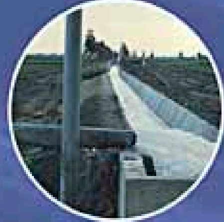
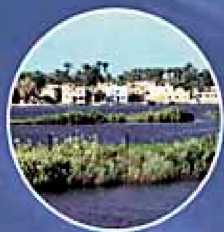
National Water Resources Plan Egypt

Arab Republic of Egypt

Ministry of Water Resources and Irrigation




Water *for the* Future



National Water Resources Plan 2017

January 2005

NWRP PROJECT

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
Marsá Matruh
Alexandria
Edfina Barrage
Farascour Dam
Port Said
Israel/ Palestine
El-Salam Canal
Zifta barrage
Delta Barrages
Cairo
Suez
Jordan
Lake Qarun
Nile
Al Fayoum
Beni Suef
Sinai
Siwa Oasis
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
Naga Hammadi Barrage
Kelabia Canal
Luxor
Asfoun Canal
Esna Barrage
Kharga Oasis
Dakhla Oasis
Idfû
New Valley
Aswan
High Dam
Toshka
Sheikh Zyed Canal
Lake Nasser
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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.

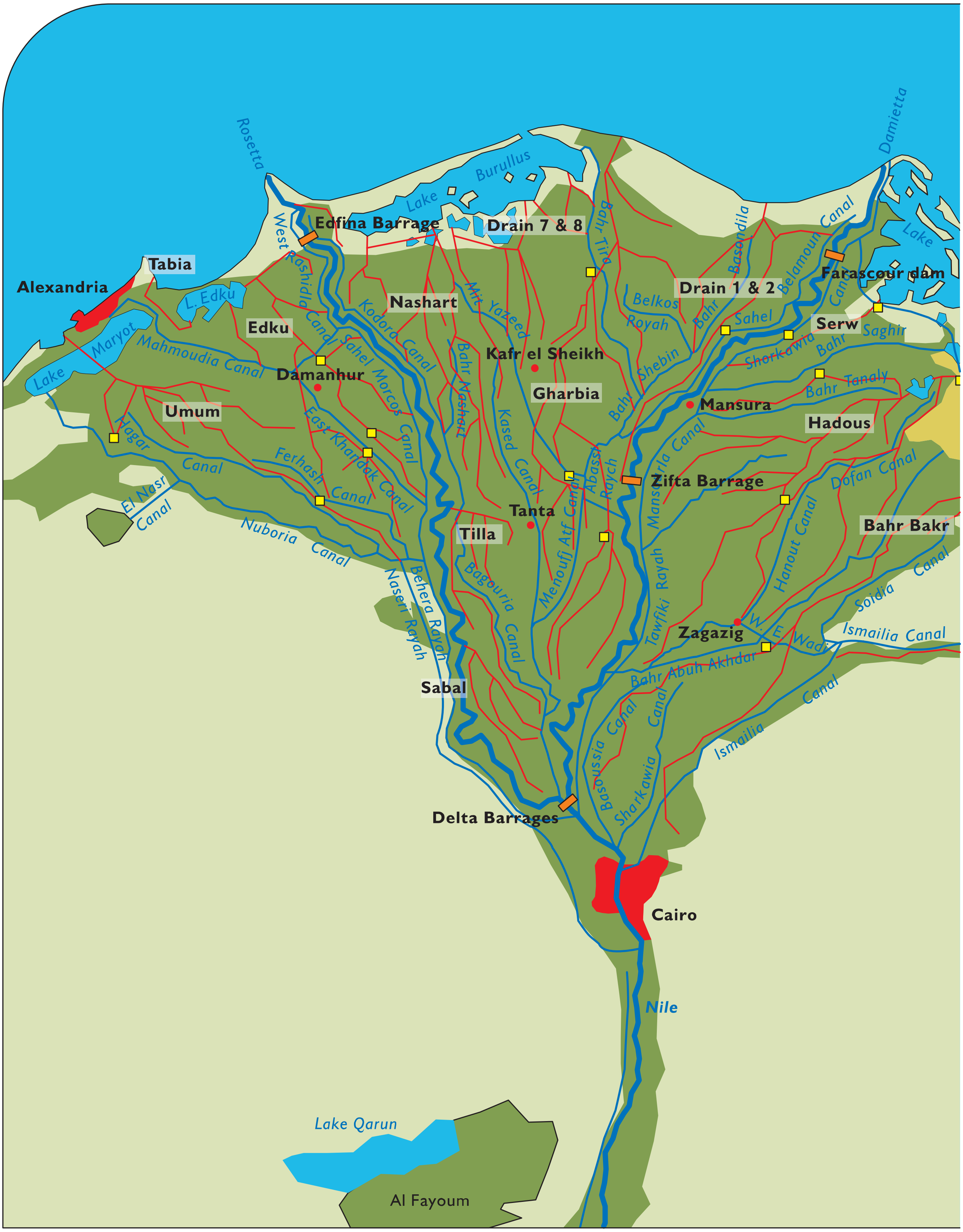
The core of the National Water Resources Plan consists of the strategy "Facing the Challenge" that has been discussed extensively with all stakeholders. This strategy is included as Chapter 5 of the plan.

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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Royah
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Belamoun Canal
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Damanhur
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Hagar Canal
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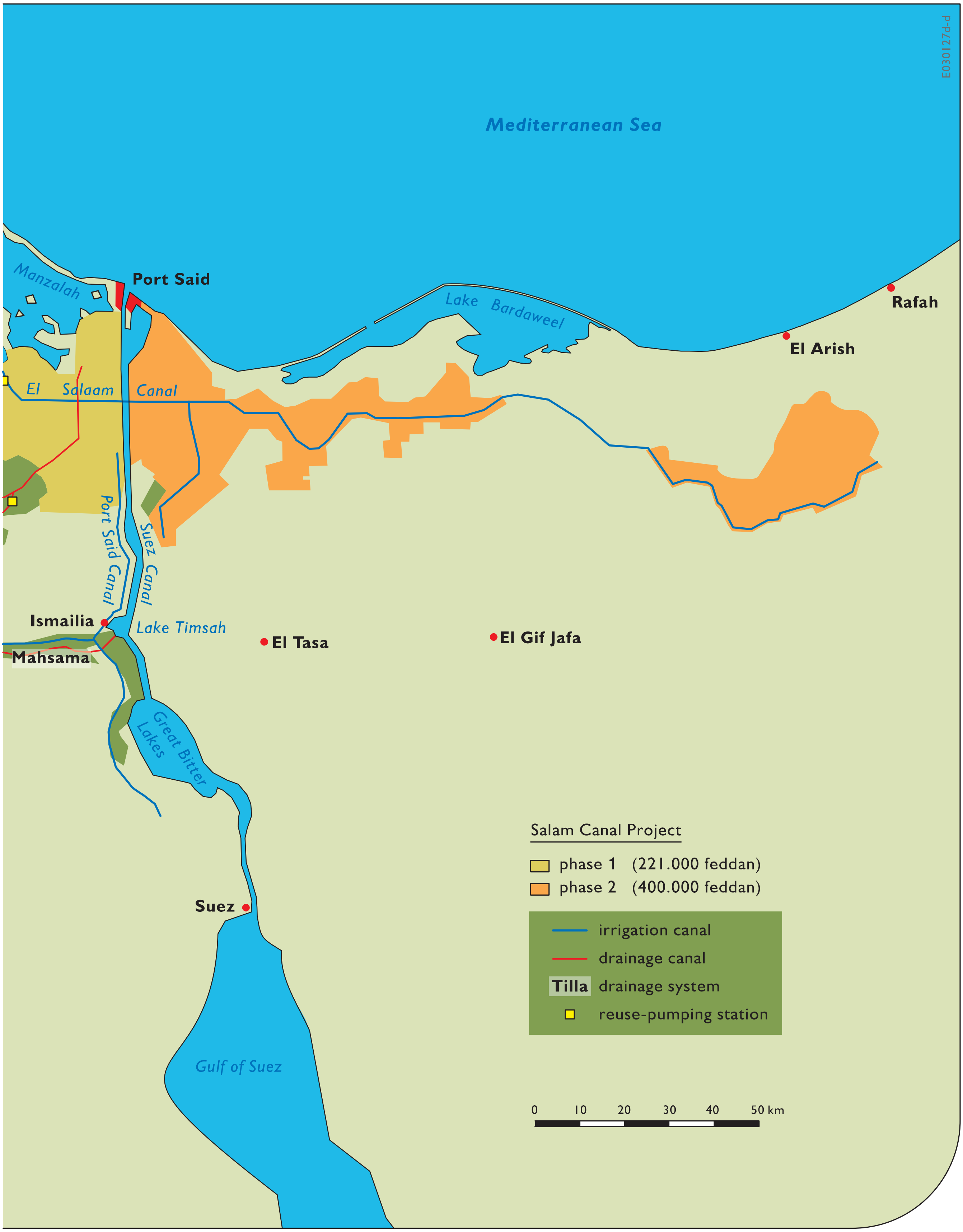

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Mediterranean Sea
Manzalah
Port Said
Lake Bardaweel
Rafah
El Arish
El Salaam Canal
Port Said Canal
Suez Canal
Ismailia
Lake Timsah
El Tasa
El Gif Jafa
Mahsama
Great Bitter Lakes
Suez
Gulf of Suez
Salam Canal Project
phase 1 (221.000 feddan)
phase 2 (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	2nd 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	3rd 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.

