INECO

Institutional framework and decision-making practices for water management in Egypt

Towards the development of a strategy for water pollution prevention and control in the Bahr Basandeila region

March 2009

Prepared by International Consultants Egypt

INECO ("Institutional and Economic Instruments for Sustainable Water Management in the Mediterranean Basin") is a Coordination Action Project supported by the European Commission through the 6th Framework Programme (Contract No: INCO-CT-2006-517673).

SIXTH FRAMEWORK PROGRAMME

PREFACE

Water quality problems in Egypt vary with location and depend on factors such as water flow rates, water uses, population densities, sanitation systems, industrial discharges, demands for navigation, and agricultural runoff. Discharge of untreated, or partially treated, industrial and domestic wastewater, leaching of pesticides and residues of fertilizer and navigation are often factors that affect the quality of water. The major water quality problems are related to the presence of pathogenic bacteria/parasites, heavy metals and agrochemicals in water supplies. Currently, there are increasing concerns on water misallocation, declining water quality and the rising costs of environmental degradation in the country.

In this regard, several policies have been developed for preventing further water quality degradation and ensuring adequate water supply and sanitation coverage. Instruments targeting the industrial and agricultural sector are of particular importance, and aim at providing the appropriate incentives and disincentives to water users for adopting more environmentally friendly practices.

In this context, this volume of the INECO Publishable Reports outlines the analysis of the institutional framework and decision-making practices for water management in Egypt. It highlights the main water management challenges faced in the country today, and focuses on significant water management issues pertaining to the “sharing”, “valuing” and “governing” dimensions of water resources management. The second part of the report presents the results of the INECO Egypt Case Study on water quality deterioration in the Bahr Basandeila Region. The Basandeila Region is located in the Dakahlia Governorate, and has a total area of 5739 feddans. The cultivated area is estimated at 5524 feddans, representing 96.3% of the total area. The total population of the region is currently around 45,000 inhabitants. Currently, the area faces serious problems affecting mostly the quality of drinking water supply and having impact on population health. Water pollution is primarily due to the discharge of industrial and municipal effluents without prior treatment. The problem is similar (in terms of causes and impact) to the overall water quality problems experienced in the River Nile and its distribution network. In this area, the INECO effort was primarily aimed at fostering discussions among citizens, stakeholders and local water management authorities, in order to identify deficiencies and suggest instruments that could assist in addressing the issues at hand.

This volume was developed by International Consultants Egypt, with the support of the Water Management Research Institute of the Ministry of Water Resources and Irrigation, and the Agricultural Research Centre of the Ministry of Agriculture and Land Reclamation. Special thanks are extended to Dr. Fathy El Gamal, Director of WMRI, and Prof. Samy El Fellaly, Emeritus Professor in the Soils, Water and Environment Research Institute, for their valuable support and provision of the relevant data and information. The authors would also like to thank Prof. Dionysis Assimacopoulos, INECO Project Coordinator, for his valuable guidance, and all stakeholders and citizens who participated in the events organized in the area within the framework of the INECO project.

March 2009

International Consultants - Egypt

CONTENTS

PART I: WATER MANAGEMENT IN EGYPT: SETTING THE SCENE

GENERAL CONTEXT

The Arab Republic of Egypt is located at the North-Eastern corner of Africa and, with an area of almost 1,000,000 km^2, occupies nearly 3% of the total area of the continent (Figure 1). Most of the country falls within Africa's dry desert region, except for a narrow strip along the northern coast, which experiences Mediterranean climate. These, relatively favourable climatic conditions, when compared to the desert areas of the south, have led to a concentration of rainfed agriculture in the north-west coastal region. Egypt is predominantly desert and only 5% of its total land is cultivated and permanently inhabited.

