It is expected that in 2017 the water supply in these rural areas will have improved significantly.

The coverage of sewerage systems and wastewater treatment plants is also expected to increase considerably.

Equity in the water distribution for irrigation

The present distribution of irrigation water is sub-optimal, resulting in inequities between regions and within regions. Especially areas at the tail end of the canal system suffer from water shortage.

Equity between regions

Reported reasons for regional inequities in irrigation supply are:

- *Operational problems in water distribution*: due to the lack of discharge measuring stations the water distribution is often based on canal levels and outdated rating curves. In June 1999 MWRI adopted a policy that water distribution among irrigation directorates should be based on both water levels and volumetric flows. In the present policy of the Ministry this will be also extended to the Inspectorate and District levels (APRP, 2000a and 2000b).
- *System capacities*: the system capacity is not always sufficient to cope with increasing demands. In some cases the increased demands are caused by uncontrolled horizontal developments.
- *Insufficient maintenance of canals and leakage from canals*.
- *Illegal growing of rice* resulting in water shortage elsewhere.

Equity within regions

In many areas there is a large inequity in water supply amongst farmers living in the same command area. Over-irrigation usually takes place at the head-ends of branch and distributary canals, and *mesqas*. This over-irrigation sometimes results in water logging, while tail-end farmers face shortages, especially in summer. At least to some extent this practice seems related to the rotational supply and uncertainty about the timing of the next supply. Another reason mentioned in relation to over-irrigation by head-end farmers is the avoidance of salinisation in areas that lack proper subsurface drainage systems. The use of larger capacity pumps to replace the traditional water wheels (*sakias*) may also play a role in the over-irrigation.

To supplement their irrigation supply farmers at the tail ends increasingly rely on pumping from the (often polluted) drains and the groundwater. This practice results in sub-optimum crop production. When the future water supply would decrease because of increasing scarcity, also the amount of drainage water and groundwater would become less and if no measures are taken to distribute shortages equally, most of the future shortages will be shifted to the tail-end farmers.

A major development that results in a more equal distribution of water amongst farmers is the Irrigation Improvement Project (IIP). Assuming that in the 2017 Reference Case a total of 2.5 million feddan is covered by IIP improvements, it is expected that the equity in water distribution will increase.

Water wheels in Fayoum

Seasonal inequities

Apart from inequities in the water distribution there also are seasonal inequities in supply and demand. Water allocations nowadays are based on some kind of target cropping patterns. At the end of the season, MALR officials survey the actual areas that were cultivated under different crops. Given the crop rotations experienced in the past season, the target-cropping pattern for the next year is established. This cropping pattern is then used for water allocation purposes for the next season, based on so-called water duties established by MWRI for different crops. These water duties are supposed to cover the crop water demands plus the losses in the field and the conveyance/distribution losses from the supply system. Water allocations to the new lands are simply based on an annual unit supply of 5000 m^3/feddan, irrespective of the cropping pattern.

Any deviation between actual cropping pattern and target cropping pattern, and between the actual irrigation requirements and the MWRI crop water duties, will result in a mismatch between demand and supply. When complaints arise from the farmers these are usually accommodated through some adjustments in the supply during the season.

Food self-sufficiency

Egypt currently imports substantial quantities of its wheat and varying proportions of other agricultural commodities and processed food, whereas rice, potatoes, cotton and citrus are exported. Food self-sufficiency will further reduce towards 2017 due to the population increase and an expected shift towards more export-oriented crops (although the present agricultural policy aims at increasing self-sufficiency in staple crops). The self-sufficiency for cereals for example is 73% in the Base Year and would be 53% for the Reference Case.

4.6.3 Meeting water needs

Water resources development

In the most likely scenario it is assumed that there will be no increase in Nile water availability by the year 2017. The only major development foreseen is the groundwater development for irrigated agriculture in the desert areas. Desalination of brackish water or seawater is expected to keep pace with increase in tourist development in coastal resorts.

In the Western Desert there still is a large potential for groundwater development. Here, the total groundwater development taking place until 2017 is estimated at 2 to more than 3 BCM/year (ref. Table 4-9).

Groundwater abstractions are also expected to increase in the Nile Valley and Delta. However, the Nile aquifer is not an independent/separate resource. Any increase in groundwater abstraction in the Valley will result in less groundwater outflow to the Nile. In the Delta a further increase in groundwater abstraction may ultimately result in seawater intrusion.

Agriculture

Due to the Toshka development and the New Industrial Cities, the outflow of Nile water to sinks in the desert will increase. On the other hand the losses to the Coastal Lakes, the sea and the Suez Canal are expected to be less, mainly as a result of more drainage water reuse. If no additional measures are taken, the total losses to the desert and the sea will increase somewhat (from 13.7 till 15.4, see Table 4-11) between 1997 and 2017, resulting in a slightly lower overall water-use efficiency of the Nile system.

Irrigation efficiencies are generally low because of operational losses in the distribution system and losses at the field level. Operational losses arise for example from differences in supply and demand and some reluctance of farmers to irrigate at night. Field application efficiencies are generally low because there are no incentives for the farmers to increase efficiencies. Other reasons for low field application efficiencies are poor land levelling and fragmentation of land into small and separate holdings.

Water scarcity in irrigated agriculture is considered a major constraint in the further development of the sector. A simulation run with the ASME model suggested that already in the Base Year 1997 the supply fell short of the demand. As a result of lower water availability per feddan in 2017, the supply/demand ratio is expected to further decrease in 2017. Especially in summer more land will remain fallow if the water availability is not increased.

Water supply in rural areas

Municipal and industrial water

Coverage

Notwithstanding the large increase in water treatment plants during the last decades, there still are many people that lack a proper water supply. This is especially the case in rural areas, where some 5% depend on other sources of supply and some 38% only have partial coverage with, in some cases, only a few hours of supply per week. In 1997 the average coverage rates of public water supply systems were as follows:

- Full coverage: 73%
- Partial coverage: 24%
- No coverage: 3%

Per capita supply

The amount of drinking water production and consumption per capita varies largely between and within Governorates. In comparison with the rest of the country, the per capita water consumption in the larger urban conglomerates Greater Cairo, Alexandria and the Canal Cities (representing some 28% of the population) is high (Table 4-14). This high per capita use is thought to be caused by a) low water charges, b) the lack of a properly functioning metering system, and c) the lack of public awareness on water scarcity.

Outside the large urban centres the average water production and consumption appears quite low. However, the new plants that are being constructed and those that are planned will improve the equity in drinking water supply (Table 4-14).

Service area	2000 (lcd)	2017 ref. case (lcd)
Average Cairo, Giza, Alexandria and Canal Cities	260	220
Rest of the country	72	119

Table 4-14 Per capita consumption in 2000 and 2017, corrected for industrial use

Unaccounted For Water (UFW) losses

UFW losses amount to 34% as a national average, ranging between Governorates from 15% to 65%. The accuracy of these figures is somewhat questionable since most connections are not properly metered. However, supported by various studies it is concluded that a significant part of the UFW consists of leakage losses in the supply- and distribution systems.

Phasing out of groundwater wells

A number of groundwater wells drawing from the Nile aquifer are phased out due to water quality problems. Apart from pollution from human activities, many wells experience high iron and manganese concentrations and a few wells have salinity problems. Approximately 50% of the groundwater systems in the Nile Valley and Delta are affected by these problems (NWRP, 2001e). However, to solve the iron and manganese problems there are technical solutions and there seems no reason to phase out affected wells.

Operation and Maintenance

Reportedly, the allocated budget for the operation and maintenance of water treatment plants (and also wastewater treatment plants) is not sufficient to guarantee a good system performance. It was suggested that part of the budget presently allocated for the construction of new plants, could be more beneficially used for repairs and improved operation and maintenance activities of existing plants.

Industrial Water Supply

There was a large growth in industrial water demand during the last decades. Excluding cooling water for power plants, the total industrial water use in the year 2000 was estimated at 2.2 BCM of which approximately half is directly abstracted from the Nile and irrigation canals. Almost 60% of all industrial water use in Egypt is in the large urban conglomerates of Cairo, Giza and Alexandria. The total industrial water demand in 2017 is expected to increase by about 90% from 2.2 BCM in 2000 to 4.2 BCM in 2017. This includes the demand for mining activities (about 1.2 BCM).

4.6.4 Health and environment

Water quality in the Reference Case 2017 will decline as a result of increasing pollution loads. This affects the user functions of the water system as well as the health and environmental conditions.

Pollution

The production of polluting substances increases due to population growth and increase in industrial activities. Although the wastewater treatment increased significantly in the last decades, it does not keep pace with the increase in wastewater production; much of the municipal and industrial wastewater presently enters the water system untreated or only partially treated. Also, the pollution will be less diluted because of lower flows in the Nile (due to the future demand in Toshka and other horizontal expansion areas) and drains (due to increased reuse).

Major constraints that hamper the effective solution of the pollution problem relate to institutional difficulties and the lack of funds. Co-ordination between ministries and institutions involved in distribution of water and treatment of wastewater is insufficient and investments in treatment plants or reuse pump stations do not lead to optimal benefits. Implementation and enforcement of laws and regulations are ineffective, and are generally more aimed at the text of the law rather than at the purpose of the law. Also, the dissemination of information is insufficient and many agencies and institutions have to work without sufficient insight in the actual status of the system.

The lack of available financial resources limits the implementation of measures. This is partly caused by the fact that a large portion of the finances is presently expected to come from the central government. For that part of the required funds that is presently recovered from beneficiaries of the services, there is a problem to obtain social acceptance of the actual costs, but there are also problems related to billing and metering. Problems with cost recovery limit the possibilities of implementing BOT and other involvement of the private sector in financing measures.

Impacts of pollution on the surface water system

Although the water quality in the Nile is reasonable at present, water quality problems occur locally, caused by effluents from larger urban areas and industries. The water quality condition in local drains seems more severe. Many drains are highly polluted and this poses a direct health risk, especially in and around villages and towns in densely populated rural areas. If no additional measures are taken, the situation in the rural areas will deteriorate seriously in the future, while also more canals as well as larger parts of the Nile River will become unsuitable as a source for drinking water.

In the oases, including Fayoum, the drainage water discharges into lakes or evaporation ponds. Although the actual production of pollutants may not be very high, the absence of a drainage outflow creates an accumulation of substances, which results in unhealthy conditions.

Impacts of pollution on groundwater

The quality of groundwater in the Nile aquifer is generally still fairly good. However, in some shallow groundwater bodies pollution has reduced its suitability for drinking water. Presently, about 20% of the groundwater does not meet the standards for drinking water production. Especially in the fringes of the Nile Valley and Delta where there is no protective clay cap, the groundwater is highly vulnerable to pollution. If no measures are taken the groundwater pollution will increase in future. This poses a direct threat to public health since groundwater is consumed without any treatment.

In the New Industrial Cities insufficient treatment of wastewater (due to limited capacity of treatment plants or due to a breakdown of treatment systems as a result of toxic waste) has created situations where polluted wastewater is dumped in ponds or injected into the acquifer. This is threathening the sustainable use of the groundwater resources.

Need for clean water

Ecology and sustainability

Groundwater development in the Western Desert is taking place at a rapid pace and in the Reference Case it is assumed that the development in the Western Desert will reach its potential in 2017. Since this groundwater is non-renewable, abstraction levels cannot be sustained in the long term. Already many artesian wells that were free flowing before ceased to do so, especially in Kharga, Dakhla and Bahariya. Most wells in Farafra are still free flowing but also here the pressure decrease is noticeable.

From an ecological point of view three areas in Egypt deserve special attention. The first one is the area of Lake Nasser. As the main storage area for water in the country its protection is essential for a sustainable development of Egypt. The area is still unspoiled and present plans and policies aim to preserve this status.

The second site is the Bardawil area which is an official Ramsar wetland site. This very valuable area will be affected by nutrient inflow that results from the El Salam development scheme in North Sinai.

The third area includes the lakes along the North Coast. In the present situation these lakes are already polluted. This situation will further deteriorate in the Reference Case 2017 since pollution loads are expected to increase.

Institutional setting for water quality management

The management of pollution in Egypt is rather fragmented. Ministries have responsibilities for certain aspects, but there is no overall co-ordination. Although measures of prevention, treatment and impact modifying are being applied, they are not implemented on the basis of a common and co-ordinated set of priorities. Therefore, there is a need for more co-ordination between responsible institutions at the same level or between institutions at different levels, to allocate the available resources in an optimal way. The rather 'vertical' institutional organisation of the government clearly hampers the management of an 'integrated' aspect as pollution control. As a result, effects of investments are not optimal. For example, when treated effluent is mixed with untreated effluent from other sources, the drain water is just as unusable as it was before.

Although the responsibilities for discharges of pollutants lie with the different sectors, MWRI has the responsibility to implement the main tool available at present: Law 48 of 1982. Through regional offices of the Irrigation Sector, the Ministry controls the issuing of permits. It also can take action on non-compliance. In practice, the law is not effectively used. Many of the discharging facilities do not have a permit (MoHP estimates 95%), and those that have a permit, but do not comply, are not effectively prosecuted. Reasons for this ineffectiveness of the law are:

- The weak institutional strength of MWRI in this field. The establishment of the new Water Quality Management Unit aims at improving this problem.
- Insufficient willingness at all levels of society to actually bear the consequences of the implementation of the law. (e.g. a higher priority to reuse of drainage water than to prevention of pollution of canals).
- Inflexibility in the law with respect to the period for compliance, and standards which made it practically impossible for most polluters to comply.
- Limits to financial resources allocated to implement the required measures to comply with the law (e.g. construction of treatment plants).
- The law was not embedded in a clear strategy in which it would be used as a tool.

The industrial sector is responsible for pollution sources originating from industries. Law 48 of 1982 stipulates that only treated effluents that meet a specified standard can be discharged to the surface or groundwater system. In practice, few industries have licences. Several industries do have some form of treatment, although they rarely meet the standards. More recent pollution control measures aim at the reduction of direct industrial effluents to the river Nile through a combination of prevention and treatment measures. Concentration of industries in the desert areas is to be considered as an impact modifying measure.

In the *domestic sector*, the responsibility for pollution control lies with several institutions. Individual households, local councils, sanitary drainage authorities, and Governorates, all have a role in pollution control. Law 48/1982 applies the same license obligation to domestic sources as it does to industrial sources with the added constraint that no discharge is allowed (treated or untreated) to the Nile, irrigation canals or the groundwater. Pollution control is only possible through the use of septic tanks in individual systems or wastewater treatment facilities in larger scale systems.

Larger cities are generally equipped with sewer systems and have some sort of treatment. New plans concentrate on the cities as well. Several plans have been developed or are being developed for Governorates (e.g. Fayoum, Minya and Beni Suef) that aim at full treatment coverage. However, actual implementation is constrained by financial boundary conditions.

In the *agricultural sector*, the responsibility for pollution control is shared between individual farmers and the Ministry of Agriculture and Land Reclamation. Several measures are in place, especially those aimed at agro-chemicals. Subsidies have been reduced and many biocides have been forbidden.

4.7 Inventory and screening of measures

Based on the analysis described in the previous sections, a full inventory was made of all potential measures which can solve the problems and issues and which could contribute to meeting the policy objectives as mentioned in Chapter 3. These measures were collected from existing reports or suggested by stakeholders involved. Some of these measures are single actions (e.g. a project). Other form more a 'programme' and contain several actions. An overview of the measures that have been looked into is given in Annex B7. A full description of these measures is given in Technical Report TR24 of the NWRP project (NWRP, 2002b). The measures have been classified according to the following three major categories:

- Develop additional resources. Examples are fresh groundwater development, rainfall harvesting and desalination.
- Make better use of the existing water resources. This means an improvement of the efficiency of water use such as improvement of irrigation, influencing the consumption of drinking water, etc.
- Protect environment and health, e.g. pollution control.

In addition measures have been defined that focus on institutional changes. These measures will be needed to provide the conditions for a successful implementation of the more technical measures.

The inventory resulted in about 150 individual measures and programmes. All these measures were assessed on their performance with respect to the policy objectives that they are supposed to address. This assessment was mainly done in terms of the criteria: effectiveness, efficiency, legitimacy and sustainability (see text box). The results of this inventory are included in (NWRP, 2002b). An overview of this assessment is given in Annex B7. The aim of the screening process was to get some feeling on how promising these measures are to alleviate the present and expected problems. No final judgement was given and no measures were really discarded in this process. The screening was based on 'expert judgement' and not on a quantitative assessment.

Effectiveness

meaning that measures to be taken are those which solve the most serious problems and have the highest impact on the objectives. Measures to prevent the problem will be preferred to those that solve the problem. Also, measures that solve the problem are preferred to those that only control the problem.

Efficiency

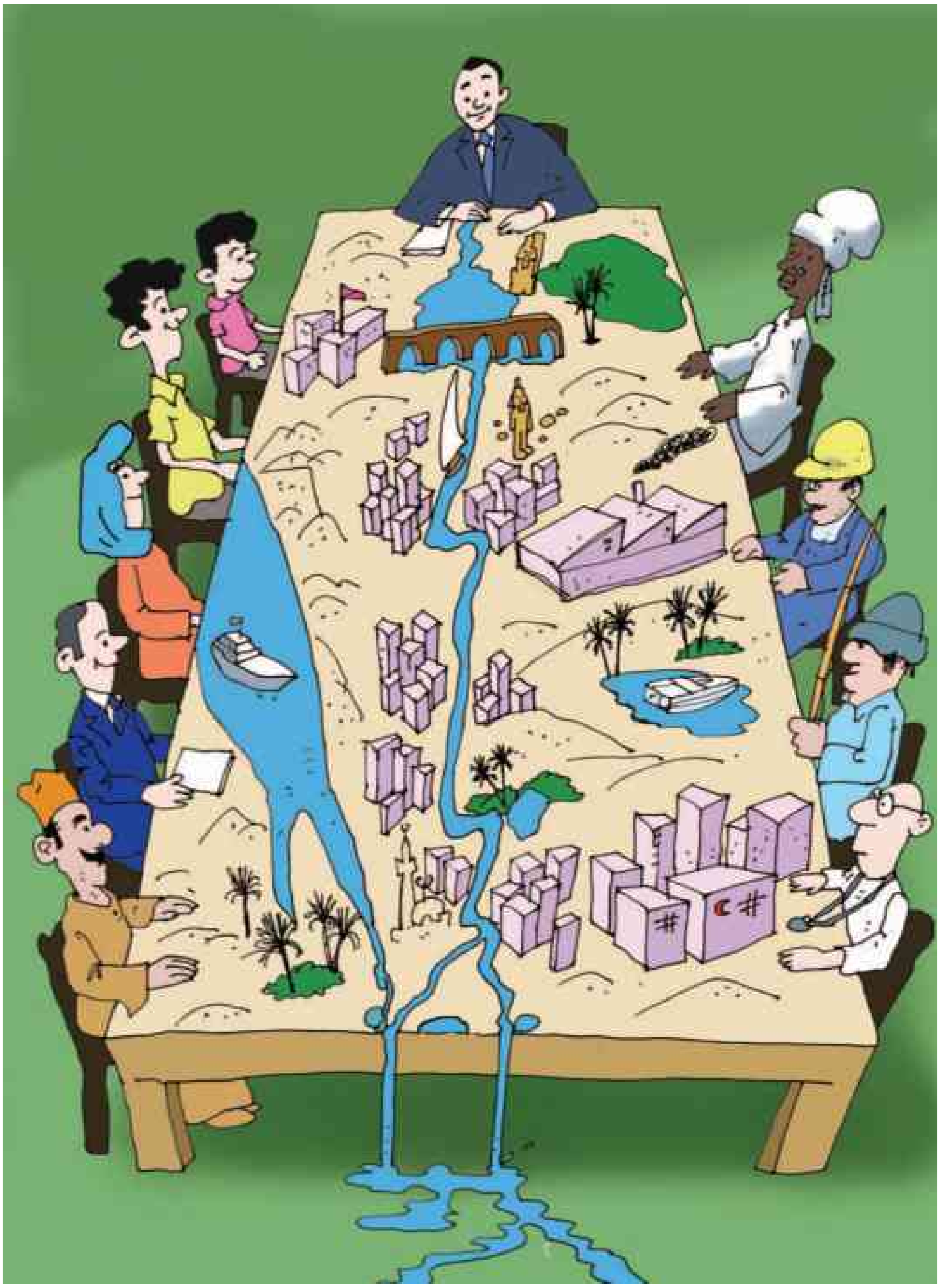
Measures to be taken should not fulfil the explicit objectives at the expense of other implicit objectives. The cost-benefit analysis (at the national level) is one indicator to infer efficiency. An example is to issue a law that forces industrial firms to incur the full cost of end-of-pipe treatment. This would improve the Nile-system water quality, thus will save health and environmental damage, but on the other hand this may impose high costs to the firms, possibly resulting in loss of employment. An efficient decision may then be to go only for cost sharing rather than full cost recovery.

Legitimacy

Measures to be included in the strategy should not rely on uncertain legal/institutional changes. Measures should also be as fair as possible, thus not opposing to the preference of the public, thereby those measures can be favoured by as many stakeholders as possible. For instance, control of drainage water pollution via subsidising non-chemical pesticides will be more legitimate than preventing this type of pollution by applying penalties on excessive use of chemical pesticides.

Sustainability

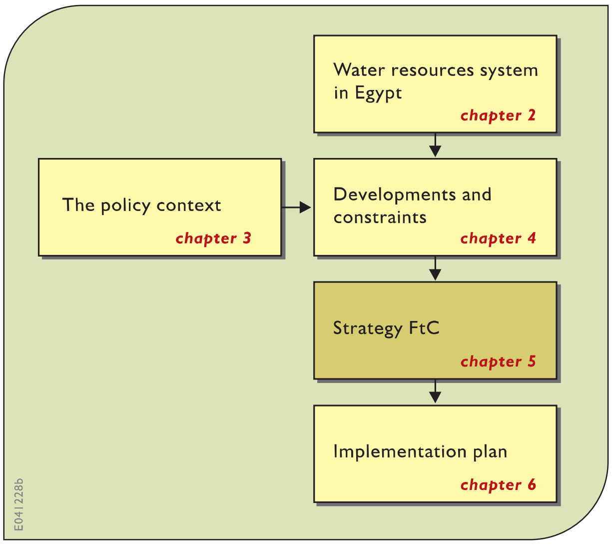
Measures to be taken are those which improve (or at least maintain) the present environmental and socio-economic conditions for the next generations.



Jointly developing an integrated strategy for Egypt

5 STRATEGY 'FACING THE CHALLENGE'

- A **national** water resources strategy – how to develop and manage Egypt's water resources to face the demands of 2017 for sufficient and good quality water
  - *Developing additional water resources* – deep groundwater withdrawals promising but not sustainable
  - *Better use of the existing resources* – continuing improvement projects in combination with a good institutional structure of Water Boards and/or Water User Associations
  - *Protecting public health and environment* – priority for preventing pollution above treatment and control
  - *Institutional measures* – a condition for successful implementation
- The impacts – do we reach our development objectives?
- What if the future develops differently? Is the strategy robust and does it leave room for adjustment?



The strategy Facing the Challenge (FtC) presented in this chapter describes the new water resources management strategy for Egypt. The strategy is based on the key policies as mentioned in Chapter 3 while addressing the present and anticipated problems as presented in the previous chapters.

Egypt has a long history in water resources management and many activities and programmes have been initiated by the Government of Egypt to further improve the performance of the water resources system. The strategy Facing the Challenge builds upon the present policy but extends it and will include new aspects. The strategy is based on the concept of Integrated Water Resources Management (IWRM) and will take all national policy objectives into account. In that sense it is part of a true 'national' water resources plan, addressing the interests of all stakeholders involved and not only the interests of MWRI.

The measures included in FtC are a combination of the most promising measures from the inventory of potential measures as listed in Annex B7. These measures have been categorized according to the three basic pillars of the water resources policy of Egypt:

- Developing additional resources (Section 5.1)
- Making better use of the existing resources (Section 5.2)
- Protecting health and environment (Section 5.3)

Where appropriate, institutional and financial measures are included in the strategy components mentioned above. Some institutional measures have a more general character and are described separately in Section 5.4.

5.1 Developing additional resources

5.1.1 Nile water

The Nile water available for Egypt is 55.5 BCM/year, based on an average natural flow of 84 BCM/year, a reservoir evaporation loss in Lake Nasser of 10 BCM/year and an allocation of 18.5 BCM/year for the Sudan. As a result of climate change it is likely that the average Nile flow will change. The natural Nile flows are very sensitive to relatively small changes in rainfall. Comparing for example the relative wet 7-year period August 1993-July 2000 with the dry period August 1980 - July 1987, it appears that the rainfall in the wet period was only 12% higher whereas the runoff was 38% higher. Since most of the climate models predict an increase in rainfall in the Nile Basin, it seems likely that the Nile flows will on the average increase in future. A very first estimate indicates an additional supply for Egypt of about 4 BCM per year.

Options to further increase the amount of Nile water entering Lake Nasser are mainly related to upstream water conservation schemes in the White Nile basin. In this basin there are many swamps where large amounts of water are lost through evaporation. The most evident scheme is the Jonglei Phase 1 scheme, the construction of which already started in the past but was stopped due to political instability in the Sudan. Nowadays there may also be increasing environmental concerns amongst possible donors to finance this scheme. Apart from the Sudd swamps there are many other swamp areas in the basin. Reclaiming swamp areas on a smaller scale in different parts of the basin may result in less pronounced environmental impacts, while at the same time creating opportunities for agricultural development for e.g. the cultivation of rice. Even in case of double rice cropping, using shorter duration varieties, there would be substantial water savings.

Another measure to increase the Nile water availability from Lake Nasser is to change the reservoir operation. The present operation of the Lake Nasser reservoir is based on a fixed annual release of 55.5 BCM. An alternative reservoir operation could be to change the fixed annual release to a variable annual release, depending on the reservoir level. Larger releases at high reservoir levels would (i) reduce the spill to the Toshka depression and (ii) lower the average reservoir level and by that reduce the reservoir evaporation losses. At lower reservoir levels the release should be reduced. Assuming a moderate 10% release reduction at lower reservoir levels the (long term) average water availability from Lake Nasser would increase by some 2 BCM/year. The operation of the Lake Nasser Reservoir is subject of research in the LNFDC project (see also Section 5.2.8).

Considering many uncertainties, the above measures have not been included in the basic strategy. However, it may be concluded that future increases in Nile water availability are certainly not unrealistic. This option will therefore be considered in a more optimistic scenario for Egypt's water strategy.

In view of all potential developments in the Nile Basin, in particular in the Sudan and in Ethiopia, with benefits for various countries, the continued co-operation with the riparian states is considered of high importance. Egypt will also continue to play an active role in the activities initiated within the scope of the Nile Basin Initiative (NBI). The initiative is guided by a shared vision to achieve sustainable socio-economic development through the equitable utilization of, and benefit from, the common Nile Basin resources.

5.1.2 Groundwater

Deep groundwater

Fresh groundwater

The aquifers in the Western Desert hold vast amounts of fresh groundwater and are by far the most important source of fresh water outside the Nile system. The groundwater in the Western Desert is in general non-renewable fossil groundwater. The age of the groundwater in the central part of the Western desert varies between 20,000 and 40,000 years. Its use will be carefully planned and monitored so that future generations are not faced with the consequences of a poorly managed resource.

The total abstraction potential of fresh water in the Western Desert is estimated at about 3.5 BCM/year. Considering the planned horizontal expansion in the Western Desert this potential will be fully utilised by 2017. Most of the development (more than 85%) will take place in East Oweinat and the Farafra and Dakhla oases.

Drilling for groundwater

As the groundwater in the Western Desert is non-renewable, the piezometric levels will decline. Since this will have impacts for the interests of future generations it is important that developments take place gradually to enable the Government to intervene if groundwater levels drop more rapidly than expected. Close monitoring of groundwater levels seems essential in this respect.

Apart from the Western Desert, there is also potential for further groundwater development in Sinai (some 200 to 300 MCM/yr) and the Eastern Desert (roughly 50 to 100 MCM /yr). The water is found in a mixture of aquifers that receive recharge (wadi aquifers and basement rocks) and aquifers that contain fossil water (Nubian sandstone and carbonate rocks). To determine the quantity and quality of these groundwater reserves close to the areas of demand would need more detailed hydrogeological studies. Summarizing, it is estimated that the future total abstraction of deep groundwater in the country may reach 4 BCM/year.

Brackish groundwater

There are vast amounts of unpolluted brackish groundwater of varying salinity in the Nubian sandstone and Moghra aquifers. Potential use of this largely untapped resource includes use in agriculture (salt tolerant crops), aquaculture, and industry. Depending on distance to settlements brackish water could also be used as a raw water source for public water supply, since desalination of brackish water is cheaper than desalination of seawater.

The brackish water reserves will be explored in more detail to determine the locations for large capacity wells and to forecast the salinity changes in time. Based on these investigations the viability of using brackish groundwater for aquaculture and agriculture will be studied in pilot projects. Such pilot projects will also investigate possible environmental impacts.

Shallow groundwater

Nile aquifer

The shallow groundwater in the Nile aquifer is not to be considered a separate resource. Recharge of the aquifer is mainly from the surface water system, through excess irrigation water, and outflow from the aquifer is mainly to the surface water system, through abstractions, outflow to the drainage system and the Nile, and through seepage (mainly in the northern Delta). Other in- and outflows are only minor (small rainfall contribution to recharge and small lateral outflow to the Moghra aquifer and the Wadi Natrun area.

Any increase in groundwater development in the Nile Valley will not increase the overall water availability since the outflow from the aquifer to the Nile will decrease proportionally. Nevertheless, increased groundwater abstraction will be justified for a number of reasons:

- Further development of groundwater for irrigation may be useful in some areas when the capacity of the existing system is insufficient to cope with peak water demands. In certain parts of the fringes, especially in areas that experience water logging conditions, a combination of well drainage and supply of irrigation water seems a feasible option.
- Groundwater abstraction may locally be the cheapest solution for M&I supply. Since groundwater is a major source of drinking water in many areas, much emphasis will be given to the protection of this source from pollution.

In the Delta there are indications that the total groundwater abstractions already exceed the safe yield. If in future the supply of irrigation water to the Delta region would reduce, also the safe yield would decrease due to less recharge. This was already experienced in 1988. In this year the release from Aswan decreased to 52.8 BCM due to the low level in the reservoir. The groundwater tables during 1988 reportedly were lower indeed, showing abstraction rates exceeding the safe yield. Therefore, any plans to increase groundwater abstractions will be carefully reviewed. Locally, in some areas groundwater abstraction could be increased but in other areas there will be a reduction in groundwater abstraction to avoid lowering of groundwater tables and induced seawater intrusion.

With regard to any future increase in pumping from the Nile aquifer, the Groundwater Sector of MWRI prioritises abstractions for drinking water above the use of groundwater for irrigation. Also, the Groundwater Sector intends to prepare an inventory of all users and to strengthen the license system for groundwater abstractions. These ideas are considered important for the strategy Facing the Challenge.

Coastal aquifers

Many coastal areas have sustained on small-scale exploitation of a thin fresh water lens over the centuries through shallow wells and galleries (skimming). However, potential abstraction rates are small due to the presence of saline water underneath the thin fresh water lens. Present abstractions are less than 100 MCM/yr of which most from the Quaternary aquifer in the northern part of Sinai. Locally some scope for increase in groundwater abstraction may exist, but care will be taken not to disturb the fragile balance between the fresh and saline water because this may have a devastating effect on the fresh water resources.

5.1.3 Rainfall and flash flood harvesting

Rainfall harvesting along the Mediterranean coast

Although only minor in magnitude compared with surface and groundwater resources, rainfall harvesting techniques play an important role in rainfed agricultural areas near the Mediterranean, where there is no access to Nile water and groundwater availability is limited. The interception of surface runoff and its storage in the soil profile requires simple and low cost techniques that can be implemented by the farmers. Therefore, its intensification and expansion will be pursued.

Harvesting of flash floods

Harvesting of flash floods may be considered in, for example, Sinai or the Eastern Desert, through the development of small reservoirs for storage and subsequent infiltration to recharge the groundwater. A major problem is that rainfall in these areas is highly irregular in time and variable in magnitude. Larger reservoirs will have a low yield/capacity ratio and their benefit/cost ratio is considered low. Small reservoirs on the other hand will have a higher yield/capacity ratio but they will rapidly fill with sediment. For these reasons such schemes will only be considered in areas where small dams also have an important flood protection function, or where no other options (e.g. underground cisterns) are available. This is the case in some areas of Sinai.

Potential locations for such harvesting, in combination with flood protection, will be determined on the basis of feasibility studies.

5.1.4 Desalination

Seawater obviously is available in unlimited quantities in coastal areas. It is expected that desalination plants for drinking water and industrial use in areas where no other cheaper resources are available, will be developed as the demands grow. However, if brackish (ground)water is nearby available in sufficient quantities, this may be the preferred source for desalination, depending on the distance to this source.

Summary of actions and measures to develop additional resources

Nile water

- Continue the co-operation with the riparian countries in the Nile Basin and investigate the possibilities to increase the supply of Nile water

Groundwater

- deep groundwater development in the Western Desert, including close monitoring
- investigate potential of deep groundwater development in Sinai and Eastern Desert
- study the development potential of brackish groundwater for aquaculture and agriculture (pilot projects)
- increase management of shallow groundwater of Nile aquifer (monitoring, licensing, prioritisation)

Rainfall and flash flood harvesting

- stimulate small-scale rainfall harvesting along the Mediterranean coast
- carry-out feasibility studies on flash flood harvesting in Sinai in combination with flood protection

Desalination in coastal area

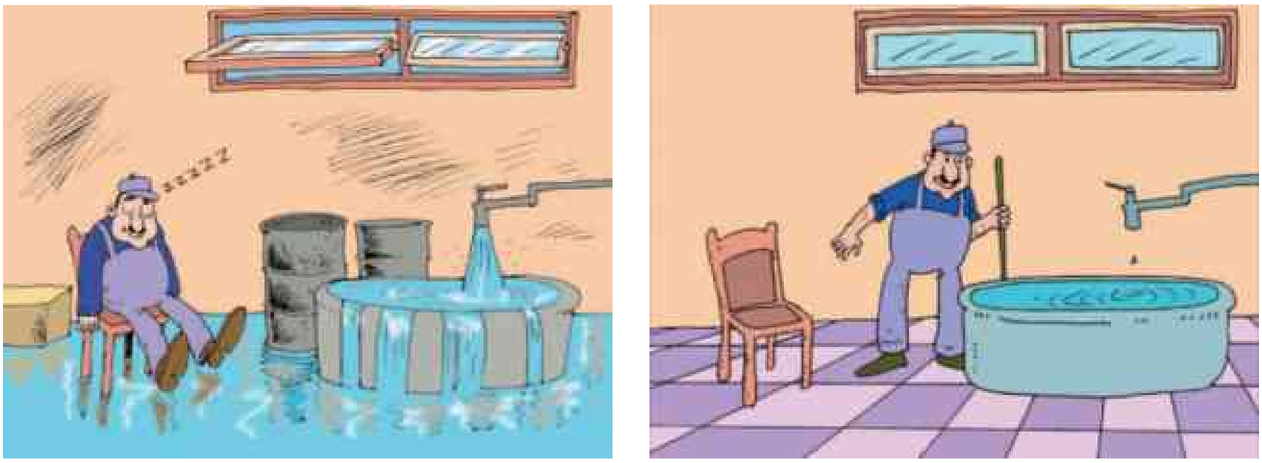
- increase brackish / salt water desalination in line with demands

5.2 Making better use of existing resources

5.2.1 General

According to the Government plans the total irrigation area between 1997 and 2017 will increase by some 3.4 million feddan. Almost 75% of these new areas will be supplied with Nile water, about 18% with groundwater and for the remaining 7% treated wastewater will be used. Irrigation developments that depend on groundwater (mainly in the Western Desert) will obviously go parallel with the construction and development of deep wells. The direct use of treated wastewater for irrigation is expected to gradually increase, especially in areas where this wastewater is lost outside the system ('sinks') and where areas are available to use this water for irrigation of non-food crops, without harmful effects to the environment.

Given the increasing water scarcity, a major challenge will be to improve the overall water use efficiency in order to minimise the losses to sinks. Another major challenge will be to distribute the available water for agriculture in an equitable way.



Making better use of existing resources

5.2.2 Development of horizontal expansion area dependent on water availability

Considering the increasing stress on the system and the reduction in water availability per feddan, the horizontal expansion of agricultural area will be made dependent on the availability of additional water resources. The Middle Sinai scheme (250,000 feddan) will be postponed as this scheme was to be developed in combination with the Jonglei Phase I upstream water conservation scheme that is far from certain. It has been suggested to irrigate this area by groundwater instead of surface water, but available information indicates that the amount of groundwater available in the area is by far not sufficient to cover the irrigation demands of the Middle Sinai project.

In the strategy Facing the Challenge the reduction in horizontal expansion by 250,000 feddan is to some extent compensated by about 100,000 feddan, to be irrigated with treated wastewater from the New Industrial Cities (see Section 5.2.5).

In addition the remaining planned horizontal expansion up till 2017 will be temporized in such a way that it will be in line with further water saving measures and measures to distribute the water over the farmers in an equitable way. At all cost it will be avoided that increasing shortages will be at the expense of tail-end farmers.

5.2.3 Improvement of water use efficiency

Improvement of water use efficiency both in- and outside the Nile system will largely depend on the efficient use of water in agriculture. Therefore the emphasis in this section is on the agricultural sector. Improvement of water use efficiency in the municipal and industrial sector is discussed in Section 5.2.4.

Nile system

Reduction of losses to sinks (general)

The overall water use efficiency of the Nile system can be increased through measures that are aimed at a reduction of outflows to sinks (desert areas, inland lakes, coastal lakes/sea and Suez Canal). If no measures are taken the outflows to sinks are expected to increase between 1997 and 2017 (see Table 4-11 and Table 4-13). Most relevant measures to reduce the outflow to sinks relate to increased efficiency and reuse of drainage water and treated wastewater.

Improvement of irrigation efficiencies and reuse of drainage water and treated wastewater are major water saving measures, but their overall impact on water savings in the Nile system largely depends on where these measures are applied. For example, improved efficiencies in the Nile Valley will result in lower diversion requirements. However, since practically all inefficiently used water will remain in the Nile system for further downstream use, there hardly would be any impact on the reduction in outflow to sinks. Therefore, major impacts of improved efficiencies on overall water savings are expected in areas where the drainage water would otherwise directly flow to sinks.