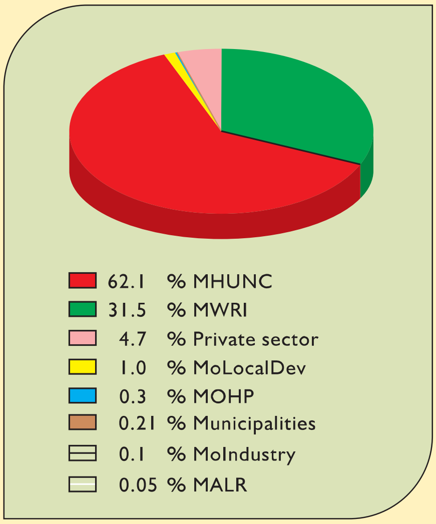
The strategy also includes a number of general **institutional measures**. The initiated process of decentralisation (to Water Boards) and privatisation will be strengthened, including a restructuring of the role of MWRI, e.g. by establishing Integrated Districts at local level. Cost-sharing and cost-recovery 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

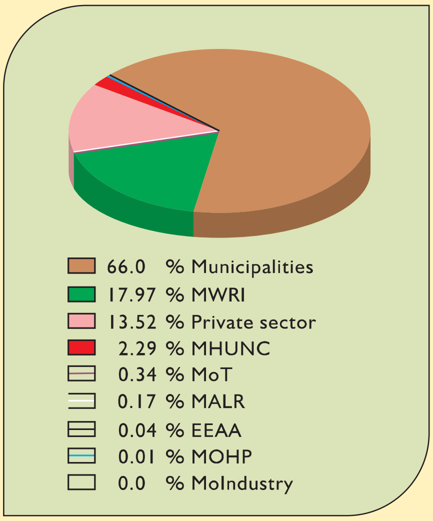
Implementing the strategy 'Facing the Challenge' will improve the performance of the water resources system. More water will be available for the various uses and the water quality will improve significantly. The agricultural area will increase by 35% as a result of horizontal expansion and the two mega 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.



Investment by stakeholder category



Recurrent costs by stakeholder category

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.

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

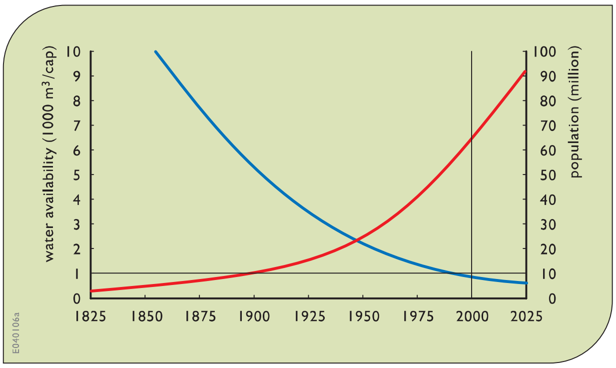


Figure 1-1 Population growth and water availability

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.

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.

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.

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.

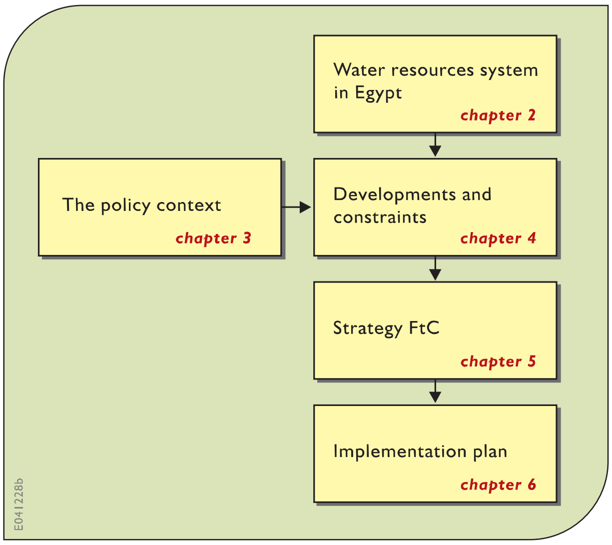


Figure 1-2 Content of National Water Resources Plan

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.

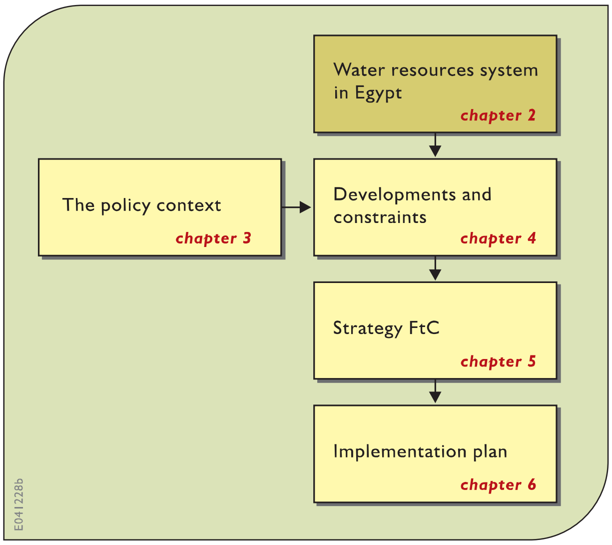
The final Chapter 6 describes how the plan will be implemented. The two main components of that chapter are the Investment Plan (the amount of investments involved and who will pay) and the Implementation Plan (who will do what and when).

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



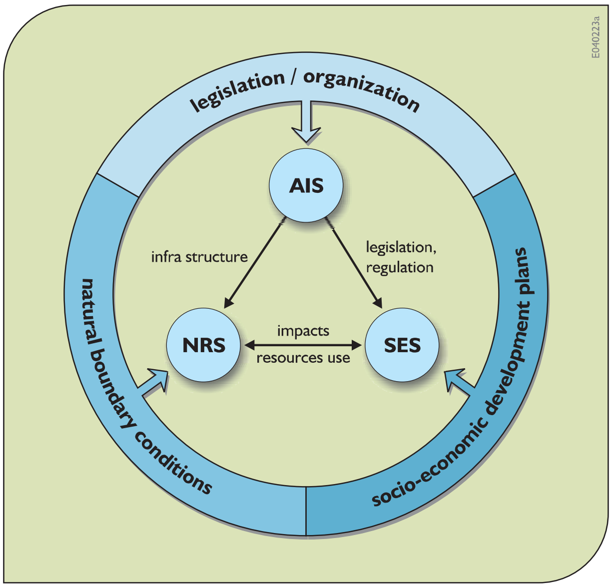


Figure 2-1 The Water Resources System in its environment

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.

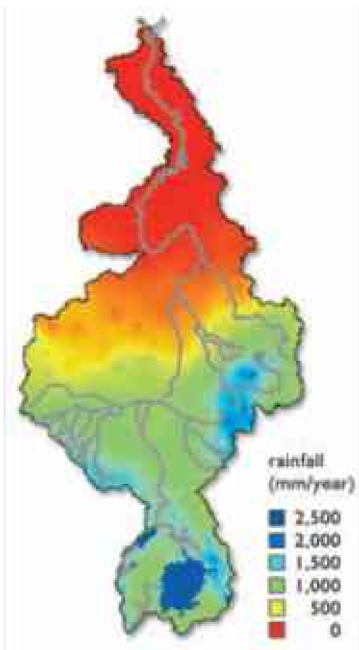


Figure 2-2 Rainfall in the Nile Basin

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

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

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.