Figure 1: The location of Egypt

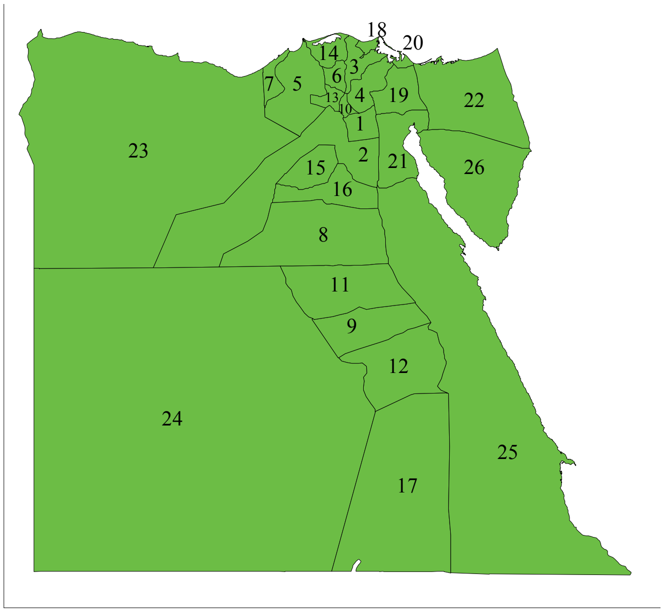
PHYSICAL CHARACTERISTICS

Geography and administration

Geographically, Egypt is divided into four regions:

- The **Nile Valley and Delta**, including Cairo, the El Fayum depression and Lake Nasser (3.6%);
- The **Western Desert**, including the Mediterranean coastal zone and the New Valley (68%);
- The **Eastern Desert**, including the Red Sea coastal zone and the high mountains (22%);
- The **Sinai Peninsula**, including the coastal zones of Mediterranean, the Gulf of Suez and the Gulf of Aqaba (6.4%).

The country is divided into administrative Governorates. These governorates and their total area are illustrated in Figure 2.



Governorate ID	Governorate	Area (km²)
GOV01	Cairo	457
GOV02	El-Giza	4840
GOV03	El-Dakahlia	3459
GOV04	El-Sharkia	4190
GOV05	El-Beheira	9504
GOV06	El-Gharbia	1943
GOV07	Alexandria	2879
GOV08	El-Minya	2263
GOV09	Sohag	1574
GOV10	El-Kaliobia	1001
GOV11	Assiut	1558
GOV12	Kena	12743
GOV13	El-Menoufia	2158
GOV14	Kafr El-Sheikh	3748
GOV15	El-Fayoum	4949
GOV16	Bany Swif	9576
GOV17	Aswan	34608
GOV18	Demiat	1029
GOV19	El-Ismailia	4483
GOV20	Port Said	1351
GOV21	El-Suez	25000
GOV22	North Sinai	31000
GOV23	Matroh	212000
GOV24	New Valley	376505
GOV25	Red Sea	130000
GOV26	South Sinai	28438
GOV27	Luxor City	55.4
Total Area (km²)		911311.4

Figure 2: Administrative Governorates of Egypt

Geomorphology and geology

The landscape in Egypt can be broadly divided into the elevated structural plateaus and the low plains, fluviatile and coastal (Figure 3). These units play a significant role in the determination of the hydrogeological context of the country and define natural constraints in population distribution. The structural plateaus constitute the active and semi-active watershed areas, whereas the low plains can contain productive aquifers and, in some cases, they are also areas of groundwater discharge.