Improvement of irrigation efficiency and reuse of drainage water are measures that are quite different in nature. In principle increase in irrigation efficiency to reduce losses is preferred due to the possible adverse effects of reuse. By reusing drainage water, poor and good quality water are mixed, which may interfere with the interests of other downstream users that take water from the canal system (notably the intakes for municipal and industrial use). Another negative aspect of drainage water reuse is the risk of groundwater pollution in certain areas. However, the scope for improvement of irrigation efficiencies is limited in the Nile system where traditionally surface irrigation is practiced. This practice is not expected to change in the future. Even if the conveyance-, distribution-, and field application efficiencies are increased there still will be significant quantities of drainage water that will flow to sinks if not captured by downstream reuse pumping stations.

In view of cost-benefit considerations and possible adverse effects of drainage water reuse, the following priorities are set:

- Drainage water reuse in areas where:
  - drainage water would otherwise flow to sinks
  - the least harm is done to other downstream users
  - groundwater is least vulnerable to pollution
- Improvement of irrigation efficiencies in areas where:
  - drainage water would otherwise flow to sinks
  - reuse of drainage water will not take place because of adverse impacts

Areas where water is lost to sinks

In the Nile system the major sinks include the desert areas, the inland- and coastal lakes, the Suez canal, and the Mediterranean.

In Toshka modern irrigation systems will be applied such as drip and sprinkler irrigation. The expected non-recoverable losses here are in the order of 20%. The losses of municipal and industrial water are conservatively estimated in the same order. Reuse of drainage water in the new areas and direct use of treated wastewater for specific purposes will be considered in future. The losses to sinks from the New Industrial Cities in the desert will in the first place be controlled by measures that reduce the demands and in the second place by reuse of treated wastewater. These measures are discussed in Section 5.2.5.

Wadi El Rayan

In Fayoum the outflow to Lake Qarun could still be reduced through increased reuse of drainage water. With regard to the outflow to Wadi Rayan the situation is different. Although this water body was first intended as an additional sink, to avoid high water levels in Lake Qarun, the upper of the two Wadi Rayan lakes now operates more as a storage reservoir which is increasingly used for irrigation and aquaculture. This development gradually reduces the loss to sinks, but may have a negative impact on the environmental condition of the lower lake which is part of a protected nature area. The higher the water use efficiency, the less water will flow to the lower lake and the more the size of the lower (terminal) lake will be reduced.

The drainage outflow to sinks from the Delta area is by far the largest. In the following attention is given to measures aimed at a reduction of these losses. If drainage outflows to the lakes are reduced significantly, this will have a pronounced environmental impact on the water quality and the fisheries in the lakes. Fresh water inflow will be less and salinity will increase. Salinity in itself may not be such a problem since the coastal lakes were also more saline in the past. However, it will affect the livelihood of the fishermen. A different flow pattern will also change the pollution field near the outlets of the drains.

Improvement of irrigation efficiencies

Within irrigation command areas the following types of irrigation efficiencies can be identified:

- conveyance efficiency: efficiency of the canal and conduit network from the river diversion or pumping station to the offtakes of the distributary system
- distribution efficiency: efficiency of water distribution canals and conduits supplying water from the conveyance network to individual fields
- field application efficiency: relation between quantity of water furnished at the field inlet and quantity of water effectively used for evapotranspiration.

Losses in the conveyance and distribution system include leakage losses, evaporation losses, evapotranspiration losses from aquatic weeds and vegetation along the banks of the canal, and operational losses. Leakage losses in unlined canals can be quite significant in sandy areas. High losses are experienced in certain stretches of the El-Mansouria canal, the El Hamami canal (branch canal of El Mansouria canal), the Nubariya canal and the Ismailia canal. To reduce the high conveyance losses in these canals the feasibility of canal lining will be examined. Leakage losses are usually higher in canals that are operated under a rotational system as compared with canals that flow continuously.

Evaporative losses are generally minor if there is proper weed control in the canals. Operational losses depend on the distribution system, the available regulating and measurement structures and the skill and discipline of the operators.

To increase the distribution efficiency, the establishment of Water Boards and Water User Associations is considered important. The Water Boards will have an important function in the future operation and maintenance of the system within the boundaries of the irrigation districts up to the mesqa units. At the *mesqa* level the Water User Associations will then be responsible for the water distribution amongst the farmers. The importance of Water Boards and Water User Associations in the water distribution is discussed in more detail in Section 5.2.4. The set-up of Water User Associations is an integral part of the ongoing Irrigation Improvement Project (IIP) that, apart from this institutional component also includes the following major components that will increase the distribution efficiency:

- renovation and improvement of branch and distributary canals;
- downstream water control and conversion from rotational to continuous flow;
- *mesqa* improvement by conversion from low level mesqas to raised canals or pipelines.

The total area planned to be improved under the IIP programme by the year 2017 is about 3.5 million feddan of which about 70% is located in the Delta. To attain maximum benefit of these measures by the farmers, the IIP developments are supported through Irrigation Advisory Services (IAS). These IAS will also support WUAs that will be established outside the areas that are considered for IIP improvements.

Other measures that will improve the field application efficiency are land levelling and controlled drainage. Laser land levelling in sugar cane areas (some 200,000 feddan) showed promising results. Controlled drainage is especially effective in rice fields where considerable amounts of irrigation water can be saved by blocking the subsurface drainage system during the growing season. When drainage water cannot be recovered for reuse, controlled drainage would result in a seasonal water saving of about 1,400 m^3/feddan (Morris, 2001).

In all new development areas that depend on Nile water and that have light textured soils, losses will be kept to the minimum through the application of modern irrigation techniques (sprinkler and drip irrigation). However, application of modern irrigation systems in itself does not warrant high efficiencies. Introduction of these new techniques will also be supported by Irrigation Advisory Services in order to advise farmers on proper irrigation practices (application depths and irrigation frequencies).

Improvement of drainage conditions

The on-going drainage programme of EPADP will be continued. Sub-surface drainage is of paramount importance for irrigation under arid conditions. So far, about 5 million feddan has been provided with sub-surface drainage systems. This is planned to be increased to 6.40 million feddan by 2017. Besides installing, replacing and maintaining the sub-surface drainage systems, EPADP is also involved in the construction and improvements of surface drains.

It is envisaged that the present EPADP programme will be integrated with related programs of IIP rehabilitation of pumps. The Integrated Irrigation Improvement and Management Project (IIIMP) will support this process.

Reuse of drainage water

Even though efficiencies are increased in the water distribution system and at the on-farm level, there still will be a significant quantity of water that is lost if no further measures are taken. The major measure to reduce these losses is through reuse of drainage water, after mixing this water with fresh canal water. Reuse of drainage water has already been practised at a larger scale during the last decades, whereby water from main drains is pumped into main canals. A major problem experienced is the deteriorating water quality in many drains that are polluted from municipal and industrial sources. Mixing of this water with canal water in a number of cases threatened other water users that are located downstream of the mixing points. For this reason a number of main drain reuse stations had to be closed in the past. To bring these pumping stations into operation again, large efforts to reduce the pollution loads would be necessary. Therefore, alternatives for this type of reuse have to be found.

As an alternative to the reuse of drainage water from larger drains the reuse could shift to smaller less polluted drains in the upper part of the system. This so-called intermediate reuse would pump drainage water to lower order irrigation canals (see Figure 5-1) where it does not have harmful impacts on downstream domestic water intakes.

However, care will be taken in areas where groundwater is vulnerable for pollution in the absence of a protecting clay cap (Figure 5-2). Moreover, intermediate reuse schemes in some areas may negatively affect the availability of drainage water quantity and quality for existing downstream reuse projects. The major challenge in increasing the drainage reuse will therefore be to find an optimum mix of main drain reuse and intermediate reuse that is both effective in terms of overall water savings and costs, and that has the least negative impacts on the groundwater and other water users.

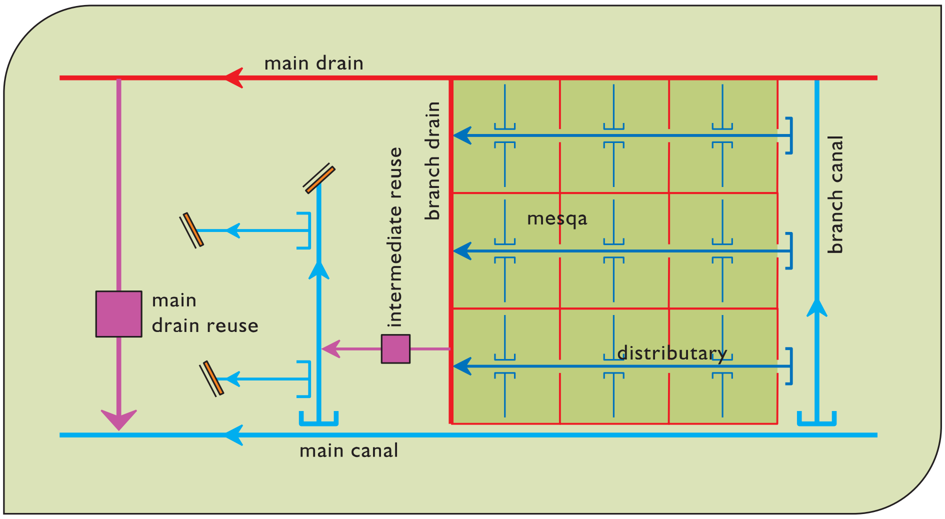


Figure 5-1 Schematic presentation of main drain reuse and intermediate reuse

In the strategy the main drain reuse and intermediate reuse are limited to:

- canals where there are no drinking water intakes from the canal downstream of the mixing points;
- areas where the groundwater is protected by a clay cap of sufficient thickness, corresponding to areas with low vulnerability shown in Figure 5-2.

The total quantity of potential reuse depends on the salinity of the irrigation water after mixing. In view of increasing demands for irrigation water it will be considered to allow the salinity level to be increased to 1,600 ppm. This will have some impact on the cropping pattern and yields since this salinity is considered too high for a number of crops such as most vegetables, maize, berseem, flax and a number of fruit trees. Therefore, such measure will be combined with the promotion of salt tolerant crops in parts of the Delta.

Increased reuse of drainage water obviously also requires that pollution levels in the drainage water are controlled.

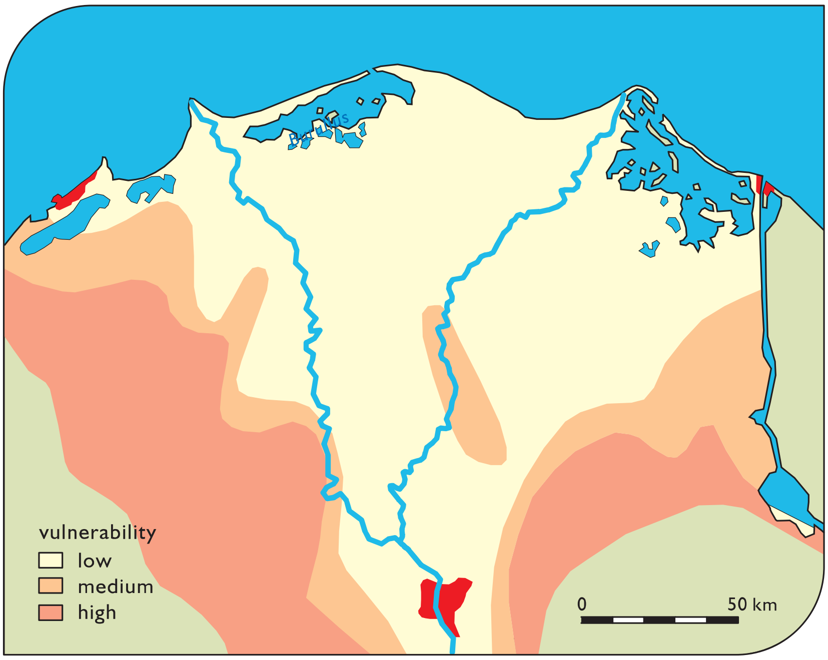


Figure 5-2 Vulnerability of the Nile aquifer to pollution in the Nile Delta and fringes (source: RIGW)

Areas irrigated by deep groundwater

The application of modern irrigation techniques in the new areas to increase irrigation efficiency alone is not a guarantee that water is used efficiently. Therefore, also in these areas (largely developed by private investors) a proper Irrigation Advisory Service (IAS) is needed to advise on irrigation intervals and application depths.

The traditional surface irrigation systems in the oases will gradually be replaced by modern irrigation techniques. Priorities in these areas are to better control the well discharges in accordance with the actual irrigation requirements and to gradually phase out the cultivation of rice. Apart from water savings such measures will result in improved drainage conditions and reduced risks of evaporation ponds having insufficient capacity.

Reduced irrigation supply after rainfall

When rainfall occurs (especially in the northern part of the Delta) the irrigation supply in principle could be reduced. However, because of the long travel times and the lack of storage in the system, it was hardly possible in the past to react to rainfall in the operational management, by reducing the release from Aswan. After rehabilitation of the barrages on the Nile and its branches, the system becomes somewhat more flexible. Water levels upstream of the barrages can be increased more, thus creating opportunity for temporary storage in the order of about 200 MCM in the entire system. On a yearly basis this could save some 0.5 to 1 BCM. However, considering the irregularity of rainfall both in time and space, and the complexity of the water distribution system, it is difficult to assess the impact of temporary storage upstream the different barrages on water savings without further study.

Summary of measures to improve overall water use efficiency in agriculture

Horizontal expansion
- make further horizontal expansion depending on the availability of additional water

Improvement of irrigation efficiencies
- prioritize efficiency measures in effective areas
- continue IIP and IIIMP related activities to rehabilitate the water distribution system in prioritised areas: (i.e. areas where drainage water would otherwise flow to sinks and where reuse of drainage water is not recommended because of adverse impacts)
- provide Irrigation Advisory Services including in all new development areas
- apply canal lining in canal stretches that suffer from high leakage losses
- apply laser land-levelling where possible and needed to increase field application efficiencies
- apply controlled drainage during the cultivation of rice
- apply modern irrigation techniques in all new development areas with light textured soils
- gradually introduce modern irrigation techniques to replace traditional irrigation methods in the oases and gradually phase out the cultivation of rice in these areas
- control well discharges in desert areas
- improve O&M activities through private participation (Water Boards and Water User Associations)
- reduce irrigation supply after rainfall, combined with extra storage upstream from barrages in the Delta

Improve drainage conditions
- continue sub-surface drainage program of EPADP, with the intent to integrate the activities with IIP into IIIMP

Reuse of drainage water
- review the drainage water reuse policy of Egypt, including:
  - the application of intermediate reuse at appropriate locations
  - the prioritisation of drainage water reuse in areas where a) drainage water would otherwise flow to sinks, b) the least harm is done to other downstream users, and c) groundwater is least vulnerable to pollution
  - to allow higher permissible salinity of irrigation water after mixing with drainage water
- promote the use of crops that are less sensitive to salinity

5.2.4 Water allocation and distribution in the Nile system

After implementing the measures to reduce the losses to sinks, the amount of water that is available per feddan will still be less compared with the present situation in case the release at the HAD is unchanged. An important question is then how to allocate and distribute the scarce irrigation water from the Nile over the different regions and within the regions.

Water allocation

The water distribution between the various regions (old lands and new lands in Upper, Middle and Lower Egypt) will reflect some kind of equity in terms of opportunities for existing and future farmers. This equity will take into account the type of farms (small holdings versus large estates), differences in climate, and differences in water quality. Equity in water distribution requires much attention for system improvement and operation.

It is intended to apply a de-central water allocation that is fixed in advance and strictly adhered to. Within the regions the water will be distributed equally in terms of annual volume per feddan. A question with respect to this equity is to what extent allocations will be increased to allow the cultivation of crops that are notorious for their high irrigation requirement, such as rice and sugar cane. It could be in the national interest, for example, to grow sugar cane in certain areas in the Valley to keep the existing sugar cane mills in operation. With regard to the cultivation of rice in the northern Delta it is believed that rice cultivation here is necessary to suppress the seepage of saline water. If these arguments are considered valid, it would make sense to allocate additional water for the cultivation of these crops. At any rate, the illegal growing of rice will be strictly controlled in future.

Once the water allocations for a specific year are fixed, the farmers can decide on their crops. The resulting cropping pattern within a *mesqa* or larger unit will have an irrigation requirement that matches the pre-set annual allocation. Some adjustments may be needed to avoid peak

requirements that exceed the system capacity. Reference is made to the measures about the institutional arrangements (farmers, MALR and MWRI) to collect and transfer cropping pattern data (APRP, 2000a and APRP, 2001).

The water supply each year will be guaranteed within reasonable limits. This could be formalised in an agreement between MWRI and farmers' organisations. As a result of the above-described water allocation procedure it is thought that the mismatch between supply and demand can be minimised. Although the procedure and seasonal supply is simple and straightforward, its implementation is far from simple and certainly cannot be done overnight. It requires large investments in system rehabilitation, installation of new structures and last but not least it requires an intensive programme of human resources development through training.

Water distribution mechanisms

Already under the present conditions water constraints are experienced by farmers, especially by the farmers at the tail-end of irrigation systems. To supplement their irrigation water, these farmers use groundwater and/or directly pump water from the drains. In future, after the implementation of all planned horizontal expansion, the water available per feddan is expected to be less and if no measures are taken to distribute the available water equally, the tail-end farmers will suffer most, leading to unacceptable social conditions.

To distribute the increasingly scarce water fairly amongst the farmers the operational management of the system will be improved. This requires a better control of discharges and more involvement by the farmers in the system operation and maintenance.

Discharge control

Traditionally, the water distribution is based on water levels but this system will not be adequate for future water management since it results in unequal distribution with water logging in certain areas and water shortage in other areas. Presently, the water distribution between the Irrigation Directorates is already based on volumetric discharge control. All cross regulators between neighbouring Irrigation Directorates have been calibrated for this purpose. However, within the Irrigation Directorates and Districts there still are inequities in water distribution. In part this is caused by over-sized cross-sections of canals compared to their original design. This over-sizing is reportedly caused by mechanical maintenance operations, widening the canals, and dredging.

Delta Barrage

To improve the water distribution a number of measures are needed. Already MWRI adopted a policy to distribute the water up to the district level based on water levels and discharge (APRP, 2000b). This will need additional weirs or cross-regulators in the system. The investment costs for these additional structures are estimated at 200 to 300 LE per feddan. In addition, rating curves and/or discharge coefficients of control structures will be established, and irrigation staff will be trained in the proper operation of the system, including the regular adjustments of gate settings.

Under the ongoing IIP activities part of the system is already being rehabilitated. Modular discharge regulators are constructed at the head of branch canals and at canal cross regulators. Downstream of these discharge regulators there will be no more discharge measuring structures. Instead there will be downstream control structures in the branch canals.

Water Boards and Water User Associations

Part of the Ministry's water management responsibility will be shifted in future to the water users through the establishment of Water Boards. Some consequences of this institutional change for water management are briefly described below. For further details reference is made to Section 5.4.

The Water Boards that have been established so far at the pilot level cover areas in the order of 4,000 to 5,000 feddan. Future Water Boards are expected to grow in size and to be responsible for the O&M at district level (45,000 to 50,000 feddan). The Water Boards will then be accountable to the inspectors and to the users. Sub-units of these Water Boards will be needed for the communication and the distribution of water. Given the pre-determined and controlled inflows to the branch canals the Water Boards / BCWUAs have the responsibility to distribute this flow over the distributaries and the mesqas. The daily intakes by the *mesqas* have to be controlled by the number of pumping hours that *mesqas* are allowed to pump, depending on the size of the *mesqa* unit and the installed pump capacity. To avoid that certain *mesqas* take more water at the expense of other *mesqas* there will be a strict control on these pumping hours. For each individual mesqa the pumping hours will be scheduled in advance. Depending on the storage capacity of the entire system under control of the Water Board, the pumping hours may have to be spread. To fulfil this task, the responsible staff of the Water Boards will be thoroughly trained. It is expected that the water distribution will improve, among others because of a social control mechanism.

Within the *mesqa* unit the water distribution is to be organised by the farmers. To avoid conflicts amongst the farmers, Water User Associations (WUAs) are to be formed. These WUAs are an integrated part of the ongoing IIP and IIIMP developments. Also outside the IIP areas the WUAs could play an important role in the water distribution between farmers at the *mesqa* level as well. However, this will be more difficult to control since, contrary to IIP improved *mesqas*, individual farmers have their own pumping unit which they can operate at any moment unless strict rules are set between the farmers within the *mesqa*. The Irrigation Advisory Service (IAS) is doing the preparatory activities to install WUAs. To guide the WUAs presently an IAS unit is established at the central level.

The Water Boards also have a task in controlling unofficial reuse of drainage water in the system and unauthorised pumping of groundwater, since this will affect the conditions elsewhere in the system.

In future, when all planned horizontal expansion areas are developed, there may not be sufficient water to grow crops throughout the irrigation area in the summer. This means that if water is equally distributed over the farmers, proportional to the size of their land, each farmer is forced to leave part of his land fallow. In special cases water redistribution can take place between farmers. Such redistribution will be controlled through the WUA to avoid any future conflicts.

Rehabilitation, operation and maintenance of distribution system

The strategy Facing the Challenge described here is focussing on new policies and actions to be taken. It goes without saying that the on-going 'routine' activities of MWRI with respect to the rehabilitation, operation and maintenance of the distribution system will also continue. This includes:

- The construction and rehabilitation of barrages and regulators by the Reservoir and Grand Barrages Sector of MWRI (among others the replacement of the Abbasi Head Regulator and the rehabilitation of the Assiut and Zefta Barrages).
- The rehabilitation and further development of the pumping stations in the river and canal system by the Mechanical and Electrical Department of MWRI (among others to support the El Salaam and Toshka projects).
- The improvement and maintenance of the High Aswan Dam and Lake Nasser System by the High Aswan Dam Public Authority (including the Toshka spillway).
- The improvement and maintenance of the banks of the river Nile by the River Nile and its Fringes Sector of MWRI.
- The protection of Egypt's shores along the Mediterranean Sea and Red Sea by the Egyptian Public Authority for Shore Protection.
- The continuation of the surveying and mapping activities of the Egyptian Public Authority for Surveying and Mapping of MWRI.

New barrage at Esna

Weed control in canals

Reference is made to existing plans of above Sectors and Authorities for a detailed description of the activities. Based on the strategy Facing the Challenge some of the long-term plans may need to be adapted to reflect this new strategy. Costs for investments and operation and maintenance of on-going activities are included in the Implementation Plan that will be described in Chapter 6.

Maintenance of water distribution- and drainage system
In many rural area, solid waste is dumped in the canals and drains because of lack of a suitable solid waste collection and disposal system. Since this practice obstructs the proper functioning of these waterways, the solid waste has to be removed during maintenance work. Also, the disposal of outdated leftovers and used pesticide and fertilise containers may affect the water quality. Thus, it seems more cost effective to prevent this practice through solid waste collection and disposal.

The performance of the irrigation and drainage system is often seriously hampered as a result of abundant growth of aquatic weeds in the system. The on-going mechanical weed control programs will be continued.

Biological weed control with grass carp has proven to be a feasible and cost effective measure for canals with a design bed width of 6 m and larger. Apart from controlling weed, the carp is a good supplementary source of protein or income for the rural population.

Summary of measures to improve water allocation and distribution of Nile water

Institutional measures
- install Water Boards at Irrigation District level
- continue set-up of Water User Associations at mesqa level

Water allocation
- de-central water allocation to be based on equal opportunities for farmers
- allocation within region to be based on fixed annual amount per feddan and improve physical infrastructure to enable this (see also below)
- establish coordination system between MALR (and in future Water Boards) and MWRI to avoid mismatch between water supply and demand
- seasonal supply to be laid down in an agreement between MWRI and Water Boards

Improvement physical infrastructure for proper water distribution
- install discharge control structures at key points and system rehabilitation where needed
- install modular discharge regulators at intakes of branch canals
- install downstream control structures in branch canals
- install additional weirs/cross regulators in the system where needed
- rehabilitation and maintenance of distribution system

Human resources development
- training of MWRI and Water Board staff

Maintenance
- provide solid waste collection and disposal systems in rural areas
- continue and intensify on-going mechanical weed control programs
- introduce grass carp to control aquatic weed in canals wider than 6 metres in

5.2.5 Municipal and industrial water

The amount of drinking water produced in parts of the country is unnecessarily high due to:
- low prices charged and absence of a cost incentive system to reduce consumption and wastage, e.g. lack of metering system;
- lack of public awareness on water scarcity and on public costs for drinking water production;
- high levels of physical water losses in network.

If no measures are taken to control the demands and to reduce the unaccounted for water (UFW) losses, the capacity of drinking water plants will not be sufficient to cover the demand in 2017, even when all planned capacity increase is realised. Therefore, it is considered essential to reduce both the demands and the losses.

Demand management

Water pricing for municipalities and industries

The influence of the water price on demand is expressed in the parameter price elasticity. A price elasticity of for example –0.3 means that for a price increase of 1% the demand will reduce with 0.3%. Worldwide the price elasticity varies between less than -0.1 to almost -0.5 (NWRP, 2001c). To assess the impact of price increase on demand in the present strategy a real price increase of 50% with an elasticity of –0.3 is assumed. A price increase of 50% seems very moderate compared with the price increase over the last decades of other utilities, such as electricity.

With respect to the industrial sector, efforts will be made to decrease the water demand through incentives that include water pricing measures and incentives to adopt water saving technologies, such as recycling of cooling water and other less water consuming technologies. Water pricing could, for example, be connected to the potential of water savings in various types of industry. Pricing measures will be carefully introduced. They will be combined with options for alternative sources (e.g. drain water for low quality use) and/or restrictions in developing alternative sources (e.g. groundwater) that will have negative impacts for others.

Demand management is especially important in areas where the wastewater is lost to sinks (New Industrial Cities in the desert, Canal Cities, and Alexandria). The set-up of a pilot project will be considered to introduce water saving household appliances, such as "low flush" toilets. In other countries that experience water shortages such programmes have proven successful. Industrial activities, especially in the New Industrial Cities, will aim at low water demand types of industry.

Public awareness campaigns

Public awareness campaigns to reduce wasteful use of water will be intensified. Such campaigns have shown to be effective in many countries. For example such campaign in the Netherlands resulted in a reduction in water demand of approximately 10%. The campaigns were applied by means of television spots, various leaflets and folders.

Reduction of physical water losses in the water supply system

The purpose of this measure is to reduce the leakage of drinking water from the distribution system. The leaks firstly have to be detected, using modern detection equipment, after which repairs can be made. To fully control all leakage in the supply systems, huge investments would be required. A more realistic approach seems to repair the most severe leakages and to reduce the total UFW losses from the present 34% to a future 25%. An estimated UFW loss of 34% in Egypt is considered too low by many experts who consider a total loss of 50% more realistic.

The leakage losses are primarily considered financial losses (cost of pumping, treatment, and capital cost). Most of the leakage water in the Nile system will infiltrate into the groundwater and still be available for downstream use. However, outside the Nile system (for example New Cities in the desert) this water or at least part of this water cannot be recovered and therefore also is to be considered as a loss to the Nile system. In cities some of the leakage water will enter the sewage system and be a burden for the treatment facilities.

To reduce the portion of UFW not caused by leakage losses would require the installation of water meters for individual consumers, repair of defect water meters, and the detection of illegal connections. Although the main benefit is the increase in income for the drinking water companies, these measures may be expected to lead to water savings as well.

Reuse of treated wastewater

The planned horizontal expansion that is based on treated wastewater is some 250,000 feddan. Apart from some 20,000 feddan in Middle Egypt, most of the planned area is located in the Western and Eastern Delta, with Greater Cairo and Alexandria as the main suppliers of treated wastewater.

Reuse of treated wastewater (domestic and to some extent also industrial wastewater) is considered an effective water saving measure in areas where this water would otherwise flow to sinks. Thus, also the reuse of treated wastewater from the New Industrial Cities in the desert, and the Canal Cities will be considered in the future. Primary use of treated wastewater is for irrigation of green areas (landscape development) and irrigation of non-food agriculture. Factors that are relevant for the feasibility of treated wastewater reuse for irrigation will largely depend on:

- the type of treatment and the type of industrial pollutants
- availability of suitable areas for irrigation
- irrigation methods and soil types
- cropping pattern
- matching of supply and demand
- environmental impacts
- costs

The total volume of treated wastewater from the New Cities and Canal Cities is in the order of 1.4 BCM per year, of which more than 85% from the New Industrial Cities. The reuse potential obviously will depend on the quality of the wastewater. This depends on the type of treatment of domestic wastewater and, especially, on the industrial pollutants and their removal during the on-site treatment process.

To find suitable areas for irrigation around the New Industrial Cities in the desert does not seem to be a problem. The most suitable irrigation method for reuse of treated wastewater is drip irrigation because irrigation efficiency is high, labour requirement is low and contact between farm workers and effluent is minimal. However, high quality effluent is required to prevent clogging of the emitters. Sprinkler irrigation is not suitable because it will expose workers to pollutants and may result in severe damage to the leaves of the plants and significant yield loss.

The type of crops to be grown depends on the quality of the treated wastewater, which in turn depends on the type of treatment. Primary treated domestic wastewater is suitable for non-food crops such as fibre crops and silviculture. Secondary treated wastewater may also be used for other crops while health risks for farm workers are less. Presently the trend in Egypt is to apply secondary treatment to wastewater.

Instead of the conventional wastewater treatment techniques, also low-cost treatment systems could be used such as wastewater stabilisation ponds. This system is lower in cost, less sophisticated in operation and maintenance, and often more reliable in removing pathogens.

Wastewater discharges vary during the year and during the day. However, in comparison with seasonal variation in irrigation demands, the effluent flow variability is much less. The crop irrigation demands must, as far as possible, be matched with the available effluent to achieve optimum physical and financial utilisation throughout the year. The total area that can be irrigated is therefore based on the irrigation demand of winter crops. In summer, when crop water demands are much larger, the crop intensity will be reduced. In case of the Canal Cities, shortages in summer could be supplemented from already existing irrigation canals.

Better matching of supply and demand could also be realised by storing part of the treated wastewater underground. Where soil and groundwater conditions are favourable for artificial recharge of groundwater through infiltration basins, a high degree of upgrading can be achieved by allowing partially-treated sewage effluent (low suspended solids content) to infiltrate into the soil and move down to the groundwater. This type of treatment is essentially a low-technology, effective wastewater treatment system. However, such storage of treated wastewater in the aquifer system would be in conflict with Law 48 (in case the groundwater is used for drinking water) and thus will require a lot of studies and/or a change of this law. Also in case that treated wastewater is not stored in the groundwater, the groundwater may be at risk of pollution through a downward flow of excess irrigation water. In view of this and possible other environmental impacts, an environmental impact assessment will be made prior to any reuse of treated wastewater.

Cropping pattern	Irrigation area (feddan)	Crop intensity (-)	Assumed irrigation afficiency (%)	Water-use*) efficiency waste water (%)
Trees - flax	305,800	1.56	80	71
Flax - cotton	292,200	1.36	80	63
*) crop consumptive use as percentage of waste water volume				

Table 5-1 Example water-use efficiency wastewater

A total volume of treated wastewater of 1.4 billion m^3/yr could irrigate about 300,000 feddan. Even when high irrigation efficiencies are assumed, the overall water use efficiency of the available wastewater flow will not be higher than about 65 to 70%. As an example the two cropping patterns are assumed as given in Table 5-1.

If only trees will be irrigated with treated wastewater, the total irrigation area will be restricted to about 170,000 feddan and the water-use efficiency of the treated wastewater would be only 57%.

As part of the strategy site-specific feasibility studies will be carried out to determine the potential and options for reuse of treated wastewater. As part of these studies an environmental impact assessment will be made, with special emphasis on the risks of groundwater pollution. For the purpose of the strategy impact assessment in Chapter 6, it has been assumed, somewhat arbitrarily, that 160,000 feddan will be irrigated using treated wastewater from the New Industrial Cities and Canal Cities.

Summary of measures on Municipal and Industrial water

Demand management

- Install/rehabilitate metering system and apply progressive tariff structure
- Initiate public awareness campaign to reduce wasteful use of water
- Promote the application of water saving technologies in industry through incentives

Reduction of UFW losses

- Reduce leakage losses through leak detection and repair based on priorities for the most urgent rehabilitation work
- Reduce other UFW losses through repair/installation of metering system

Reuse of treated wastewater

- Carry out feasibility studies, including environmental impact assessment for reuse of treated wastewater in the New Industrial Cities and the Canal Cities

5.2.6 Aquaculture

There presently are restrictions on cage culture in the Nile and the irrigation canal system. Also in view of the fact that the inland fisheries production is expected to be less in future, the restrictions will be reviewed in order to investigate whether these practices can be allowed as far as not interfering with other water users. According to the Fisheries Authority (GAFRD), there are no negative side effects of this type of aquaculture on water quality. Especially khors in Lake Nasser were mentioned as suitable locations for cage culture.

5.2.7 Navigation

In view of increasing water demands no water will be released from Lake Nasser exclusively for navigation. Therefore, any navigational bottlenecks caused by shallows in the river have to be eliminated through dredging.

Summary of measures on aquaculture and navigation

Aquaculture

- Review restrictions on cage culture in the Nile and canal system

Navigation

- Remove shallows in the navigation system through dredging

5.2.8 Research related activities and Family Planning Campaigns

In this section a number of activities in the field of investigations and research are listed that are considered relevant.

Change in operation of Lake Nasser

As described in Section 4.3.1, the water availability from Lake Nasser can be increased by reducing reservoir losses. An option to reduce evaporation losses would be to operate the reservoir at a lower average water level. Besides a decrease in evaporation, spill losses will also decrease, thus allowing the average annual release to be higher. This could be achieved by introducing a variable annual reservoir release for agriculture, depending on the amount of water stored in the reservoir at the start of the season. At high reservoir levels, more water would be released and at lower levels the release would be less. The disadvantage of variable annual water allocation to agriculture could, at least partly, be compensated by the conjunctive use of surface water and groundwater, using the storage capacity of the groundwater aquifers in the Nile Valley and Delta. A second option is to make better use of the flood storage zone of the reservoir by allowing higher reservoir levels at the first of August, in combination with an increase in the capacity of the Toshka spillway.
The implications of a change in reservoir operation are subject of the ongoing Lake Nasser Flood and Drought Control (LNFDC) project.

New crop varieties

Research on and the promotion of salt tolerant crop varieties and short duration varieties will result in a more efficient water use.

Salt tolerant crop varieties

Agricultural research has to provide new opportunities for using more saline irrigation water. Development of new, salt tolerant crop varieties such as sugar beets, will make it possible to use more drainage water and thus to reduce outflow to sinks.

Short duration and drought resistant crop varieties

Short duration crop varieties need less water to produce similar yields as longer duration varieties and are hence more water efficient. For a number of crops already short duration varieties are being cultivated (maize, cotton and rice).

Aquaculture using brackish groundwater

Research on the development of aquaculture using brackish groundwater will be initiated in view of the large potential of this so far untapped resource of unpolluted water.

Research at the National Water Research Centre

The mission of the National Water Research Centre (NWRC) is to conduct research to fulfil the strategy of MWRI. Hence, the strategy Facing the Challenge as described in this National Water Resources Plan will be a guiding document in the further development of the research and monitoring programmes of NWRC. Most of the on-going research programmes of NWRC already fit in the lines laid down in FtC, as might be expected. Many elements of FtC are based on the results of the research of NWRC. On the other hand, FtC includes new elements which might redirect some of the research of NWRC. NWRC will be asked to evaluate their on-going programmes with respect to FtC and, where necessary, reprogram their activities.

Family Planning Awareness Campaigns

Organising Family Planning Awareness Campaigns is an on-going activity of the Ministry of Health and Population. These campaigns will be continued, for many more reasons than water alone. Still, population growth is the main reason that Egypt has reached its limits with respect to the availability of water from the Nile. A further substantial growth in the population, in particular in the rural areas, will be very difficult to cope with. Family Planning Awareness Campaigns are included in Facing the Challenge to underpin this fact.

Summary of general and research related activities

General

- Continue family planning awareness campains

Research

- Change in operation of Lake Nasser
- Research and promotion of crop varieties suitable for particular conditions, i.e. salt tolerant, short duration and drought resistant crops
- Aquaculture development using brackish groundwater
- Specific research at NWRC to support the developments as included in NWRP

5.3 Protection of public health and environment

Based on the principles described in Section 4.4, packages of measures have been selected that address the objectives and include: (1) measures that have a direct impact on the issue at stake, (2) measures that assure the required financial resources and (3) measures that address the proper institutional setting to implement the package. The packages are reflected in this section, grouped along the following lines:

- Prevention and/or reduction of domestic, agricultural and industrial emissions;
- Treatment of waste that cannot (yet) be prevented;
- Control of those situations where emissions cannot yet be treated (and which can also not be prevented) so that the least harm is done.

Some of the measures described in this section assume that the policy changes as mentioned in Section 4.4 are implemented, in particular changing Law 48/1982 and the adoption of the polluter-pays-principle.

5.3.1 Prevention

Preventive measures are aimed at eliminating harmful substances from products (and consequently from waste) entirely, or closing cycles to ensure the substance does not reach the environment. The emphasis is on the industrial and agricultural sectors. As such solutions can be found in the production and use of clean products and the improvement of in-plant processes.

Protecting public health and environment

Prevention of industrial pollution

Technological improvements have enabled industries to produce more and more environmental friendly products. However, it is not always attractive to industries to change to these new technologies. The package of measures is therefore aimed at providing incentives for industries to adopt best available technology while encouraging the public to buy clean products, to generate funds for these actions and to enhance the supporting institutions. The components of this package are:

Introduce financial incentives to promote clean industrial products

By using taxes, tax-exemptions and subsidies to industrial investors and end-users, a more environmentally friendly and/or water saving production and consumption of industrial products can be stimulated. While looking at environmental friendliness (with a focus on water), the whole lifecycle of products - from raw material to disposal - has to be taken into account. An example are tax exemptions for investments related to cleaner industrial processes and water recycling technologies or higher taxes on old-technology products. Besides purely financial incentives, technical assistance is required as well.

Start public disclosure pollution control programme for industries

The PRogramme for Pollution control Evaluation and Rating (PROPER) aims at generating pressure from the public, NGO and business community (banks) to enhance the compliance of industries with laws, but even to surpass that by encouraging them to apply the best available technology. This is achieved by introducing a rating system whereby industries receive a gold, green, blue, red or black label that is frequently presented to the public. At the same time technical assistance is offered to red and black factories to improve their performance. This approach has proven to be effective where legal difficulties made law enforcement less efficient. The incentives are public praise for the cleaner industry and increased public pressure and legal enforcement for the remaining industries. The results in Indonesia showed a compliance increase from 35% to 51% within a period of 18 months.