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.

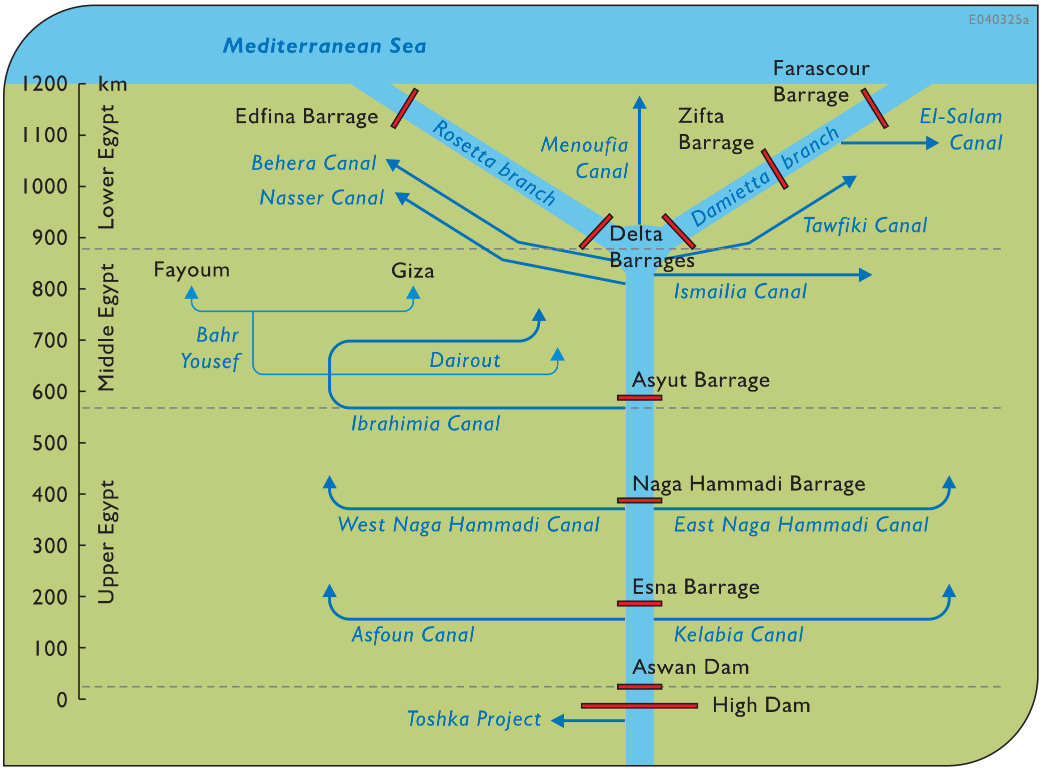


Figure 2-4 Schematic diagram of major control structures on the Nile in Egypt

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

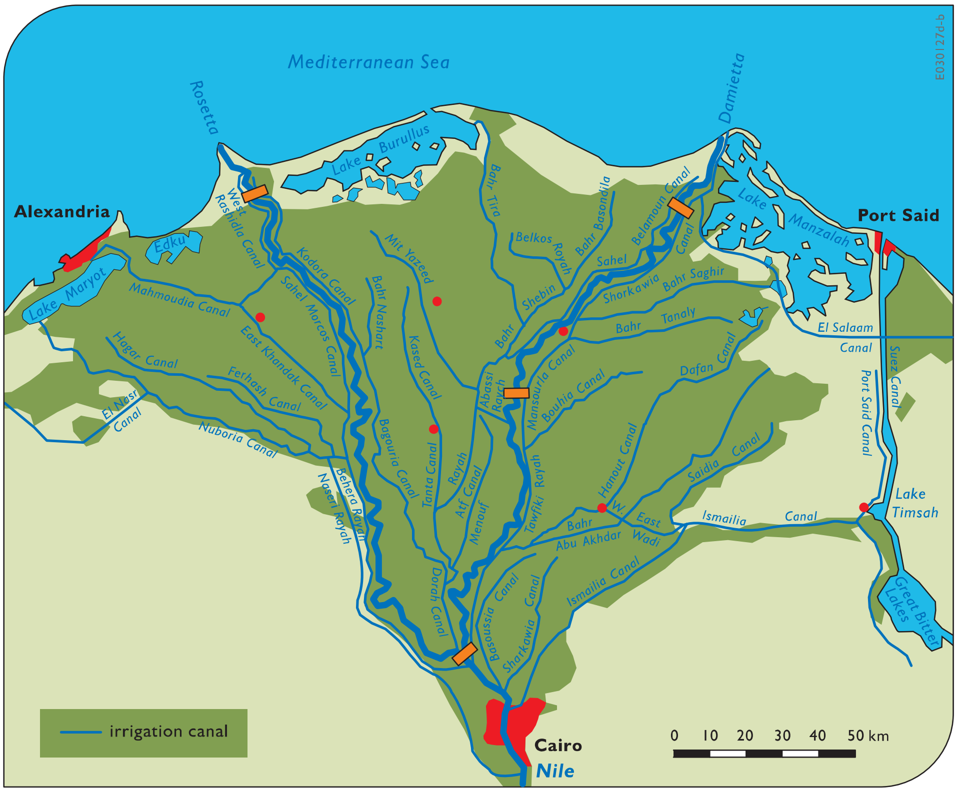


Figure 2-5 Irrigation canals in the Delta

Figure 2-6 Main drainage canals in the Delta

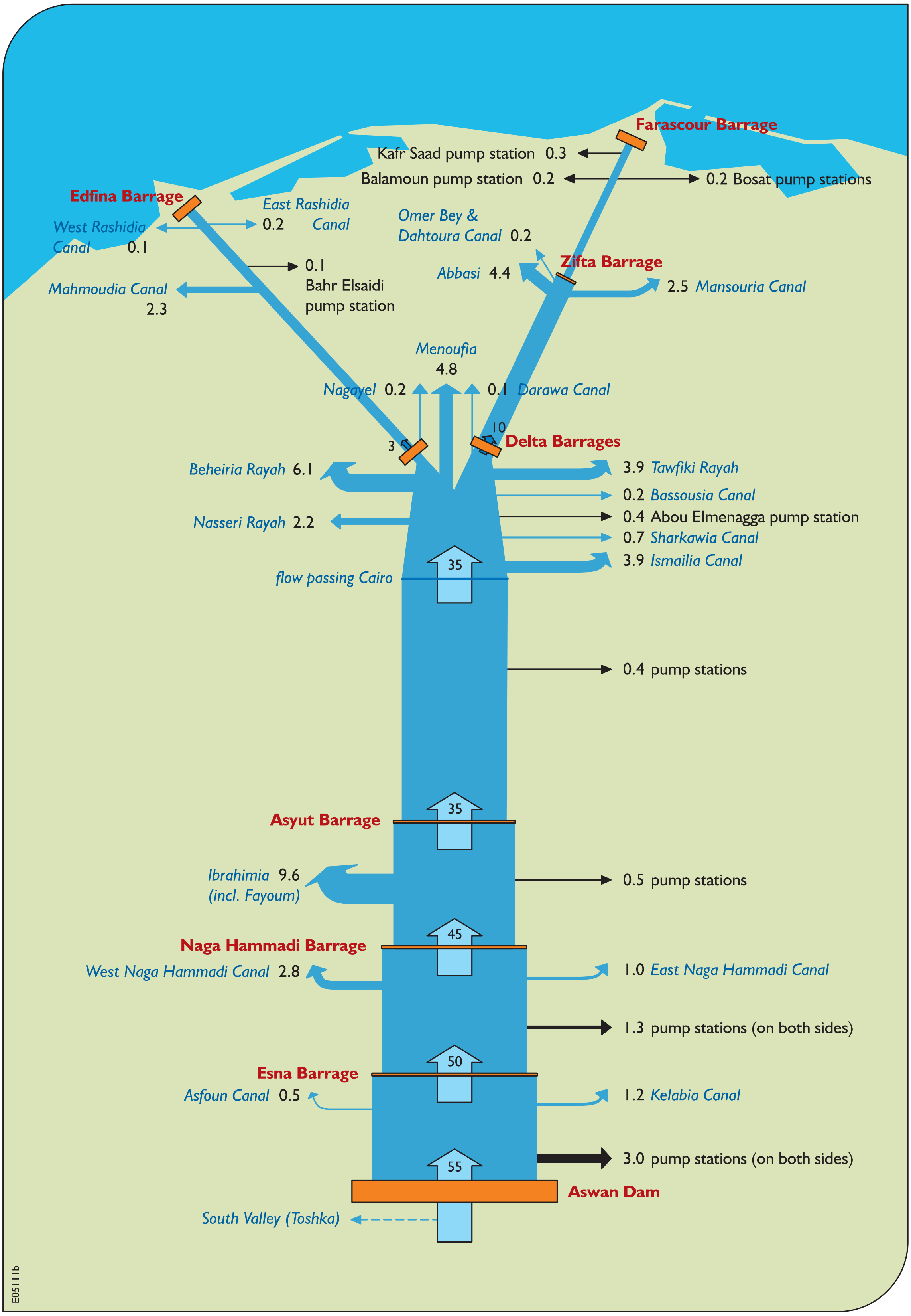


Figure 2-7 Water distribution Nile System (source: NAWQAM project)

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.