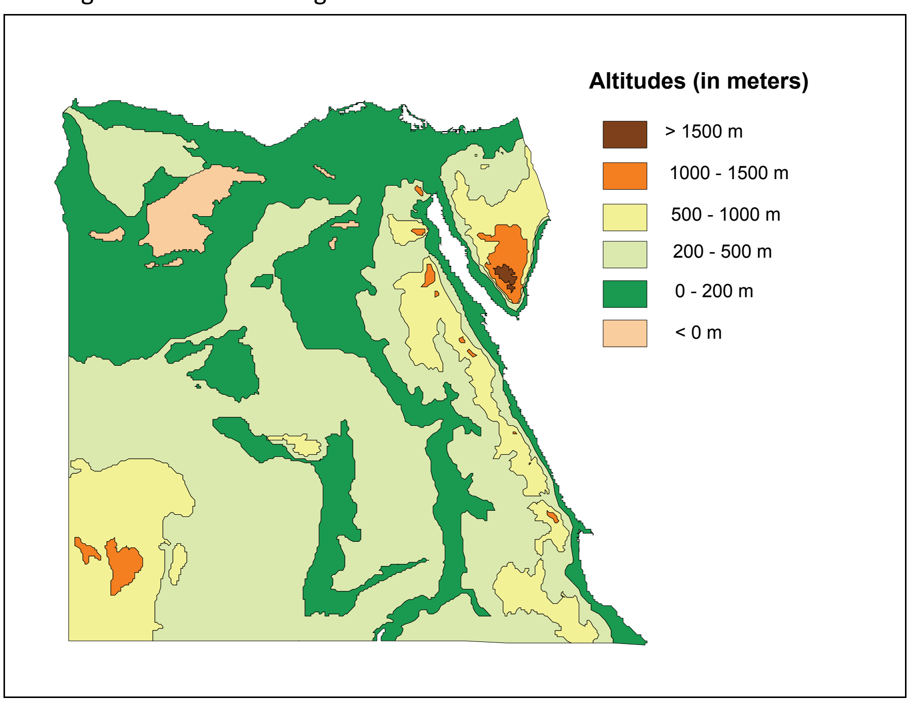


Figure 3: Topography of Egypt

Climate

Egypt lies in the dry equatorial region, except for its northern areas, which lie in the moderate warm region, and have climate similar to other Mediterranean areas. The climate is characterized by hot dry summers, while winters are moderate with limited rainfall that increases in the coastal area. Overall, the country can be divided into six climatic districts (Figure 4):

(1) Mediterranean District:	It extends along the Mediterranean Sea with several kilometres to the interior. In the summer, the mean temperature is about 23°C while during winter it is about 14°C. This district is the rainiest (100-190 mm/yr).
(2) Nile Delta District:	It lies to the south of the Mediterranean District. The mean temperatures are 13°C (January) and 27°C (July). In this district the annual average amount of rainfall decreases sharply to the range of 20-50 mm/yr.
(3) Sinai Highlands District:	It includes the highlands of Sinai. The weather differs from other parts of Sinai in terms of temperature and rainfall. It is colder with a minimum of 10°C difference in temperature. Rainfall reaches the amounts of the Mediterranean district.
(4) Middle Egypt District:	It lies between Cairo and Assiut and extends up to the borders of the country in the west and to the highlands of the Red Sea in the east. During the winter, it is the coldest district, whereas the average temperature in the summer is equal to 30°C on average. Annual average rainfall is very limited (< 10 mm).
(5) Upper Egypt District:	It extends from the south of Assiut to the southern borders. Rainfall is rare and the difference between the day and night temperatures can exceed 18°C (desert area).
(6) Red Sea District:	The region of Red Sea highlands differs climatically from other neighbouring low-lands, being colder and rainier.

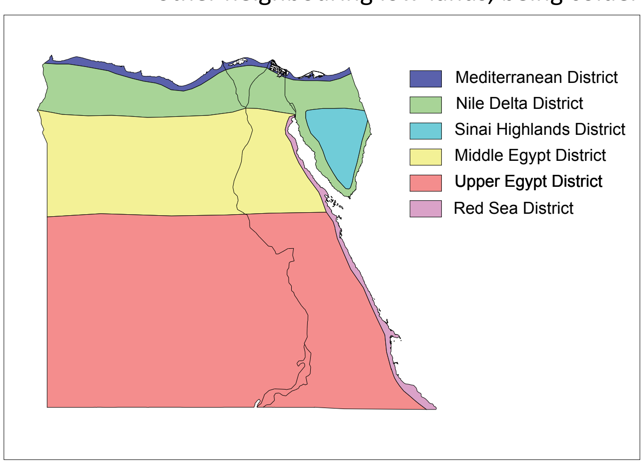


Figure 4: The climatic districts of Egypt

Overall, summer temperatures are extremely high, reaching 38°C to 43°C with extremes of 49°C in the southern and western deserts. The northern areas on the Mediterranean coast are much cooler, having a maximum temperature of 32°C. Around April, a hot windstorm, the “Khamsin”, sweeps across the country. Its driving winds blow large amounts of sand and dust at high speeds. The Khamsin may cause temperatures to rise to as much as 38°C, and hot winds can damage crops.

Hydrology

The hydrogeological framework of the country comprises six aquifer systems, as shown in Figure 5:

1. The Nile Aquifer System, assigned to the Quaternary and Late Tertiary periods, which occupies the Nile flood plain region (including Cairo) and the desert fringes;
2. The Nubian Sandstone Aquifer System, attributed to the Palaeozoic-Mesozoic periods, which mainly occupies the Western Desert.
3. The Moghra Aquifer System, assigned to the Lower Miocene period, mainly occupying the western edge of the Delta.
4. The Coastal Aquifer Systems, assigned to the Quaternary and Late Tertiary periods, and occupying the northern and western coasts.
5. The Karstified Carbonate Aquifer System, formed during the Eocene and to the Upper Cretaceous periods, which outcrops in the northern part of the Western Desert and along the Nile system.
6. The Fissured and Weathered Hard Rock Aquifer System, attributed to the Pre-Cambrian period, which outcrops in the Eastern Desert and Sinai.