Compliance action plans for industries

Given Egypt's development goals, it is very difficult to shut down industries that do not install required treatment equipment. Faced with these realities, it is preferred to use site-specific compliance agreements to establish schedules for feasible improvements for industries causing the most significant water quality problems. Generally, these compliance agreements include requirements for periodic reporting of progress and sanctions on bad performance. The PROPER approach, especially when it is part of a Compliance Agreement Plan, can make a major contribution to the improvement of water quality.

Public awareness campaigns

People are often not aware of the effect their daily behaviour can have on improving water quality. As consumers they have a choice between buying clean or polluting products. Public awareness campaigns promoting the consumption of clean products in terms of water quality will be required to make people aware of the environmental impact of certain products and their alternatives. First priority will be to emphasise products from non-polluting local factories as identified by the PROPER programme that can be identified by a green label for instance. Additionally, generally clean products like non-phosphatic detergents, biological pesticides, cadmium free plastics, batteries and degradable packaging material can be promoted.

Phase-out industries along vital inland waters and residential areas towards new cities
Many industries originally at the fringes of cities have been slowly engulfed by the ever-growing urban expansion.This limits their potential for expansion and modernisation, but also increases the impact of the pollution of these industries on the living environment. As a result many old technology industries have become a hazard to both water and people.

The measure entails the stimulation for new industries to be established away from the Nile valley and population centres towards the new industrial cities, but also to stimulate existing industries that intend to modernise to do so at a new location.

Introduce load based discharge levies
Discharge levies, based on the Polluter Pays Principle, are negative incentives that are related to the load of pollutants an industry puts into the system, even if the discharge is completely in compliance with the license or permit. Such load based discharge is not a fine. A fine is only applied if there is no compliance with the permit. In that case the polluter will, in principle, pay a fine plus a pollution charge.The objective is to reduce the concentrations below the standard, NOT at the standard. Funds collected in this way can be used to cover (part of) the costs of the package to prevent industrial pollution.

At present there is no discharge levy, only a fee to obtain a permit, but this is not related to a load.The present law also stipulates a fine or closure in case of exceeding the standards set in the permit. Under the present Law 48 it will be impossible to implement discharge levies in their original form. However, it might be possible to achieve consensus on linking the amount of the fine and the extent of exceeding the standard. As such it will only work in case of non-compliance. In the mean time efforts have been restarted to change the law.

Strengthen institutions controlling and monitoring industrial pollution
Several institutions, mainly within the Ministry of Industry, Ministry of Health and Population, Ministry of Environment (Quality department, Regional Branch Offices, Environmental Management Units), and the Ministry of Water Resources and Irrigation (water quality unit, licensing department, inspectorates) are involved in issuing permits, overseeing compliance, monitoring and awareness campaigns. In order to enable them to implement the package effectively and efficiently, the capacities of these institutions require strengthening. Co-ordination

between them and exchange of information and data needs to be enhanced so that limited resources are used efficiently and a comprehensive activity such as the PROPER programme can be implemented.

Prevention of agricultural pollution

Agricultural pollution can be divided into the more 'natural' products such as salts and organic wastes and the more 'chemical' products resulting from fertiliser and pesticide use.

Encourage the use of environmentally friendly agricultural methods

Although the contribution of agriculture to the deterioration of water quality is not always clear, it is sure that the use of fertilisers and pesticides affects water quality. At the same time this sector depends very much on a good environmental quality and has an interest in good water quality. In view of this, it is necessary that farmers are becoming more aware of the options available to them to protect good water quality. Through the extension service of the MALR, the ongoing promotion of integrated pest management and proper use of fertilisers will be continued.

Control the production and import of agrochemicals

By prohibiting the production or import of harmful agrochemicals for which less harmful alternatives exist, the availability of products to the farmers is steered towards environmentally friendly products. The production of good products is stimulated by disseminating information on new technologies to producers and by financial incentives for changes to cleaner products.

Control the use of organic fertilisers

The use of contaminated animal manure and sludge from wastewater treatment facilities is a major source of pollution of agricultural drainage water. Legal action is to be taken to limit the deposit of this material on agricultural land. In the same time, technical solutions should be found for the disposal of the sludge.

Summary of measures on preventing or reduction of emissions

Prevention of industrial pollution package

- introduce financial incentives to promote clean industrial products
- start public disclosure pollution program for industries (PROPER)
- introduce compliance action plans for industries
- initiate public awareness campaigns
- phase-out industries along vital inland waters and residential areas towards new cities
- introduce load based discharge levies
- strengthen institutional control and monitoring of industrial pollution

Prevention of agricultural pollution package

- encourage the use of environmental friendly agricultural methods
- control the production and import of agrochemicals
- control the use of organic fertilisers

5.3.2 Treatment

When a pollution load cannot be prevented, treatment is the next option. But as treatment is necessary as long as the source exists, sustainable funding, operation and maintenance is required for continuous operation. The measures towards treatment are focused on treatment of industrial and domestic wastewater, with a different approach in the urban areas and in the rural areas.

Treatment of urban wastewater

Urban areas are characterised by high population densities and a high land value. Most people are served by a water supply connection. Under such circumstances, a sewerage system connected to a high-tech wastewater treatment plant (using limited space) is most effective and efficient. The following measures are part of this approach:

Increase municipal sewerage and wastewater treatment

The capacity of wastewater treatment plants has increased by more than six times in the last two decades.The existing capacity of 6 MCM/day (as estimated in a survey described in NWRP 2001c) presently serves about 18 million people in mainly urban areas to process about 4.5 MCM/day (about 50% of the total production). NOPWASD has planned to reach a total available capacity of 15 MCM/day by 2017, serving all the urban areas (about 40 million people) and processing about 10 MCM/day of wastewater.

It will be regularly evaluated whether all urban areas, including the fast-growing fringes are served. Implementation of the plans will be such that the maximum effect is reached by ensuring that sewerage schemes and WWTPs are built and put into operation in a short time span. Priorities with respect to areas will be defined by MWRI and NOPWASD together.

Initiate cost recovery for urban sanitary services

The investment and operation and maintenance costs involved in providing urban sanitary services (sewerage system and treatment) are huge. Estimates suggest that around 2 billion LE is required annually for investments and operation and maintenance serving 40 million urban people. To maintain this service in view of increasing population, it is not sustainable to rely on projects or loans to fund this activity. Taxes or fees will structurally generate a substantial amount yearly. Full cost recovery would require a charge of more than 0.60 LE/m^3 or 45 LE/person/yr. At present (2004) the charge for water supply is around 0.20 LE/m^3 while the combined costs for water supply and wastewater treatment amount to 1.10 LE/m^3. Gradually the users of the service will generate a portion or this entire amount, to ensure continuous new investments and O&M.

Treatment plant

Local action plans on domestic sanitation in rural areas

Special attention is needed for sanitation in rural areas, especially those areas that are not connected to a sewerage infrastructure or those that are connected but have no treatment infrastructure. The lack of sanitation affects daily life profoundly.

Many septic tanks merely function as cesspits, with the wastewater flowing largely untreated to drains or lower order canals. Village structure often does not allow for traditional sewerage systems, and lower population densities and absence of qualified people make high-tech options less feasible. Also income levels are generally lower, making cost recovery in cash difficult. Nevertheless good sanitation is still an urgent requirement in these areas. Low cost community-based solutions using appropriate technology are encouraged to be executed, operated, managed and maintained by local communities. At present the Shorouq programme of the Ministry of Local Development provides an example of this approach.

Treatment of industrial wastewater

Despite the implementation of prevention measures, industries will still produce a large amount of wastewater. This load can be treated by a combination of measures.

Treatment or pre-treatment of industrial wastewater by the industries themselves

Industries are encouraged to incorporate the treatment of wastewater into their production process. This ensures that the most appropriate technology for the particular type of waste is used, and all options for reuse are utilised. Also it assures the incorporation of the costs of environmental aspects of the production into the production costs. When full treatment is not possible and a domestic sewerage and treatment system is available, it is encouraged that the industry pre-treats up to acceptable levels for the domestic WWTP.

Separate collection and/or pre-treatment of industrial wastewater

Municipal wastewater treatment plants are designed to treat municipal wastewater, using bacteria as cleaning agent. The operation of these plants is affected by chemicals, used engine oil, paint solvents and other liquid waste from workshops and small and medium industries that do not have dedicated treatment facilities, but dump their waste in the sewer. The chemicals, together with the poorly treated municipal wastewater end up in the drains and the Nile, causing water quality problems downstream. By separate collection of these wastes, this problem can be solved as has been proved elsewhere. In many cases collection enables economically viable recycling (e.g. engine oil).

Introduce load-based discharge levies

Discharge levies, based on the Polluter-Pays Principle, have been introduced in Section 5.3.1. The objective is to reduce the concentrations below the standard; levies are not to be considered as fines for exceeding the standard. In this package they function as an incentive to encourage self-treatment and a form of income to recover the cost of treatment.

Awareness and capacity building in industry

In addition to treatment it will be required to increase the awareness and capacity in the industry sector on pollution aspects. Awareness raising should address the importance of continuity and sustainability of industrial waste water treatment plants and the importance of transparency in presenting problems in order to find suitable solutions. Capacity building should include the O&M of industrial waste water treatment plants and the strengthening of self-monitoring systems in industry. A mechanism to evaluate the performance of waste water treatment plants should be established which will also consider the availability of spare parts and required chemicals at the plants. It might be considered to establish a specific company for this task.

Increase drinking water treatment capacity

The capacity of drinking water plants more than tripled in the last 2 decades. The total installed capacity of water treatment plants in the year 2003 was 22.9 million m^3/day. According to the plans of MHUNC/NOPWASD this capacity will be increased to 34.7 m^3/day in the year 2017. This includes 59 water treatment plants that are already under construction and an additional 43 that will be constructed in the coming years.

Summary of measures on treatment of waste that cannot (yet) be prevented

Treatment of urban wastewater package

- increase municipal sewerage and wastewater treatment
- initiate cost recovery for urban sanitary services

Local action plans for rural areas

- start local action plans (package of measures) on domestic sanitation

Treatment of industrial wastewater package

- treatment or pre-treatment of industrial wastewater by the industries themselves
- separate collection and/or pre-treatment of industrial wastewater
- introduce load-based discharge levies
- Awareness and capacity building in industry

Increase drinking water treatment capacity

- construction and O&M of treatment plants

5.3.3 Control

Despite all measures to prevent or to treat pollution sources, it is not realistic to assume that within the planning period all pollution problems will be solved. It is therefore essential to take control measures that reduce the harmful effects of these polluting discharges.

Define functions of waterways and introduce water quality standards based on receiving water

It is generally acknowledged that the conditions imposed by Law 48/1982 are too strict to expect, or even to enforce, compliance by industries at the short term. In Section 5.3.1 the introduction of compliance action plans has therefore been mentioned. Although recent attempts to change Law 48 were not successful, discussions between the stakeholders concerned during the preparation of the NWRP indicate that there is a clear need for reconsideration. It is intended to define the functions of the various water bodies in Egypt and to introduce water quality standards based on the function of the receiving water.

Incorporate reduction of contact with polluted water in local action plans

In the local action plans that will be developed for domestic sanitation, activities are required for risk reduction (contact with dirty water, laundry locations, cattle drinking and washing, etc.). Information needs to be disseminated on the status of water quality in the de-central waters and advice will be given regarding usage and risks. Depending on the situation in the region, activities could also include: restriction of access to dirty drains or canals by fencing, steep embankments or covering. Additionally, infrastructure can be created to guide people to safe water by constructing laundry sites at stand pipes. To support local action plans and information dissemination on water quality, the health extension service and the environmental management units at the de-central level can be used. When the covering of drains and canals in housing areas is considered, sufficient attention will be given to maintenance aspects.

Divert pollution away from Lake Bardawil

Lake Bardawil is considered as one of the most important water bird wintering areas in North Africa. The lake is connected to the sea through two openings. So far the lake does not receive any significant brackish or fresh water. However this is expected to change because of the potential effects of the Northern Sinai Agricultural Development project. Lake Bardawil is also an important seawater fed fishery area, which produces high value marine fish.

The horizontal expansion project of El-Salam Canal is expected to have severe ecological impacts on Lake Bardawil. Significant inflow of drainage water is expected to reach the lake, lowering salinity and adding nutrients. The amount of pesticides, reaching the lake, is certainly an important issue that needs to be taken into consideration, as it greatly affects fish quality.

To avoid or mitigate the negative impact of this project, it is planned to construct a number of open drains or collection points from where the water is diverted away from the lake.

Protect groundwater and in particular the areas around wells

Poor septic tank design and lack of maintenance often allows wastewater to infiltrate in the direct vicinity of shallow groundwater wells. Additionally some wells suffer from pollution originating around the well itself (washing, etc). Moreover, the drinking water from hand pumps located along drains is subject to a serious contamination risk. Improving the design of wellheads will prevent infiltration of wastewater in the direct vicinity of water wells. The relocation of water wells away from reuse stations and polluted drains or increasing the depth of their intake point will furthermore reduce the contamination hazards.

Most municipalities have recognized the problem. Locally, the situation has been improved with respect to, a.o. the well heads ('Well Proper' concept).

Select proper sources for public water supply

There are some polluted sources for drinking water supply, especially in the Delta. In most cases they have high levels of salinity, or are polluted by reuse water. In the fringes of the Delta natural iron and manganese also pose problems.
The measure consists of two components:

- Selection of the proper water sources or relocation of intakes to provide suitable raw water for drinking water production, avoiding/reducing pollution.
- Phasing out of drinking water intakes and or plants that can not comply with standards.

Provide appropriate on-site sanitation systems in unconnected areas

Many unconnected areas at present use septic tanks or sludge collection tanks. Vacuum trucks regularly collect the content of these tanks. In the absence of proper disposal sites, many vacuum trucks dump their waste in the nearest drain.
This measure consists of several steps with progressively more effort required:

1. select least harmful drain location for dumping if no better solution is possible
2. provide collection station on local sewer or at treatment station
3. make collection station with forced main to existing sewer
4. make appropriate treatment plant at collection station.

5.3.4 Institutional actions for water quality and public health

Besides the packages that directly address water related environmental issues, which include a number of institutional measures, some more general institutional measures are defined to support the implementation of the strategy:

Enhance water quality monitoring and information dissemination

In order to keep track of developments in the water system and the impact of policies and measures on the quality of water, managers require regular updates on the status and trends. An efficient water quality monitoring programme is required that keeps all relevant governmental and non-governmental institutions adequately informed about the status of water quality. Presently good monitoring programmes are established by the NWRC, but also by the Ministry of Health and EEAA.

Activities included in this measure are primarily aimed at co-ordinating the efforts of the institutions involved to make the system more efficient, and enhancing the dissemination of the data and information to make the efforts more effective.

Co-ordinate investments on the de-central and central levels

Several of the measures included in this strategy are corrective. Examples are: select proper locations for drinking water intakes, phase-out industries along vital water courses, etc. This measure aims at creating the proper co-ordination framework to enhance sustainable investments that take into account the plans and investments that are prepared by other sectors. Co-ordination of the location of drinking water intakes and reuse pumping stations is essential. Co-ordination between reuse and wastewater treatment investment is another important issue. This co-ordination needs to take place at the appropriate level where most information is present. Mostly this will be at a de-central or Governorate level.

Train MWRI and Water Boards staff on pollution control and water quality management

The main task of MWRI has always been quantity oriented, i.e. to supply water and take care of proper drainage conditions. The staff of MWRI has been trained to carry out those tasks and the organisation has ample experience in this field. The care for the quality aspects of water, except salt in drainage water, has received less attention comparatively and additional training of the MWRI engineers in this field is required. Such training programme can be combined with the training that will take place for MWRI and Water Board staff to improve the water allocation and distribution.

Summary of measures to control situations where emissions cannot be prevented or treated

- define functions of waterways and introduce water quality standards based on receiving waters
- incorporate reduction of contact with polluted water in local action plans
- divert pollution away from Lake Bardawil
- protect groundwater, in particular around wells
- select proper sources for public water supply
- provide appropriate on-site sanitation systems and safe disposal sites in unconnected areas

Summary of institutional measures on water quality

- enhance water quality monitoring and information dissemination
- co-ordinate investments on de-central and central level
- training of MWRI and Water Board engineers on pollution control and water quality management

5.4 General institutional and financial measures

Many of the measures mentioned in the previous sections have an institutional character. Those institutional measures are clearly linked to one of the three basic components of the strategy: developing additional resources, making better use of existing resources, and protecting health and environment.

Some institutional measures have a more general character. They are listed in this separate section. However, it is stressed that also these more general measures will contribute to the above mentioned basic components.

5.4.1 Institutional reform

Restructuring of MWRI and establishment of integrated MWRI Districts

Institutional reform unit

Decentralisation and privatisation will result in a different role for MWRI. This is already recognised and an Institutional Reform Unit (IRU) within MWRI has been set-up to initiate and co-ordinate the decentralisation and privatisation activities. Given the ambitious agenda for institutional reform in water management the establishment of such a dedicated unit is important. It will ensure that the reforms remain on track and well paced.

Decentralization of government services

Establishment of integrated MWRI Districts

The transfer of authority to Water Boards means that the role of MWRI is changing from an operational into a more strategic and supervisory one. The strategic role comprises the leading role of MWRI in national planning and policy making. Their supervisory role will have to be taken up by Districts. These Districts will enable local water management to be carried out by Water Boards and WUAs within the national regulatory policy framework. The Districts will ensure that the MWRI's operational planning is increasingly based on the local needs expressed by the water users.

The planning for the establishment of Integrated MWRI Districts is to achieve full coverage by 2022. By 2007, the structure should be operational in 4 Governorates. It should be noted that pilot experience will help to recognize whether the District is the right level to integrate MWRI services.

Transfer water management authority from MWRI to District Water Boards

The experience accumulated with Water Boards/ WUAs at branch canal level will be used to further develop the concept and move towards Water Boards at district level. Water Boards at district level will assume an integrated water management responsibility. Water Boards can take over the operation and maintenance of many components (pumps, structures, canals, etc.) from MWRI.

The transfer of management responsibility from the MWRI to Water Boards needs to be enshrined in a revision of Law 12 on Water Resources. Publication of the revised Law 12 is expected in 2005. Its implementation requires to be taken strongly in hand. This would include wide publicity around the promulgation of Law 12, ensuring its availability to relevant actors.

Farmer participation

A tentative planning schedule discussed at the 2001 Round Table Conference, aims for full coverage by Water Boards in Old Lands by 2022, and full coverage of Oases (smallholder cultivated) by 2017. The recently formed Institutional Reform Unit is responsible for developing a more detailed planning. Apart from development of Water Boards at district level, the formation of WUAs at branch canal level (BCWUAs) and at *mesqa* level will be continued (see also Section 5.2.4).

5.4.2 Financing and privatisation

Implement systems for cost-sharing for all water users

Cost recovery through collection of water service fees – for irrigation, drinking water, industrial water supply or wastewater treatment – forms an important measure to promote the wise use of water resources. At the same time, having to pay for something that used to be provided for free is not an easily accepted measure. Measures to introduce cost-sharing have been included in FtC for agriculture, domestic and industrial water supply and for improving the water quality.

The recovery of partial service fees has become an accepted practice in drinking water supply already. Steps will be taken to appraise users of the real cost of the water service – including depreciation of treatment plants – and subsequently to gradually increase the service fees towards those levels. At the same time measures will be taken to ensure correct water metering.

Cost recovery for irrigation water will take place in new developments, like Toshka. On the Old Lands and most of the New Lands no costs are recovered as yet. It is expected that Water Boards will make a start with cost recovery, by levying their own costs on their membership. This, however, would only be a partial recovery of costs and does not take into account the costs for the main system. A major effort is needed to enhance the recovery of the costs of irrigation from the irrigators.

It should be made clear to water users and policy makers that cost recovery is needed for new investments and for main system O&M and that cost recovery is an important policy element of the Government, though the Government may cover part of the cost as a temporary subsidy. Reference in made to a recent study on cost recovery in the Irrigation and Drainage sector (MWRI, 2004) which describes options for such recovery of costs.

As a start, steps will be taken to understand the real cost of the water services delivered. Publicity campaigns to appraise water users of the value of water services are needed. The mechanism of tariff setting needs to be defined. It is envisaged to install a regulatory body for controlling water prices and cost recovery.

Stimulate private sector participation

Private participation in agricultural water management
The MWRI vision on water management seeks to privatise selected Government responsibilities in water management. Building private sector capacity to take these responsibilities requires good preparation. It is needed to assess private sector capabilities in water delivery on New Lands and in the mega projects; to identify capacity building needs (financial policy, management capacity, legal aspects, etc.); and to identify training needs.

A programme to assist private investors in taking over O&M activities is needed. The Institutional Reform Unit of MWRI and the Central Directorate for IAS will play an important role in facilitating that such a programme is developed and subsequently implemented, including a clear definition of the division of roles between the private sector and WUA's.

The aim for privatisation of MWRI assets and services, as discussed in the first Round Table Conference on institutional reform (2001) is to complete the privatisation drive by 2012. Again, the IRU has the mandate to specify and, if needed, to adjust this planning schedule.

Private Sector Participation in other water management sectors
The turnover of management and development responsibilities of water resources is an important measure to enhance economic efficiency also outside the irrigation sector. This applies to industrial and public water supply, dredging, sewage collection and treatment, etc. Where appropriate privatisation of these tasks will be considered.

5.4.3 Planning and co-operation

The following measures are included in view of the need to continue water sector planning in the future and to increase the co-operation between different authorities.

Continue water sector planning as a rolling exercise

This National Water Resources Plan has been completed in 2004 and has a planning horizon up to 2017. The MWRI vision on institutional reform, which is fully incorporated in the measures in the present plan, even has set its time horizon up to 2022. Given changing circumstances, lessons from experience and new insights, plans with such distant horizons need to be periodically updated. It is intended that every five years a National Water Resources Plan is produced, each time with a 20-years' planning horizon (as is the case with the Ministry's Policy). In order to bring the timing of planning in line with the Government's operational planning cycle, which is also based on 5 years, the next National Water Resources Plan will be developed by 2007.

Integrated Water Resources Planning does not and cannot take place within the confines of one organisation only. Water is part of everybody's life and consequently many parties have an impact on water. This leaves a real challenge to be faced: How to ensure coherence between various initiatives and perspectives? The National Water Resources Plan is a first one only. Continued planning efforts by, and collaboration between, stakeholders are needed to translate general measures into on-the-ground action and to adequately react to changing circumstances.

The Government allocates resources to its activities via its Ministries and their Sectors through a five-year planning cycle and an annual budget exercise. Besides its own resources, the Government also channels international funds to activities, often through projects. The introduction of a National Water Resources Plan is a new element within the existing ways of allocating resources to activities. For the National Water Resources Plan to provide added value to the existing planning exercises, its role vis-à-vis these planning exercises should be well-defined. Two measures appear to be of importance:

- The National Water Resources Plan needs to be accepted at the level of the Cabinet.
- New implementation plans in the Water Sector need to be checked for compliance with the National Water Resources Plan.

Enhance data and information exchange among different authorities

In order to follow an integrated approach for developing and managing the water resources system it is essential that the different authorities have access to all data and other information on the status of the system and planned developments. It will not be needed (nor realistic) to thrive for one central data and information system on water resources for the whole country.

Continue enhancing stakeholder involvement

Monitoring and data collection and storage will remain to be carried out by the appropriate authorities. What will be needed is to have a good overview of the kind of information and data that is available and that others can retrieve this information. Where possible and relevant co-ordination will take place to avoid duplication of activities.

Co-ordinate investments between ministries and between de-central and national levels

A particular kind of information is the one on investments by the various ministries and the authorities at de-central level. The benefits of many measures can be greatly enhanced if these investments are tuned to each other. Examples in this respect are the measures taken on preventing water pollution and the reuse of water in agriculture. Such co-ordination is the essence of the Integrated Water Resources Management approach that is advocated in FtC and the National Water Resources Plan. Action plans will be developed at the de-central level to co-ordinate intended actions.

Establish a National Water Council (NWC): a permanent Inter-Ministerial High Committee on IWRM

The National Water Resources Plan has been developed under the aegis of a temporal Inter-ministerial High Committee especially created for this purpose. There are other Inter-Ministerial High Committees that touch upon water resources, such as the one for Reclamation and Mega Projects and Supreme Committees on water quality at other Ministries. Given the ambition to have a rolling National Water Resources Plan, which is renewed every 5 years, it is intended to establish one permanent Inter-Ministerial High Committee for Integrated Water Resources Management, which incorporates all water-related policy fields. A proposal to such National Water Council will be developed.

Continue enhancing stakeholder involvement in planning

The National Water Resources Plan has been developed through the involvement of representatives of the main stakeholder categories. Doing so has both enriched the plan and enhanced its acceptance. National Water Resources Planning shall continue to exist at two levels:

- Recurring strategic planning resulting in national resource allocation
- Operational planning resulting in clear plans of action for tackling specific issues, often in a de-central (local) context.

Both levels of planning would continue to benefit from meaningful involvement of stakeholders. Means of stakeholder involvement are to be incorporated in procedures for planning.

Enhance role of NGOs and Civil Society (e.g. in local action plans)

Even though the present national plan has been discussed extensively with many stakeholders at the national and the local level, the present plan remains to be largely based on a top-down approach in which the central ministries are the key-stakeholders. This national plan will be translated into more de-central plans that will be more action oriented. The development of those local actions plans and the implementation of the plans will require an active role of local stakeholders, including NGOs and individual citizens.

Related to the involvement of NGOs and individual citizens in the planning and implementation of water resource development activities, there is a need to enhance the 'ownership' feeling of the farmers and other citizens towards public property. Actions will be taken to stimulate this ownership.

5.4.4 Gender issues

The presented strategy FtC is formulated in a gender neutral format. This bears the risk that the role of women in decision making about and implementation of the strategy does not receive sufficient attention. To highlight the position of FtC on this matter the following policy principles are stated on what FtC will pursue with respect to gender issues:

- Equal opportunities for men and women with regard to:
  - involvement in discussion and decision making on water use and resources issues;
  - dissemination of information and communication about water resources and water se issues and financial consequences provided by institutions concerned;
  - active participation in decision making bodies dealing with water resources and irrigation management;
- Equal benefits for men and women deriving from effective and efficient water resources management.

Involvement of women in decision making

The implementation of several measures of FtC will strongly depend on the input of women. This will in particular be the case for the measures in the category 'Protecting health and environment' but also for some measures in the other categories. These measures have been screened on gender issues involved and, where necessary, were adapted to increase their efficiency and/or chance of success of implementation. The Gender Focal Unit of MWRI has been involved in this process. In a later stage it is intended to consult also the National Council of Women.

More specifically the following recommendations were made with respect to gender within MWRI:

- Expand the involvement of women in Water User Associations.
- Provide technical and financial support to gender issues in the different activities of the Irrigation Advisory Services.
- Develop awareness campaigns for the rural community with specific messages to women.
- Organize seminars and training courses on gender issues for MWRI and the rural community.
- Strengthen the cooperation and coordination between the Gender Focal Unit of the Ministry and the different projects and MWRI sectors.

Summary of general institutional measures

Institutional Reform

- restructure the role of MWRI – IRU
- restructure MWRI - establish integrated districts
- transfer authority to water boards (WB) at district level
- continue the set-up of Water Users' Associations (WUA) at branch canal and mesqa level

Financing and privatisation

- implement systems of cost sharing for all water users
- stimulate Private Sector Participation in infrastructure and O&M

Planning and co-operation

- continue water sector planning as a rolling exercise
- enhance the data exchange among different authorities
- co-ordinate investments at de-central versus national level
- establish a permanent inter-ministerial High Committee on IWRM
- continue enhancing stakeholder involvement in planning
- enhance role of NGOs and Civil Society (e.g. in local action plans)

Gender issues

- screening of measures on gender issues

5.5 Assessing the impacts

The strategy 'Facing the Challenge'(FtC) as defined in the previous sections aims to solve or alleviate the problems as foreseen for 2017 if no additional measures would be taken. In this section the assessment is carried out of the impacts of FtC. This will be done in terms of the objectives and indicators as also used in the problem analysis 2017 as described in Chapter 4. In fact, the comparison between the strategy FtC and the problem situation 2017 will show how far FtC indeed will be successful. The basic assessment will be made for the situation without availability of additional Nile water. Next, conclusions will be drawn with respect to possibilities for further improvement.

This Section 5.5 will present the results of FtC, including some brief explanations, in particular when these results are not straightforward. The results are valid for the situation in which the future will indeed develop as expected in the Most Likely Scenario (see Section 4.1) and under the various assumptions made about the system and the implementation of the measures. In Section 5.6 will be described what the effects will be if the future develops differently.

The impact assessment of the basic strategy, expressed in indicator values for various objectives, is given in Table 5-2, in the column marked "Strategy FtC". Comparison of these values with the indicator values for the 2017 Reference Case gives a direct indication of the effect on the water resources system of the measures included in the strategy.

Economic development

The irrigation area is reduced somewhat as compared with the area in the Reference Case due to the fact that the Middle Sinai project (250,000 feddan) has been deleted from the total planned horizontal development. The development of this project is made dependent on additional water becoming available from the Jonglei project. The gross agricultural production value appears to increase by some 8 % compared to the Reference Case.

Although the outflow to sinks is significantly reduced through a number of measures, the agricultural production will still be clearly limited by water availability, as reflected by the expected crop intensity of 1.7 (compared to the present – 1997 – cropping intensity of 2.1). Therefore, increasing areas will have to be left fallow during the summer. However, the export–import ratio of agricultural products is expected to increase significantly to 0.2 (about double the present one) through the increased export of high-value commodities and the import of low-value commodities. The net production value per feddan is about 4% higher than in the Reference Case.

The inland fish production in 2017 in the strategy is not yet clear. This will depend on the lifting of restrictions on cage culture in the Nile and canals system, and the possible use of brackish groundwater for aquaculture.

The industrial sector will face higher water charges, both for their intake water and for wastewater treatment. It is expected that higher charges for intake water will encourage the development of more water-efficient industrial processes.

General	Unit	1997 base	2017 ref. case	Strategy FtC
Population	Million	59.3	83.1	83.1
Urbanisation	Ratio	0.44	0.48	0.48
GDP at economic growth of 6%	Billion LE	246	789	789
Economic development objectives				
• **Agriculture**				
Irrigation area	Mfeddan	7.985	11.026	10.876
Gross production value	Billion LE	34.46	35.76	38.50
Crop intensity	Ratio	2.1	1.5	1.7
Net value production per feddan	LE/feddan	2,812	2,075	2,153
Net value production per unit of water	LE/m^3	0.64	0.66	0.60
Export/import value	Ratio	0.09	0.12	0.20
• **Industry**				
Costs polluted intake water	LE/m^3	0.65 - 1.10	0.65 - 1.10	2.00
Waste water treatment costs	LE/m^3	0.22 - 0,50	0.22 - 0,50	1.00
• **Fishery**				
Production (index 100 in 1997)	Index	100	86	*)
• **Tourism**				
Navigation bottlenecks	Index	100	114	<100
Social objectives				
• **Create living space in desert areas**	% of tot. pop	3%	23%	22%
• **Employment and income**				
Employment in agriculture	M pers.year	5.01	6.24	7.30
Employment in industry	M pers.year	2.18	4.99	4.99
Average income farmers	LE/yr	5,362	4,629	4,309
• **Drinking water supply**				
Coverage	Percentage	97.3%	100%	100%
• **Sanitation**				
Coverage	Percentage	28%	60%	60%
• **Equity**				
Equity water distribution in agriculture	-, 0, +	0	+	+
• **Self sufficiency in food**				
Cereals	Percentage	73%	53%	46%
Meeting water needs				
• **Water resources development**				
Available Nile water	BCM	55.5	55.5	55.5
Abstraction deep groundwater	BCM	0.71	3.96	3.96
• **Water use efficiency Nile system**				
Outflow to sinks from Nile system	BCM	16.3	17.6	12.5
Overall water use efficiency Nile system	Percentage	70%	67%	77%
• **Water in agriculture**				
Supply/demand ratio (1997 assumed 1.0)	Ratio	1.00	0.80	0.92
Water availability per feddan Nile system	m^3/feddan/yr	4,495	3,285	3,866
• **Public water supply**				
UFW losses	Percentage	34%	34%	25%
Supply/demand ratio	ratio	0.67	0.76	1.00
Health and environment				
• **Pollution and health**				
E-coli standard violation (1997 = 100)	Index	100	121	110
Water quality shallow groundwater	-, 0, +	0	-	-
• **Ecology and sustainability**				
Sustainability: use of deep groundwater	abstr/pot	0.15	1.00	1.00
Condition Bardawil (Ramsar site)	-, 0, +	+	-	+
Condition coastal lakes	-, 0, +	0	-	0

*) fisheries production 2017 FtC: see previous page

Table 5-2 Indicator values for Base Year 1997, Reference Case 2017 and Strategy 2017

Even if in 2017 less water would be released from the High Aswan Dam, the navigation conditions are expected to improve through dredging.

Social objectives

Through the development of New Industrial Cities and horizontal expansion areas, the population living outside the old lands in the Valley and Delta will be about 22% of the total population in 2017.

The employment in agriculture and agro-industry is expected to increase by about 16% compared with the Reference Case, but the average farmer income is slightly less. The degree of cereal self-sufficiency (taken as an indicator for food self-sufficiency in general) is significantly lower than in the present situation and also lower than in the Reference Case. However, this is an outcome of analysis with the agro–economic ASME model, based on cropping patterns determined by economic optimisation. The real self-sufficiency figures will be strongly dependent on actual choices made with respect to cropping patterns.

The percentages of population covered by drinking water supply and sanitation are considered similar as in the Reference Case. The planned developments by MHUNC/NOPWASD for 2017 are considered realistic in terms of present investments.

Meeting water needs

In the middle scenario it is has been assumed that the Nile inflow into Lake Nasser will not increase. However, overall water availability will increase, mainly due to groundwater development in the Western Desert. The water use efficiency of the Nile system is expected to increase due to a significant reduction in losses to sinks. This will have a positive impact on the supply/demand ratio of irrigation water, but this ratio is going down as compared with the present situation. An increase in the release from Lake Nasser in the order of 10 BCM/yr is required to avoid a decrease in the water availability per feddan (see water balance in Table 4-11 in Chapter 4). It has been explained in Sections 4.3.1 and 5.1.1 that some increased release at the High Aswan Dam does not seem unrealistic.

Measures related to demand of drinking water, in combination with measures to reduce the UFW losses have a significant impact on the supply/demand ratio for drinking water. If these measures are implemented there will be no shortages in public water supply in 2017.

Health and environment

The impacts of stimulation measures to decrease pollution are difficult to predict. The impact assessment of the strategy is therefore largely based on expert judgement regarding the reaction of sectors to the measures, in terms of reduction in pollution loads. The impact of this reduction on the indicators, such as concentrations of substances in the water system, is assessed more easily. However, this does not add any certainty to the outcomes.

The prevention measures as formulated in the industrial package are expected to reduce effluent loads on the Nile water system with 30% by 2017 compared to the year 1997. The highest effect is expected from the phasing out of older industries, combined with incentives for new technology. In the table of indicators the effect of this reduction is visible in the indicator regarding water quality standard violations (Coli and NO_3 as indicators).

The prevention measures for the agricultural sector are focused on agro-chemicals and will lead to a reduction of harmful agro-chemicals with 30%. Because no indicators reflect these chemicals distinctively, the effect of this measure is somewhat disguised in the table of indicators.

Local action plans aim at providing basic sanitary provisions to the rural communities reducing primarily the risks of contact with polluted water and groundwater pollution, and secondarily also reducing the total load of rural domestic pollution to the water system. The effect of the first aspect will be reflected in the general health condition of the population (not an indicator). The actual reduction of load compared to the 1997 situation is limited. Whereas the overall reduction of per capita load is estimated at 20%, the rural population itself increases from about 34 million to 43 million people. The rural domestic pollution is therefore expected to stabilise as a result of the measure: in 1997 there were 34 population equivalents (p.e.) and in 2017 80% of 43 million p.e. equaling 34.4 million p.e.

The improved treatment of urban wastewater is expected to have a significant effect on the pollution load reaching the water system. Almost all urban water will be treated in this strategy, while also the performance of the system is expected to improve through better operation and maintenance. In 1997 18 million (out of the 26 million) urban people were served, and in this strategy all 39 million urban people will be served in 2017. Assuming an overall treatment efficiency of 80%, the urban pollution reaching the water system will decrease from 0.2x18+8=11.6 million population equivalents to 0.2x39=7.8 million p.e., a reduction of about 33% .

The improved treatment of industrial facilities is expected to reduce industrial loads by 30-40%, but because the industrial loads are relatively small compared to other loads, the effect on the indicator is limited.

Control measures are primarily aimed at reducing the harmful effect of loads, and not the loads themselves. Comparable with local action plans, the effect will be primarily in improved health and not in the water quality indicators.

Conclusions

When all horizontal expansion projects are implemented by 2017, the system will be more stressed compared to the present situation as the water availability per feddan and the average cropping intensity will decrease and certain water quality indicators are foreseen to violate acceptable standards. The strategy FtC follows an integrated approach to cope with the increasing pressure on the water resources system in Egypt and contains a wide range of measures and policy changes. The pressure on the water system can not be mitigated by efficiency improvements alone. Much effort is required to achieve an increase in the water supply from Lake Nasser. In this context the co-operation with the riparian states is of vital importance. Preliminary studies indicated that such increased supply is not unrealistic but that it will take quite some time before this additional water will become available.

It is a challenge by itself to implement this strategy. When Egypt is successful in doing so, several national objectives will be achieved. The gross production and employment in agriculture will increase substantially, and the drinking water supply and sanitation situation will improve. Further development after 2017 may require that some drastic policy decisions are made at the national level, e.g. by accepting some limitations in growth of the agricultural sector and aiming at increasing developments and corresponding employment in the industrial and services sectors.

5.6 What-if

The strategy Facing the Challenge was developed for the most likely scenario with respect to assumptions on how the future will develop. A key question is of course what will happen if the assumptions made for this most likely scenario appear not to be valid. Will the strategy Facing the Challenge remain to be a good strategy, also under different conditions? In other words, how robust is the strategy?