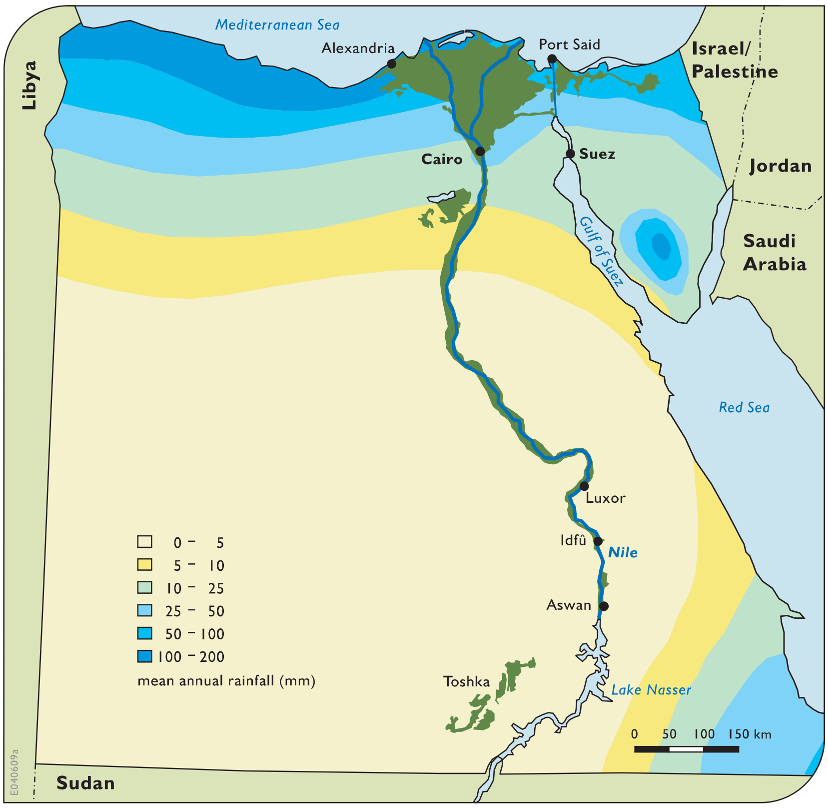


Figure 2-8 Average annual rainfall in Egypt

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.

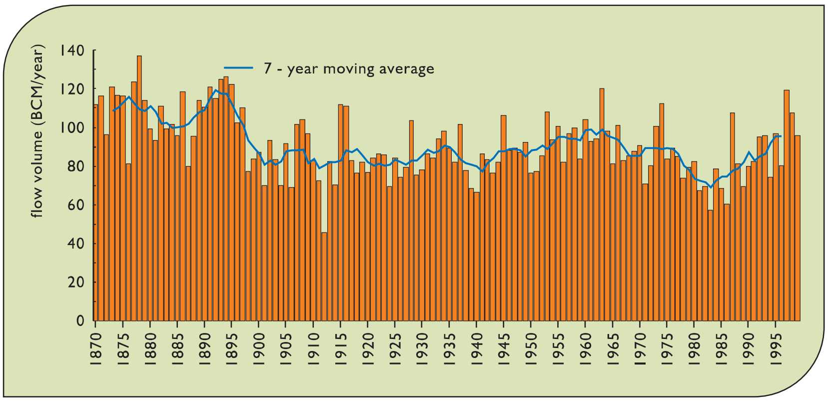


Figure 2-9 Natural flows of the Nile at Aswan (source: Nile Water Sector)

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.

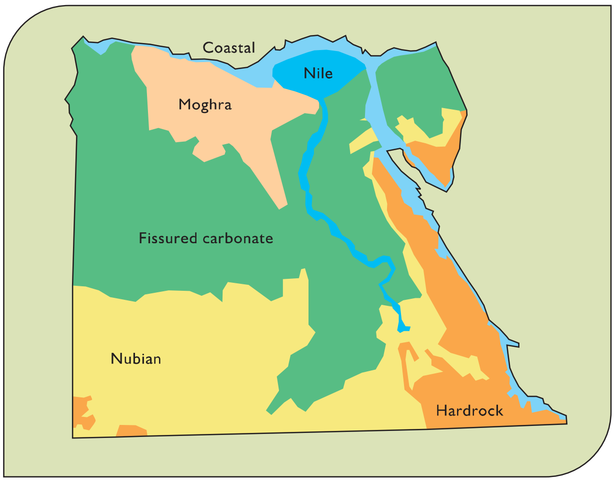


Figure 2-10 The major aquifer systems in Egypt

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).

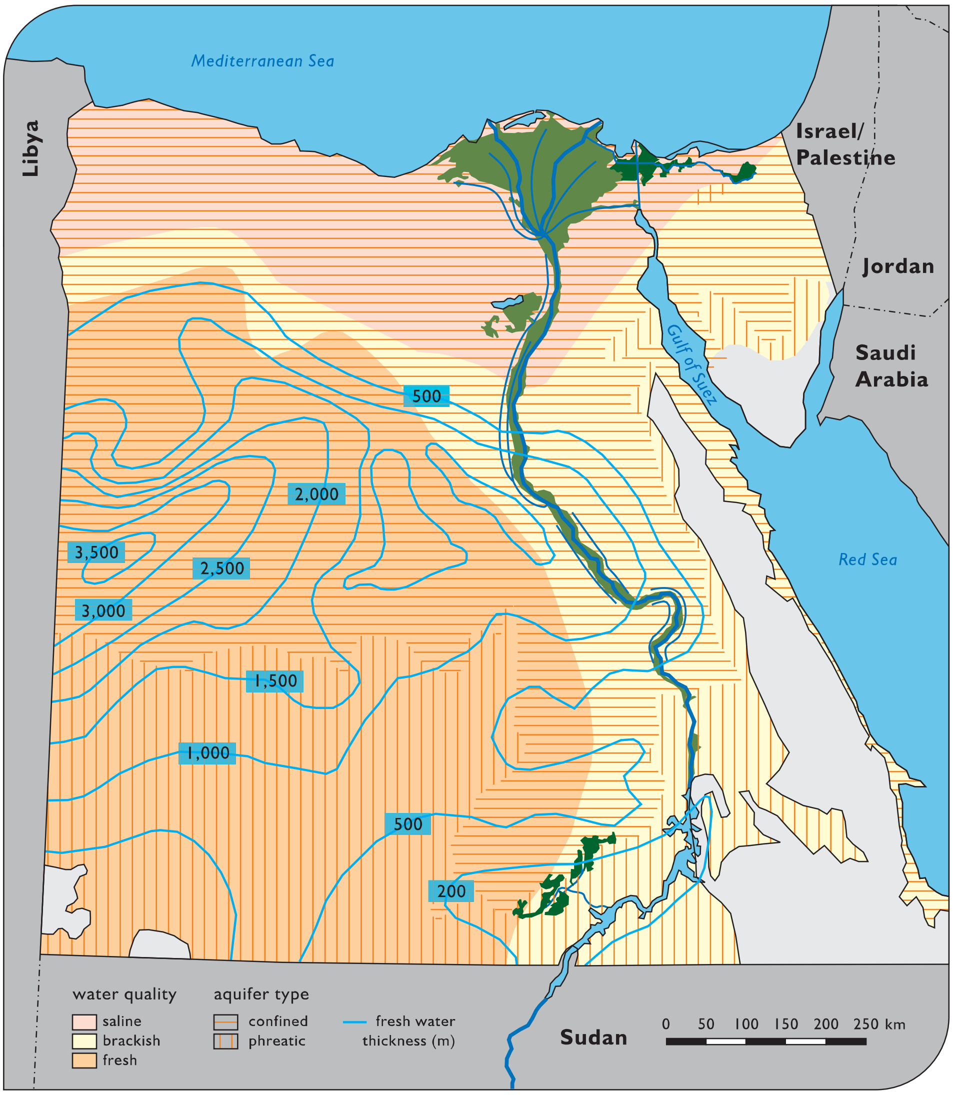


Figure 2-11 Extent and main characteristics of the Nubian Sandstone Aquifer in Egypt

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.