Evaluating the various elements of the strategy Facing the Challenge it appears that from a **quantity point of view** this strategy is not very sensitive to changes in external conditions with the exception of the availability of Nile water. As explained in Section 4.1 it is not needed to carry out a formal scenario analysis as this will not change the main elements of the strategy Facing the Challenge. Details and timing of measures might change somewhat but these changes can be taken into account at the time that the measures will be included in the operational planning procedures of the stakeholders.

From a **water quality and investment point of view** the conclusion is different. A higher population growth than estimated will result in additional investments for drinking water facilities and waste water treatment facilities. Moreover, in this case it may be expected that it will not be possible anymore to achieve the targets for full coverage of sanitation, resulting in a lower quality of the surface water and groundwater. This in turn will reduce the possibilities of water reuse for agriculture.

The following developments are identified as important factors that will affect the strategy Facing the Challenge:

- availability of Nile Water;
- demand for drinking- and industrial water; and
- the quality of drainage water for reuse in agriculture.

Availability of Nile Water

The availability of Nile Water will have major impacts on the performance of the water resource system, as expected. In Figure 5-3 the impact of an (hypothetical) range of 54.5 till 63.0 BCM is given. Of particular importance is the inflow of 57.5 BCM which corresponds with the inflow after the Jonglei Canal has been constructed (part of the more favourable scenario).

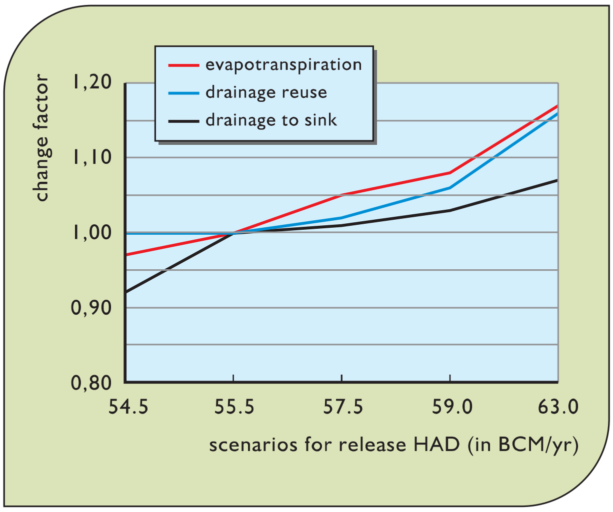


Figure 5-3 Impacts of availability Nile Water

The conclusions that can be drawn from this figure are rather straightforward:

- all additional water from the Nile will become available for agriculture;
- the total amount of additional water for agriculture will even be more than the additional water from the Nile, despite additional losses to sinks; this is caused by an improvement of water quality that enables more reuse of drainage water.

A possible increase in Nile Water availability has not been taken into account in NWRP because of its high uncertainty. However, such increase is not unrealistic, either from upstream developments or as a result of climate change (see Section 4.3.1).

Changes in estimated demand for drinking water and industrial water

Drinking water has priority in Egypt and any increase in this demand will be at the expense of water available for agriculture. At the other hand a decrease in drinking and industrial water demand will result in more water for agriculture. Industrial water demand does not have the same priority as drinking water but given the importance for the national economy and employment, (reasonable) demands of industry will be supplied, and again, at the expense of water available for agriculture.

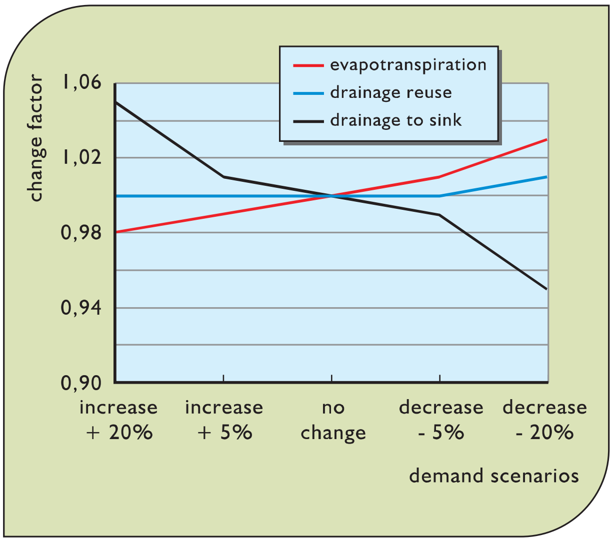


Figure 5-4 Changes in drinking- and industrial water demand

Figure 5-4 shows the impacts of changes in the municipal and industrial water demands in a range between an increase of +20% (meaning an underestimation in NWRP) till a decrease of -20% (overestimation in NWRP), expressed in water availability for agriculture (evapotranspiration). In addition the impacts on drainage to sinks (the real 'loss') and for drainage reuse are given. The figure shows that the impacts could be important. Water availability for agriculture will decrease about 2% under an (be it extreme) increase in M&I demand of 20%. Given the importance of agriculture in the Egyptian water management this is an important impact.

The net municipal consumption (intake minus return flow) in 1997 was 0.9 BCM which covers the needs of 61 million people. In 2017, the municipal consumption will be 1.6 BCM which covers the needs of about 83 million people (about 36% increase).

If the municipal consumption is underestimated by 20%, it will require an additional investment of about 28 BLE to maintain the water quality at the proposed conditions in the most likely scenario. Any reduction of these extra investments will always cause a water quality deterioration in the Delta and consequently a reduction of the amount of drainage water that could be reused.

If municipal consumption is overestimated by 20% (as a result of lower population growth), the water quality conditions will improve. In addition, the amount of investments required in the most likely scenario will be less by about 28 BLE in addition to the benefits to the environment and public health. This will result in increasing water availability for agriculture.

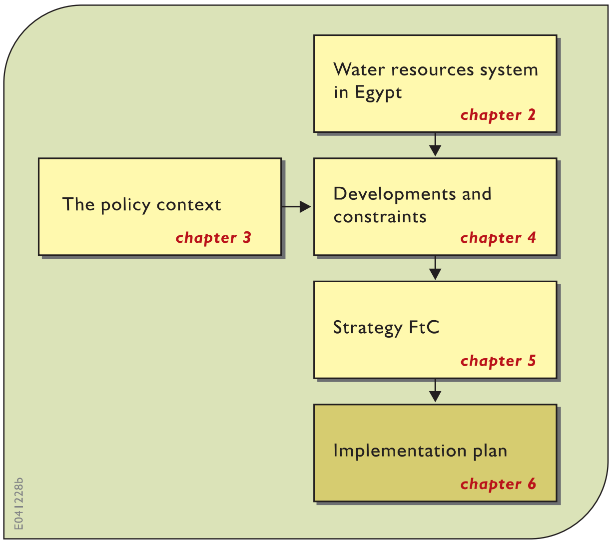
Insufficient improvement of water quality – reuse

The strategy Facing the Challenge includes major investments in sewage and wastewater treatment systems. Not only will this improve the water quality in general and improve the living conditions and health of the population, but these measures will also make it possible that the drainage water can be reused in agriculture.

In the most likely scenario, investments for treatment of the increasing domestic wastes will cost about 54 BLE/year up to 2017. The yearly O&M costs for these sewage treatment plants is in the range of 0.5-0.8 BLE/year. This will maintain/improve the water quality conditions in the Delta at reasonable limits and enable the reuse of about 7.4 BCM of drainage water which provides yearly about 3.9 BCM additional water for agriculture. In case the water quality improvement does not materialize, this additional water will not become available for agriculture. The economic return of 1 BCM of irrigation water is estimated at about 500 MLE. This value is higher if the environmental and public health costs that could be avoided are added. Hence, the total benefits of treating the generated domestic waste water will be in the order of 2.0 BLE annually.

6 IMPLEMENTING THE PLAN

- Implementation of NWRP – a coordinated effort of all stakeholders, supervised by the National Water Council
- Required investments and recurrent costs – to be incorporated in annual and 5-year plans of the stakeholders
- Total NWRP 2003-2017 costs for investments are BLE 145, and total operational and maintenance costs are approximately BLE 44 for the same period
- Communication and consultation – crucial elements in implementation



6.1 Implementation framework

The strategy Facing the Challenge described in the previous chapter includes a large number of policy decisions and measures that will be implemented in the coming years. Many stakeholders are involved in this implementation and careful planning and coordination is required. This chapter describes the implementation framework of the NWRP. This implementation framework will have an 'open' and 'rolling' character, meaning that it is not static or prescriptive, and leaves room for individual stakeholders to further elaborate upon in relation to their own responsibilities. At the other hand this implementation framework will be concrete, by translating the strategy FtC into specific activities and assigning clear responsibilities for carrying out the activities involved. It also includes the budgetary requirements for the implementation, including investments and recurrent costs. The framework will specify:

- *what*: the concrete actions that have to be taken
- *who*: the stakeholder that will be the prime responsible and who will take the lead in the implementation of the action;
- *how*: the steps to be taken and the consultative process involved; and
- *when*: the time planning.

The implementation of the National Water Resources Plan will follow the five-year and annual planning system of Egypt. The most recent five-year plan covers the period 2002-2007. This five-year plan includes investment allocations that cover various elements of NWRP and, hence, already provides room to implement NWRP. It appears that implementation of the NWRP will require some additional budget compared to the present five-year plan. More specific allocations for investments and other strategy elements of NWRP will be included in the Annual Plans as developed by the stakeholders.

The implementation of NWRP will be an element of the overall planning and coordination structure of the water sector. Actually, the implementation framework covers the bottom part of the planning cycle, illustrated in Figure 6-1. The main elements of this framework are:

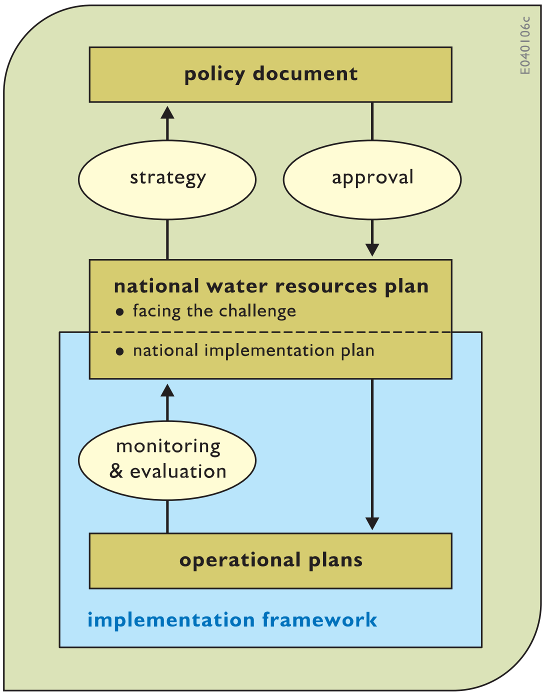


Figure 6-1 Implementation framework NWRP

The National Implementation Plan

The National Implementation Plan will provide an overview of the actions to be taken. It includes a listing of the actions and required budgets for investments and/or recurrent costs involved and indicates which stakeholder will be first responsible to take action. Moreover, the National Implementation Plan will describe how the actions of the individual stakeholders will be coordinated, monitored and evaluated. This chapter describes the National Implementation Plan.

The Operational Plans

The operational plans of the individual stakeholders contain the translation of the National Implementation Plan into concrete activities of the stakeholders and the assignment of the responsible organizational units. Some of these operational plans have a national nature, others a more local one. They are all to be included in the regular 5-year and annual planning cycle of the stakeholders. The stakeholders will have the full responsibility for their own plans. Therefore, these operational plans will not be included in the NWRP Coordination of the operational plans over the various stakeholders will be taken care of by the (intended) National Water Council (NWC).

Monitoring, Progress Reporting and Evaluation

The stakeholders will also be responsible for the monitoring, progress reporting and evaluation of the implementation. This monitoring will follow the progress of implementation and provide feedback on the impacts of the implementation on the water resources system. As such it will contribute to the next round of planning. The monitoring, progress reporting and evaluation will be overseen by the National Water Council.

Above description of the elements of the implementation framework illustrates that the main responsibility for the implementation remains with the individual stakeholders. This is similar to the present situation. What is new is that the implementation of the various measures is placed in an overall national context (the National Water Resources Plan), coordinated at a national level (the NWC) and that the results of the implementation will provide feedback for the next round of planning.

6.2 National implementation plan

The National Implementation Plan describes how the (approximately 90) water resources management measures of the strategy Facing the Challenge will be implemented. First the implementation process will be described (Section 6.2.1). The next Section 6.2.2 deals with the various roles the stakeholders will have in the implementation. In Section 6.2.3 an overview is given of the estimated Investments and Operation & Maintenance costs (O&M) that will be required.

6.2.1 Implementation process

Implementing the strategy of NWRP encompasses more than just technical measures. These measures are needed and very essential indeed. Drinking water purification plants and sewage treatment plants have to be built, the IIP/IIIMP and EPADP activities have to be continued and many other technical and operational actions should be taken. However, these actions will only be effective and sustainable if they are placed in institutional and social settings that support these measures.

First of all a proper **enabling environment** is needed. This enabling environment basically consists of the national, regional and local policies and legislation that enable all stakeholders to play their respective roles in the development and management of water resources and provides for information and capacity building to facilitate and exercise effective stakeholder participation. The role of the government is crucial in this respect. The traditional prescriptive, central approach will have to be replaced by the creation of a framework within which participatory and demand-driven sustainable developments can take place. This includes decentralization and privatisation aspects, while the national government will act more as a regulator and controller. Water legislation will be developed to enable this changing role. Further development of Water Boards and Water User Associations is important and will be pursued. And last but not least, there should be the political will to enforce these developments.

Secondly, the **institutional roles** are to be considered. In a changing institutional environment the role and functions of the organisations at different levels should be clearly described. This includes the creation of effective coordination mechanisms between the different agencies and the development of financial structures that enable these agencies to perform their tasks efficiently. The Institutional Reform Unit established within MWRI will play a major role in this respect.

Finally, the **actual interventions (measures)** in the system will be developed further. This includes the technical and economic measures for developing new resources, making better use of existing resources and measures to protect health and environment. Moreover, additional management instruments will be developed. They will include a continuous assessment of supply and demand, an efficient, coherent system of recurrent monitoring, progress reporting and evaluation and the further development of a water resources knowledge base in the various ministerial research institutes.

The actions needed for an enabling environment, the institutional roles and the additional management instruments are included in the strategy Facing the Challenge. The development of the institutional, legal and financial measures mentioned will be given priority, among them the establishment of the National Water Council (NWC). They are indispensable for a sustainable, cost-effective implementation of the technical measures. The plan for the establishment of Integrated MWRI Districts is to establish full coverage by 2022, preceded by the establishment of the structure in four Governorates by 2007. Full coverage by Water Boards in Old Lands is aimed at by 2022, and full coverage in the Oases (smallholder cultivated) by 2017. Regarding MWRI assets and services the aim is to complete the privatisation drive by 2012. A more detailed planning is being developed. As part of it, full coherent implementation of the whole package of institutional, legal and financial measures in at least four Governorates is aimed at by 2007.

It should be noted that above developments on Integrated Districts are dealing with MWRI only. From a viewpoint of IWRM tuning of activities of other Ministries will also be needed. The Integrated Districts of MWRI can play a coordinating role in this, comparable with the role of MWRI at state level.

6.2.2 Role of stakeholders

An Integrated Water Resources Management approach as presented in this National Water Resources Plan aims to stimulate the co-ordinated development and management of the water resources in Egypt. Many measures as presented in NWRP involve or affect many stakeholders and all these stakeholders will be included in the implementation process in order to guarantee a successful implementation and a sustainable benefit of the measure. Even though IWRM requires the involvement of all stakeholders, not all stakeholders have an equal role in that process. In general one can distinguish the following roles:

- **Responsible:** the stakeholder has the first responsibility for the implementation of the measure but will co-operate with and/or consult other stakeholders in this process. In the table indicated by the symbol: ●.
- **Co-operate:** the stakeholder has an important say in the implementation of the measure but is not the first responsible and is expected to work with other stakeholders in this matter. In the table indicated by the symbol: **o**.
- **Consult:** the stakeholder has an interest in the implementation of the measure and will be consulted by the first responsible, but does not have a final say in its implementation. In the table indicated by the symbol: **x**.

Table 6-1 and Table 6-2 provide an overview of above defined roles of the stakeholders in the implementation of the various measures of the NWRP for respectively the Water Quantity measures (Table 6-1) and Water Quality and Institutional Measures (Table 6-2).

6.2.3 Required investments and related recurrent costs

Table 6-1 and Table 6-2 also contain information about implementation aspects of the measures. The headings under 'Implementation info' refer to the following aspects:

- '*No. of the measure*' refers to the number of the measure in Technical Report 24 of NWRP (NWRP 2002b) which contains more detailed information about all measures.
- '*Type of measure*' distinguishes the 12 categories of measures: investment, study, pilot project, management action, stimulation programme, feasibility study, policy, institutional, maintenance, research, financial and capacity building. Some of these types of measures require specific investments; many others require recurrent costs such as operation and maintenance costs. Some measures require neither of both because they are policy and management related. For measures that require investments it is often necessary to take into account operation and maintenance costs as well.
- '*Total investment*' is the cumulative required investment in MLE over the period 2003 – 2017 (see also Annex C).
- *'Total recurrent costs'* are the cumulative required Operation and Maintenance costs over the period 2003 – 2017 (see also Annex C).
- *'Starting and Ending years'* indicate the period during which the measure will be implemented.

In Table 6-1 and Table 6-2 the stakeholders have been listed that are responsible for the implementation of the measures. In general this means that they are also responsible to provide the funds necessary to do so. In a few cases cost sharing between various stakeholders will take place. This does not preclude the possibilities of those stakeholders to request donors to participate in the investments in the form of grants or loans, or to supply technical assistance. It also does not preclude the possibilities for stakeholders to recover (part of) the recurrent costs through user charges, e.g. for drinking water supply or sewage collection and treatment. The involvement of the Private Sector in Public-Private Partnerships has been assumed for certain investments. All investment and recurrent costs are expressed in Egyptian Pounds of the 2000-2001 price level. An exchange rate with the US Dollar of LE 4.5 was used in case costs had to be converted

Measure-related investments

The investments required for the measures included in NWRP come to BLE 145 for the period 2003-2017. These investments comprise all investments to be made by the various Ministries as well as by the private sector. Part of the funds could be provided by the donor community. The investments are summarized in Table 6-3 and presented at measure level in Annex C, which provides also for a distribution over the stakeholders that are primary responsible for the implementation of these measures.

Table 6-1 Responsibility of stakeholders for Water Quantity measures

Recommended Measures/Actions Water Quantity Management Measures			Stakeholders: Nat. Water Council / MWRI	Min. of Water Res.& Irrig.	Min. of Agric.& Land Recl.	Ministry of Industry	Ministry of Environment	Ministry of Housing	Ministry of Health	Ministry of Electricity	Min. of Transportation	Ministry of Planning	Min. of Local Developm.	Ministry of Tourism	NGOs, etc.	WUAs / Water Boards	Directorates/Decentr.Org.	Private Sector	Implementation info: No. of the measure	Type of measure	Total Investment (in MLE)	Total recurrent costs (MLE)	Starting year	Ending year
Develop more resources	Nile	Continue co-operation with the Nile countries	o	●															120	pol+	2533	237	2003	2017
	Groundwater	Groundwater development Western Desert		●	o													x	35	inv.	3500	1400	2003	2017
		Groundw.developm. Sinai and Eastern Desert		●	o													x	119	stud.+ inv.	807	323	2003	2017
		Development brackish groundwater for agriculture and aquaculture		●	o													x	37	stud./ pilot	4	1	2004	2017
		Increase management of shallow groundwater		●	o		x	x								x		x	121	man.	0	14	2004	2017
	Rainfall/ flash fl.	Stimulate rainfall harvesting along Northern coast		●	o								o					x	40	Inv.	100	6	2004	2017
		Stimulate on-farm rainfall harvesting along Northern coast		o	●								o						48	man.	0	14	2004	2017
		Flash floods harvesting in Sinai and Eastern Desert		●									o					x	41	study +inv.	531	55	2006	2017
	Desal	Increase brackish / salt water desalination		o										o					49	inv.	800	282	2005	2017
Management and increase efficiency of existing resources	Horiz. exp.	Continue planned horizontal expansion projects (postponing Middle Sinai development and making further development dependent on availability)		●	o							x						o	95, 112, 123	inv.+ pol.	7750	644	2003	2017
	Irrigation efficiency Nile system	Prioritise efficiency measures in effective areas		●	o											o	o		124	pol.	0	0	2003	2017
		Continue IIP in prioritised areas / IIIMP		●	o											o		x	90	inv.	6700	297	2003	2017
		Strengthen Irrigation Advisory Service		●	o											o	o	x	71	inst.	0	338	2003	2017
		Apply canal lining in effective stretches		●												o			86	inv.	335	45	2004	2004
		Apply land-leveling with laser techniques		o	●											o		o	36	man.	0	180	2003	2017
		Introduce controlled drainage during rice cultivation		●	o											o		o	57	man.	16	0	2005	2017
		Improve drainage conditions (EPADP)		●	o											o			50	inv.	3833	1320	2003	2017
		Apply modern irrigation techniques in new areas		●	o													o	78	inv.	3003	1802	2004	2017
		Gradually introduce modern irrigation techniques in oases		●	o													o	82	inv.	143	21	2004	2017
		Control well discharges in desert areas		●														x	99	inv.	0	0	2003	2017
		Reduce irrigation supply after rainfall		●												o			122	man.	0	0	2003	2017
	Drainage	Apply intermediate reuse at appropriate locations		●				x								o	o		51	inv.	63	8	2003	2017
		Prioritise drainage water reuse in selected areas		●	o		o									o	o		115	pol.	0	0	2003	2017
		Allow higher salinity in irrigation water		●	o		o		o									x	114	pol.+ stud.	94	0	2004	2017
		Promote cultivation of salt tolerant crop varieties		o	●		o											x	97	man.	8	3	2003	2017
	Water allocation and distribution Nile system	Install Water Boards at irrigation district level		●												o	o		33	inst.	pm	pm	2003	2017
		Continue set-up of Water User Associations at mesqa level		●												o	o	x	69	inst.	0	0	2003	2017
		Introduce regional water allocation based on equal opportunities		●	o											o	o	x	93	pol.	0	0	2003	2017
		Introduce water allocation based on fixed annual amounts per feddan		●	o											o	o	x	67	pol.	90	0	2003	2017
		Continue canals and drains dredging and de-weeding		●	o											o	o	x	98	inv.	2100	0	2003	2017
		Improve physical infrastructure for proper water distribution		●												o	o		68	inv.	183	49	2003	2017
		Establish MALR/MWRI co-ordination on supply and demand		●	o											o			111	inst.	0	0	2003	2017
		Introduce water delivery contracts between MWRI and Water Boards		●												o			116	man.	0	0	2003	2017
		Train MWRI and WB staff on system operation		●												o			113	cap. build.	1	0	2003	2017
		Rehabilitate barrages and regulators		●						x									32	inv.	2225	297	2003	2017
		Rehabilitate and further develop pumping stations in river and canal system		●												o			42	inv.	10021	401	2003	2017
		Maintain and improve High Aswan Dam and Lake Nasser		●															38	inv.	1765	35	2003	2017
		Continue works on River Banks, Sea shores and Mapping (combined 'measure')		●															61, 91/2	inv.	1630	49	2003	2017
		Provide solid waste collection and disposal systems in rural areas		x			x		x				●		o	x	o	o	6	man.	0	0	2003	2017
		Extend aquatic weed biological control		●	x											o	o	x	46	O&M	143	19	2004	2017
	Municipal and industrial water	Install / rehabilitate drinking water metering systems						●					o					x	18	inv.	249	104	2003	2017
		Review price policy for drinking water						●										o	19	pol.	1	0	2003	2017
		Intensify water conservation awareness campaigns		o				●					o		o				43	man.	90	0	2003	2017
		Promote water saving technologies in industry				●												o	54	man.	27	0	2003	2017
		Reduce leakage losses in PWS network by prioritisation						●					o		o				87	inv.	0	2000	2003	2017
		Reuse treated wastewater in New Industrial and Canal Cities		o				●					o					o	56	study	0	0	2005	2017
	Fish	Review restriction on cage culture in the Nile and canal system		●	o														75	pol.	1	0	2004	2004
	Nav.	Improving the navigational channel in the Nile through dredging		o							●						o		60	O&M	0	3000	2003	2017
	Research	Study different operations of High Aswan Dam		●															34	study	16	0	2003	2004
		Study short duration crop varieties			●														44	study	8	0	2003	2017
		Study salt tolerant crop varieties			●														62	study	8	0	2003	2017
		Continue activities Nat.Water Research Center		●															96	study	799	16	2003	2017
	Fam.	Conduct family planning awareness campaigns							●										129	man.	203	0	2003	2017

Table 6-2 Responsibility of stakeholders for Water Quality and Institutional measures

Recommended Measures/Actions Measures / Actions Water Quality and Institutional Reform			Stakeholders																Implementation info					
			National Water Council / MWRI	Ministry of Water Resources and Irrigation	Ministry of Agriculture and Land Reclamation	Ministry of Industry	Ministry of Environment	Ministry of Housing	Ministry of Health	Ministry of Electricity	Ministry of Transportation	Ministry of Planning	Ministry of Local Development	Ministry of Tourism	NGOs/ Community Based Organisation	Water Users Associations/Water Boards	Directorates/Decentral Organisations	Private Sector and Investor Groups	No. of the measure	Type of measure	Total investment (in million LE)	Total recurrent costs (in million LE)	Starting year	Ending year
Water quality management measures	Prevention	Introduce financial incentives to promote unpolluted industrial waste water		x		●	o		o									o	4	man.	900	0	2003	2017
		Start public disclosure pollution control program for industries				o	●		o						o			o	80	man.	0	2	2003	2017
		Introduce compliance action agreements for industries				o	●		o									o	101	man.	0	14	2003	2017
		Initiate public awareness campaigns for clean industrial production				o	●		x						o			o	3	man.	6	0	2004	2005
		Initiate water quality awareness campaigns		o		o	●						o		o				5	man.			2004	2017
		Phase out and relocate polluting industries along vital waters		x		●	o		x									o	17	man.	0	0	2003	2017
		Introduce load based discharge levies		●		o	o												9	pol.	0	0	2003	2017
		Strengthen institutions controlling and monitoring industrial pollution		o		o	●		o										107	inst.	0	0	2003	2017
		Encourage use of environmentally friendly agricultural methods			●		o												13	man.	33	24	2003	2007
		Control the production and import of agrochemicals			●	o	o												31	man.	0	13	2003	2017
		Control the use of organic fertilisers			●		o								o				??/ 135	man.	0	0	2003	2017
	treatment	Increase municipal sewerage and waste water treatment		o				●	o				o						10	inv.	61 765	12 084	2003	2017
		Increase drinking water treatment capacities		o				●	o				o						11	inv.	28 250	15 621	2003	2017
		Initiate cost recovery for urban and rural sanitary services						●					●						108	man.	2	0	2003	2017
		Start local action plans on domestic sanitation in rural areas						o					●		o		o		103	man.	1 500	0	2003	2017
		Encourage treatment or pre-treatment of industrial waste water by industries		o		o	●		x									o	127	inv.	0	30	2003	2017
		Collect and/or pre-treat industrial waste water separately		o		●	o											o	102	inv.	2 220	3 010	2003	2007
	Control	Define functions of waterways	o	●	o		o	o	o		o						o		89	man.	1	0	2005	2005
		Define water quality standards based on receiving water		o			o	o	●								o		29	pol.	0	0	2003	2017
		Include reduction of human contact with polluted water in local action plans		o					o				●		o				7	man.	0	0	2003	2007
		Divert pollution from northern lakes		●			o		x					x					2	inv.	43	13	2005	2017
		Protect groundwater from pollution in particular around wells		●					o						o				79	inv.	4	0	2003	2012
		Select proper sources for public water supply		o				●	o				o		x		o		1	inv.	38	0	2003	2007
		Provide sewage disposal systems in unconnected areas		x			o	o					●		o				8	man.	75	0	2003	2007
	Institutional	Enhance water quality monitoring and information dissemination		●			o		o						o		o		117	inst.	195	3	2003	2017
		Train MWRI and WB staff on pollution and water quality		●												o	o		128	cap.	0	0	2003	2017
Institutional reform	Institutional reform	Restructure the role of MWRI		●												o	o		106	inst.	54	0	2003	2017
		Restructure MWRI - establish integrated water management districts		●												o	o		130	inst.	140	33	2004	2017
	Fin./priv.	Stimulate private sector participation in infrastructure and O&M		●													x	o	20	inst.	5	0	2003	2017
		Implement systems of cost sharing and cost recovery for all water users		●													o	o	100	inst.	5	0	2003	2017
	Planning / co-operation	Continue water sector planning as a rolling exercise	●	o	o	x	o	o	o	x	o	x	o	x	x	o	o	x	131	pol.	3	3	2003	2017
		Enhance data exchange among different authorities	●	o	o	x	o	o	o	x	o	x	o	x	x	o	o	x	132	inst.	3	0	2003	2017
		Co-ordinate investments on the regional and national levels	o	o	o	o	o	o	o			●	o				o	o	109	inst.	7	0	2004	2017
		Establish permanent inter-misterial high committee on IWRM (NWC)	●	o	o	o	o	o	o	x	o	o	o	x			x		94	pol. + inst.	4	0	2003	2017
		Enhance role of NGO's and civil society (e.g. in local action plans)	●	o									o		o		o		133	inst.	2	0	2003	2017

	Total	2003	2004	2005	2006	2007	2007-12	2012-17
Developing additional resources	**8,274**	**350**	**537**	**579**	**612**	**613**	**2,961**	**2,622**
▫ Nile water	2,533	34	222	218	223	224	975	636
▫ Groundwater	4,311	287	287	292	287	287	1,436	1,436
▫ Rainfall and flash flood harvesting	631	28	28	38	38	38	230	230
▫ Desalination	800	0	0	32	64	64	320	320
Making better use of existing resources	**41,512**	**2,819**	**3,709**	**3,622**	**3,326**	**3,317**	**13,098**	**11,623**
▫ Horizontal expansion	7,750	601	701	602	305	305	2,618	2,618
▫ IIP / IIIMP	6,700	400	450	450	450	450	2,250	2,250
▫ Water use efficiency Nile system - irrigation efficiency	3,496	22	637	638	638	638	790	132
▫ Water use efficiency Nile system - reuse of drainage water	3,998	335	336	336	336	336	1,460	860
▫ Water allocation and distribution Nile system	18,158	1,359	1,484	1,498	1,503	1,494	5,517	5,303
▫ Municipal and industrial water (quantity)	367	26	24	25	25	25	122	121
▫ Aquaculture	1	0	1	0	0	0	0	0
▫ Navigation	0	0	0	0	0	0	0	0
▫ Research	1,042	76	76	73	69	69	341	339
Protection of public health and environment	**95,031**	**8,808**	**8,812**	**8,827**	**8,823**	**8,823**	**30,367**	**20,571**
▫ Prevention	939	67	70	70	67	67	300	300
▫ Treatment - waste water	65,486	5,956	5,956	5,956	5,956	5,956	22,501	13,206
▫ Treatment - drinking water supply	28,250	2,750	2,750	2,750	2,750	2,750	7,500	7,000
▫ Control	161	23	23	39	38	38	1	0
▫ Institutional actions for water quality and public health	195	13	13	13	13	13	65	65
General institutional, legal and financial measures	**245**	**7**	**20**	**20**	**16**	**16**	**82**	**82**
Total	**145,063**	**11,984**	**13,078**	**13,049**	**12,777**	**12,770**	**46,508**	**34,897**

Table 6-3 NWRP investments costs (in million LE)

The investment flow is depicted in Figure 6-2 and the distribution over the various stakeholders in Figure 6-3. The figure on the investment flow shows that the largest investment category is the Protection of public health and environment. Within this category the measures I*ncrease municipal sewerage and wastewater treatment* and *Collect and pre-treat industrial wastewater separately* are the main components.

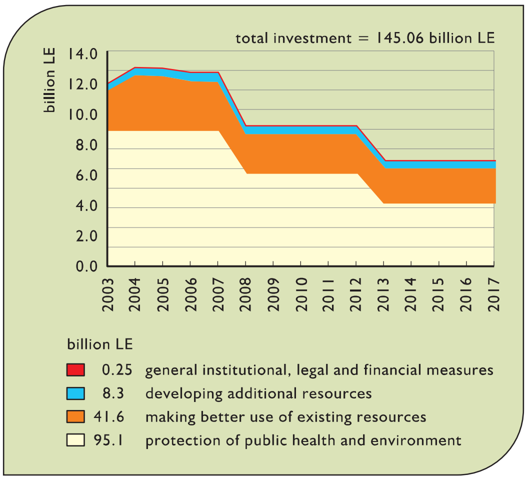


Figure 6-2 Investment flow and destination

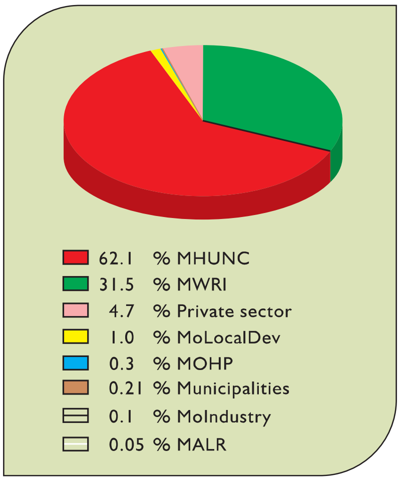


Figure 6-3 Investment by stakeholder

The second important category is 'Making better use of existing resources'. Within this category the measures *Continue IIP in prioritised areas* and *Apply modern irrigation techniques in new areas* are the most prominent ones. This last measure would be carried out by the private sector. In the category 'Developing additional resources' the measure *Groundwater development in Western Desert* is the major one as far as investment is concerned. Water conservation in the Upper Nile river basin has not yet been taken into account, also because reliable estimates of the investment costs cannot be made yet. The category 'General institutional, legal and financial measures' carries only small investment costs. The main measure is the *Transfer of water management authority to Water Boards at District level.*

Figure 6-3 shows that, as far as the share of the various stakeholders is concerned, MHUNC has the largest share because of the construction of wastewater treatment plants. The second largest entity is the MWRI which is responsible for the largest number of measures, as can be expected from NWRP. The Private Sector is important because of its expected investments in modern irrigation systems and the collection and pre-treatment of industrial wastewater.

Measure-related recurrent costs

The "recurrent costs" constitute the costs of proper operation and maintenance of the investments included in NWRP and other costs of a recurrent nature. The personnel costs of governmental agencies are not included in these recurrent costs! The reason for this is that these personnel costs are covered from different budget categories. The total recurrent costs for NWRP for the period 2003-2017 are BLE 43.8. The recurrent costs are summarized in Table 6-4 and are presented at measure level in Annex C, which provides also for a splitting up over the Agencies that are primary responsible for the implementation of these measures. The recurrent cost flows are depicted in Figure 6-4 and their distribution in Figure 6-5.

The largest recurrent costs category is 'Making better use of existing resources'. Within this category the measure *Apply modern irrigation techniques in new areas* is the most prominent one. The second category is 'Protection of public health and environment'. Within this category the measures *Increase municipal sewerage and wastewater treatment* and *Collect and pre-treat*

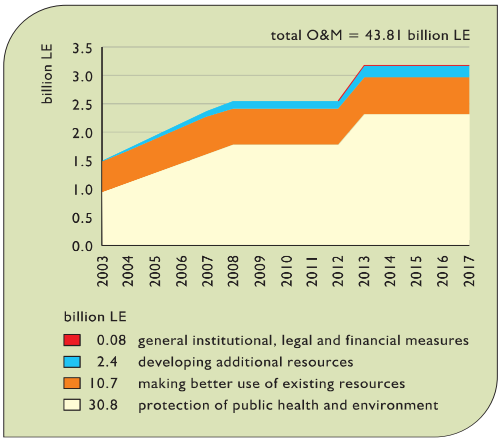


Figure 6-4 Recurrent costs flow and destination

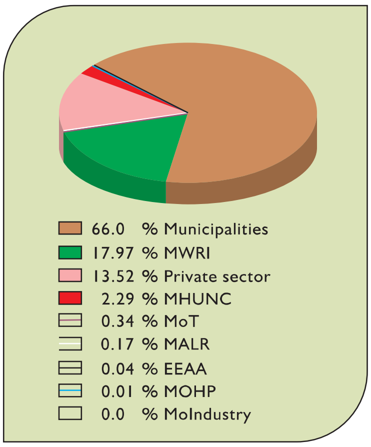


Figure 6-5 Recurrent costs by stakeholder

	Total	2003	2004	2005	2006	2007	2007-12	2012-17
Developing additional resources	**2,331**	**21**	**38**	**59**	**88**	**116**	**791**	**1,217**
Nile water	237	7	7	8	9	10	94	103
Groundwater	1,738	14	30	44	59	73	580	939
Rainfall and flash flood harvesting	75	0	1	1	3	5	31	32
Desalination	282	0	0	6	17	29	86	144
Making better use of existing resources	**10,627**	**492**	**570**	**646**	**725**	**800**	**3,615**	**3,778**
Horizontal expansion	644	18	39	57	66	76	154	233
Water use efficiency Nile system - irrigation efficiency	2,682	16	58	100	145	195	1,059	1,111
Water use efficiency Nile system - reuse of drainage water	1,331	81	81	81	91	92	452	453
Water allocation and distribution Nile system	850	43	57	71	85	99	243	252
Municipal and industrial water (quantity)	2,104	134	135	136	137	138	701	723
Aquaculture	0	0	0	0	0	0	0	0
Navigation	3,000	200	200	200	200	200	1,000	1,000
Research	16	1	1	1	1	1	5	5
Protection of public health and environment	**30,784**	**1,180**	**1,338**	**1,494**	**1,649**	**1,805**	**10,137**	**13,179**
Prevention	53	1	4	4	3	3	18	20
Treatment - waste water	15,093	492	592	693	793	894	5,128	6,502
Treatment - drinking water supply		687	742	797	852	907	4,985	6,651
Control	13	0	0	0	1	1	5	5
Institutional actions for water quality and public health	3	0	0	0	0	0	1	1
General institutional, legal and financial measures	**71**	**0**	**4**	**5**	**6**	**7**	**23**	**28**
Total	**43,814**	**1,694**	**1,951**	**2,204**	**2,468**	**2,728**	**14,566**	**18,202**

Table 6-4 NWRP recurrent costs (in million LE)

industrial wastewater separately are again the main components. In the third category 'Developing additional resources', the measure *Groundwater development in Western Desert* is the most prominent one as far as recurrent costs are concerned. The category 'General institutional, legal and financial measures' carries only small recurrent costs. This category is not depicted in Figure 6-4 as it is too small to be shown at the scale of the graph.