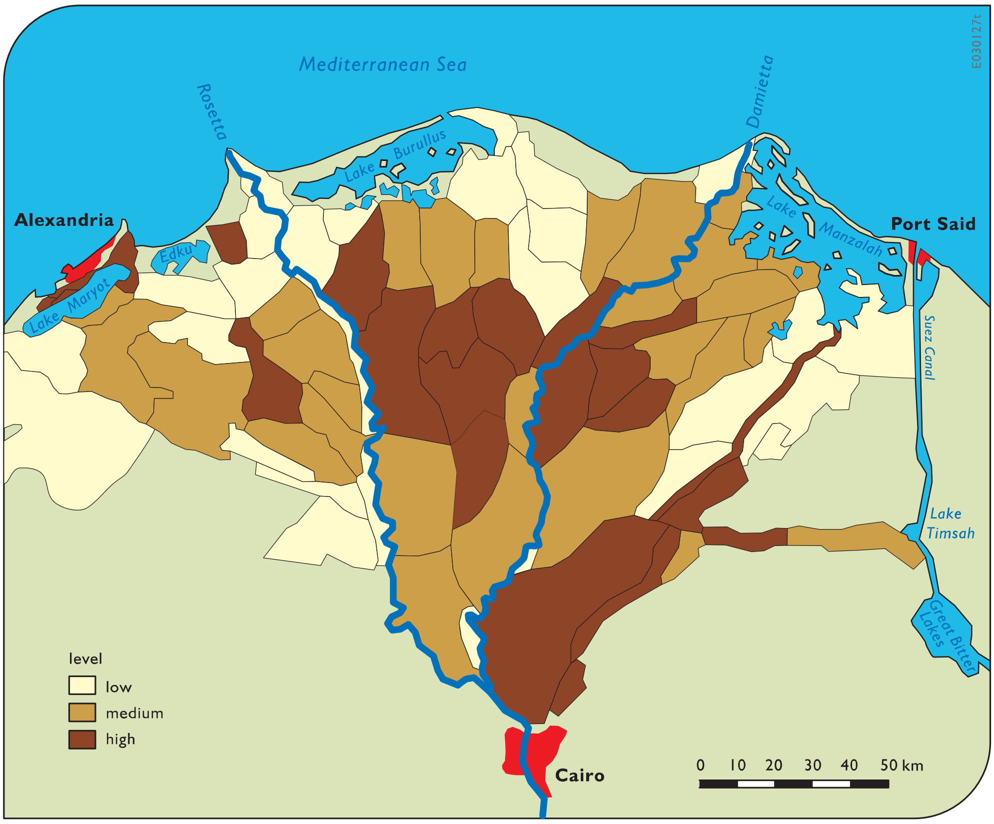


Figure 2-12a Drainage catchments in the Delta with pollution problems

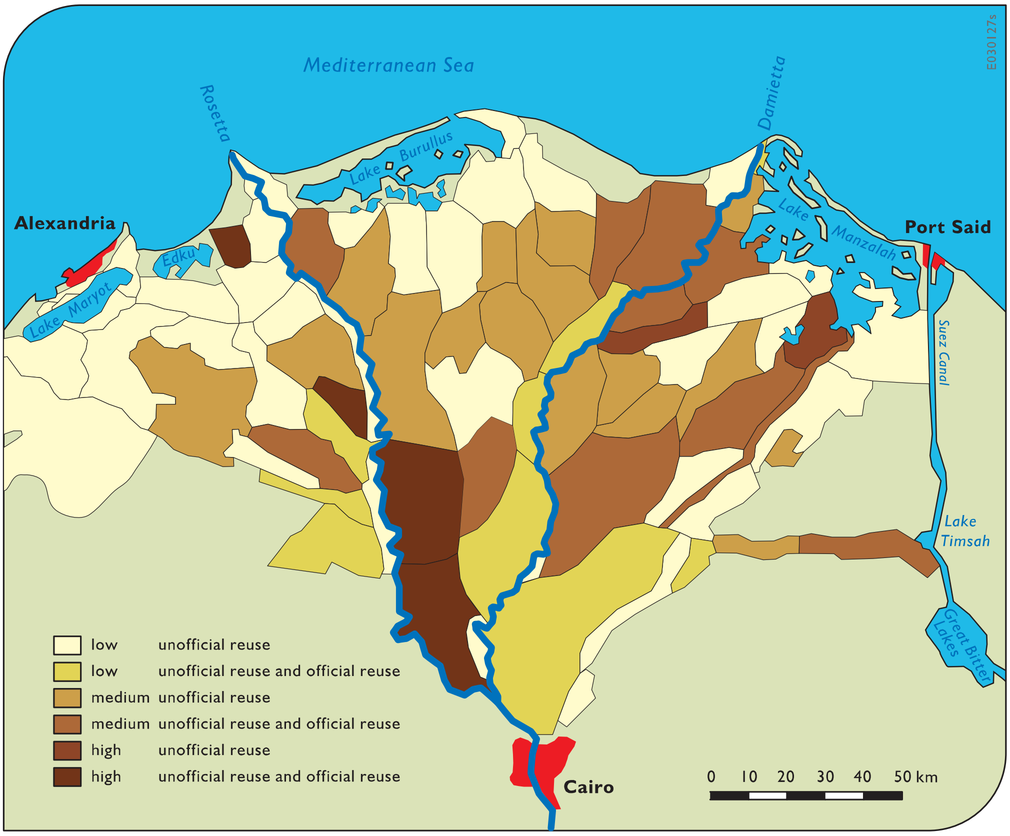


Figure 2-12b Drainage catchments in the Delta with official and un-official reuse

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

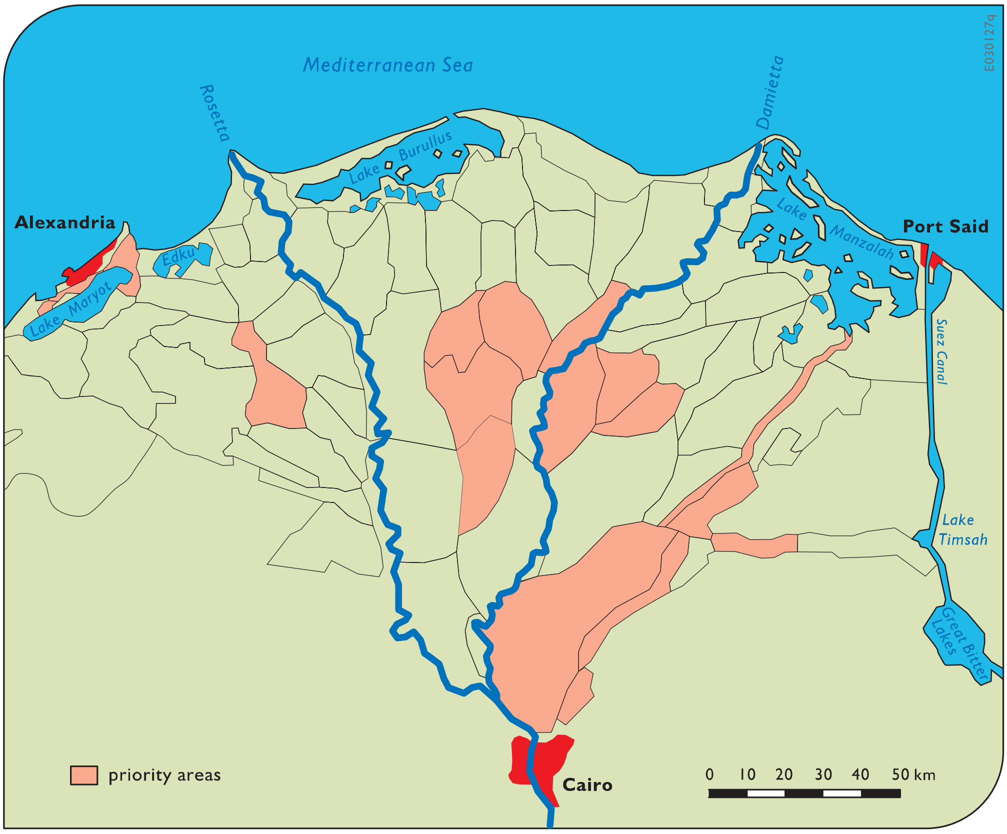


Figure 2-13a Priority areas in the Nile Delta based on health criteria

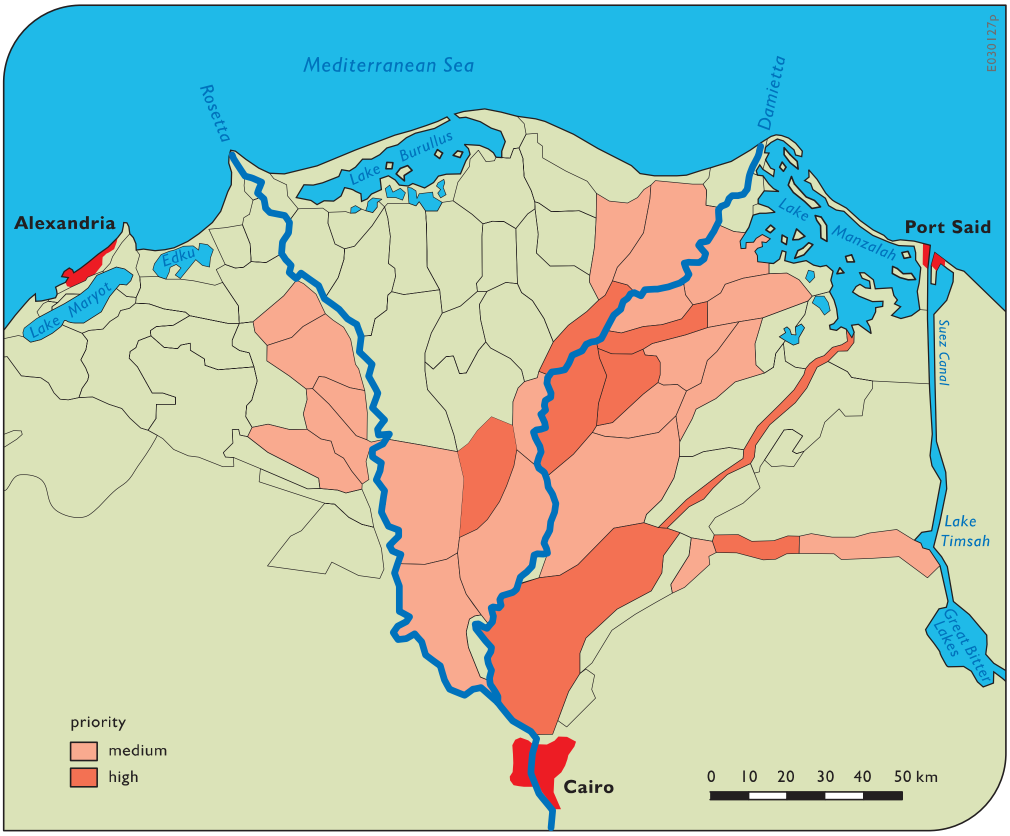


Figure 2-13b Priority areas in the Nile Delta based on the official reuse criteria

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

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.

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

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.

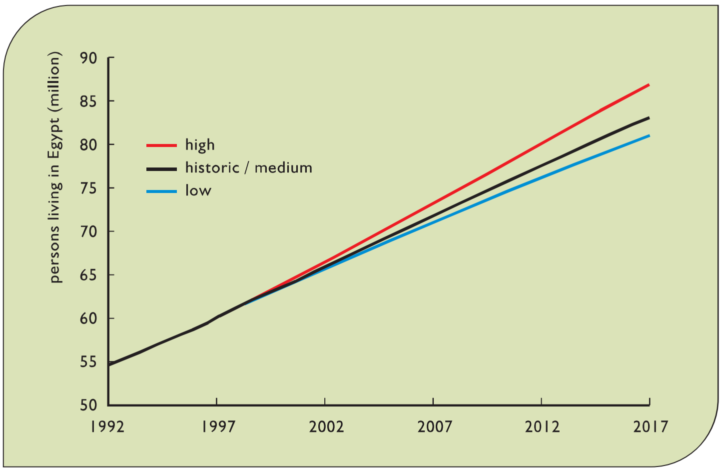


Figure 2-14 Population projections

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).

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.

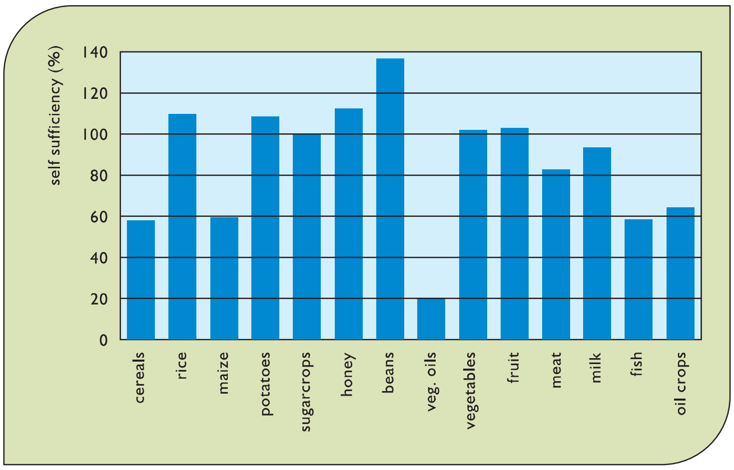


Figure 2-15 Self-sufficiency in major food items (2001) Source: FAO (food balance), 2001