Figure 6-5 shows that, regarding the share of the various recurrent costs, the Municipalities have the largest share because of the O&M costs of the WTP's and WWTP's. Next is the Private Sector because of its recurrent costs of the modern irrigation systems and the collection and pre-treatment of industrial wastewater. The third largest entity is the MWRI, with expensive recurrent costs of the groundwater development. MHUNC is next with the reduction of leakage losses in the drinking water systems. These costs are somewhat arbitrarily placed under recurrent costs as leakage reduction is a continuous effort.

6.3 Operational planning

The NWRP has developed a national framework that defines the planning environment for the relevant stakeholders, where it relates to water resources. It places the operational planning of the measures of NWRP at the level of each stakeholder, while overall coordination and control mechanisms are established through the National Water Council.

The planning presented in the NWRP is at a national level. Ultimately (e.g. in about 20 years) planning in Egypt will take place at national and de-central levels. Given the present situation of institutional development and practices, this first National Water Resources Plan will be confined to the state level only. Pilots are suggested to start IWRM strategic and operational planning at lower governmental levels, too.

6.3.1 National operational planning for NWRP

Operational planning by the stakeholders comprises the inclusion of the strategy of NWRP into the Five-year and Annual Plans of each stakeholder. NWRP provides a general description of the activities and budget estimates only. Details will be worked out at the level of the individual stakeholders. More specifically the stakeholders are requested:

- To develop detailed operational plans for the measures listed in NWRP, including specific activities, locations, time schedules, responsibilities within the organization, detailed budgets, a communication plan for the involvement of relevant other stakeholders and a monitoring plan. For many (on-going) measures such detailed plans will already be available and they only need to be adapted to have these plans fit within the overall NWRP framework.
- To include the required activities in their annual plans and budgets.
- To include the required activities in their (next) five-year plans.
- To implement the measures, involving and consulting other stakeholders as planned.
- To monitor the progress of the implementation, identify possible bottlenecks and communicate these to the NWC (see also Section 6.4).
- To participate in the discussions in the NWC on the overall progress of the implementation of NWRP, possibly leading to some adjustments in the implementation.

It is stressed that this operational planning will follow as much as possible the existing planning protocols of the various stakeholders. It will not be needed to change the present way of working. The additional tasks involved are to report the progress of the implementation of the measures to NWC and participate in the discussions in NWC. From these discussions it could appear that some adaptations in the implementation of a measure might be needed, e.g. with respect to timing, in order to optimize its performance in the overall development of the water system in Egypt.

6.3.2 The future: hierarchical planning at central and de-central level

The implementation of the strategy Facing the Challenge presented in NWRP will mainly be done at the national level (the Ministries). Like many other countries Egypt has started a process of decentralization and privatization. This will also affect water management. It is expected that in about 20 years time a hierarchical system will have been developed in Egypt with responsibilities for water management at the lowest appropriate governmental level (principle of subsidiarity). For the water management in Egypt this will include responsibilities at state, governorate, inspectorate and district level.

How this decentralization will affect water resources planning in relation to NWRP is still uncertain. A hierarchical planning will develop in which the national plan will provide directives to the lower level plans, while the lower level plans will provide input to the higher level (national) plan, e.g. by proposing measures and by requesting services from the government. Such hierarchical system may include 3 levels (e.g. national, governorate and inspectorate or district) or 2 levels (e.g. national and governorate). Given the present institutional development at the decentralized level, a 2-level hierarchical system seems more realistic. In a 2-level system with national and governorate levels the distinction between the levels will be as follows:

- The state level will concern all water resources measures that have a national nature. Examples of such measures in the present plan are 'Continue the cooperation with the riparian states of the river Nile', general institutional, legal and financial measures, and measures that are related to the main ('national') water infrastructure What is going to be considered as central (national) and de-central (local) still has to be defined. The national system will at least comprise the Nile, the main tributaries, Lake Nasser and related infrastructure. The national level will also provide the national policy and guidelines.
- The governorate level will elaborate all water resources management measures that have a more local nature, taking into account the framework provided by the national level and carefully considering governorate level issues. A choice for planning at this level is in line with the MWRI vision that its services will in due course be concentrated in Water Management Districts. The Governorates will have a strong say in the IWRM planning at this level. This is also the level where an important role of active stakeholders, including NGOs and individual citizens, is expected.

The text box on the next page provides a first indication of the steps involved in such hierarchical planning and management approach. In order to gain the necessary experience with the procedure for planning at regional level, a pilot will be conducted in one or two governorates of the 4 governorates selected to be established by 2007 and, hence, where the new institutional framework for water resources will largely be in place. Outcomes of the pilots will be used for the elaboration of both the final planning procedure and general guidelines for drafting other regional plans.

The (draft) National Water Resources Plan has been discussed at several seminars at de-central level. The conclusion of these seminars was that the Governorates are indeed the most appropriate level to follow-up the implementation of the operational plans at national level and to provide feedback to the Technical Secretariat of the NWC. At this level Regional Management Committees for Irrigation and Drainage (RMC) can be used to support the process.

Example of hierarchy in central (national) and de-central (local) water management planning

The **National Water Resources Plan** will cover the following aspects:

- Translation of general national objectives and policies into water related objectives and policies
- Legal and institutional development at a national scale
- Measures that relate to the national water resources system
- Water allocation at a national scale
- Guidelines for planning and management at the regional scale

For national planning the following steps are distinguished:

1. The five yearly planning cycle starts with planning of the respective package of measures by the primarily responsible Ministry, the national policy being taken into account;
2. The responsible Ministry consults the other Ministries involved;
3. MWRI takes the lead in the integrated planning process, taking into account the local plans (see below);
4. The draft plan is presented in the NWC for comments;
5. The national plan is adopted by a common decision of the Ministries involved;
6. The planning cycle continues with translation into operational plans (annual activities and budgets).

The **De-central Water Resources Plans** (local plans) will cover:

- The use of the local water resources;
- In connection with these uses, an indication of the pursued development, functioning and protection of the water resources, as well as an indication of the corresponding deadlines for achieving the objectives;
- The programme of measures and arrangements needed for the development, functioning and protection mentioned before;
- The mode of operation under normal and abnormal conditions;
- The financial means needed for both the operational management and the implementation of the programme.

For the de-central plans the following steps in the planning cycle are distinguished:

1. The Five-year de-central planning cycle starts at the level of the Governorate, by differentiating the general objectives of the Governorate into specific objectives for the region, integrate across sectors and taking the national plan (NWRP) into account;
2. The inspectorates/district offices of the various ministries will contribute their plans, consulting other inspectorates/district offices as required.
3. The MWRI Inspectorate / District takes the lead in the coordination and integration.
4. The stakeholders in the respective area are consulted, among others the District Water Boards;
5. The draft regional plan is submitted to the Executive Board of Local Councils for comments;
6. The Governorate decides on the regional plan which is subsequently submitted to the Government for final approval;
7. The de-central plan is adopted by the Government after consultation of the NWC;
8. The planning cycle continues with technical review and plan compilation at Ministerial level, and is translated into annual activities and budgets at Governorate and Inspectorate/District level.

6.4 Monitoring

After the drafting and approval of the operational plans, their actual implementation by the stakeholders is at stake. It is time for action then. However, various problems may arise in practice, e.g. the availability of budget, unexpected technical obstacles and procedural delays. In addition, the current operation and maintenance, as well as the implementation of already existing plans should not be overlooked. Here an efficient, coherent system of monitoring and progress reporting is of paramount importance, particularly for identifying bottlenecks at an early stage and keeping the implementation process on the right track.

Annual progress reports will be submitted to the NWC. They will enable the NWC to perform an overall evaluation of the implementation of all plans. The monitoring and annual progress reporting will provide feedback on the impacts of the implementation of measures on the water resources system. As such it will contribute to the next round of planning. It will help to define the issues that are to be addressed then, and to adjust the priorities, if needed.

Crucial here is the development of a coherent monitoring and progress reporting system that will be accepted and applied by all stakeholders. This will facilitate aggregation and exchange of information. Such 'infostructure' will be a powerful means for water resources management both at policy and operational level. It will be essential for effective overall coordination by the NWC.

More specifically, the following steps are identified in monitoring, progress reporting and evaluation.

- Monitoring on progress will be done by the stakeholder that is primarily responsible for the NWRP measure. The progress reporting based on this monitoring will include for each measure:
  - quantified statement on what the measure aims to achieve (number of sewer connections, area levelled, etc),
  - the progress of the implementation of the measure (what has been completed, etc.),
  - an assessment to what extent the underlying objective of the measure has been addressed; this includes the monitoring of certain indicator values, in particular the ones that are related to the WRM objectives, and
  - identification of bottlenecks, if any, that hamper the implementation progress.
- To enable this monitoring process it is recommended that all Ministries establish a kind of 'Water and Environment Unit' to coordinate and discuss the various activities and issues on a technical basis within their Ministries as well as with the Technical Secretariat of the NWC.
- The stakeholders will submit an annual report on the progress of 'their' measures to the secretariat of NWC.
  - one page report per measure, containing above elements,
  - conclusions on the overall progress of the implementation of their measures.
- The secretariat of NWC will consolidate the progress reports of the stakeholders into an overall annual progress report of NWRP, including:
  - a consolidation by the 4 main policy lines of NWRP (Developing additional resources, Making better use of existing resources, Protecting health and environment, General

  institutional, legal and financial measures), identifying progress and bottlenecks,
  - a consolidation of all measures in one table, providing quantitative information on the progress,
  - an assessment in how far the national policy objectives are being met (the scorecard of NWRP, categorised in Economic development, Social objectives, Meeting water needs, and Health and environment),
  - an overall conclusion with respect to the progress,
  - recommendations for decisions and directions to be made by the NWC,
  - the detailed progress reports of the stakeholders will be included as annexes.
- NWC will discuss this annual NWRP report and, where needed, make the proper decisions and provide directions.
- NWC will report their conclusions to the Cabinet.

The timing of all actions still has to be worked out by the secretariat of NWC. This timing will have to be tuned to the normal planning and budgeting cycle of Egypt in order to accommodate the adjustments in the operational plans.

Nile near Cairo

6.5 Financial – economic consequences

Financing NWRP

Macro-economic indicators show that the Gross Domestic Production (GDP) in Egypt has been growing rather steadily, but that total public indebtedness has been growing faster recently and has reached almost 100% of GDP in 2001-2002. With a budget deficit of almost 6% the room for new policies that would require major investment and/or recurrent expenditure deserves careful consideration. The Government Investment Expenditure is rather low with only 4.2% of GDP in 2001-2002.

The strategy Facing the Challenge described in this National Water Resources Plan takes these facts into account. The total amount of investments is more or less in the range of the investments that the stakeholders have budgeted in recent years. Where needed the disbursement schedule of the measures has been shifted or extended in order to keep the expenditure within reasonable boundaries for water related activities for each stakeholder.

It should be noted that the estimates of the investments for the various stakeholders have been done for the water-related activities only, while the relations of these investments to their total expenditures are not clear for the NWRP-unit preparing this plan. Within the framework of NWRP no detailed information on budget and costs of routine activities of all stakeholders could be collected. This is true for the present situation but in particular for the future where policy decisions of the stakeholders beyond the control of NWRP will influence the expenditures, e.g. decisions on decentralization, privatisation and cost recovery. The figures presented in NWRP should be treated as rough estimates only. All individual stakeholders will extend the analysis of NWRP and will most probably come up with more detailed budgets in their operational plans, in particular in the framework of the Five-year plans and/or the annual plans of their Ministry. Furthermore it should be noted that major savings will be achieved by the NWRP (e.g. reduction of costs of health care with respect to water related diseases).

Financing the investments

Nearly all investments included in NWRP and listed in detail in Annex C can be covered by the regular budgets of the stakeholders. Annex C provides some information on those measures that are 'new' and for which funding still has to be secured. Part of the funding can possibly be provided by the donor community.

For MWRI, being one of the more important stakeholders in NWRP, a first estimate was made of the required investments including the new measures that are included in the NWRP, compared to the investment level projected by MWRI independent of NWRP. Figure 6-6 illustrates the results of this comparison. Reference is made to Annex C2 for further details on this figure for MWRI.

MWRI investments until 2000-2001 are represented by the black line. The continuation of this line for later years represents the investments that have been already projected by MWRI. The MWRI investments estimated in the NWRP (and included in this Investment Plan in Table C-3) are also shown. It should be taken into account that a large number of measures belong to the current MWRI policy and have been included already in the projected investments.

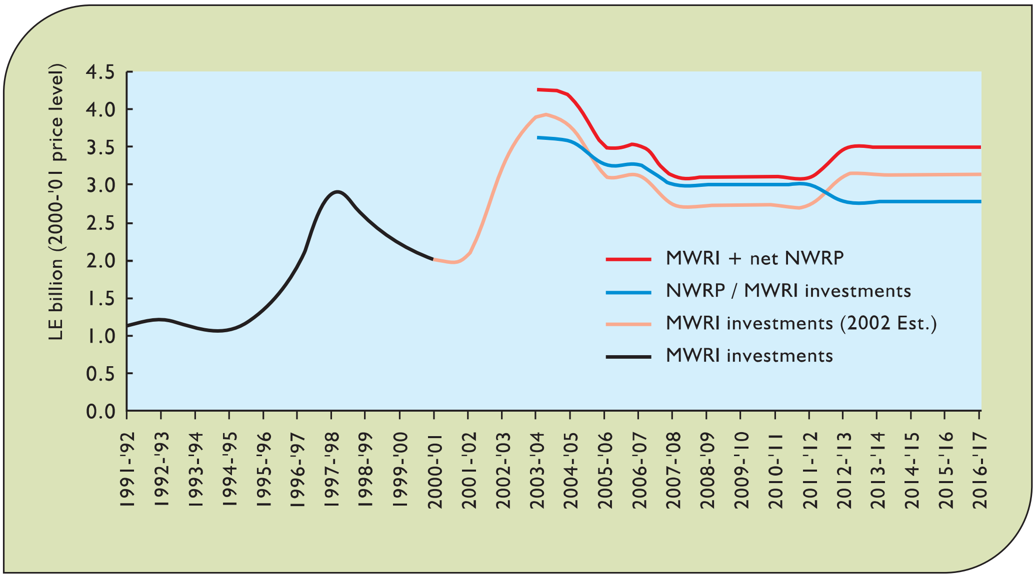


Figure 6-6 Investments MWRI and available budgets

Therefore an estimate has been made of the extra MWRI investments required as a result of NWRP. The upper line in Figure 6-6 shows the increased investment budget that will be required if all measures will be implemented on top of the regular investments. For other ministries this estimate could not be made due to lack of information on details of their existing budgets.

Part of the investment costs may be recovered by the stakeholders by charging the water users (or polluters) for their use and/or misuse. For most of the investments as included in NWRP this is not common practice yet in Egypt. Exceptions are the investments by the private sector. Given the emphasis that the Egyptian government puts on privatization and cost recovery it might be that this picture will change in the near future. However, for the strategy as described in this plan it has been assumed that most investment costs will be taken up by the government. A considerable part of the costs involved may be recovered by cost-sharing or cost recovery mechanism. However, this is not included in the overview as presented in this plan.

Financing recurrent costs

The quality level of the water services in Egypt is very much determined by the limitations in availability of funds to finance the recurrent costs. The availability of sufficient funds is considered to be pivotal to attain a sustainable system. In that sense Egypt could widely introduce the 'user pays' principle and polluter pays principle in their management system, to recover at least the recurrent costs involved. In several sectors this is already common practice, such as in the drinking water sector, although the level of cost recovery is not yet sufficient. In irrigation and drainage and in the sanitation sector this cost recovery approach is still under development.

Benefits and other impacts

The benefits and other impacts of NWRP are described in Chapter 5 in terms of performance indicators for the four main water-related objectives of the Egyptian government:

- Economic development
- Social development
- Meeting water needs

- Health and environment

While addressing the individual 'sectors' in Egypt, in particular farmers, industry, and households, it is difficult to draw general conclusions as measures that are positive for one sector, will have a negative impact for another sector. Overall these impacts are positive, of course, this being the objective of water management at the onset.

Agriculture/farming is a clear example of a sector that will face both positive and negative impacts of the strategy. At the positive side a tremendous increase in irrigated area is expected, from a present 7,985 Mfeddan in 1997 till 10,776 Mfeddan in 2017, resulting in a substantial increase in employment in agriculture and an increased crop production. However, because of the constraints in water availability the average crop intensity and average income per farmer can only be maintained at the present level under the assumption that additional water will become available from Lake Nasser (the optimistic scenario).

The impacts for **industry** are also mixed. Industry can expect a more reliable supply of good quality water. At the other side of the picture industry will face constraints in their discharge of pollutants in the water system, requiring them to make investments (in some cases even relocation of the industry) and/or requiring them to pay for disposal of wastewater. Government subsidies can somewhat ease the pain. Part of the additional costs involved will be transferred to the consumer, i.e. the households. The overall conclusion for industry is that their production costs will increase and that some reduction in profit should be expected. This should be seen as a price that society will have to pay to create a healthy environment, needed for Egypt's population, which, by the way, includes owners and employees of industries.

The **households** can expect an extended and more reliable drinking water supply, both with respect to delivery as well as quality. The same applies for their sanitation facilities. The costs involved are expected to be acceptable given the increased services provided. Some subsidies might be needed to protect the poor. Some of the additional costs incurred in industry and agriculture might be transferred to the households through higher prices for products. How much this will be depends on the international market prices. A main impact for the households will be the healthier environment that is expected from the measures that aim to prevent, treat or control the water-related pollution. The reduction in health care costs of water-related diseases should be mentioned here.

6.6 Risks and risk management

Two categories of risks are identified. The first kind of risk is the risk that the implementation of the strategy Facing the Challenge will fail for various reasons. These are called the Implementation risks and will be dealt with in Section 6.6.1. The second kind of risks are the Resource risks; what may happen to the resource as a result of unexpected or very uncertain events such as climate change of accidental toxic spillings. These risks are described in Section 6.6.2.

6.6.1 Implementation risks

There are several kinds of risks and constraints that might impede the successful implementation of this NWRP. They are identified in this Section, together with the way these risks can be mitigated. Most risks are multi-dimensional in the sense that more than one category of risk is involved and that mitigation measures should address all categories simultaneously.

It should be noted that uncertainties about the future always lead to risks in implementing policies and strategies. Circumstances may develop in a different way than anticipated and priorities may change. This means that plans like NWRP will be updated regularly. Reference is made to Section 6.8 that describes the continuous character of this kind of planning. A continuing planning enables to deal with the risks involved and adapt the policies and strategies if this is required to cope with different circumstances. It enables to take actions to mitigate the risks as identified in this Section.

Political and institutional risks

The first and utmost issue at stake here is the awareness at a high political level (the Cabinet) that water is a limited and precious resource in Egypt that should be taken into account when major decisions are taken. Economic development (industry, agriculture and tourism) will require water and will lead to an additional stress on the water system both with respect to the quantity and the quality of the water. This awareness should include the awareness of possible constraints in the availability of water and, when decisions on developments and investments are taken, to make funds available for proper treatment of the resulting flows of return water or wastewater.

A major institutional issue is the cooperation between the stakeholders, required in order to implement NWRP. Traditionally, institutions in Egypt have been vertically structured, even within the organizations of the stakeholders. Communications amongst and between organizations have tended to be at high level only and limited to exchange of information, often upon request only. The true concept of Integrated Water Resources Management (IWRM) requires that the stakeholders should increase their cooperation; they are jointly responsible for the implementation of NWRP. The National Water Council has a major task to facilitate communication and cooperation. At an NGO level it is expected that the Egypt Water Partnership will play an important role.

Another institutional issue that will emerge in future, is that IWRM aims to integrate the common top-down approach in water resources management with a bottom-up process in which the people that are actually dealing with the water (the farmers, industries, citizens, etc.) are forwarding their demands and plans. This requires a decentralised and integrated organisation at a rather low level. Most ministries are in a process to develop such a decentralised organisation. For example MWRI is experimenting with Water Boards at District level and with 'integrated' districts at Governorate level. Still, those institutions remain related to the tasks of MWRI only. From a perspective of IWRM, cooperation between the decentralised organisations of the various ministries is needed. This issue is not urgent at this moment as it was decided to start IWRM at State level first and, hence, NWRP has a focus on actions that can be dealt with (or initiated) at the level of the Ministries.

A further political and institutional risk concerns the acceptability for the Government of implementing firm cost recovery schemes in their management structure. Cost recovery measures are often not popular and, without proper awareness-raising campaigns, can lead to social unrest. However, cost recovery is indispensable to make the system perform adequately; without this it will not be possible to provide sufficient funds to cover all recurrent costs.

A final political risk is the cooperation with the upstream riparian states. In order to provide sufficient water for all users and uses also after 2017, it is anticipated in the optimistic scenario of NWRP that additional water can become available from Lake Nasser by implementing upstream water conservation schemes. This cooperation takes place in the framework of the Nile Basin Initiative (NBI) and shows positive signs. However, there remains an important aspect of risk involved in the assumption that these conservation schemes will be implemented, as illustrated by the halting of the Jonglei canal project in 1983 because of the domestic political troubles in Sudan.

Need for awareness raising

Social risks

The social risks have two dimensions. The first dimension is the awareness of people that water should be dealt with carefully and that all individuals have a role in saving and protecting water. In particular with respect to water quality such awareness is at present rather low, or at least, actions to improve the situation got a low priority in the past. Some of the measures included in NWRP require a full cooperation of the population. Such cooperation depends on the second dimension of the social risks, being the willingness and ability of the government to acknowledge the important role that the grass root level can play in the management of the water and that they should be properly informed and consulted about planned developments. Examples are the (further) introduction of cost recovery and polluter pays principles, the wise and regulated use of the natural resources and the development of a community responsibility for the operation and maintenance of their schemes.

Environmental risks

The most important environmental risk is that economic development and economic gains are considered to be more important than environmental quality and that violations of standards are tolerated in view of a high priority for Egypt's industrial development. Arguments often used are that industries otherwise would go out of business or that their products would become too expensive for the people to buy. Awareness raising about the importance of a healthy environment and the provision of targeted subsidies should reduce this risk.

A second environmental risk is the insufficient awareness of people that they play a key-role in safeguarding the quality of water, mentioned also above under social risks. Disposal of waste, both liquid and solid, in the surface water system should be considered as unwanted, or even unacceptable. Awareness programmes are included in NWRP to convince the people that a proper disposal of waste will lead to a healthier environment. The government should provide sufficient facilities to enable such proper disposal.

A third risk lies in the sub-optimal O&M of the wastewater treatment systems. Because of insufficient budgets or cost-recovery schemes, many treatment facilities are operating at a sub-optimal level and some are not even functioning at all. Cost-recovery schemes should provide the funding for such O&M. If the implementation of these schemes is lagging behind or otherwise unsuccessful, this will lead to a continuation of the underperformance of the wastewater treatment systems.

Financial risks

Financial risk is involved in both investment and recurrent costs. As far as investments are concerned it has been mentioned that these will mainly be funded from existing budgets and traditional sources. However, these sources depend on both global and national economic developments which are highly uncertain. This uncertainty also applies to the availability of funds from the donor community which has political, social and environmental dimensions. In case the total of funds will become less than required, the consequence will be that the implementation rate of measures will be slowed down. Although very unfortunate this will have no major consequences for the implementation of NWRP other than that the improved performance of the system will be achieved at a later date.

Recurrent costs represent a more serious risk. Much of the underperformance of existing facilities is the result of insufficient operation and maintenance due to lack of funds. Moreover, contributions from donors for investments will inevitably be linked to conditions of proper cost recovery schemes. NWRP recognizes this risk and places the responsibilities for performance and the operation and maintenance of the schemes firmly with the users. The government should enable cost recovery, both legally and institutionally.

Technical risks

Most of the more important measures of NWRP are based on proven technology in Egypt. Examples are IIP, drinking water and wastewater treatment plants. As a result of the experiences that have been gained during earlier projects it can be concluded that there are no major technical risks involved in NWRP. Where such risks are identified in the projects it was decided to study those first, either under laboratory conditions or as pilot projects.

A kind of technical risk is associated with the availability and reliability of appropriate information and the willingness to exchange this information among the stakeholders. As mentioned under the institutional risks, it is anticipated that the NWC will play a major role in stimulating the exchange of information. With respect to the availability and reliability of appropriate information it seems that the main risks relate to information on water quality, both with respect to pollution loads as well as in-stream quality data. On the other hand it can be concluded that more detailed and reliable data on pollution loads and water quality will not change the need to implement the measures. Unreliable data might influence the dimensions of the (treatment) facilities involved.

6.6.2 Natural risks and uncertainties

The natural risks and uncertainties relate to changes in climate in Egypt and the Nile Basin and to calamities as a result of exceptional conditions.

Climate change

Much uncertainty exists on the effects of climate change, both globally as well as for Egypt. According to various sources the temperature in the Mediterranean region may rise between 1.4 and 2.6 °C by the 2020's. No major effects on rainfall in Egypt are expected although the flash floods in the Sinai might increase a little. The level of the Mediterranean Sea is expected to rise between 30 and 50 cm by the year 2050. The consequences of all this for Egypt as such are that the potential evaporation will slightly increase (leading to higher water demands in agriculture), that some loss of land and/or the need to make endiked polders may occur, that drainage conditions along the coastal area will deteriorate (also caused by subsidence of land), resulting in increased pumping needs, and that coastal aquifers would become more saline. Although these are important impacts, it can be concluded that these impacts are small considering Egypt as a whole and can be dealt with in time, also considering the uncertainties involved.

More important is what is going to happen in the Nile basin. It appears that the discharge of the Nile into Lake Nasser is highly sensitive to a change in rainfall in the catchment. An increase in rainfall of 10% in the Sudanese and Ethiopian source areas is expected to result in a 40% increase in the annual flow of the Nile. On the other hand a 10% decrease in rainfall will reduce the annual flow by 40%. Such decrease would be disastrous for Egypt. Climate change in the Nile basin is still subject of much research.The various global climate models are not producing consistent results. However, most models do predict wetter conditions in the Nile basin. Assuming a 2.5% increase in rainfall means that a 10% increase in the inflow into Lake Nasser can be expected, i.e. an additional 8 BCM per year. Dividing this over Sudan and Egypt leaves Egypt with an additional supply of 4 BCM per year. If and when such additional supply will indeed happen on a structural basis is still very uncertain. It will certainly not happen before 2020. Given the uncertainties involved this additional supply has not been taken into account in the most likely scenario of NWRP.

Figure 6-7 illustrates the uncertainties associated with climate change.The figure shows the combined results of 11 global climate models with respect to the estimated annual natural inflow into Lake Nasser. The central estimate is the average of those 11 models, the high estimate is the average plus the standard deviation, and the low estimate is the average minus the standard deviation. The average inflow will indeed increase from 84 BCM/year now to about 110 BCM/year in the year 2100. However, it might also become 220 BCM/year (in the high estimate) and a dramatic 35 BCM/year (in the low estimate). It is stressed that the uncertainties involved are related to conceptual differences in the models and not to stochastic variability.The state-of-art of climate modelling is still insufficient as a base for policy decisions.

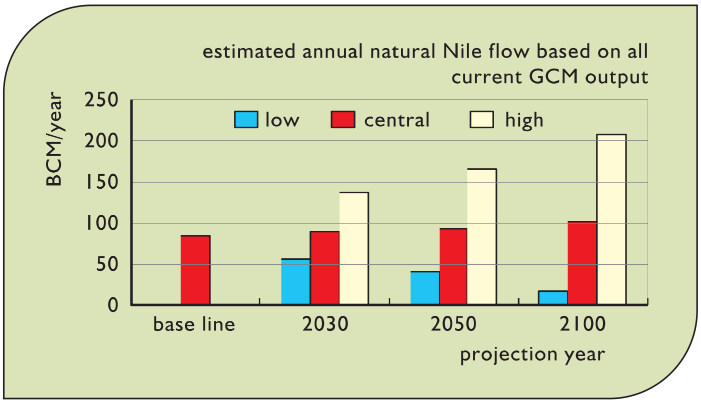


Figure 6-7 Possible effects of climate change on Nile flow

Calamities – flooding

With the exception of some flash floods in the Sinai, flooding is not a major issue in the water management of Egypt.The reason for this is the lack of rainfall in Egypt itself and the construction of the High Aswan Dam (HAD) in 1968, creating Lake Nasser, one of the biggest reservoirs in the world and able to store about 2 times the average annual flow in the Nile.This over-year storage capacity of Lake Nasser almost completely stopped flooding of the Nile in Egypt. During the period 1999-2001 some additional release from Lake Nasser was needed because of a prolonged high Nile inflow in the previous years and the limited capacity of the Toshka spillway. The resulting high(er) discharge of the Nile in Egypt caused hardly any damage. In August/September 2001 about 270 MCM/day (130 m^3/s) was discharged during 5 days, compared to a normal discharge in that period of the year of 175 MCM/day. Only some minor damage occurred due to flooding of agricultural areas around Giza. The planned increase of the discharge capacity of the Toshka spillway will decrease the probability of flooding even more. On the other hand it is expected that climate change may increase the probability of flooding again. The on-going "Lake Nasser Flood and Drought Control Project' is studying these aspects. Overall it seems that flooding is not going to be a major issue. An upgrading of the conveyance capacity of the Nile to 300 MCM/day will even further reduce the risk to any flood damage. MWRI is investigating the possibility of such increase.

Calamities – drought

The large capacity of Lake Nasser has also caused a substantial reduction of the probability of drought conditions, in particular the occurrence of an unexpected drought that can be regarded as a calamity. Even during the dry period in the 1980's when the Nile inflow was rather low, Lake Nasser was able to deliver most of the agreed upon 55.5 BCM. The lowest recorded delivery was 52.5 BCM in 1988. Sliding scales (hedging rules) are applied at the HAD to start reducing the release from Lake Nasser if the water level falls below a critical level. This aims at saving water to avoid a dry period with hardly any flow which would be disastrous for agriculture. Moreover, a situation with reduced flow at Aswan like the one in the year 1988 can be reasonably well predicted, enabling the agricultural sector to adapt to such situation. Overall it can be concluded that drought at present should not be taken into account as a major risk in terms of calamity.

This will be different in case climate change would result in less rainfall in the Nile Basin. Small decreases in rainfall (e.g. 2%) will result in a major (10%) decrease in annual discharge of the Nile. This 10% decrease will mean 8 BCM/yr less discharge and, hence, 4 BCM/yr less for Egypt. In which direction climate change will develop in the Nile basin is still uncertain. Most present models indicate an increase in rainfall. Further studies on this subject are being carried out in the framework of the above mentioned 'Lake Nasser Flood and Drought Control Project'.

Calamities – toxic spills

A final risk is the possibility that toxic spills are occurring in the Nile or its branches. These spills will be transported downstream and will threaten the ecosystem and the water users. The largest risk is the occurrence of dangerous spills from factories along the Nile and its branches and from navigation on the Nile, involving chemical substances (heavy metals, pesticides, oil, etc.). These spills may be a result of an accident or from a willing act to dispose of the waste at an illegal but cheap way.

All necessary precautions should be taken to avoid such spills but it can not be ruled out that such circumstances will happen. It is beyond the scope of NWRP to describe in detail the mitigating actions that should be taken in case spills happen. In general it will be needed to flush the spill into the Mediterranean, at the same time closing all intake points to avoid the spreading of toxic substances into canals and other intakes.

National Plan to Prevent Environmental Risks

The risks described above and the preparation and mitigation actions required, are addressed in the National Plan to Prevent Environmental Risks (EEAA, 2002). This plan covers pollution but also non-pollution aspects such as (flash) floods and failure of structures (e.g. HAD or barrages in the Nile). The plan describes the activities and institutional arrangements needed for preparation and mitigation (before the event happens), response (during the event) and recovery (after the event). The water quality related aspects of the National Plan to Prevent Environmental Risks have been linked with Law 42 of 1982, giving the Ministry of Water Resources and Irrigation specific tasks how to deal with environmental calamities.

6.7 Communication, public awareness and gender issues

6.7.1 Communication

The implementation framework as described before provides for decentralized implementation at operational level on the one hand and effective overall coordination of the implementation process on the other hand. This approach enables optimum use of existing regional and local knowledge on water problems and possible solutions. Moreover it will promote that the approaches of the various stakeholders are harmonized and the dissemination and exchange of relevant knowledge and information among them will go smoothly and efficiently at all levels.

A well structured, transparent, user-friendly information exchange system is very important, the more since it will encourage regional and local cooperation and will contribute to mutual understanding of problems to be solved, e.g. in cases that a downstream problem most effectively can be tackled by taking upstream measures. Such system is also important for enhancing the involvement of stakeholders and acquiring public support for the implementation of operational plans. It may help to understand the reasons for certain measures, and it may facilitate that well balanced, cost-effective, generally accepted measures are taken.

Particularly the measures for enhancing cost recovery may appear to be sensitive. On the short term they may have a substantial socio-economic impact on individual households and companies. Many measures will not lead to concrete benefits immediately, and therefore the public will not observe these benefits, contrary to the immediate additional financial burden. Such cost recovery measures will be introduced in a very careful way with ample dissemination of information among the relevant target groups. In many cases a more gradual introduction of such measures will facilitate the accommodation of them.

Of course a key role will be played by the National Water Council with its coordinating task, that is of paramount importance for safeguarding a coherent implementation of the national water resources strategy that will contribute greatly to the prosperous and sustainable development of Egypt. It will help the Government to achieve its long term socio-economic policy targets, together with protection of health and environment, even though the population is growing and demands for water are increasing. By implementation of this approach a much better performance of the water resources system, both on water quantity and on water quality, will come within reach.

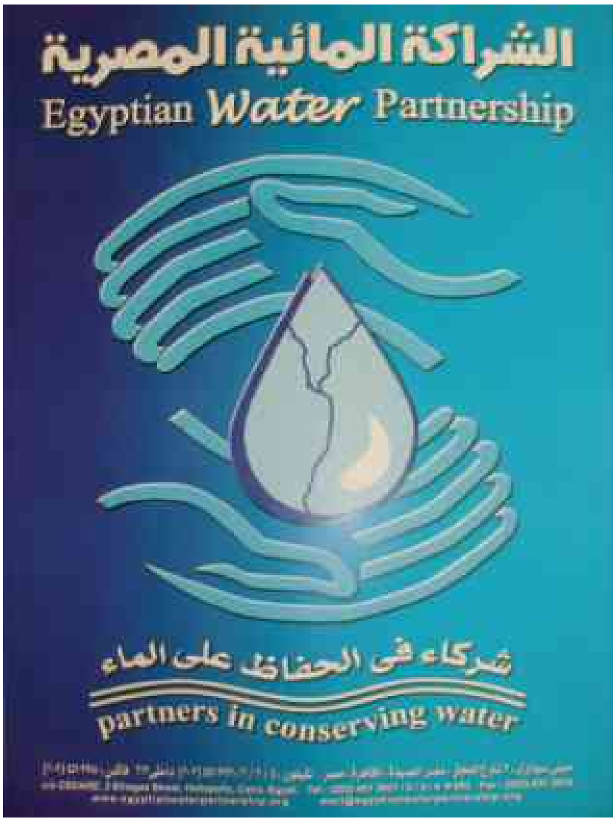
Achieving effective implementation of NWRP will require a lot of everybody's efforts and professional abilities, as well as sometimes some patience and a persistent willingness for cooperation and communication with other stakeholders, NGOs and civil society. If water resources management would lead to much more national, regional and local cooperation, this would already be a very positive side effect. And finally, it should always be borne in mind that by definition Egypt, because of its downstream position, is far from controlling everything in the river basin. This emphasizes the importance of good cooperation with the other riparian states in the Nile River basin.

6.7.2 Public awareness and consultation

In the strategy of the National Water Resources Plan, public awareness has been mentioned several times as a component of the activities needed to reach certain policy goals. A lot of investments and operational costs can be avoided if the water is used more efficiently and pollution is prevented.

In the framework of the Implementation Plan a similar reason exists to inform the public and other institutions about the planned developments and to consult them on this matter. The success of many measures depends on the acceptance of these measures by the public and other institutions.

In the process of developing NWRP consultation has mainly taken place at ministerial (central) level. During some events also other water-related stakeholders have been invited but in general this was limited to information dissemination only. No real large scale communication could be established during the NWRP process. To broaden the scope of consultation it is needed that target group oriented consultations will take place at the de-central level, e.g. through the Under Secretaries of MWRI and other ministries in the Governorates.



Next, specific efforts need to be directed to the Corporate sector, in particular to organizations that have a strong interest in water. Effective means and methods for consultation with this sector include meetings, newsletters, magazines (of those organizations), conferences, etc.

The same applies for the non-profit sector, in particular the NGO's that cover issues on environment, education, health and gender equality. This cooperation could include making use of the communication channels of these organizations, jointly launching awareness campaigns and participating in conferences.

Finally, at the level of the communities it is intended to cooperate with the national Shorouq program that has been integrated into the Organization for the Development and Reconstruction of Egyptian Villages (ORDEV) belonging to the Ministry of Local Development. The collaboration with Shorouq will be twofold: a) to have Shorouq representatives participate in the decentral meetings on NWRP, and b) to implement awareness campaigns for the public at large.

6.7.3 Gender issues

Communication and consultation will give opportunities for making steps forward with regard to gender issues. Women are important users of water resources and are aware of their own situation in relation to water resources and irrigation management.

Due to the tasks and responsibilities of men and women in irrigated agriculture and related to the domestic area according to societal norms and traditions, women and men have their specific knowledge about water use and water resources management. Differences in these tasks and responsibilities appear to be based on socio-economic class, region, age and are also observed between male and female headed households. Furthermore, due to these differential tasks and responsibilities women and men have different preferences and priorities concerning water use and water resources and irrigation management.

Male and female farmers are both concerned about water distribution issues from the perspective of their respective responsibilities and options to deal with the issues. As water users from a broader perspective than irrigation only, both men and women have their own area of interest. It appears that men are more concerned about water quantity issues, but as heads of households and community managers they evidently have a stake in water quality issues as well. Based on their responsibilities women's activities have a major impact on water quality issues, which in turn affect the irrigation system as well as the environment (affecting health). Women's concern and interests are to a great extent related to the consequences of irrigation system interventions (safety, health), water quality issues, water supply and sewage discharge practices.