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

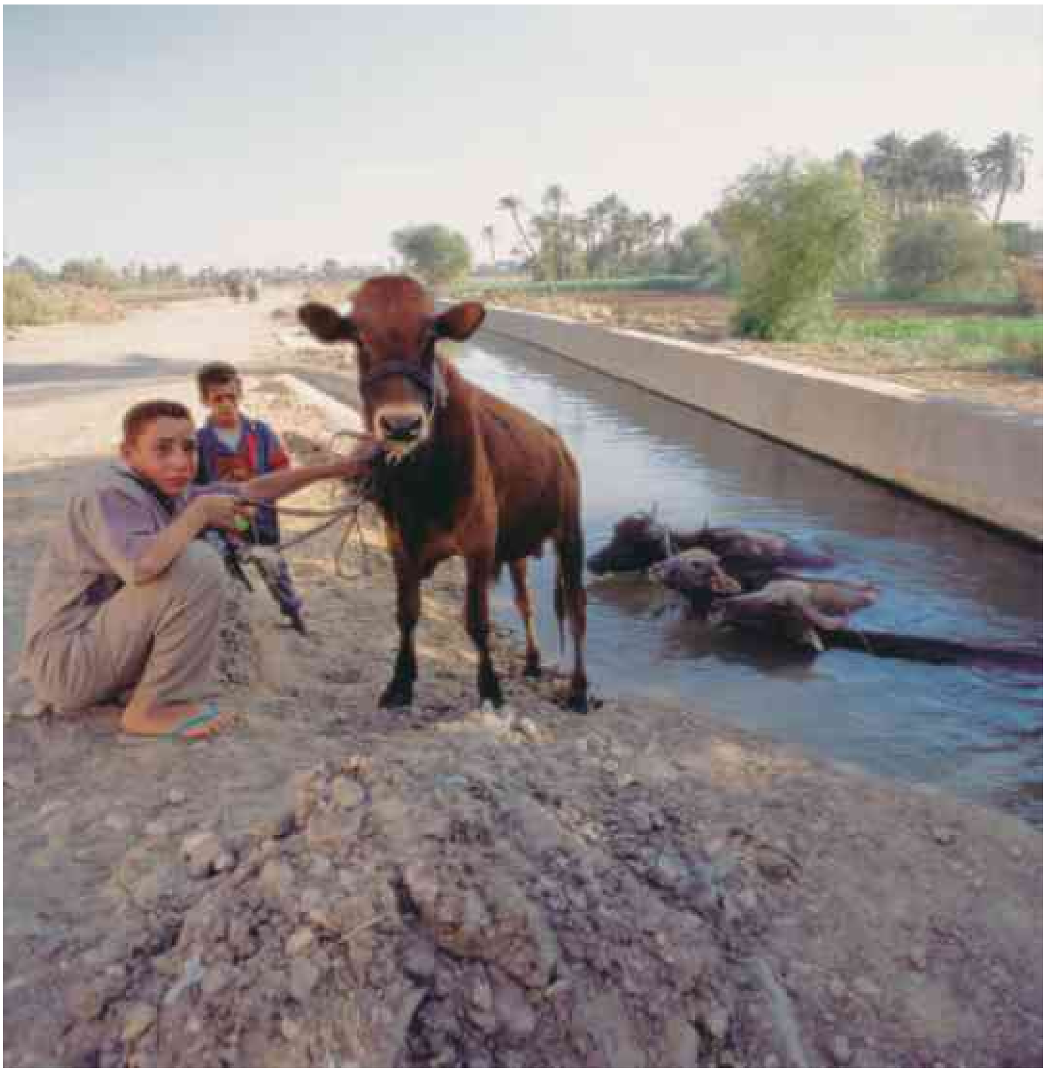

Sugar cane

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 17^{th} in 2000 and 14^{th} 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 Total	Lower Egypt Urban	Lower Egypt Rural	Upper Egypt Total	Upper Egypt Urban	Upper Egypt Rural	Frontier govern'tes	Weighted average
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 Total	Lower Egypt Urban	Lower Egypt Rural	Upper Egypt Total	Upper Egypt Urban	Upper Egypt Rural	Frontier govern'tes	Weighted average
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.

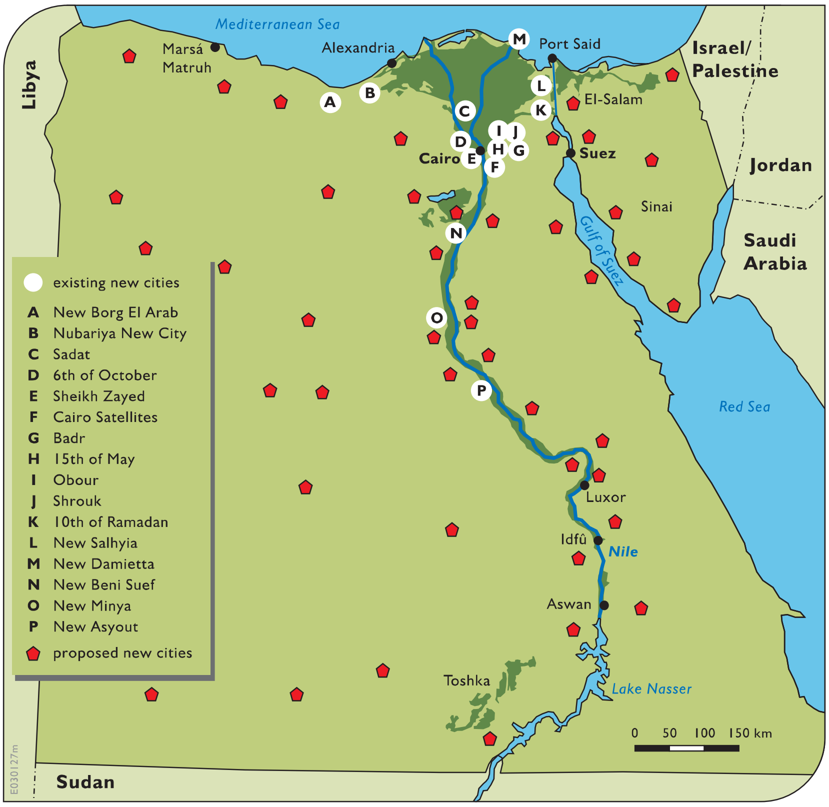


Figure 2-16 Location of new cities

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)

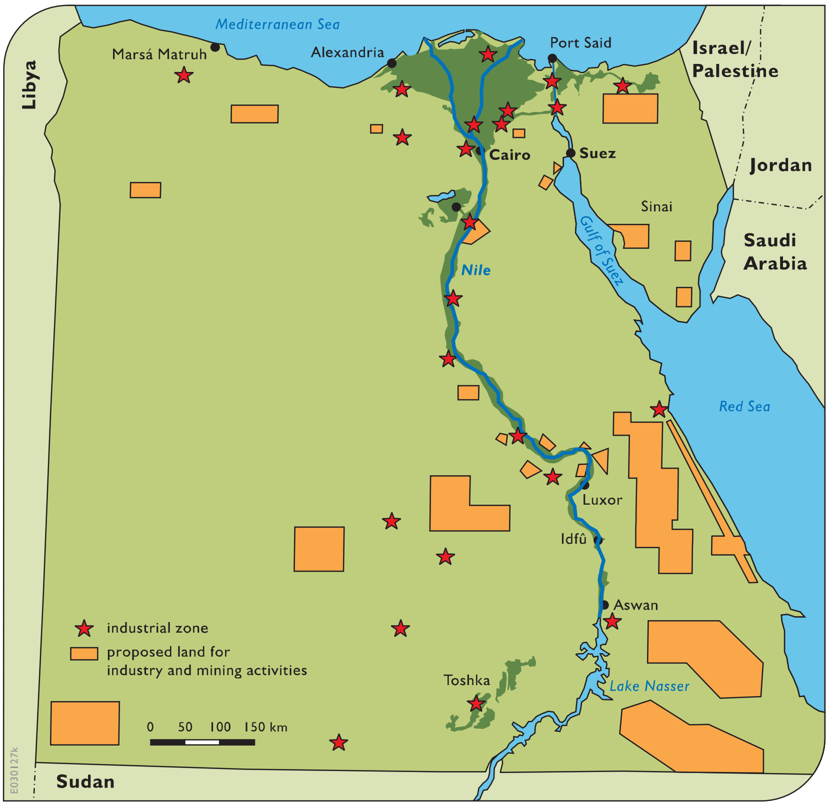


Figure 2-17 Location of new industrial areas

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

Cage Cultures in the Nile

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

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.

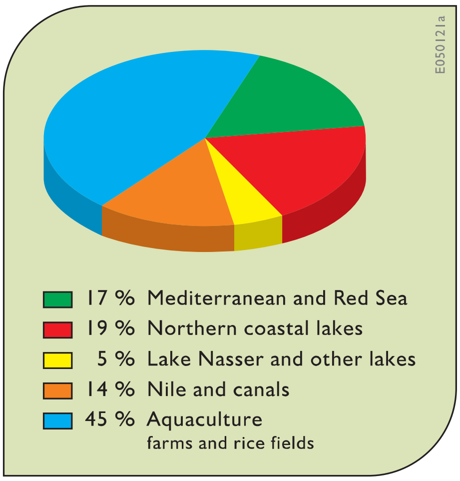


Figure 2-18 Fish production, 2001
(source: CAPMAS 2003)

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

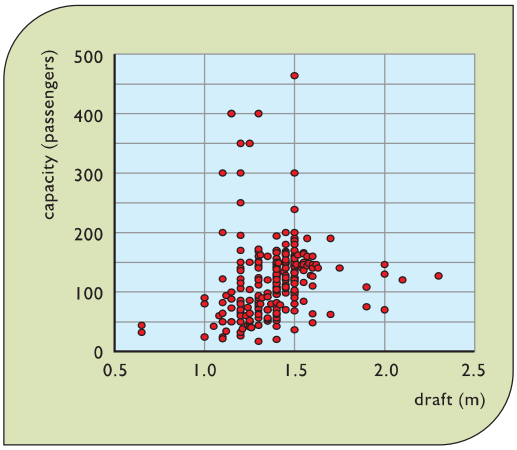


Figure 2-19 Capacity versus draft of hotel boats

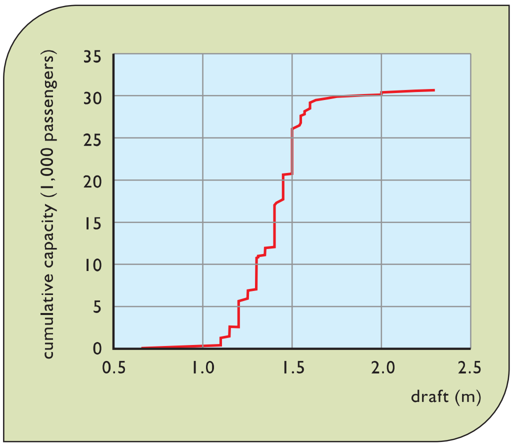


Figure 2-20 Cumulative capacity versus draft of hotel boats

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 I	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)