Therefore it is important to consider women's interests when intervening in water resources and irrigation systems. At least, not only men but also women are to be well informed about such interventions, their expected benefits and their technical and financial consequences. Both men and women are to be considered as stakeholders, and they both should be involved to a greater extent. Both their involvement is needed for a smooth, effective implementation of measures. Also when it comes to decision making, the role of women needs to be strengthened. Their participation in Water Boards has to be enhanced. However, it should be borne in mind that changing attitudes of men and women is a slow process.

Thus for the sake of achieving effective and efficient water resources and irrigation management it is important to (i) address the real issues as felt by men as well as women and (ii) involve not only men but also women in discussions and decision making. The enhancement of the involvement of women in discussion and decision making on water use and water resources management will consist of the following elements:

1. The establishment of specific channels to inform and communicate with women about water resources and water use issues and financial consequences.
2. The creation of space for women to voice their views regarding water use issues on equal terms with men and to discuss and solve problems related to water quantity and water quality together with them.
3. The promotion of opportunities for women who are willing to play an active role in discussion and problem solving related to water use and management and who are willing to take responsibility in decision making on water related issues.

4. The establishment of guidelines for the development of area-specific strategies to overcome obstacles for women's involvement in discussions and decision making in water resources management.

Generally many factors influence the interest and willingness of people to participate actively in discussions and decision making processes. It is a process in which some people immediately take the opportunity, while others will follow slowly. However, the opportunities and obstacles men face are different from those faced by women in which societal acceptable roles are of critical importance. Both from the point of view of sustainability and of equal opportunities these differences have to be taken account of.

6.8 Planning – a continuous process

One of the 'measures' of NWRP is to continue water sector planning. Planning should be regarded as a rolling exercise. The present plan has a planning horizon up to 2017, is based mainly on 1997 data and was completed in 2004. Circumstances will change, lessons will be learned from experience and new insights will be gained. The monitoring, progress reporting and evaluation described in Section 6.4 will also provide input to update the National Water Resources Plan.

This National Water Resources Plan should be seen as a first step towards real IWRM, requiring a process of full cooperation of all stakeholders, including the public and the various governmental levels. This first step can and should be followed by next steps. The cooperation between the stakeholders in the High Committee and Technical Committee for the NWRP should be continued in the National Water Council. Steps to involve also other stakeholders have been brought forward (see Section 6.7) and first ideas about involving lower governmental levels have been developed (see Section 6.3.2).

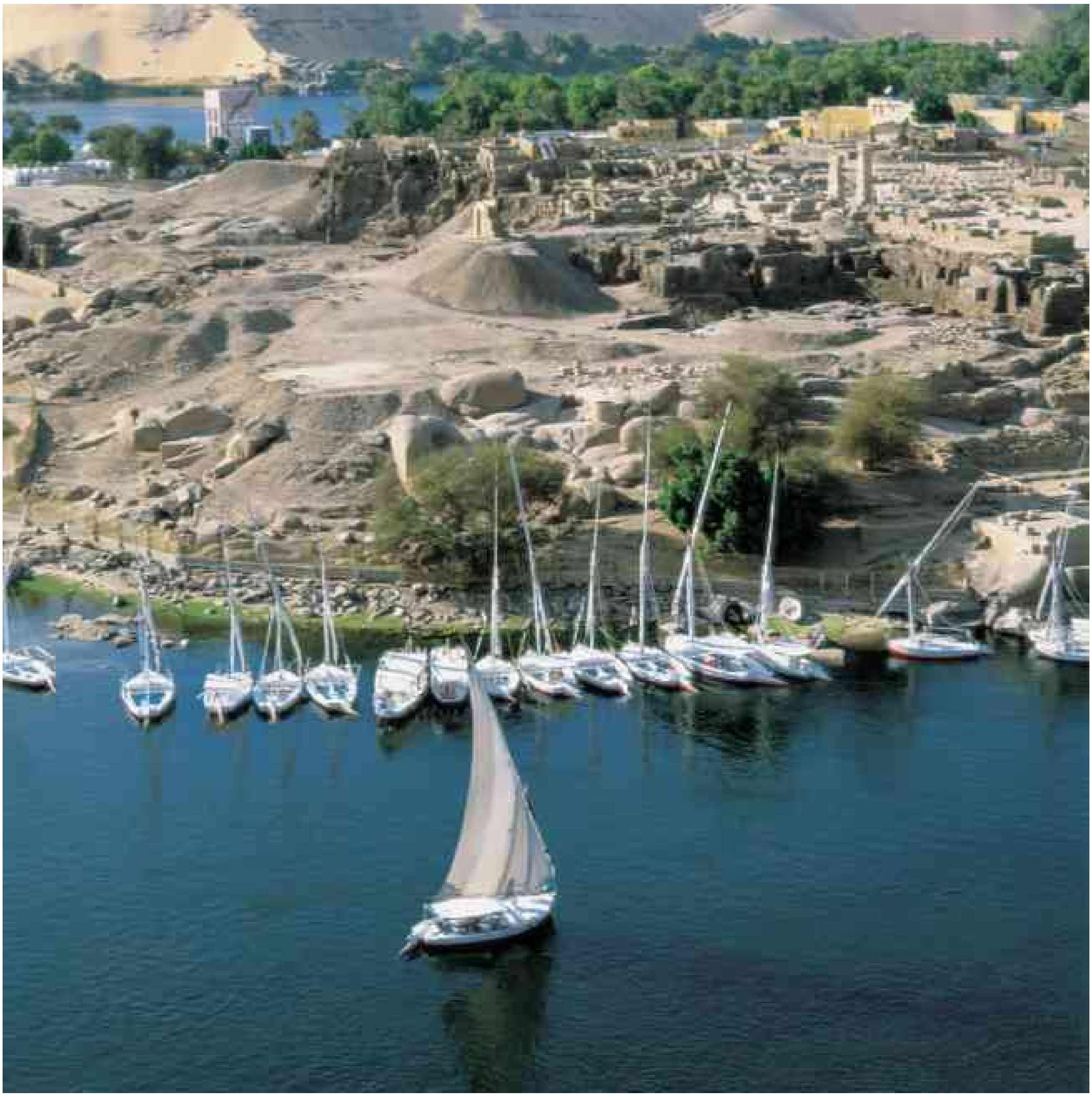
All above arguments lead to the need to consider planning as a continuous process. Such continuous process would include:

- an updating of NWRP every five years, in line with the Government's operational planning cycle, and covering a 20-year planning horizon; and
- initiation of a 2-level planning process by means of a pilot plan at the local level.

To have NWRP run in line with the Government's operational planning cycle would mean that the next plan should be developed by 2007. It is noted that such next plan does not have to start all over again. The present plan can be updated and extended with the experience gained so far. It can also accommodate new data that has become available. Hence, drafting the next plan as such does not have to be a major exercise. What will take time and effort is the continued discussion between the stakeholders on how to further tune their activities towards full IWRM. A new plan by 2007 will also enable to develop consistent operational plans, in particular the Five-Year plans of the individual stakeholders. Like the present plan it will be required that the Cabinet approves the next NWRP.

The next step will be to initiate a 2-level planning process as indicated in Section 6.3.2. The on-going process of decentralization will strengthen the role of decentralized agencies and it can be expected that these agencies will start to play a major role in strategic planning, too. This makes sense because those agencies have a much better insight in the problems in their area and the ways these problems can be solved. It also is in line with the concepts of IWRM that emphasize the importance of bottom-up processes.

The institutional structure in Egypt at the decentral level is not sufficiently equipped yet to start a full 2-level process now already. A pilot project will be initiated to gain experience with this kind of integrated planning at the local level. A decision still has to be taken which region will be used as a pilot.



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ANNEX A

Overview of NWRP Documents

Project Reports

Inception Report, August 1999
Interim Report 1: Results Preparation Phase, May 2001
Interim Report 2: Results Analysis Phase, July 2002
National Water Resources Plan, January 2005
Policy Document, February 2005
Project Completion Report, March 2005

Technical Reports

TR 1	Socio-economic Background, July 1999
TR 2	Aquifer Systems in Egypt (prepared by RIGW), April 1999
TR 3	Groundwater Models Developed by RIGW (prepared by RIGW), April 1999
TR 4	NWRP Decision Support System, August 1999
TR 5	Water Quality and Pollution Control, January 2000
TR 6	Fisheries and Water Resources, June 2000
TR 7	Task Force on the National Water Pollution Control Plan; Report of the Working Group on Criteria and Priorities, December 1999
TR 8	Crop Water Use and Water Balance of the Nile System, September 2000
TR 9	Groundwater Well Inventory in the Nile Valley and Delta, (prepared by RIGW), March 2000
TR10	Water-related Health Hazards and Potential Measures, June 2000
TR11	Towards Crop-based Water Charges - Suggestions for a Restart, July 2000
TR12	Conjunctive Use of Groundwater and Surface Water in Egypt: a Review, November 2000
TR13	Desalination in Egypt, November 2000
TR14	Water Resources in the Northwest Coast, Sinai and Eastern Desert, April 2001
TR15	Groundwater in the Western Desert, June 2001
TR16	Groundwater in the Nile Valley and Delta, June 2001
TR17	Stakeholders Involved in Municipal Water and Sanitary Drainage, Industrial Wastewater and Fisheries, February 2001
TR18	Demand for Municipal and Industrial Water (draft), May 2001
TR19	ASME, The Agricultural Sector Model for Egypt, May 2001
TR20	Population and Tourism Projections, June 2001
TR21	Impacts of Climate Change on Egypt's Water Resources System: a Review, June 2001
TR22	Actor Analysis for Strategy Formulation Activities, June 2001
TR23	Problem Analysis 2017, July 2002
TR24	Water Management Measures, August 2003
TR25	Future Water for Agriculture in the Nile system of Egypt, July 2002
TR26	Investment Plan 2003 – 2017, January 2004

NWRP Discussion Papers

DP 1 Scenarios, Measures and Strategies, Cairo, June 2000
DP 2 Reference Case 2017, Cairo, June 2000
DP 3 Facing the Challenge, Outline of a Draft Strategy, final version 3.0, Cairo, May 2003
DP 4 Implementation Plan for the strategy Facing the Challenge, final version 2.0, Cairo, 10 January 2004
DP 5 National Water Resources Plan for Egypt, draft version 2.1, Cairo, June 2004
Note: All Discussion Papers have been superseded by the present final version of the National Water Resources Plan

Workshop Reports

WR 1 Towards the Analysis Phase: Analysis Conditions and Concepts, Workshop Alexandria 4-6 July 2000
WR 2 Workshop on Fisheries and Water Resources, Cairo, 9 April 2001
WR 3 Workshop on Agriculture in 2017, Cairo July 2001
WR 4 Workshop on Water Quality Issues of Drinking Water, Cairo July 2001,
WR 5 Workshop on De-central Level Stakeholders Involvement (Fayoum and Menya Governorates) in the Plan Preparation Phase of the NWRP project, Cairo, 15 November 2001
WR 6 Workshop on De-central Level Stakeholders Involvement (Kafr El Sheikh, Beheira and Alexandria) in the Plan Preparation Phase of the NWRP project, Alexandria, 4 January 2002.
WR 7 Workshop on Domestic Sanitation and Public Health, Cairo, 16 March 2002,
WR 8 Workshop on Water for Agriculture, Ismailia, 9-10 April 2002,
WR 9 Workshop on Water Resources and Industry, Cairo, 2 July 2002,
WR10 Workshop on Proposed Strategy and Introduction to Implementation and Investment Plan, Ain El-Soukhna, 2-3 April 2003
WR11 Workshop on Implementation and Investment Plans, Ain El-Soukhna, 15-16 January 2004

Conference Proceedings

NC 1 Facing the Challenge, Cairo, April 29, 2002.

Reports from Egyptian Consultants and Institutes, prepared for the NWRP project

Drainage Research Institute (DRI)

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ANNEX B

Supporting Information

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B1 Existing and Proposed New Cities

Existing New Cities

Name	Location	Governorate	Inhabitants (thousand) 2000	2017	Water source	Waste water destination	Treatment plant 2000	Existing/ proposed main industries
10^{th} of Ramdan	Cairo/Ismailia road	Sharkia	160	500	Nile	Desert	Yes	Ready made garments, weaving, ceramics, marble
Badr	Cairo/Suez road	Cairo	8	428	Nile (10^{th} of Ramadan	Desert	No	Sports suits, building materials
Shrouk	Cairo/Ismailia road	Cairo	10	500	Nile (10^{th} of Ramadan	Desert	No	
Obour	Cairo/Ismailia road	Cairo	15	500	Nile	Desert	Yes	Car assembly, phamaceuticals, electrical sets
New Damietta	North of Delta	Damietta	85	350	Nile	Desert	Yes	Wood, plastics, paper
Cairo Satellites	East of Cairo ring road				Nile (Obour)	Desert	No	
New Salhyia	Sharkia	Sharkia	40	70	Nile	Desert	Yes	Car assembly, furniture
Sadat	Cairo/Alex desert road	Menoufia	70	500	Ground	Desert	Yes	Reinforced steel, carpets, ceramics
6^{th} of October City	Cairo/Alex desert road	Giza	250	2000	Nile	Desert	Yes	Electrical, mechanical, metal and wooden products
Sheikh Zayed	38 km from Cairo	Giza	2	500	Nile	Desert	Yes	
Nubariya New City	50 km from Alexandria	Bahera	6	30	Nile (Max plant)	Desert	No	Food, paper, plastics
15th of May	35 km from Cairo	Cairo	160	250	Nile (Tibbin plant)	Desert	No	
New Borg El Arab	60 km south east of Alex.	Alexandria	50	500	Nile	Desert	Yes	Food, building materials
New Asyout	20 km from Asyout City	Asyout		100	Ground	Desert	Yes	
New Minya	West of Nile	Minya	15	156	Ground	Desert	Yes	Food products, paper, plastics
New Beni Suef	Before existing Beni Suef City	Beni Suef	20	420	Nile	Desert	Yes	Food products, building materials
Total			**891**	**6,804**				

Source: Compiled by Ministry of Housing, Utilities and New Communities for NWRP
Updated May 2000

Proposed New Cities till 2016/17

Governorate	Name of city	Total area (feddan)	Residential area (feddan)	Inhabitants at full implementation	Employment opportunities
Ismailia	Wadi El Technologia	40,000	5,000	400,000	47,500
	Shark El Bohayrat	80,000	7,000	300,000	66,500
North Sinai	New Rafah	30,000	5,000	200,000	47,500
	New Nakhl	40,000	3,500	140,000	33,300
South Sinai	Abou Znema	40,000	3,500	140,000	30,000
	Wadi Firan	35,000	2,500	100,000	23,800
	Ras Mohamed/ Shark El Toor	50,000	5,000	200,000	47,500
Alexandria	Fayoum/Alexandria	35,000	2,500	100,000	23,800
Matrouh	South Sedi Barani	40,000	3,500	140,000	33,300
	South Marsa Matrouh	80,000	7,000	300,000	66,500
	South El Dabaa'a	35,000	2,500	100,000	23,800
	South Sedi Abdel Rahman	35,000	2,500	100,000	23,800
	Wadi El Natroun/El Alameen	35,000	2,500	100,000	23,800
	El Wahat/El Alamein	25,000	1,500	60,000	14,300
	North Siwa	30,000	3,000	120,000	28,500
	East Siwa	35,000	2,500	100,000	23,800
	El Bweety/Siwa	35,000	2,500	100,000	23,800
Beni Suef	El Korayemat/El Zafarana	35,000	2,500	100,000	23,800
	El Fashn	50,000	5,000	200,000	47,500
Fayoum	New Fayoum	30,000	3,800	150,000	34,900
	West Qarun Lake	25,000	1,700	70,000	16,200
Menia	Bani Mazar	80,000	7,000	300,000	47,500
Asyout	Dayrut	40,000	3,500	140,000	40,000
	West Asyout	80,000	7,000	300,000	40,000
Suhag	New Suhag	80,000	7,000	300,000	52,000
Qena	New Qena	80,000	7,000	300,000	50,000
	West Kaft	30,000	2,500	100,000	40,000
	Edfu	50,000	5,000	200,000	40,000
Aswan	Sohail Island	40,000	3,500	140,000	20,000
	Karkar	80,000	7,000	300,000	40,000
	Toshka	35,000	2,500	100,000	40,000
	Wadi El Alaky	35,000	2,500	100,000	24,000
Red Sea	Wadi Arba/West El Zafarana	35,000	2,500	100,000	23,800
	Bani Mazar/Ras Ghareb	35,000	2,500	100,000	23,800
New Valley	El Wahat El Baharya	35,000	2,500	100,000	40,000
	El Farafra	40,000	3,500	140,000	40,000
	Dayrut/El Farafra	25,000	1,500	60,000	40,000
	El Kharga	40,000	3,500	140,000	40,000
	El Dakhla	40,000	3,500	140,000	40,000
	East El Oweinat	35,000	2,500	300,000	40,000
	Morr Well	35,000	2,500	100,000	40,000
TOTAL	**41 proposed new cities**	**1,790,000**	**153,500**	**6,680,000**	**1,465,000**
Source: Ministry of Planning, 1997					

In addition to the New Cities mentioned above, the Ministry of Housing, Utilities and New Communities in Decree 59/1979 also mentions the new cities Elamal, New Akmein, New Nag Hammadi, and New Aswan.

B2 Horizontal Expansion Projects

Horizontal Expansion Projects (1,000 feddan)

Region	Total area	Completed by 2004	Under implementation in 2004	To be initiated 2004 -2017
Irrigated by groundwater				
Western Delta	*60.0*	*15.0*	*45.0*	*0.0*
Wady El Faregh	60.0	15.0	45.0	0.0
Sinai	*25.4*	*5.9*	*19.5*	*0.0*
Hadaba El Seneia	3.9	0.0	3.9	0.0
Sahel El Kaa	1.5	0.8	0.7	0.0
Wady Wateer	1.5	0.8	0.7	0.0
Hadaba El Teah	2.3	0.8	1.5	0.0
Middle Sinai	10.0	3.0	7.0	0.0
El Hadaba El Hdoudia	2.3	0.5	1.8	0.0
Altaerk Al Awsat	3.9	0.0	3.9	0.0
Western Desert	*514.0*	*83.0*	*166.0*	*265.0*
East El Owenat	200.0	20.0	80.0	100.0
North East Toshka	50.0	0.0	50.0	0.0
Darb El Arbeen	12.0	0.0	12.0	0.0
El Kharga Oasis	34.0	15.0	0.0	19.0
El Dakhla Oasis	106.0	30.0	0.0	76.0
Farafra & Sahel El Karaween	65.0	15.0	0.0	50.0
El Wahat El Baharia	20.0	0.0	0.0	20.0
Siwa Oasis	27.0	3.0	24.0	0.0
Eastern Desert	*70.0*	*0.0*	*60.0*	*10.0*
Halayeb and Shalateen	60.0	0.0	60.0	0.0
East Luxor	10.0	0.0	0.0	10.0
Irrigated by treated waste water				
Eastern Delta	*45.0*	*0.0*	*0.0*	*45.0*
Jabel Asfar - El berka	45.0	0.0	0.0	45.0
Western Delta	*95.0*	*95.0*	*0.0*	*0.0*
Zenean & Abu Rawash	95.0	95.0	0.0	0.0
Middle Egypt	*20.7*	*0.0*	*0.0*	*20.7*
El Saf and Ghamaza	20.7	0.0	0.0	20.7

Horizontal Expansion Projects (1,000 feddan) (continued)

Region	Total area	Completed by 2004	Under implementation in 2004	To be initiated 2004 -2017
Irrigated by surface water				
Eastern Delta	*465.2*	*317.0*	*25.7*	*122.5*
West Suez	40.0	21.0	9.0	10.0
El Shabab Extension	17.5	0.0	0.0	17.5
El Adeleia	20.0	13.0	0.0	7.0
El Salhya Desert	40.0	0.0	0.0	40.0
El Salam (West)	220.0	165.0	15.0	40.0
El Manaef	21.5	21.5	0.0	0.0
Direct Expansion on Esmailia Canal	5.0	5.0	0.0	0.0
Elshsbab	36.0	28.0	0.0	8.0
Agriculture Projects in Salhya	13.0	13.0	0.0	0.0
Group of Arabian Engineer	3.2	1.5	1.7	0.0
Expansion in Port Said	19.0	19.0	0.0	0.0
East ElBouherrat Extension	30.0	30.0	0.0	0.0
Middle Delta	*124.9*	*115.9*	*9.0*	*0.0*
North Mtoubs	11.0	2.0	9.0	0.0
Balteem	13.0	13.0	0.0	0.0
Abu Mady	56.0	56.0	0.0	0.0
Elkalabshaa	8.4	8.4	0.0	0.0
Hafeer Shehab Eldin	24.0	24.0	0.0	0.0
West Borolous	12.5	12.5	0.0	0.0
Western Delta	*324.0*	*299.0*	*0.0*	*25.0*
El Bustan	75.0	68.0	0.0	7.0
El Naser canal belt	35.0	26.0	0.0	9.0
El Hamam Extension	148.0	148.0	0.0	0.0
El Hamam	45.0	45.0	0.0	0.0
El Bouseli and Houd El Remal	21.0	12.0	0.0	9.0
Sinai	*690.0*	*310.0*	*10.0*	*370.0*
East Suez (Sheikh Zaid Canal)	40.0	30.0	10.0	0.0
Middle Sinai (after compl. Jonglei)	250.0	0.0	0.0	250.0
El Salam (East)	400.0	280.0	0.0	120.0
Middle Egypt	*81.0*	*43.7*	*8.8*	*28.6*
Wady El Rayan	4.0	4.0	0.0	0.0
Kouta El Gededa	16.0	0.0	0.0	16.0
Sediment & Miana	3.0	3.0	0.0	0.0
Kebli Karoun Extension	5.0	5.0	0.0	0.0
North & East Bahr Wahby	9.0	7.5	0.0	1.6
El Saef and Khamaza	22.0	7.0	5.0	10.0
Shabab Elkheregeen &West Fashn	10.0	10.0	0.0	0.0
Elgamaiat	12.0	7.2	3.8	1.0

Horizontal Expansion Projects (1,000 feddan) (continued)

Region	Total Area	Completed by 2004	Under implementation in 2004	To be initiated 2004-2017
Upper Egypt	*962.4*	*66.8*	*246.3*	*649.4*
El Salam Farm in Abu Simbel	2.5	0.5	0.0	2.0
Kasdel and Adnedan	4.0	1.0	0.0	3.0
Toshka	540.0	0.0	200.0	340.0
Wady El Koubaniea	10.0	0.0	0.0	10.0
Wady El Nokra	65.0	15.0	15.0	35.0
West Kum Ambo	50.0	0.0	0.0	50.0
Wady El Saieda	30.0	23.0	0.0	7.0
Old El Marashda	3.5	3.5	0.0	0.0
New El Marashda	12.5	1.3	11.3	0.0
Wady El Laketa	135.0	0.0	0.0	135.0
Quena Valley	9.0	0.0	0.0	9.0
Naga Hamady & Awlad Touk	12.5	12.5	0.0	0.0
West Gerga	5.0	0.0	0.0	5.0
West Sohag	5.0	0.0	0.0	5.0
West Tahta	5.0	0.0	0.0	5.0
Wady El Sheh	10.0	10.0	0.0	0.0
El Ghanyem	3.0	0.0	0.0	3.0
East Assiout &El Wady El Asiouty	25.0	0.0	20.0	5.0
West Manflout	15.0	0.0	0.0	15.0
Dandarah ElAref	20.4	0.0	0.0	20.4

B3 Developments Public Water Supply

Capacities in 1000 m³/day

Governorate	Existing Plants: Design capacity	Existing Plants: Production	Extensions: Under constr.	Extensions: Planned	Future plants: Under constr.	Future plants: New planned	Total design capacity
Alexandria	2,414	2,002	0	234	180	0	2,828
Asyut	781	318	0	35	121	45	981
Aswan	227	146	0	26	173	75	501
Beheira	521	492	52	207	138	130	1,048
Beni Suef	356	232	0	43	104	60	563
Cairo	4,122	3,947	0	1,100	400	0	5,622
Dakahlia	861	703	104	86	267	0	1,318
Damietta	335	230	35	86	69	0	526
El Menia	418	286	0	35	475	0	928
Fayoum	367	315	0	120	173	50	709
Gharbia	883	479	17	121	104	0	1,125
Giza	1,964	1,659	181	0	519	242	2,907
Ismailia	379	250	0	256	35	0	669
Kafr el Sheikh	519	423	0	69	0	294	882
Kaliubia	844	591	35	417	930	276	2,501
Marsa Matrouh	70	23	0	0	338	0	408
Menoufiya	519	312	0	0	567	0	1,086
New Valley	131	84	0	0	0	0	131
North Sinai	147	114	0	3	0	0	150
Port Said	282	203	0	125	0	0	407
Qena	501	355	56	104	138	52	851
Red Sea	76	77	54	20	70	0	220
Sharkia	1,028	718	17	106	699	52	1,902
Sohag	416	297	5	52	193	0	667
South Sinai	82	48	0	0	0	52	134
Suez	274	234	180	63	69	0	585
Total	**18,516**	**14,540**	**736**	**3,307**	**5,761**	**1,328**	**29,648**

B4 Industrial Water Demand

Governorate	Demand in 2000														Estimated demand 2017
	Chemical		Food		Textile		Engineering		Mining		Metal		Total		
	Number of labour (-)	Water use '000 m^3/s	Number of labour (-)	Water use '000 m^3/s	Number of labour (-)	Water use '000 m^3/s	Number of labour (-)	Water use '000 m^3/s	Number of labour (-)	Water use '000 m^3/s	Number of labour (-)	Water use '000 m^3/s	Number of labour (-)	Water use '000 m^3/s	'000 m^3/s
Alexandria	41,473	125,058	33,594	151,842	75,090	36,309	20,265	4,237	10,400	11,138	13,688	19,037	194,510	347,621	426,839
Asyut	1,837	5,539	3,830	17,311	2,236	1,081	691	144	3,386	3,626	16	22	11,996	27,725	56,584
Aswan	3,137	9,459	5,125	23,165	0	0	334	70	1,882	2,016	1,944	2,704	12,422	37,413	69,008
Beheira	1,935	5,835	6,715	30,351	38,922	18,820	303	63	2,542	2,722	238	331	50,655	58,123	74,995
Beni Suef	47	142	2,954	13,352	2,026	980	590	123	1,223	1,310	53	74	6,893	15,980	24,357
Cairo	61,950	186,805	43,746	197,728	31,918	15,434	59,915	12,528	23,917	25,615	55,176	76,737	276,622	514,846	634,707
Dakahlia	5,725	17,263	9,067	40,982	8,507	4,113	2,010	420	1,806	1,934	871	1,211	27,986	65,925	85,457
Damietta	404	1,218	2,063	9,325	4,558	2,204	550	115	388	416	21	29	7,984	13,307	48,249
El Menia	12	36	9,229	41,714	2,126	1,028	773	162	538	576	54	75	12,732	43,591	65,722
Fayoum	32	96	3,142	14,202	1,866	902	680	142	2,698	2,890	51	71	8,469	18,303	26,661
Gharbia	7,103	21,418	15,713	71,021	56,968	27,546	2,874	601	2,206	2,363	1,074	1,494	85,938	124,443	149,332
Giza	39,973	120,535	38,918	175,906	17,168	8,301	24,903	5,207	10,227	10,953	8,900	12,378	140,089	333,280	452,096
Ismailia	310	935	3,491	15,779	1,978	956	1,184	248	494	529	556	773	8,013	19,220	50,552
Kafr el Sheikh	30	90	4,916	22,220	2,220	1,073	446	93	598	640	72	100	8,282	24,218	33,115
Kaliubia	19,223	57,965	9,648	43,608	27,601	13,346	18,032	3,770	16,617	17,797	11,483	15,970	102,604	152,457	182,948
Marsa Matr	2,445	7,373	302	1,365	0	0	35	7	18	19	0	0	2,800	8,764	10,517
Menoufiya	1,532	4,620	5,672	25,637	12,197	5,898	1,068	223	2,821	3,021	1,286	1,789	24,576	41,187	76,076
New Valley	16	48	630	2,848	0	0	10	2	10	11	0	0	666	2,909	3,364
North Sinai	0	0	109	493	0	0	0	0	931	997	0	0	1,040	1,490	1,788
Port Said	789	2,379	2,162	9,772	7,978	3,858	3,206	670	649	695	351	488	15,135	17,862	22,035
Qena	0	0	9,169	41,443	1,710	827	679	142	0	0	10,611	14,757	22,169	57,169	145,306
Red Sea	7,335	22,118	52	235	0	0	130	27	2,696	2,887	0	0	10,213	25,268	30,321
Sharkia	14,205	42,834	21,266	96,120	32,047	15,496	17,916	3,746	9,975	10,683	3,658	5,087	99,067	173,967	258,528
Sohag	291	877	6,485	29,312	2,667	1,290	455	95	356	381	79	110	10,333	32,065	43,187
South Sinai	2,945	8,880	122	551	0	0	15	3	1,081	1,158	0	0	4,163	10,593	12,711
Suez	11,071	33,384	1,712	7,738	3,613	1,747	1,078	225	1,567	1,678	13	18	19,054	44,790	54,024
Total	**223,820**	**674,910**	**239,832**	**1,084,018**	**333,396**	**161,210**	**158,142**	**33,067**	**99,026**	**106,057**	**110,195**	**153,255**	**1,164,411**	**2,212,517**	**3,038,480**

B5 Developments Waste Water Treatment

Governorate	Existing Plants: Design capacity	Existing Plants: Production	Extensions: Under constr.	Extensions: Planned	Future plants: Under constr.	Future plants: Planned extens.	Future plants: New planned	Total design capacity
Alexandria	777	585	400	0	0	0	0	1,177
Asyut	50	53	30	40	185	165	40	510
Aswan	54	47	11	30	75	8	118	296
Beheira	185	71	0	136	138	216	44	719
Beni Suef	26	35	0	54	113	101	60	354
Cairo	1,712	1,379	400	0	25	80	250	2,467
Dakahlia	150	144	46	10	449	239	30	924
Damietta	144	90	0	84	84	4	90	406
El Menia	88	43	0	10	265	125	130	617
Fayoum	109	72	0	64	83	70	84	409
Gharbia	294	157	30	90	154	78	10	656
Giza	1,030	794	0	280	90	0	0	1,400
Ismailia	100	80	0	50	34	10	20	214
Kafr el Sheikh	19	19	0	0	263	95	99	475
Kaliubia	625	374	8	85	203	170	125	1,216
Marsa Matrouh	25	4	25	0	0	0	18	68
Menoufiya	143	111	53	11	180	0	120	507
New Valley	26	22	0	13	30	0	0	69
North Sinai	51	29	0	0	0	0	0	51
Port Said	190	124	0	190	22	0	6	408
Qena	38	48	26	60	189	113	180	605
Red Sea	0	0	0	0	0	0	0	0
Sharkia	81	69	20	0	588	320	80	1,089
Sohag	22	18	28	0	170	130	168	518
South Sinai	20	12	0	20	11	0	0	51
Suez	130	120	0	65	0	0	2	197
Total	**6,087**	**4,497**	**1,076**	**1,291**	**3,351**	**1,924**	**1,674**	**15,403**

B6 Planned Drainage Water Reuse

DELTA pump stations	From drain	To canal	1997 MCM/yr	2007 MCM/yr	2017 MCM/yr
Eastern Delta					
Wadi P.S.	Qalyubeya	Wadi El Sharky	32	183	183
Blad El Ayad P.S.	Bahr Baqar br.	Wadi El Sharky	121	121	121
Bahr Baqar Irr. P.S.	Bahr Baqar	Battikh	22	22	22
Hanut P.S.	Saft El Qibly	Mois.	253	253	253
Saft P.S.	Saft	Daffan	123	123	123
Mahsama P.S.	Wadi	Ismailia	0	37	37
New Kassasin P.S.	Wadi	Ismailia	240	0	0
Upper Serw P.S.	Serw	Damietta Br.	260	260	260
Farasqur P.S.	Farasqur	Salam	n.a	300	300
Salam 1 (Lower Serw)	Serw	Salam	363	400	435
Salam 3	Bahr Hadus	Salam	360	1 000	1 905
Middle Delta					
Mahalla El Kubra P.S.	Upper Gharbia	Damietta Br.	101	100	100
Upper No.1 P.S.	No.1	Damietta Br.	0	21	21
Outflow No.1 & No.2	No.1&2	Khasha area	0	500	1 000
East Menufeya P.S.	Menufi	Bahr El Abasy	57	57	57
Mahallet Ruh P.S.	Upper Gharbia	Mit Yazid	77	77	77
Hamul P.S.	Gharbia end	Tira, El Nil etc	390	390	390
Gharbia outfall	Gharbia end	Tira, El Nil etc	0	970	970
No.11 P.S.	No.11	El Nour + Abo Ismiel	0	178	178
Nashart drain	Nashart		0	236	236
Tilla (gravity)	Tilla	Rosetta Br.	112	61	61
Sabal (gravity)	Sabal	Rosetta Br	71	69	69
Western Delta					
Etay Barud P.S.		El Khandak El Sharki	55	55	55
Khandak El Gharbi P.S.		Abo Diab	58	58	58
Edko P.S.	Edko	Mahmoudya	88	88	88
Dilingat P.S.		El Hagar + Frahash	245	245	245
Dilingat Ext. P.S.		Nubaria	78	78	78
Maryut Khalt P.S.	Umoum	Nubaria	67	n.a.[1)]	n.a.
Umum Reuse PS	Shereshra	Nubaria	0	500	1 100
Bustain P.S.	Nubaria	Nubaria	46	46	46
Drain 3 (gravity)	Drain 3	Nubareya			
Drain 6 (gravity)	Drain 6	Nybareya			
Total			**3 219**	**6 428**	**8 468**

[1)] Amount is covered under Umum Reuse PS

FAYOUM pump stations	From drain	To canal	Capacity 1997 m^3/s	Planned m^3/s	Maximum reuse MCM/yr
Baga	Shahat	Baga	0.20		5.47
Tanhala	Tanhala	El Wati	0.20		5.47
Yasser Wahby	Batts	End Wahby	0.04		1.09
Tourbine Aneli	Batts	Naqula	0.25		6.84
Hayer	Batts	Hayer	0.75		20.53
Batts	Batts	Wahby	4.20		114.97
Zenket	Zenket	Zenkat	0.25		4.56
Tagen	Tagen	Nezle	5.20		113.88
El Gahaba	Shahat	Gahaba	0.50		13.69
Garaq	Garaq	Bashawat	0.09		2.46
El Arin	Abou Denkash	El Arin	0.40		5.47
Ihreat	Abou Denkash	Ihreat	0.02		0.55
Gass	Rayan	Gass	0.50		13.69
Ibgig	El Shahat	Ibgig		0.20	5.47
Nezla	Rayan	Nezla		1.50	41.06
Raya n	Rayan	Qasr El Banat		1.50	41.06
Total			**12.60**	**3.20**	**396.26**

Sources: 1997 data: DRI, personal communication
2007 & 2017 data: Horizontal Expansion Sector, MWRI

B7 Screening of Measures

One of the steps in the analysis process for FtC involved the screening of potential measures based on the following criteria (see also Section 4.7):

- Effectiveness: are we doing the right things?
- Efficiency: are we doing the things right?
- Legitimacy: can we implement the measure?
- Sustainability: will the measure also be beneficial for our children?

This annex B7 contains the end results of the screening. For a more detailed description of the measures and the screening process reference is made to the Technical Report on Measures (TR24). The column 'No.' in the following tables refers to the numbers as used in this Technical Report. The scoring as applied in the screening process was that a very positive scoring was valued with '++', a positive scoring with '+', a neutral scoring with '0' and a negative scoring with '-', whereas NA means "not applicable". The basis of this scoring was as follows:

Effectiveness (are we doing the right thing?)

Not effective	(-)
Little effective	(0)
Effective	(+)
Very effective	(++)

Efficiency (are we doing things right?)

Benefits may not offset costs	(-)
Negligible effect	(0)
Benefits may offset costs	(+)
Benefits will clearly offset costs	(++)

Legitimacy (need for change in the existing legal framework)

Need complete change	(-)
Need major change	(0)
Need small change	(+)
No change needed	(++)

Sustainability (inter-generation equity)

Against sustainability	(-)
Negligible effect	(0)
Could be sustainable	(+)
Highly sustainable	(++)

An overall score for the measure was achieved by assigning the values 2, 1, 0 and – 1 to above scores and adding these values. This means that the maximum score for a measure can be 8 while the minimum score is – 4.

It is stressed that the main purpose of this screening process was to get some feeling on how promising these measures are. The screening was not used to discard measures nor to make final decisions on which measures should be included in FtC. Even less promising measures can be included in FtC if the problems and political situation requires such inclusion. The screening process has been a supporting step only. This is also the reason why no weights have been given to above criteria.

No	Measures on NEW WATER RESOURCES	Criteria				Score
		Effectiveness	Efficiency	Legitimacy	Sustainability	
40	Stimulate rainfall harvesting along Northern Coast	+	++	+	++	6
121	Increase management of shallow groundwater Nile aquifer	++	++	+	+	6
49	Increase brackish/salt water desalination	+	++	+	+	5
35	Develop groundwater in the Western Desert	++	++	+	-	4
119	Develop groundwater in Sinai and Eastern Desert	++	++	+	-	4
120	Continue the coperation with riparian states of the Nile Basin	++	+	O	+	4
37	Study use brackish groundwater for aquaculture	++	+	+	NA	4
58	Negotiate larger share of Nile water	++	++	-	O	3
134	Completion of Jonglei Canal	++	+	-	O	2
41	Flash flood harvesting in Sinai and Eastern Desert	+	-	+	+	2

No	Measures on WATER QUALITY	Criteria				Score
		Effectiveness	Efficiency	Legitimacy	Sustainability	
4	Introduce financial incentives for clean industrial products	++	+	++	++	7
13	Encourage the use of environmentally friendly agricultural methods	++	+	++	++	7
103	Start local action plans on domestic sanitation in rural areas	++	+	++	++	7
9	Introduce load-based discharge levies	++	++	+	+	6
10	Increase municipal waste water treatment	++	+	++	+	6
107	Strengthen institutions controlling and monitoring industrial pollution	+	+	++	++	6
108	Initiate cost recovery for urban sanitary services	++	++	O	++	6
110	Prioritise development of Nile aquifer for drinking water	+	++	+	++	6
1	Select proper sources for public water supply	++	+	+	+	5
5	Initiate water quality awareness campaigns	+	O	++	++	5
8	Provide sewage disposal in unconnected areas	+	+	++	+	5
29	Define effluent standards based on receiving water	+	++	NA	++	5
31	Control the production and import of agro-chemicals	+	O	++	++	5
66	Initiate environmental awareness campaigns	+	+	+	++	5
117	Enhance water quality monitoring and information dissemination	+	+	++	+	5
127	Encourage treatment of industr. waste water by industries	++	+	+	+	5
128	Train MWRI and WB staff on pollution and water quality	+	+	++	+	5
2	Divert pollution away from Lake Bardawil	+	+	+	+	4
26	Improve monitoring of the environment	+	+	+	+	4
27	Register industrial emissions	O	+	++	+	4
79	Protect groundwater from pollution (in particular around wells)	+	O	++	+	4
80	Start public disclosure pollution control for industries (PROPER)	+	++	+	O	4
101	Introduce compliance action agreements for industries	+	+	+	+	4
102	Collect/(pre-)treat industrial waste water separately	+	+	+	+	4
3	Initiate public awareness campaigns for clean products	++	O	+	O	3
17	Phase out and relocate polluting industries along vital waters	++	-	+	+	3
7	Reduce human contact with polluted water	+	+	+	O	3
84	Relocate El - Umum pumping station	+	O	+	+	3
89	Define functions of waterways	O	+	O	++	3
16	Introduce separate disposal of unfit waste water	+	-	++	O	2
25	Introduce water quality dependent water charges	O	++	-	+	2
65	Introduce tradable pollution rights	+	++	-	-	1
74	Restore ecology of Northern Lakes by flushing	+	-	+	O	1
14	Relocate sewage outlets to drains	O	-	+	O	0
28	Enforce effluent standards	-	-	O	++	0

No	Measures on MORE EFFICIENT USE	Criteria				Score
		Effectiveness	Efficiency	Legitimacy	Sustainability	
	AGRICULTURE					
	Institutional and cost recovery					
113	Train MWRI and Water Board staff in system operation	++	++	+	+	6
33	Transfer water management authority to Water Boards	+	++	+	+	5
69	Continue the set- up of Water Users Associations	+	++	+	+	5
71	Strengthen Irrigation Advisory Service	+	++	+	+	5
100	Implement systems of cost sharing for all water users	++	+	O	+	4
21-23	Set import duties to affect self - sufficiency of various commodities	+	0	+	+	3
24	Introduce crop- based cost recovery	O	+	O	+	2
	Horizontal expansion					
123	Make hor. expansion dependent on availability of new water res.	++	++	O	++	6
95	Continue horizontal expansion	+	+	+	+	4
112	Postpone Middle Sinai developments	+	+	+	+	4
118	Enforce reduction of loss of agricultural land	++	+	O	+	4
	Improvement overall water use efficiency					
57	Introduce controlled drainage for rice cultivation	+	++	+	+	5
78	Apply modern irrigation techniques in new areas	++	+	+	+	5
97	Promote cultivation of salt tolerant crop varieties in the Delta	+	++	+	+	5
114	Allow higher permissible salinities of irrigation water	+	++	+	+	5
36	Apply land levelling with laser techniques	+	+	+	+	4
50	Improve drainage conditions in old lands	++	+	O	+	4
51	Apply intermediate reuse of drainage water at appropriate locations	+	+	+	+	4
82	Gradually introduce modern irrigation techniques in oases	++	+	O	+	4
86	Apply canal lining in effectives stretches	+	+	+	+	4
90	Continue IIP activities in prioritised areas	++	+	O	+	4
115	Prioritise drainage water reuse in selected areas	+	+	+	+	4
124	Prioritise efficiency measures in effective areas	++	+	O	+	4
56	Reuse treated waste water in New Industrial and Canal Cities	+	+	O	+	3
63	Restrict rice cultivation	+	+	O	+	3
39	Reduce evaporation losses from fallow lands	-	O	++	++	3
83	Transfer drainage water from Middle Delta to Eastern Delta	+	+	O	+	3
81	Apply conjunctive use of surface and groundwater	+	++	-	-	1
	Water allocation and distribution					
111	Establish MALR/MWRI coordination mechnism on supply&demand	++	++	+	+	6
68	Improve physical infrastructure for water distribution	+	++	+	+	5
104	Introduce deficit irrigation	+	++	+	+	5
99	Control well discharges in desert areas	+	+	+	+	4
122	Reduce irrigation supply after rainfall	+	+	O	++	4
93	Introduce regional water allocation based on equal opportunities	+	+	O	+	3
98	Introduce water allocation based on fixed annual amounts per feddan	+	+	O	+	3
116	Introduce water delivery agreements between MWRI and WBs	+	+	O	+	3
72	Provide WUAs with continuous water supply	O	O	+	+	2
	Demand management and maintenance					
6	Provide solid waste collection and disposal systems in rural areas	++	++	+	+	6
46	Extend aquatic weed control by grass crap	+	++	+	+	5
52	Tax high water consuming crops	O	+	O	+	2
59	Introduce tradable water rights	+	+	-	+	2
53	Subsidise low water consuming crops	O	O	O	+	1
	Research					
34	Study different operation of High Aswan Dam	+	++	+	+	5
44	Develop salt tolerant crop varieties	+	++	+	+	5
62	Develop short duration and drought resistant crop varieties	+	++	+	+	5
45	Enhance research on solar desalination for agriculture	+	-	+	+	2
	MUNICIPAL AND INDUSTRIAL					
11	Increase drinking water treatment capacity	++	++	++	+	7
18	Install / rehabilitate municipal water metering & control	++	+	+	+	5
19	Review price policy of drinking water	+	++	+	+	5
49	Increase brackish/salt water desalination	+	++	+	+	5
43	Intensify water conservation awareness campaigns	+	+	+	+	4
87	Reduce leakage losses in PWS systems by prioritisation	+	O	+	+	3
54	Promote water saving technologies in industries	+	O	O	+	2
47	Use aquifer for storing of treated waste water	+	O	O	O	1

No	Other Measures	Criteria				Score
		Effectiveness	Efficiency	Legitimacy	Sustainability	
109	Coordinate investments on the regional and national levels	++	++	+	++	7
94	Establish permanent Inter- Ministrial High Committee on IWRM	+	++	++	+	6
106	Restructure the role of MWRI	++	++	+	+	6
130	Restructure MWRI: establish integrated Districts	++	++	+	+	6
131	Continue water sector planning as a rolling exercise	+	+	++	++	6
132	Enhance data exchange among different authorities	++	++	+	+	6
133	Enhance role of NGOs and Civil Society (e.g. in local action plans)	++	++	+	+	6
30	Improve food & fish quality control	+	+	+	++	5
60	Remove shallows in the Nile through dredging	++	++	++	-	5
20	Stimulate Public Private Partnership for infrastructure and O&M	+	++	O	+	4
75	Review restrictions on cage culture in the Nile and canal system	+	+	-	+	2

ANNEX C

Investment Tables

Contents

C1 All NWRP Measures

Table C-1 and Table C-2 provide an overview of all measures included in the Investment and O&M Plan of NWRP. This includes the measures of the strategy Facing the Challenge as well as the 'on-going' activities of the Ministry of Water Resources and Irrigation.

No.		Agency	Total cost	2003	2004	2005	2006	2007	2007-12
	Developing additional resources		**8 274**	**350**	**537**	**579**	**612**	**613**	**2 961**
	Nile water		**2 533**	**34**	**222**	**218**	**223**	**224**	**975**
120	Continue the co-operation with the riparian states of the River Nile	MWRI	2 533	34	222	218	223	224	975
	Groundwater		**4 311**	**287**	**287**	**292**	**287**	**287**	**1 436**
35	Groundwater development Western Desert	MWRI	3 500	233	233	233	233	233	1 167
119	Groundwater development Sinai and Eastern Desert	MWRI	807	54	54	54	54	54	269
37	Development brackish groundwater for agriculture and aquaculture	MWRI/MALR	4.4			4.4			
121	Increase management of shallow groundwater	MWRI	0						
	Rainfall and flash flood harvesting		**631**	**28**	**28**	**38**	**38**	**38**	**230**
40	Stimulate rainfall harvesting along Northern Coast	MWRI	100	8	8	8	8	8	30
48	Stimulate on-farm rainfall harvesting along Northern Coast	MALR		0	0	0	0	0	0
41	Flash flood harvesting in Sinai and Eastern Desert	MWRI	531	20	20	30	30	30	200
	Desalination		800	**0**	**0**	**32**	**64**	**64**	**320**
49	Increase brackish / salt water desalination	Private/MWRI	800			32	64	64	320
	Making better use of existing resources		**41 512**	**2 819**	**3 709**	**3 622**	**3 326**	**3 317**	**13 098**
	Horizontal expansion		**7 750**	**601**	**701**	**602**	**305**	**305**	**2 618**
112	Postpone Middle Sinai developments	MWRI	0						
123	Make future horizontal expansion dependent on water availability	MWRI/MALR	0						
95	Continue horizontal expansion	MWRI/MALR	7 750	601	701	602	305	305	2 618
	Water use efficiency Nile system - irrigation efficiency		**10 196**	**422**	**1 087**	**1 088**	**1 088**	**1 088**	**3 040**
124	Prioritise efficiency measures in effective areas	MWRI	0						
90	Continue IIP in prioritised areas/IIMP	MWRI	6 700	400	450	450	450	450	2 250
71	Strengthen Irrigation Advisory Service	MWRI	0						
86	Apply canal lining in effective stretches	MWRI	335	22.3	22.3	22.3	22.3	22.3	111.5
36	Apply land-leveling with laser techniques	MALR	0						
57	Introduce controlled drainage during rice cultivation	MWRI/MALR	16			1	1	1	6
78	Apply modern irrigation techniques in new areas	Private	3 003		601	601	601	601	601
82	Gradually introduce modern irrigation techniques in oases	MWRI/MALR	143		14	14	14	14	71
99	Control well discharges in desert areas	MWRI	0						
122	Reduce irrigation after rainfall	MWRI	0						
	Water use efficiency Nile system - reuse of drainage water		**3 998**	**335**	**336**	**336**	**336**	**336**	**1 460**
50	Improve drainage conditions(EPADP)	MWRI	**3 833**	326.6	326.6	326.6	326.6	326.6	1400.0
	Review drainage water reuse policy, including		0						
51	- Apply intermediate reuse at appropriate locations	MWRI	63	4.2	4.2	4.2	4.2	4.2	21.0
115	- Prioritise drainage reuse in specific areas	MWRI/MALR	0.0						
114	- Allow higher permissible salinities in irrigation water	MWRI/MALR	94.2	4.1	4.3	4.5	4.5	4.5	36.2
97	Promote cultivation of salt tolerant crop varieties	MALR	7.5	0.5	0.5	0.5	0.5	0.5	2.5
	Water allocation and distribution Nile system		**18 158**	**1 359.5**	**1 483.8**	**1 497.8**	**1 502.8**	**1 493.8**	**5 517.2**
33	Transfer water management authority to Water Boards at District level	MWRI	See under General institutional, legal and financial measures						
69	Continue set-up of Water Users Associations at mesqa level	MWRI	0						
93	Introduce regional water allocation based on equal opportunities	MWRI	0						
98	Introduce water allocation based on fixed annual amounts per feddan	MWRI	90.20	8.20	5.50	5.50	5.50	5.50	30.00
67	Continue canals and drains dredging and de-weeding	MWRI	2 100.00	140.00	140.00	140.00	140.00	140.00	700.00
68	Improve physical infrastucture for proper water distribution	MWRI	183.00	12.2	12.2	12.2	12.2	12.2	61.0
111	Establish MALR/MWRI coordination mechanism on supply and demand	MWRI/MALR	0.45	0.03	0.03	0.03	0.03	0.03	0.15
116	Introduce water delivery agreements between MWRI and Water Boards	MWRI	0						
113	Train MWRI and WB-staff in system operation	MWRI	1	0.05	0.05	0.05	0.05	0.05	0.25
32	Rehabilitate barrages and regulators	MWRI	2 225	276	403	417	422	413	254
42	Rehabilitate and further develop pumping stations in river and canal system.	MWRI	10 021	668	668	668	668	668	3 340
38	Maintain and improve High Aswan Dam and Lake Nasser	MWRI	1 765	117.7	117.7	117.7	117.7	117.7	588.3
61,91	Continue works on River banks, Sea Shores and Mapping	MWRI	1 630	128	128	128	128	128	496
6	Provide solid waste collection and disposal systems in rural areas	Municipal.	0						
46	Extend aquatic weed control by grass carp in addition to the mechanical control	MWRI/MALR	142.5	9.5	9.5	9.5	9.5	9.5	47.5
	Municipal and industrial water (quantity)		**367**	**25.6**	**23.9**	**24.9**	**24.9**	**24.9**	**122.3**
18	Install/rehabilitate metering system	Municipal.	249	17.3	17.3	17.3	17.3	17.3	82.1
19	Review price policy of drinking water	Municipal.	1.00	0.10	0.10	0.10	0.10	0.10	0.25
43	Intensify water shortage awareness campaigns	MWRI	90	8.2	5.5	5.5	5.5	5.5	30.0
54	Promote water saving technologies in industry through Campaigns	MoI/MWRI	27	0.0	1.0	2.0	2.0	2.0	10.0
87	Reduce leakage losses in PWS system by prioritisation	MHUNC/Municp.	0						
56	Reuse treated wastewater in New Industrial and Canal Cities	NOPW./MALR/MWRI	0.036	0.000	0.001	0.005	0.010	0.010	0.010
	Aquaculture		**1.26**	**0.00**	**1.26**	**0.00**	**0.00**	**0.00**	**0.00**
75	Review MWRI policies regarding aquaculture	MWRI/GAFRD	1.26		1.26				
	Navigation		**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
60	Remove shallows in Nile and canals through dredging	MWRI	0.00						
	Research		**1041.65**	**75.84**	**75.84**	**73.13**	**68.72**	**68.72**	**340.68**
34	Study different operation of High Aswan Dam	MWRI	16.18	8.09	8.09				
96	Continue activities of the National Water Research Center	MWRI	799	53.2	53.2	53.2	53.2	53.2	266.2
129	Conduct family planning awareness campaigns	MOHP	203	13.5	13.5	13.5	13.5	13.5	67.5
44	Develop salt tolerant crop varieties	MALR	8	0.5	0.5	0.5	0.5	0.5	2.5
62	Develop short duration and drought resistant crop varieties	MALR	8	0.5	0.5	0.5	0.5	0.5	2.5
37	Use of brackish groundwater for agri/aquaculture	MWRI/MALR	9			5.4	1.0	1.0	1.9

Table C-1 Time Planning and Investment of total NWRP (MLE)

No.		Agency	Total cost	2003	2004	2005	2006	2007	2007-12
	Protection of public health and environment		**95 031**	**8 808**	**8 812**	**8 827**	**8 823**	**8 823**	**30 367**
	Prevention		**939**	**67**	**70**	**70**	**67**	**67**	**300**
4	Introduce financial incentives to promote clean industrial products	MoI	900	60	60	60	60	60	300
80	Start public disclosure pollution control program for industries	EEEA	0						
101	Introduce compliance action agreements for industries	EEAA	0						
3	Initiate public awareness campaigns for clean products	EEAA	6		3	3			
17	Phase out and relocate polluting industries along vital waters	MoI	0						
9	Introduce load based discharge levies	MWRI	0						
13	Encourage use of environmentally friendly agricultural methods	MALR	33	7	7	7	7	7	
31	Control the production and import of agrochemicals	MALR	0						
135	Control the use of organic fertilisers	MALR	0						
	Treatment		**93 736**	**8 706**	**8 706**	**8 706**	**8 706**	**8 706**	**30 001**
10	Increase municipal sewerage and waste water treatment	MHUNC./Mun.	61 765	5 412	5 412	5 412	5 412	5 412	22 000
11	Increase drinking water treatment capacities	MHUNC./Mun.	28 250	2 750	2 750	2 750	2 750	2 750	7 500
108	Initiate cost recovery for urban sanitary services	MHUNC/NOPW.	1.50	0.10	0.10	0.10	0.10	0.10	0.50
103	Start local action plans on domestic sanitation in rural areas	MoLocalDev.	1 500.00	100.00	100.00	100.00	100.00	100.00	500.00
127	Encourage treatment or pre-treatment of industrial waste water by industries	MoI/EEAA	0.00						
102	Collect and/or pre-treat industrial waste water separately	EEAA	2 220	443.97	443.97	443.97	443.97	443.97	
	Control		**160.75**	**22.70**	**22.90**	**38.68**	**37.73**	**37.73**	**1.00**
89	Define functions of waterways	MWRI	0.95			0.95			
29	Define effluent standards based on the receiving water	MWRI/MOHP	0.00						
7	Include reduction of human contact with polluted water in local action plans	MoLocalDev.	0.00						
2	Divert pollution away from Northern Lakes	MWRI	43.30			14.43	14.43	14.43	
79	Protect groundwater wells from pollution	MoLD/MHUNC	4.00	0.20	0.40	0.80	0.80	0.80	1.00
1	Select proper sources for public water supply	MHUNC/MWRI/MHOP	37.50	7.50	7.50	7.50	7.50	7.50	
8	Provide sewage disposal systems in unconnected areas	MHUNC(NOP.)	75.00	15.00	15.00	15.00	15.00	15.00	
	Institutional actions for water quality and public health		**195.00**	**13.00**	**13.00**	**13.00**	**13.00**	**13.00**	**65.00**
117	Enhance water quality monitoring and information dissemination	MOHP/EEAA	195.00	13.00	13.00	13.00	13.00	13.00	65.00
128	Train MWRI and WB staff on pollution and water quality	MWRI	0.00						
107	Strengthen institutions controlling and monitoring industrial pollution	EEEA	0.00						
	General institutional, legal and financial measures		**244.60**	**7.30**	**20.15**	**20.15**	**16.35**	**16.15**	**82.25**
106	Restructure the role of MWRI - establish dedicated IRU	MWRI	53.90	6.30	6.30	6.30	2.50	2.50	15.00
109	Co-ordinate investments on regional and national levels	MWRI	7.00	0.00	0.50	0.50	0.50	0.50	2.50
130	Restructure MWRI - establish integrated water management districts	MWRI	140.00		10.00	10.00	10.00	10.00	50.00
33	Transfer water management authority to Water Boards at District level	Cabinet/MWRI	22.40		1.60	1.60	1.60	1.60	8.00
20	Stimulate Private Sector Participation in infrastructure and O&M	MWRI	5.25	0.25	0.50	0.50	0.50	0.50	1.50
100	Implement systems of cost sharing for all water users	MWRI	4.80		0.50	0.50	0.50	0.30	1.50
131	Continue water sector planning as a rolling exercise	MWRI	3.00	0.20	0.20	0.20	0.20	0.20	1.00
132	Enhance the data exchange among different authorities	All Gov. Org.	3.00	0.20	0.20	0.20	0.20	0.20	1.00
94	Establish a permanent inter-minsterial Commission on IWRM	Cabinet/MWRI	3.75	0.25	0.25	0.25	0.25	0.25	1.25
133	Enhance role of NGO's and Civil Society	MWRI/Private	1.50	0.10	0.10	0.10	0.10	0.10	0.50
90	**Overall Total**		**145 063**	**11 984**	**13 078**	**13 049**	**12 777**	**12 770**	**46 508**

Table C-1 Time Planning and Investment of total NWRP (MLE) – continued

No.		Agency	Total cost	2003	2004	2005	2006	2007	2007-12	2012-17
	Developing additional resources									
	Nile water									
120	Continue the co-operation with the riparian states of the River Nile	MWRI	236.72	6.51	7.16	7.87	8.66	9.53	93.97	103.02
	Groundwater									
35	Groundwater development Western Desert	MWRI	1 400.00	11.67	23.33	35.00	46.67	58.33	466.67	758.33
119	Groundwater development Sinai and Eastern Desert	MWRI	322.67	2.69	5.38	8.07	10.76	13.44	107.56	174.78
37	Development brackish groundwater for agriculture and aquaculture	MWRI/MALR	1.37			0.19	0.19	0.19	0.39	0.40
121	Increase management of shallow groundwater	MWRI	14.00		1.00	1.00	1.00	1.00	5.00	5.00
	Rainfall and flash flood harvesting									
40	Stimulate rainfall harvesting along Northern Coast	MWRI	5.80	0.16	0.32	0.48	0.64	0.80	1.40	2.00
48	Stimulate on-farm rainfall harvesting along Northern Coast	MALR			1.00	1.00	1.00	1.00	5.00	5.00
41	Flash flood harvesting in Sinai and Eastern Desert	MWRI	55.00				1.67	3.33	25.00	25.00
	Desalination									
49	Increase brackish / salt water desalination	Private	281.69			5.75	17.25	28.74	86.23	143.72
	Making better use of existing resources									
	Horizontal expansion									
112	Postpone Middle Sinai developments	MWRI								
123	Make future horizontal expansion dependent on water availability	MWRI/MALR	1.50	0.10	0.10	0.10	0.10	0.10	0.50	0.50
95	Continue horizontal expansion	Private	642.3	18.0	39.0	57.1	66.3	75.4	154.0	232.5
	Water use efficiency Nile system - irrigation efficiency									
124	Prioritise efficiency measures in effective areas	MWRI								
90	Continue IIP in prioritised areas/IIMP	MWRI	297.00		9.00	18.00	27.00	36.00	81.00	126.00
71	Strengthen Irrigation Advisory Service	MWRI	338.40	2.40	3.60	5.40	9.00	18.00	150.00	150.00
86	Apply canal lining in effective stretches	MWRI	44.60	1.12	2.23	3.35	4.46	5.58	11.15	16.73
36	Apply land-leveling with laser techniques	MALR	180.00	12.00	12.00	12.00	12.00	12.00	60.00	60.00
57	Introduce controlled drainage during rice cultivation	MWRI/MALR								
78	Apply modern irrigation techniques in new areas	Private	1 801.80		30.03	60.06	90.09	120.12	750.75	750.75
82	Gradually introduce modern irrigation techniques in oases	MWRI/MALR	20.66		0.71	1.43	2.14	2.85	6.41	7.13
99	Control well discharges in desert areas	MWRI								
122	Reduce irrigation after rainfall	MWRI								
	Water use efficiency Nile system - reuse of drainage water									
50	Improve drainage conditions (EPADP)	MWRI	1320.0	80.0	80.0	80.0	90.0	90.0	450.0	450.0
	Review drainage water reuse policy, including									
51	- Apply intermediate reuse at appropriate locations	MWRI	8.40	0.21	0.42	0.63	0.84	1.05	2.10	3.15
115	- Prioritise drainage reuse in specific areas	MWRI/MALR								
114	- Allow higher permissible salinities in irrigation water	MWRI/MALR								
97	Promote cultivation of salt tolerant crop varieties	MALR	3.00	0.50	0.50	0.50	0.50	0.50	0.25	0.25
	Water allocation and distribution Nile system									
33	Transfer water management authority to Water Boards at District level	MWRI								
69	Continue set-up of Water Users Associations	MWRI								
93	Introduce regional water allocation based on equal opportunities	MWRI								
98	Introduce water allocation based on fixed annual amounts per feddan	MWRI								
67	Continue canals and drains dredging and de-weeding	MWRI								
68	Improve physical infrastucture for proper water distribution	MWRI	48.80	1.22	2.44	3.66	4.88	6.10	12.20	18.30
111	Establish MALR/MWRI coordination mechanism on supply and demand	MWRI/MALR								
116	Introduce water delivery agreements between MWRI and Water Boards	MWRI								
113	Train MWRI and WB-staff in system operation	MWRI								
32	Rehabilitate barrages and regulators	MWRI	297.3	8.3	20.4	32.9	45.5	57.9	65.6	66.8
42	Rehabilitate/further develop pumping stations in river/canal system	MWRI	400.9	26.7	26.7	26.7	26.7	26.7	133.6	133.6
38	Maintain and improve High Aswan Dam and Lake Nasser	MWRI	35.3	2.4	2.4	2.4	2.4	2.4	11.8	11.8
61,91	Continue works on River banks, Sea Shores and Mapping	MWRI	48.9	3.8	3.8	3.8	3.8	3.8	14.9	14.9
6	Provide solid waste collection and disposal systems in rural areas	Municipal.								
46	Extend aquatic weed control by grass carp	MWRI/MALR	19.00	0.48	0.95	1.43	1.90	2.38	4.75	7.13
	Municipal and industrial water (quantity)									
18	Install/rehabilitate metering system	Municipal.	103.68	0.86	1.73	2.59	3.46	4.32	34.56	56.16
19	Review price policy of drinking water	Municipal.								
43	Intensify water shortage awareness campaigns	MWRI								
54	Promote water saving technologies in industry through Campaigns	MoI/MWRI								
87	Reduce leakage losses in PWS system by prioritisation	MHUNC/Municipal.	2 000.00	133.33	133.33	133.33	133.33	133.33	666.67	666.67
56	Reuse treated wastewater in New Industrial and Canal Cities	NOPW./MALR								
	Aquaculture									
75	Review MWRI policies regarding aquaculture	MWRI/GAFRD								
	Navigation									
60	Remove shallows in Nile through dredging	MWRI	3 000.00	200.00	200.00	200.00	200.00	200.00	1 000.00	1 000.00
	Research									
34	Study different operation of High Aswan Dam	MWRI								
96	Continue activities of the National Water Research Center	MWRI	15.97	1.06	1.06	1.06	1.06	1.06	5.32	5.32
129	Conduct family planning awareness campaigns	MOHP								
44	Develop salt tolerant crop varieties	MALR								
62	Develop short duration and drought resistant crop varieties	MALR								
37	Use of brackish groundwater for agri/aquaculture	MWRI/MALR								

Table C-2 O&M of total NWRP (MLE)

No.		Agency	Total cost	2003	2004	2005	2006	2007	2007-12	2012-12
	Protection of public health and environment									
	Prevention									
4	Introduce financial incentives to promote clean industrial products	MoI								
80	Start public disclosure pollution control program for industries	EEEA	1.89		1.26	0.63				
101	Introduce compliance action agreements for industries	EEEA	14.00		1.00	1.00	1.00	1.00	5.00	5.00
3	Initiate public awareness campaigns for clean products	EEEA								
17	Phase out and relocate polluting industries along vital waters	MoI								
9	Introduce load based discharge levies	MWRI	0.05	0.02	0.02					
13	Encourage use of environmentally friendly agricultural methods	MALR	24.00	1.00	1.10	1.20	1.30	1.40	8.00	10.00
31	Control the production and import of agrochemicals	MALR	13.25		0.50	0.75	1.00	1.00	5.00	5.00
135	Control the use of organic fertilisers	MALR								
	Treatment									
10	Increase municipal sewerage and wastewater treatment	MHUNC(NOP.)	12 083.75	445.60	499.72	553.84	607.96	662.08	3 970.40	5 344.15
11	Increase drinking water Treatment capacities	Municipal.	15 621.25	687.00	742.00	797.00	852.00	907.00	4 985.00	6 651.25
108	Initiate cost recovery for urban sanitary services	Municipal.								
103	Start local action plans on domestic sanitation in rural areas	MoLocalDev.								
127	Encourage treatment or pre-treatment of industrial wastewater by industries	MoI/EEAA	30.0	2.0	2.0	2.0	2.0	2.0	10.0	10.0
102	Collect and/or pre-treat industrial wastewater separately	EEAA	3 009.50	46.30	92.60	138.90	185.20	231.50	1 157.50	1 157.50
	Control									
89	Define functions of waterways	MWRI								
29	Define effluent standards based on the receiving water	MWRI/MOHP								
7	Include reduction of human contact with polluted water in local action plans	MoLocalDev.								
2	Divert pollution away from Lake Bardawil	MWRI	12.99			0.36	0.72	1.08	5.41	5.41
79	Protect groundwater wells from pollution	MoLD/MHUNC								
1	Select proper sources for public water supply	MHUNC/MWRI/MHOP								
8	Provide sewage disposal systems in unconnected areas	MHUNC(NOP.)								
	Institutional actions for water quality and public health									
117	Enhance water quality monitoring and information dissemination	MOHP/EEAA	2.93	0.20	0.20	0.20	0.20	0.20	0.98	0.98
128	Train MWRI and WB staff on pollution and water quality	MWRI	0.12	0.02	0.02	0.02	0.02	0.02		
107	Strengthen institutions controlling and monitoring industrial pollution	EEEA	0.12	0.03	0.03	0.03	0.03			
	General institutional, legal and financial measures									
106	Restructure the role of MWRI - establish dedicated IRU	MWRI								
109	Co-ordinate investments on regional and national levels	MWRI								
130	Restructure MWRI - establish integrated water management districts	MWRI	33.00		1.00	2.00	3.00	4.00	9.00	14.00
33	Transfer water management authority to District Water Boards	Cabinet/MWRI	35.00		2.50	2.50	2.50	2.50	12.50	12.50
20	Stimulate Private Sector Participation in infrastructure and O&M	MWRI								
100	Implement systems of cost sharing for all water users	MWRI								
131	Continue water sector planning as a rolling exercise	MWRI	3.00	0.20	0.20	0.20	0.20	0.20	1.00	1.00
132	Enhance the data exchange among different authorities	All Gov. Org.								
94	Establish a permanent inter-minsterial Commission on IWRM	Cabinet/MWRI								
133	Enhance role of NGO's and Civil Society	MWRI/Private								
	Total		**43 830**	**1 696**	**1 953**	**2 206**	**2 470**	**2 730**	**14 576**	**18 212**

Table C-2 O&M of total NWRP (MLE) - continued

C2 Ministry of Water Resources & Irrigation

The majority of the proposed investment measures are within the jurisdiction of the MWRI, as can be expected from a NWRP. They are presented in detail in Table C-3 and Table C-4, with a total of LE 45.74 billion for the period till 2017. Cost-wise the most significant measures are:

- Continue IIP in prioritized areas
- Groundwater development in the Western Desert
- Groundwater development in the Eastern Desert
- Gradually introduce modern irrigation techniques in oases
- Flash flood harvesting in Sinai and Eastern Desert.

The strategy Facing the Challenge focuses on new policies and actions to be taken. That does not mean that many of the on-going activities of MWRI should be stopped. Those activities should continue, albeit that some activities might need be adapted somewhat to reflect the strategy FtC. These on-going activities include the work done by the following sector and departments of MWRI:

- Improvement of drainage conditions by EPADP (measure 50).
- Construction and rehabilitation of barrages by Grand Barrages and Reservoir Sector (measure 32)
- The research activities of National Water Resources Center (measure 96).
- The maintenance and system improvement by the High Aswan Dam Public Authority (measure 38).
- The various activities of the Nile Protection Sector, the Egyptian Public Authority for Shores Protection, and the Egyptian Public Authority for Surveying and Mapping (measures 61, 91 and 92)
- The rehabilitation and further development of the pumping stations in the river Nile and canal system by the Mechanical and Electrical Department.

A study is presently being tendered to determine the next phase of the IIP project with foreign funding under the name of 'Integrated Irrigation Improvement and Management Project' (IIIMP). The outcome may change the scope of this measure to some extent.

Although the groundwater development in the Eastern Desert is defined as a study, funds have been budgeted for this development, assuming a positive outcome of the study. Amounts may need to be adjusted, however.

The present investment budget of the MWRI for the period 2003-17 is LE 46 billion. An attempt has been made to identify the overlap of the investment budget of the MWRI and the one proposed by NWRP. This effort was complicated by the fact that the budget lines as used by the ministry often cover more than one measure. Where necessary the amount of overlap has been estimated. In Figures C-1 and C-2 the historic and planned investments of MWRI are depicted, together with the total proposed NWRP investments (for all entities), the NWRP investments by MWRI and the additional NWRP investments for MWRI.

The results show that for this ministry extra budget will be requested to cover the NWRP measures for MWRI. During the planning period about LE 5.74 billion extra would be required to carry out the strategy *Facing the Challenge*.

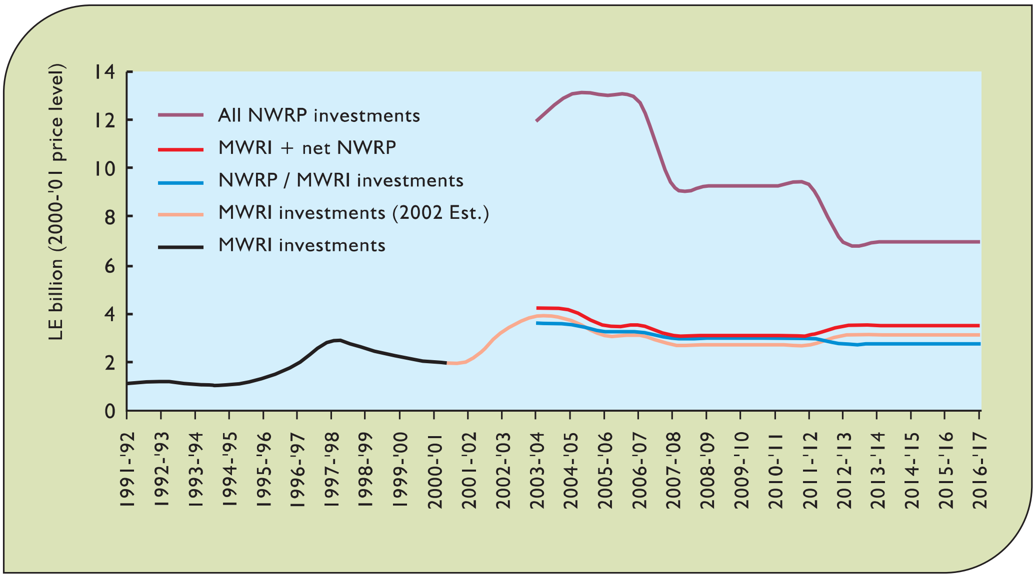

Figure C-1 MWRI, NWRP and MWRI + additional investments

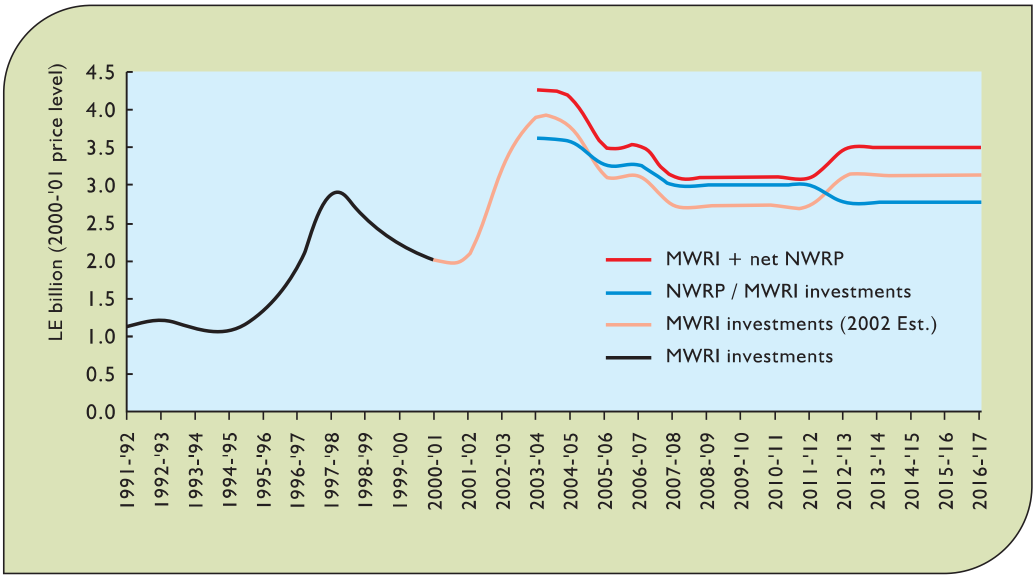

Figure C-2 MWRI and MWRI + additional investments

For O&M of the above mentioned investments and other measures that would have to be paid from the current budget, a total budget for the period till 2017 of LE 7.85 billion will be required. Cost-wise the most significant measures with respect to O&M are:

- Groundwater development in the Western Desert
- Continue IIP in prioritized areas
- Strengthen Irrigation Advisory Services
- Groundwater development in the Eastern Desert
- Continue the activities of EPADP.
- Construct and rehabilitate needed barrages by Grand Barrages and Reservoir Sector.

The share of the MWRI in the total NWRP investment is around 32%. Based on information from the Planning Sector a growth for the MWRI investments (without NWRP) is assumed from about BLE 2 in 2001-2002 to over BLE 4 in 2003-2004.