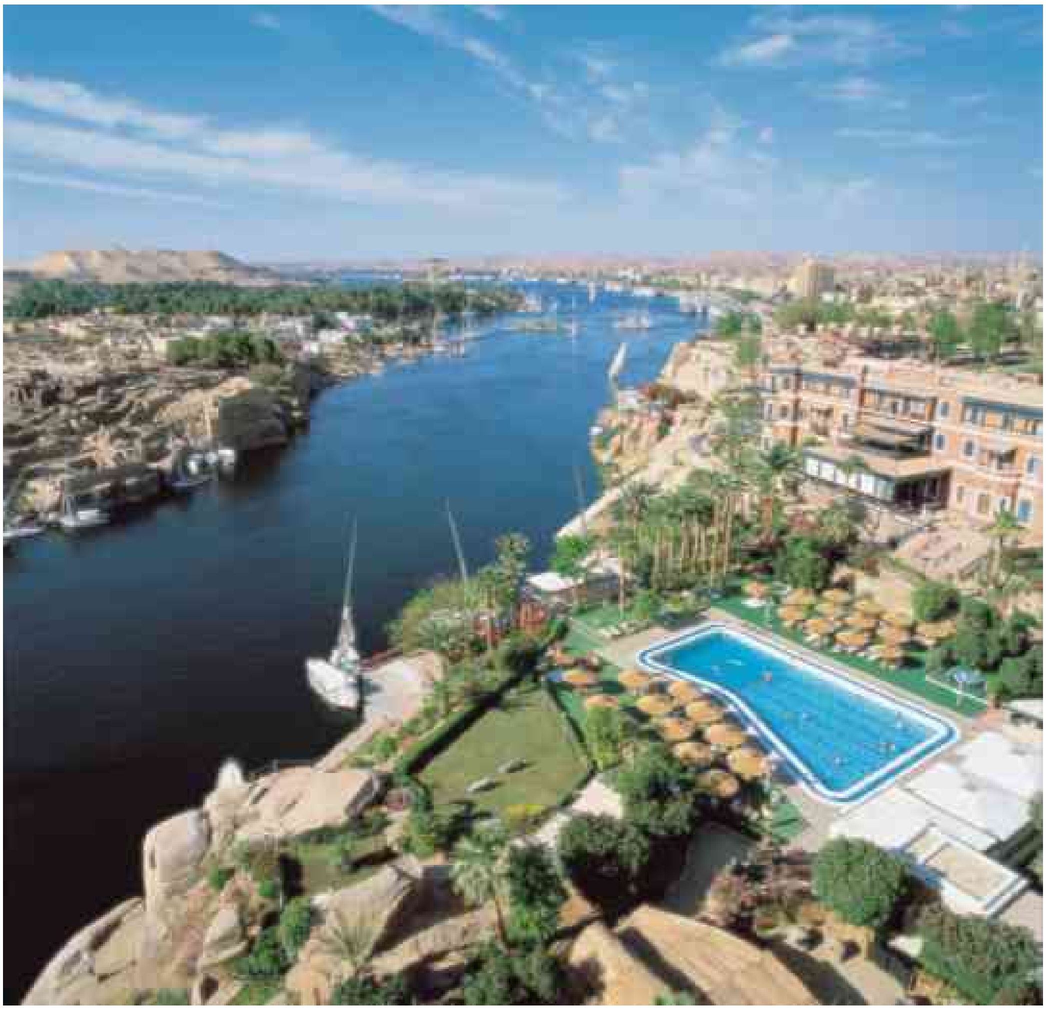
Plans for further hydropower development exist. A small hydropower station in El-Lahoon (0.8 MW) is under construction as well as an extension of the Naga Hamady power station of 80 MW (to be operational in 2005). Further possibilities for hydropower development till 2017, with a total of 70.5 MW, are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

Tourism development along the East Coast

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.

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.

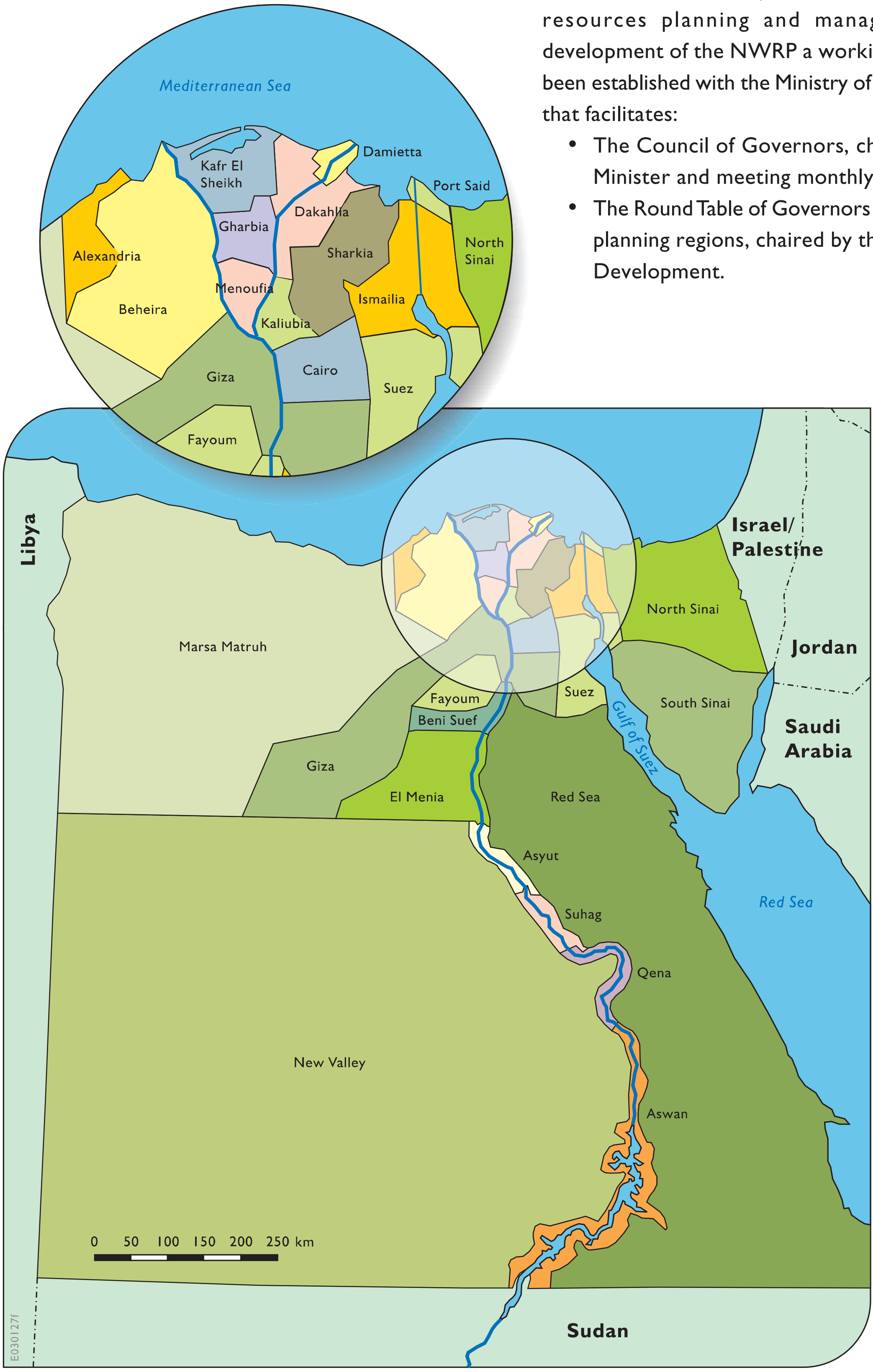


Figure 2-21 Governorates in Egypt