No.	INVESTMENTS	Agency	Total cost	2 003	2 004	2 005	2 006	2 007	2007-12	2012-17
	Developing additional resources									
	Nile water									
120	Continue the co-operation with the riparian states of the River Nile	MWRI	2 533	34	222	218	223	224	975	636
	Groundwater									
35	Groundwater development Western Desert	MWRI	3 500	233	233	233	233	233	1 167	1 167
119	Groundwater development Sinai and Eastern Desert	MWRI	807	54	54	54	54	54	269	269
37	Development brackish groundwater for agriculture and aquaculture	MWRI	4	0	0	4	0	0	0	0
121	Increase management of shallow groundwater	MWRI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Stimulate rainfall harvesting along Northern Coast									
40	Stimulate rainfall harvesting along Northern Coast	MWRI	100	8	8	8	8	8	30	30
41	Flash flood harvesting in Sinai and Eastern Desert	MWRI	530.8	20.4	20.4	30.0	30.0	30.0	200.0	200.0
	Making better use of existing resources									
	Horizontal expansion									
112	Postpone Middle Sinai developments	MWRI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
123	Make future horizontal expansion dependent on water availability	MWRI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
95	Continue horizontal expansion	MWRI/MALR	7750	601	701	602	305	305	2618	2618
	Water use efficiency Nile system - irrigation efficiency									
124	Prioritise efficiency measures in effective areas	MWRI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90	Continue IIP in prioritised areas/IIMP	MWRI	6700.0	400.0	450.0	450.0	450.0	450.0	2250.0	2250.0
71	Strengthen Irrigation Advisory Service	MWRI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
86	Apply canal lining in effective stretches	MWRI	334.5	22.3	22.3	22.3	22.3	22.3	111.5	111.5
57	Introduce controlled drainage during rice cultivation	MWRI/MALR	8.1	0.0	0.0	0.6	0.6	0.6	3.1	3.1
82	Gradually introduce modern irrigation techniques in oases	MWRI	108.3	0.0	10.8	10.8	10.8	10.8	54.2	10.8
99	Control well discharges in desert areas	MWRI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
122	Reduce irrigation after rainfall	MWRI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Water use efficiency Nile system - reuse of drainage water									
50	Improve drainage conditions (EPADP)	MWRI	3833.0	326.6	326.6	326.6	326.6	326.6	1400.0	800.0
	Review drainage water reuse policy, including									
51	- Apply intermediate reuse at appropriate locations	MWRI	63.0	4.2	4.2	4.2	4.2	4.2	21.0	21.0
115	- Prioritise drainage reuse in specific areas	MWRI/MALR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
114	- Allow higher permissible salinities in irrigation water	MWRI/MALR	94.2	4.1	4.3	4.5	4.5	4.5	36.2	36.2
	Water allocation and distribution Nile system									
33	Transfer water management authority to Water Boards at District level	MWRI	See under General institutional, legal and financial measures							
69	Continue set-up of Water Users Associations	MWRI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
93	Introduce regional water allocation based on equal opportunities	MWRI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
98	Introduce water allocation based on fixed annual amounts per feddan	MWRI	90.2	8.2	5.5	5.5	5.5	5.5	30.0	30.0
67	Continue canals and drains dredging and de-weeding	MWRI	2 100.0	140.0	140.0	140.0	140.0	140.0	700.0	700.0
68	Improve physical infrastructure for proper water distribution	MWRI	183.0	12.2	12.2	12.2	12.2	12.2	61.0	61.0
111	Establish MALR/MWRI coordination mechanism on supply&demand	MWRI/MALR	0.5	0.0	0.0	0.0	0.0	0.0	0.2	0.2
116	Introduce water delivery agreements between MWRI and Water Boards	MWRI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
113	Train MWRI and WB-staff in system operation	MWRI	0.8	0.1	0.1	0.1	0.1	0.1	0.3	0.3
32	Rehabilitate barrages and regulators	MWRI	2 225	276	403	417	422	413	254	40
42	Rehabilitate and further develop pumping stations in river/canal system.	MWRI	10 021	668	668	668	668	668	3 340	3 340
38	Maintain and improve High Aswan Dam and Lake Nasser	MWRI	1 765.0	117.7	117.7	117.7	117.7	117.7	588.3	588.3
61,91	Continue works on River banks, Sea Shores and Mapping	MWRI	1 630	128	128	128	128	128	496	496
46	Extend aquatic weed control by grass carp	MWRI	142.5	9.5	9.5	9.5	9.5	9.5	47.5	47.5
	Municipal and industrial water (quantity)									
43	Intensify water shortage awareness campaigns	MWRI	90.2	8.2	5.5	5.5	5.5	5.5	30.0	30.0
54	Promote water saving technologies in industry through Campaigns	MoI/MWRI	13.5	0.0	0.5	1.0	1.0	1.0	5.0	5.0
	Aquaculture									
75	Review MWRI policies regarding aquaculture	MWRI/GAFRD	0.9	0.0	0.9	0.0	0.0	0.0	0.0	0.0
	Navigation									
60	Remove shallows in Nile and canals through dredging	MWRI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Research									
34	Study different operation of High Aswan Dam	MWRI	16.2	8.1	8.1	0.0	0.0	0.0	0.0	0.0
96	Continue activities of the National Water Research Center	MWRI	798.7	53.2	53.2	53.2	53.2	53.2	266.2	266.2
37	Use of brackish groundwater for agri/aquaculture	MWRI/MALR	9.3	0.0	0.0	5.4	1.0	1.0	1.9	0.0
	Protection of public health and environment									
	Prevention									
9	Introduce load based discharge levies	MWRI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Control									
89	Define functions of waterways	MWRI	0.9	0.0	0.0	0.9	0.0	0.0	0.0	0.0
29	Define effluent standards based on the receiving water	MWRI/MOHP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	Divert pollution away from Lake Bardawil	MWRI	43.3	0.0	0.0	14.4	14.4	14.4	0.0	0.0
	Institutional actions for water quality and public health									
128	Train MWRI and WB staff on pollution and water quality	MWRI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	General institutional, legal and financial measures									
106	Restructure the role of MWRI - establish dedicated IRU	MWRI	53.9	6.3	6.3	6.3	2.5	2.5	15.0	15.0
109	Co-ordinate investments on regional and central levels	MWRI	7.0	0.0	0.5	0.5	0.5	0.5	2.5	2.5
130	Restructure MWRI - establish integrated water management districts	MWRI	140.0	0.0	10.0	10.0	10.0	10.0	50.0	50.0
33	Transfer water management authority to Water Boards at District level	Cabinet/MWRI	22.4	0.0	1.6	1.6	1.6	1.6	8.0	8.0
20	Stimulate Private Sector Participation in infrastructure and O&M	MWRI	5.3	0.3	0.5	0.5	0.5	0.5	1.5	1.5
100	Implement systems of cost sharing for all water users	MWRI	4.8	0.0	0.5	0.5	0.5	0.3	1.5	1.5
131	Continue water sector planning as a rolling exercise	MWRI	3.0	0.2	0.2	0.2	0.2	0.2	1.0	1.0
132	Enhance the data exchange among different authorities	All Gov. Org.	3.0	0.2	0.2	0.2	0.2	0.2	1.0	1.0
94	Establish a permanent inter-minsterial Commission on IWRM	Cabinet/MWRI	3.8	0.3	0.3	0.3	0.3	0.3	1.3	1.3
133	Enhance role of NGO's and Civil Society	MWRI/Private	1.5	0.1	0.1	0.1	0.1	0.1	0.5	0.5
	Total NWRP/MWRI		**45 741**	**3 144**	**3 629**	**3 567**	**3 266**	**3 258**	**15 038**	**13 839**
	Overlap with investments scheduled by MWRI Planning Sector		**39 999**	**2 797**	**3 259**	**3 162**	**2 872**	**2 864**	**13 099**	**11 946**
	Additional investments proposed by NWRP		**5 742**	**347**	**369**	**404**	**395**	**394**	**1 939**	**1 893**

Table C-3 Time Planning and Investments for MWRI (MLE)

No.	O&M	Agency	Total cost	2003	2004	2005	2006	2 007	2007-12	2012-17
	Developing additional resources									
	Nile water									
120	Continue the co-operation with the riparian states of the Nile	MWRI	236.7	6.5	7.2	7.9	8.7	9.5	94.0	103.0
	Groundwater									
35	Groundwater development Western Desert	MWRI	1 400.0	11.7	23.3	35.0	46.7	58.3	466.7	758.3
119	Groundwater development Sinai and Eastern Desert	MWRI	322.7	2.7	5.4	8.1	10.8	13.4	107.6	174.8
37	Development brackish grd.water for agriculture and aquaculture	MWRI	1.4			0.2	0.2	0.2	0.4	0.4
121	Increase management of shallow groundwater	MWRI	14.0		1.0	1.0	1.0	1.0	5.0	5.0
	Rainfall and flash flood harvesting									
40	Stimulate rainfall harvesting along Northern Coast	MWRI	5.8	0.2	0.3	0.5	0.6	0.8	1.4	2.0
41	Flash flood harvesting in Sinai and Eastern Desert	MWRI	55.0				1.7	3.3	25.0	25.0
	Making better use of existing resources									
	Horizontal expansion									
112	Postpone Middle Sinai developments	MWRI								
123	Make future horizontal expansion dependent on water availability	MWRI	1.5	0.1	0.1	0.1	0.1	0.1	0.5	0.5
	Water use efficiency Nile system - irrigation efficiency									
124	Prioritise efficiency measures in effective areas	MWRI								
90	Continue IIP in prioritised areas/IIMP	MWRI	297.0		9.0	18.0	27.0	36.0	81.0	126.0
71	Strengthen Irrigation Advisory Service	MWRI	338.4	2.4	3.6	5.4	9.0	18.0	150.0	150.0
86	Apply canal lining in effective stretches	MWRI	44.6	1.1	2.2	3.3	4.5	5.6	11.2	16.7
57	Introduce controlled drainage during rice cultivation	MWRI/MALR								
99	Control well discharges in desert areas	MWRI								
122	Reduce irrigation after rainfall	MWRI								
	Water use efficiency Nile system - reuse of drainage water									
50	Improve drainage conditions (EPADP)	MWRI	1 320.0	80.0	80.0	80.0	90.0	90.0	450.0	450.0
	Review drainage water reuse policy, including									
51	- Apply intermediate reuse at appropriate locations	MWRI	8.4	0.2	0.4	0.6	0.8	1.1	2.1	3.2
115	- Prioritise drainage reuse in specific areas	MWRI								
114	- Allow higher permissible salinities in irrigation water	MWRI/MALR								
	Water allocation and distribution Nile system									
33	Transfer water man. authority to Water Boards at District level	MWRI	See under General institutional, legal and financial measures							
69	Continue set-up of Water Users Associations	MWRI								
93	Introduce regional water allocation based on equal opportunities	MWRI								
98	Introduce water alloc. based on fixed annual amounts per feddan	MWRI								
67	Continue canals and drains dredging and de-weeding	MWRI								
68	Improve physical infrastucture for proper water distribution	MWRI	48.8	1.2	2.4	3.7	4.9	6.1	12.2	18.3
111	Establish MALR/MWRI coord. mech. on supply and demand	MWRI/MALR								
116	Intro. water delivery agreements between MWRI and Water Boards	MWRI								
113	Train MWRI and WB-staff in system operation	MWRI								
32	Rehabilitate barrages and regulators	MWRI	297.3	8.3	20.4	32.9	45.5	57.9	65.6	66.8
42	Rehabilitate and further develop pumping stations in river and canal system.	MWRI	400.9	26.7	26.7	26.7	26.7	26.7	133.6	133.6
38	Maintain and improve High Aswan Dam and Lake Nasser	MWRI	35.3	2.4	2.4	2.4	2.4	2.4	11.8	11.8
61,91	Continue works on River banks, Sea Shores and Mapping	MWRI	48.9	3.8	3.8	3.8	3.8	3.8	14.9	14.9
46	Extend aquatic weed control by grass carp	MWRI/MALR	19.0	0.5	1.0	1.4	1.9	2.4	4.8	7.1
	Municipal and industrial water (quantity)									
43	Intensify water shortage awareness campaigns	MWRI								
54	Promote water saving techn. in industry through Campaigns	MoI/MWRI								
	Aquaculture									
75	Review MWRI policies regarding aquaculture	MWRI/GAFRD								
	Navigation									
60	Remove shallows in Nile through dredging	MWRI	3 000.0	190.0	190.0	190.0	190.0	190.0	950.0	950.0
	Research									
34	Study different operation of High Aswan Dam	MWRI								
96	Continue activities of the National Water Research Center	MWRI	16.0	1.1	1.1	1.1	1.1	1.1	5.3	5.3
37	Use of brackish groundwater for agri/aquaculture	MWRI/MALR								
	Protection of public health and environment									
	Prevention									
9	Introduce load based discharge levies	MWRI	0.0	0.0	0.0					
	Control									
89	Define functions of waterways	MWRI								
29	Define effluent standards based on the receiving water	MWRI/MOHP								
2	Divert pollution away from Lake Bardawil	MWRI	13.0			0.4	0.7	1.1	5.4	5.4
	Institutional actions for water quality and public health									
128	Train MWRI and WB staff on pollution and water quality	MWRI	0.1	0.0	0.0	0.0	0.0	0.0		
	General institutional, legal and financial measures									
106	Restructure the role of MWRI - establish dedicated IRU	MWRI								
109	Co-ordinate investments on regional and national levels	MWRI								
130	Restructure MWRI-establish integrated water man. districts	MWRI	33.0		1.0	2.0	3.0	4.0	9.0	14.0
33	Transfer water man. authority to Water Boards at District level	Cabinet/MWRI	35.0		2.5	2.5	2.5	2.5	12.5	12.5
20	Stimulate Private Sector Participation in infrastructure and O&M	MWRI								
100	Implement systems of cost sharing for all water users	MWRI								
131	Continue water sector planning as a rolling exercise	MWRI	3.0	0.2	0.2	0.2	0.2	0.2	1.0	1.0
132	Enhance the data exchange among different authorities	All Gov. Org.								
94	Establish a permanent inter-minsterial Commission on IWRM	Cabinet/MWRI								
133	Enhance role of NGO's and Civil Society	MWRI/Private								
	Total NWRP/MWRI		**7 846**	**339**	**384**	**427**	**484**	**536**	**2 621**	**3 056**

Table C-4 O&M for MWRI (MLE)

C3 Ministry of Agriculture & Land Reclamation

With agriculture being the largest water-consuming sector, the MALR is one of the major stakeholders for NWRP. The investments proposed by NWRP for this ministry are only LE 67 million for the period 2003-17. The main measures are:

- Encourage the use of environmentally friendly agriculture, and
- Introduce controlled drainage during rice cultivation.
- Develop salt tolerant and short duration crops.
- Develop short duration and drought resistant crop varieties

The first measure is seen as an investment, as it concerns an effort during a predefined period, mainly to train farmers in the use of Integrated Pest Management and related agricultural methods. Foreign assistance may be required here in the form of projects, for which reason this budget has been placed under Investments. The costs of the second measure are assumed to be equally shared with the MWRI.

The O&M costs for MALR are with LE 90.3 million much higher than the investment costs. The main measures in this category are:

- apply land-levelling with laser techniques,
- encourage the use of environmentally friendly agricultural methods,
- stimulate rainfall harvesting along the Northern coast, and
- control the production and import of agrochemicals.

The encouragement of environmentally friendly methods here is geared towards research and extension, especially for the newly developed areas of Toshka, which have been earmarked for application of these methods. As pesticide residues in drainage water are a major health hazard for those who consume fresh water fish, the control of pesticides is seen as an important contribution to the improvement of water quality. As increased irrigation efficiency and water use in general will lead to higher levels of salinity, the development and promotion of salt tolerant crops for the Delta and the El Salam project are important. For rainfed areas along the Mediterranean Coast the availability of drought resistant crops would contribute to the economic development of this area.

GAFRD is part of the MALR, but has the specific mandate to manage inland fisheries. An investment of LE 380,000 by GAFRD is proposed to take part in MWRI's review of its policies regarding aquaculture. These policies relate to the use of main waterways and irrigation water for aquaculture.

Investments and O&M for MALR and GAFRD are presented in detail in Table C-5, Table C-6 and Table C-7.

No.	INVESTMENTS	Agency	Total cost	2003	2004	2005	2006	2007	07-12	12-17
	Developing additional resources									
	Rainfall and flash flood harvesting									
48	Stimulate on-farm rainfall harvesting along Northern Coast	MALR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Water use efficiency Nile system - irrigation efficiency									
36	Apply land-leveling with laser techniques	MALR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
57	Introduce controlled drainage during rice cultivation	MWRI/MALR	8.13	0.00	0.00	0.63	0.63	0.63	3.13	3.13
	Water use eff. Nile system - reuse of drainage water									
97	Promote cultivation of salt tolerant crop varieties	MALR	7.50	0.50	0.50	0.50	0.50	0.50	2.50	2.50
	Water allocation and distribution Nile system									
111	Establish MALR/MWRI coordination mechanism on supply and demand	MWRI/ MALR	0.45	0.03	0.03	0.03	0.03	0.03	0.15	0.15
	Municipal and industrial water (quantity)									
56	Reuse treated wastewater in New Industrial and Canal Cities	MHUNC/ MALR	0.04	0.00	0.00	0.01	0.01	0.01	0.01	0.00
	Research									
44	Develop salt tolerant crop varieties	MALR	7.50	0.50	0.50	0.50	0.50	0.50	2.50	2.50
62	Develop short duration and drought resistant crop varieties	MALR	7.50	0.50	0.50	0.50	0.50	0.50	2.50	2.50
	Protection of public health and environment									
	Prevention									
13	Encourage use environm. friendly agricultural methods	MALR	33.00	6.60	6.60	6.60	6.60	6.60	0.00	0.00
31	Control the production and import of agrochemicals	MALR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
135	Control the use of organic fertilisers	MALR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	General institutional, legal and financial measures									
132	Enhance the data exchange among different authorities	All Gov. Org.	3.00	0.20	0.20	0.20	0.20	0.20	1.00	1.00
	Total		**67.11**	**8.33**	**8.33**	**8.96**	**8.97**	**8.97**	**11.79**	**11.78**

Table C-5 Time Planning and Investment MALR (MLE)

INVESTMENTS	Agency	Total cost	2003	2004	2005	2006	2007	2007-12	2012-17
Making better use of existing resources									
Aquaculture									
Review MWRI policies regarding aquaculture	MWRI/GAFRD	0.38	0.00	0.38	0.00	0.00	0.00	0.00	0.00
General institutional, legal and financial measures									
Enhance the data exchange among different authorities	All Gov. Org.	3.00	0.20	0.20	0.20	0.20	0.20	1.00	1.00
Total		**3.38**	**0.20**	**0.58**	**0.20**	**0.20**	**0.20**	**1.00**	**1.00**

Table C-6 Time Planning and Investments GAFRD (MLE)

No.	O&M	Agency	Total cost	2003	2004	2005	2006	2007	2007-12	2012-17
	Developing additional resources									
	Rainfall and flash flood harvesting									
48	Stimulate on-farm rainfall harvesting along Northern Coast	MALR	14.0	0	1	1	1	1	5	5
	Water use efficiency Nile system - irrigation efficiency									
36	Apply land-leveling with laser techniques	MALR	36.0	2.4	2.4	2.4	2.4	2.4	12.0	12.0
57	Introduce controlled drainage during rice cultivation	MWRI/MALR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Water use efficiency Nile system - reuse of drainage water									
97	Promote cultivation of salt tolerant crop varieties	MALR	3.0	0.5	0.5	0.5	0.5	0.5	0.3	0.3
	Water allocation and distribution Nile system									
111	Establish MALR/MWRI coordination mechanism on supply and demand	MWRI/MALR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Municipal and industrial water (quantity)									
56	Reuse treated wastewater in New Industrial and Canal Cities	MHUNC/MALR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Research									
44	Develop salt tolerant crop varieties	MALR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
62	Develop short duration and drought resistant crop varieties	MALR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Protection of public health and environment									
	Prevention									
13	Encourage use of environmentally friendly agricultural methods	MALR	24.0	1.0	1.1	1.2	1.3	1.4	8.0	10.0
31	Control the production and import of agrochemicals	MALR	13.3	0.0	0.5	0.8	1.0	1.0	5.0	5.0
135	Control the use of organic fertilisers	MALR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	General institutional, legal and financial measures									
132	Enhance the data exchange among different authorities	All Gov. Org.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total		**90.3**	**3.9**	**5.5**	**5.9**	**6.2**	**6.3**	**30.3**	**32.3**

Table C-7 O&M for MALR (MLE)

C4 Ministry of Industry

For investments by the MoI LE 180 million is proposed for the *Introduction of financial incentives to promote clean industrial products*. This measure includes tax exemptions, subsidies, soft loans and technical assistance to stimulate investments related to clean industrial processes and water recycling technologies.

The budget for recurrent costs is about LE 30 million. This budget is proposed for implementation of the measure *Encourage treatment or pre-treatment of industrial wastewater by industries*. There are no further O&M costs envisaged as these are supposed to be taken care of by the industries. Estimated Investments and O&M for the MoI are presented in Table C-8 and C-9.

The measure *Phase out and relocate polluting industries along vital waters* is a very important one in the jurisdiction of this ministry, but no costs have been assigned to it under NWRP. This measure is carried out by the provision of free industrial locations and by providing tax holidays of 5-20 years, depending on the origin of the industry.

No.	INVESTMENTS	Agency	Total cost	2003	2004	2005	2006	2007	2007-12	2012-17
	Making better use of existing resources									
	Municipal and industrial water (quantity)									
54	Promote water saving technologies in industry through campaigns	MoI/MWRI	13.5	0.0	0.5	1.0	1.0	1.0	5.0	5.0
	Protection of public health and environment									
	Prevention									
4	Introduce financial incentives to promote clean industrial products	MoI	180.0	12.0	12.0	12.0	12.0	12.0	60.0	60.0
101	Introduce compliance action agreements for industries	MoI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	Initiate public awareness campaigns for clean products	MoI	6.0		3.0	3.0	0.0	0.0	0.0	0.0
17	Phase out and relocate polluting industries along vital waters	MoI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Treatment									
127	Encourage treatment or pre-treatment of industrial waste water by industries	MoI/EEAA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	General institutional, legal and financial measures									
132	Enhance the data exchange among different authorities	All Gov. Org.	3.0	0.2	0.2	0.2	0.2	0.2	1.0	1.0
	Total		**202.5**	**12.2**	**15.7**	**16.2**	**13.2**	**13.2**	**66.0**	**66.0**

Table C-8 Time Planning and Investments for MoI (MLE)

No.	O&M	Agency	Total cost	2003	2004	2005	2006	2007	2007 -12	2012 -17
	Making better use of existing resources									
	Municipal and industrial water (quantity)									
54	Promote water saving technologies in industry through campaigns	MoI/MWRI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Protection of public health and environment									
	Prevention									
4	Introduce financial incentives to promote clean industrial products	MoI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	Phase out and relocate polluting industries along vital waters	MoI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Treatment									
127	Encourage treatment or pre-treatment of industrial waste water by industries	MoI/EEAA	30.0	2.0	2.0	2.0	2.0	2.0	10.0	10.0
	General institutional, legal and financial measures									
132	Enhance the data exchange among different authorities	All Gov. Org.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total		**30.0**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**10.0**	**10.0**

Table C-9 O&M for MoI (MLE)

C5 Ministry of Housing, Utilities & New Communities

For MHUNC (NOPWASD) a total of LE 90.1 billion has been proposed for investment for the period up to 2017, about 62% of the total investment required for the strategy. The major share of this amount is destined for the *Increase of the municipal sewage networks and the construction of drinking water and wastewater treatment plants*. This large amount is justified by the desire to supply a larger part of the urban population with proper drinking water and sanitation. The urban population is growing rapidly because of general population growth and further urbanisation. Increased and improved wastewater treatment will be beneficial for public health, the environment, and will enable the reuse of wastewater. In addition, improved sewage disposal for unconnected areas is proposed.

The most important measure in the field of O&M for MHUNC (NOPWASD) is the *Reduction of physical leakage losses of the drinking water system* and hence reducing the Unaccounted for Water.

The municipalities do not make water resources related investments themselves, but become responsible for O&M. The amount budgeted for this purpose will increase with the commissioning of wastewater treatment plants. For the NWRP planning period a total of LE 1 billion has been budgeted for this purpose. However, the municipalities are more involved in the O&M of the drinking water and sanitation as the most important measures in this aspect are:

- Increase municipal sewerage and wastewater treatment
- Increase drinking water treatment capacities
- Installation/rehabilitation of the drinking water metering system.
- Reduce leakage losses in PWS system by prioritisation

Investments and O&M for the MHUNC (NOPWASD) and the Municipalities are presented in detail in Table C-10, Table C–11, Table C-12 and Table C-13.

No.	INVESTMENTS	Agency	Total cost	2003	2004	2005	2006	2007	2007-12	2012-17
	Making better use of existing resources									
	Municipal and industrial water (quantity)									
87	Reduce leakage losses in PWS system by prioritisation	MHUNC(NOP.)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
56	Reuse treated waste water in New Industrial and Canal Cities	MHUNC./MALR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Protection of public health and environment									
	Treatment									
10	Increase municipal sewerage and wastewater treatment	MHUNC(NOP.)	61 765	5 412	5 412	5 412	5 412	5 412	22 000	12 705
11	Increase drinking water Treatment capacities	MHUNC(NOP.)	28 250	2 750	2 750	2 750	5 412	2 750	7 500	7 000
108	Initiate cost recovery for urban sanitary services	MHUNC/NOPW.	1.5	0.1	0.1	0.1	0.1	0.1	0.5	0.5
	Control									
79	Protect groundwater wells from pollution	MoLD/NPOW.	2.0	0.1	0.2	0.4	0.4	0.4	0.5	0.0
1	Select proper sources for public water supply	MHUNC(NOP.)	37.5	7.5	7.5	7.5	7.5	7.5	0.0	0.0
8	Provide sewage disposal systems in unconnected areas	MHUNC(NOP.)	75.0	15.0	15.0	15.0	15.0	15.0	0.0	0.0
	General institutional, legal and financial measures									
132	Enhance the data exchange among different authorities	All Gov. Org.	3.0	0.2	0.2	0.2	0.2	0.2	1.0	1.0
	Total		**90 134**	**8 185**	**8 185**	**8 185**	**10 847**	**8 185**	**29 502**	**19 707**

Table C-10 Time Planning and Investments for MHUNC (MLE)

No.	O&M	Agency	Total cost	2003	2004	2005	2006	2007	2007 -12	2012 -17
	Making better use of existing resources									
	Municipal and industrial water (quantity)									
87	Reduce leakage losses in PWS system by prioritisation	MHUNC/Municipal.	1 000	67	67	67	67	67	333	333
56	Reuse treated wastewater in New Industrial and Canal Cities	NOPW./MALR	0	0	0	0	0	0	0	0
	Protection of public health and environment									
	Treatment									
108	Initiate cost recovery for urban sanitary services	MHUNC/NOPW.	0	0	0	0	0	0	0	0
	Control									
79	Protect groundwater wells from pollution	MoLD/NPOW.	0	0	0	0	0	0	0	0
1	Select proper sources for public water supply	MHUNC(NOP.)	0	0	0	0	0	0	0	0
8	Provide sewage disposal systems in unconnected areas	MHUNC(NOP.)	0	0	0	0	0	0	0	0
	General institutional, legal and financial measures									
132	Enhance the data exchange among different authorities	All Gov. Org.	0	0	0	0	0	0	0	0
	Total		**1 000**	**67**	**67**	**67**	**67**	**67**	**333**	**333**

Table C-11 O&M for MUHNC (NOPWASD) (MLE)

No.	INVESTMENTS	Agency	Total cost	2003	2004	2005	2006	2007	2007-12	2012-17
	Making better use of existing resources									
6	Provide solid waste collection and disposal systems in rural areas	Municipal.								
	Municipal and industrial water (quantity)									
18	Install/rehabilitate metering system	Municipal.	249.1	17.3	17.3	17.3	17.3	17.3	82.1	80.6
19	Review price policy of drinking water	Municipal.	1.0	0.1	0.1	0.1	0.1	0.1	0.3	0.3
87	Reduce leakage losses in PWS system by prioritisation	MHUNC/Municp.								
	Protection of public health and environment									
	Treatment									
10	Increase municipal sewerage and wastewater treatment	MHUNC./Mun.								
	General institutional, legal and financial measures									
132	Enhance the data exchange among different authorities	All Gov. Org.	3.00	0.20	0.20	0.20	0.20	0.20	1.00	1.00
	Total		**253**	**18**	**18**	**18**	**18**	**18**	**83**	**82**

Table C-12 Time Planning and Investment for Municipalities (MLE)

No.	O&M	Agency	Total cost	2003	2004	2005	2006	2007	2007-12	2012-17
	Making better use of existing resources									
	Water allocation and distribution Nile system									
6	Provide solid waste collection and disposal syst. in rural areas	Municipal.	0	0	0	0	0	0	0	0
	Municipal and industrial water (quantity)									
18	Install/rehabilitate metering system	Municipal.	103.7	0.9	1.7	2.6	3.5	4.3	34.6	56.2
19	Review price policy of drinking water	Municipal.	0	0	0	0	0	0	0	0
87	Reduce leakage losses in PWS system by prioritisation	MHUNC/Municipal.	1 000	66.67	66.67	66.67	66.67	66.67	333.33	333.33
	Protection of public health and environment									
	Treatment									
10	Increase municipal sewerage and wastewater treatment	Municipal.	12 084	446	500	554	608	662	3 970	5 344
11	Increase drinking water Treatment capacities	Municipal.	15 621	687	742	797	852	907	4 985	6 651
	General institutional, legal and financial measures									
132	Enhance the data exchange among different authorities	All Gov. Org.	0	0	0	0	0	0	0	0
	Total		**28 809**	**1 200**	**1 310**	**1 420**	**1 530**	**1 640**	**9 323**	**12 385**

Table C-13 O&M for Municipalities (MLE)

C6 Ministry of Health and Population

The Ministry of Health and Population is involved as a co-operating partner in a large number of measures concerning the Protection of Public Health and Environment. The tables below only show the measures for which MoHP has the main or exclusive responsibility.

An important ongoing responsibility of MoHP is the continuation of Family Planning awareness campaigns at an estimated cost of 13.5 MLE/year. Although this is not a water resources management measure as such, the effects of such campaigns will have an important impact on the demands for drinking water and sanitation facilities.

More directly water-related responsibilities of MoHP are the setting of water quality standards and the water quality monitoring programmes in connection with drinking water intakes. The first responsibility has not been quantified in terms of costs; for the continuation of water quality monitoring cost estimates of about 13 MLE/year have been included in the NWRP.

No.	INVESTMENTS	Agency	Total cost	2003	2004	2005	2006	2007	2007-12	2012-17
	Making better use of existing resources									
	Research									
129	Conduct family planning awareness campaigns	MOHP	202.5	13.5	13.5	13.5	13.5	13.5	67.5	67.5
	General institutional, legal and financial measures									
117	Enhance water quality monitoring and information dissemination	MOHP/EEAA	195.00	13.00	13.00	13.00	13.00	13.00	65.00	65.00
	Total		**397.5**	**26.5**	**26.5**	**26.5**	**26.5**	**26.5**	**132.5**	**132.5**

Table C-14 Time Planning and Investments for MoHP (MLE)

No.	O&M	Agency	Total cost	2003	2004	2005	2006	2007	2007-12	2012-17
	General institutional, legal and financial measures									
117	Enhance water quality monitoring and information dissemination	MOHP/EEAA	2.93	0.20	0.20	0.20	0.20	0.20	0.98	0.98
	Total		**2.9**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**1.0**	**1.0**

Table C-15 O&M for MoHP (MLE)

C7 Ministry of Local Development

The Ministry of Local Development will invest in the *Start of local action plans on domestic sanitation in rural areas*. Together with MHUNC (NOPWASD) it will *Protect groundwater from pollution*. For these measures a total of about LE 1.5 billion has been budgeted.

Investments for the Ministry of Local Development are presented in detail in Table C-16.

No.	INVESTMENTS	Agency	Total cost	2003	2004	2005	2006	2007	2007-12	2012-17
	Protection of public health and environment									
	Treatment									
103	Start local action plans on domestic sanitation in rural areas	MoLocalDev.	1 500	100	100	100	100	100	500	500
	Control									
7	Include reduction of human contact with polluted water in local action plans	MoLocalDev.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
79	Protect groundwater wells from pollution	MoLD/MHUNC	2.0	0.1	0.2	0.4	0.4	0.4	0.5	0.0
	General institutional, legal and financial measures									
132	Enhance the data exchange among different authorities	All Gov. Org.	3.0	0.2	0.2	0.2	0.2	0.2	1.0	1.0
	Total		**1 505**	**100**	**100**	**101**	**101**	**101**	**502**	**501**

Table C-16 Time Planning and Investments for MoLD (MLE)

C8 Egypt's Environmental Affairs Agency

The investments foreseen for EEAA mainly refer to the *Intitation of public awareness compaigns for clean products*. For the O&M budget LE 15.9 has been foreseen for the *Start of public disclosure pollution control programme for industries* and *Introduce compliance action agreements for industries*. Other EEAA measures are *Strengthen institutions controlling and monitoring industrial pollution* and *Enhance water quality monitoring and information dissemination.* Regarding the compliance action plans, a professional Unit within the Ministry will have to be created with sufficient technical know-how to determine what pollution reduction measures are available and could be applied in certain industries, and at the same time have the legal expertise to ensure that these measures are implemented within an agreed time span.

The total investment budget for the planning period is LE 9.0 million. The recurrent costs are estimated at about LE 16 million.

Investments and O&M for EEAA are presented in detail in Table C-17 and Table C-18.

No.	INVESTMENTS	Agency	Total cost	2003	2004	2005	2006	2007	2007-12	2012-17
	Making better use of existing resources									
	Water allocation and distribution Nile system									
6	Provide solid waste collection and disposal systems in rural areas	Municipal.								
	Protection of public health and environment									
	Prevention									
80	Start public disclosure pollution control program for industries	EEEA								
101	Introduce compliance action agreements for industries	EEAA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	Initiate public awareness campaigns for clean products	EEAA	6.0	3.0	3.0	3.0	0.0	0.0	0.0	0.0
	Institutional actions for water quality and public health									
107	Strengthen institutions controlling and monitoring industrial pollution	EEEA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	General institutional, legal and financial measures									
132	Enhance the data exchange among different authorities	All Gov. Org	3.00	0.20	0.20	0.20	0.20	0.20	1.00	1.00
	Total		**9.0**	**3.2**	**3.2**	**3.2**	**0.2**	**0.2**	**1.0**	**1.0**

Table C-17 Time Planning and Investments for EEAA (MLE)

No.	O&M	Agency	Total cost	2003	2004	2005	2006	2007	2007-12	2012-17
	Making better use of existing resources									
	Water allocation and distribution Nile system									
6	Provide solid waste collection and disposal systems in rural areas	Municipal.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Protection of public health and environment									
	Prevention									
80	Start public disclosure pollution control program for industries	EEEA	1.89	0.00	1.26	0.63	0.00	0.00	0.00	0.00
101	Introduce compliance action agreements for industries	EEEA	14.0	0.0	1.0	1.0	1.0	1.0	5.0	5.0
3	Initiate public awareness campaigns for clean products	EEEA	0.0	0.0	3.0	3.0	0.0	0.0	0.0	0.0
	General institutional, legal and financial measures									
132	Enhance the data exchange among different authorities	All Gov. Org.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total		**15.89**	**0.00**	**5.26**	**4.63**	**1.00**	**1.00**	**5.00**	**5.00**

Table C-18 O&M for EEAA (MLE)

C9 Ministry of Transportation

The River Transport Authority of the Ministry of Transportation is responsible for removing shallows in the Nile and navigation canals through dredging. This is different from the dredging budget for other canals, which is part of the budget of MWRI.

No.	INVESTMENTS	Agency	Total cost	2003	2004	2005	2006	2007	2007-12	2012-17
	Making better use of existing resources									
	Navigation									
60	Remove shallows in Nile and canals through dredging	MWRI/RTA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	General institutional, legal and financial measures									
132	Enhance the data exchange among different authorities	All Gov. Org.	3.0	0.2	0.2	0.2	0.2	0.2	1.0	1.0
	Total		**3.0**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**1.0**	**1.0**

Table C-19 Time Planning and Investments Ministry of Transportation (MLE)

No.	O&M	Agency	Total cost	2003	2004	2005	2006	2007	2007-12	2012-17
	Making better use of existing resources									
	Navigation									
60	Remove shallows in Nile through dredging	MWRI	150	10	10	10	10	10	50	50
	General institutional, legal and financial measures									
132	Enhance the data exchange among different authorities	All Gov. Org.								
	Total		**150**	**10**	**10**	**10**	**10**	**10**	**50**	**50**

Table C-20 O&M for Ministry of Transportation (MLE)

C10 Private Sector

A major role has been assigned to the private sector (including farmers) to make water resources related investments, with a total of LE 6.78 billion till 2017. The largest investment is to *Apply modern irrigation techniques in new areas* (LE 3 billion), followed by *Collect and pre-treat industrial wastewater separately* (LE 2.2 billion). The first measure pertains to the agricultural sector and is geared towards increased irrigation efficiency especially in areas that do not drain to the Nile system, the second measure is intended to reduce industrial water pollution.
Other investments assigned to the Private sector are the construction and operation of brackish or seawater desalination plants. A contribution has been assumed towards the promotion of clean industrial products.

Potentially the private sector could participate to a larger extent in water resources management, e.g. in the operation of drinking water supply and wastewater treatment plants. In that case a public-private partnership would have to be established with clear mutual responsibilities.

The O&M costs for the private sector pertains largely to the same measures as the investments. The agricultural sector would *Apply land-leveling with laser techniques* on a regular basis, and maintain the modern irrigation facilities provided by MWRI for the oases. In addition, the Operation and Maintenance for the new horizontal expansion areas will be done by the private sector.

Total O&M costs foreseen are LE 5.9 billion till 2017. Investments and O&M for the Private Sector are presented in detail in Table C-21 and Table C-22.

No.	INVESTMENTS	Agency	Total cost	2003	2004	2005	2006	2007	2007-12	2012-17
	Developing additional resources									
	Desalination									
49	Increase brackish / salt water desalination	Private	800	0	0	32	64	64	320	320
	Making better use of existing resources									
	Water use efficiency Nile system - irrigation efficiency									
36	Apply land-leveling with laser techniques	MALR	0	0	0	0	0	0	0	0
78	Apply modern irrigation techniques in new areas	Private	3 003	0	601	601	601	601	601	0
82	Gradually introduce modern irrigation techniques in oases	MWRI	34	0	3	3	3	3	17	3
	Protection of public health and environment									
	Prevention									
4	Introduce financial incentives to promote clean industrial products	MoI	720	48	48	48	48	48	240	240
	Treatment									
102	Collect and/or pre-treat industrial wastewater separately	EEAA	2 220	444	444	444	444	444	0	0
	General institutional, legal and financial measures									
133	Enhance role of NGO's and Civil Society	MWRI/Private	2	0	0	0	0	0	1	1
	Total		**6 779**	**492**	**1 096**	**1 128**	**1 160**	**1 160**	**1 178**	**564**

Table C-21 Time Planning and Investments Private Sector (MLE)

No.	O&M	Agency	Total cost	2003	2004	2005	2006	2007	2007-12	2012-17
	Developing additional resources									
	Desalination									
49	Increase brackish / salt water desalination	Private	282	0	0	6	17	29	86	144
	Making better use of existing resources									
	Horizontal expansion									
95	Continue horizontal expansion	Private	642.3	18.0	39.0	57.1	66.3	75.4	154.0	232.5
	Water use efficiency Nile system - irrigation efficiency									
36	Apply land-leveling with laser techniques	MALR	144	10	10	10	10	10	48	48
78	Apply modern irrigation techniques in new areas	Private	1 802	0	30	60	90	120	751	751
82	Gradually introduce modern irrigation techniques in oases	MWRI	21	0	1	1	2	3	6	7
	Protection of public health and environment									
	Prevention									
4	Introduce financial incentives to promote clean industrial products	MoI	0	0	0	0	0	0	0	0
	Treatment									
102	Collect and/or pre-treat industrial wastewater separately	EEAA	3 010	46	93	139	185	232	1 158	1 158
	General institutional, legal and financial measures									
133	Enhance role of NGO's and Civil Society	MWRI/Private	0	0	0	0	0	0	0	0
	Total		**5 900**	**74**	**172**	**273**	**371**	**468**	**2 203**	**2 340**

Table C-22 O&M for Private Sector (MLE)