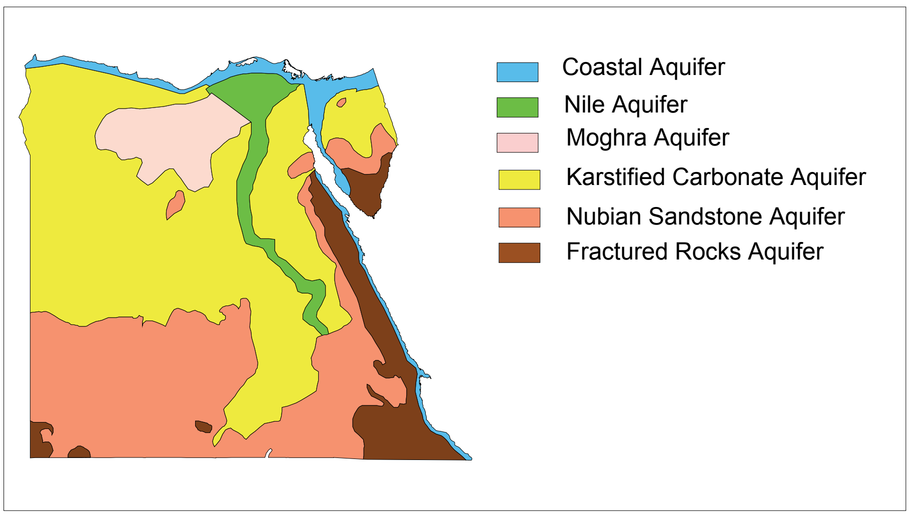


Figure 5: Location of main aquifer systems

DEMOGRAPHIC CHARACTERISTICS

The total population of Egypt is estimated at about 74 million people, with an average annual growth rate of 1.91% (2005). The rural population corresponds to 58% of the total. The average population density is 74 inhab/km². However, approximately 97% of the total population resides along the Nile Valley and Delta. In those areas, population density exceeds 1,165 inhab/km², while in the desert regions it drops to only 1.2 inhab/km². The following charts and tables present indicators relevant to the demographic characteristics of the country, including education, life expectancy and mortality.

Table 1: Population Indicators

Indicator	1991	2004
Population (million)	54.08	70*
Annual population growth rate (%)	2.28	1.94
Total number of households (million)	10.7**	15.1*

** Jan. 2005 ** 1992. Source: The Central Agency for Public Mobilization and Statistics (CAPMAS)*

Table 2: Life Expectancy and Infant Mortality Rate

Indicator	1994	2004
Life Expectancy (years): Male	64.2	68.4
Life Expectancy (years): Female	68	72.8
Infant Mortality Rate; less than one year (per thousand)	30.8*	21.9**

**1993/1994 ** 2003*

Source: The Central Agency for Public Mobilization and Statistics (CAPMAS)

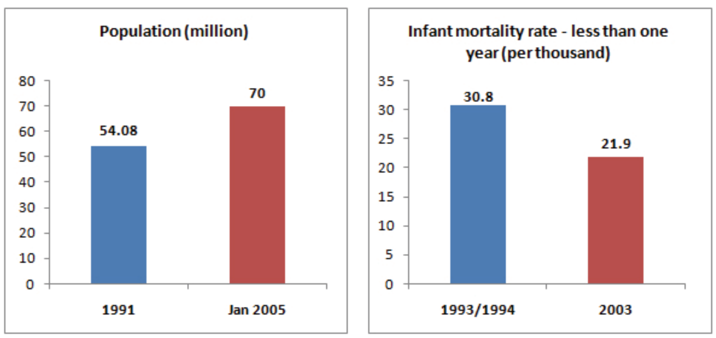


Figure 6: Population and Infant Mortality Rate indicators (Source: The Central Agency for Public Mobilization and Statistics-CAPMAS)

Table 3: Education Indicators

Indicator	1991/1992	2004/2005
Total number of students (million)	13.6	19.6*
Students enrolled in pre-universities education (million)	12.8	16.9**
Students enrolled in universities and higher education (million)	0.8	2.5*
Number of classrooms in pre-university education (thousands)	309	436
Education expenditure as a percentage of GDP (%)	3.4	6.1**

** targeted ** 2003/2004*

Source: Ministry of Higher Education, Ministry of Education & Ministry of Planning

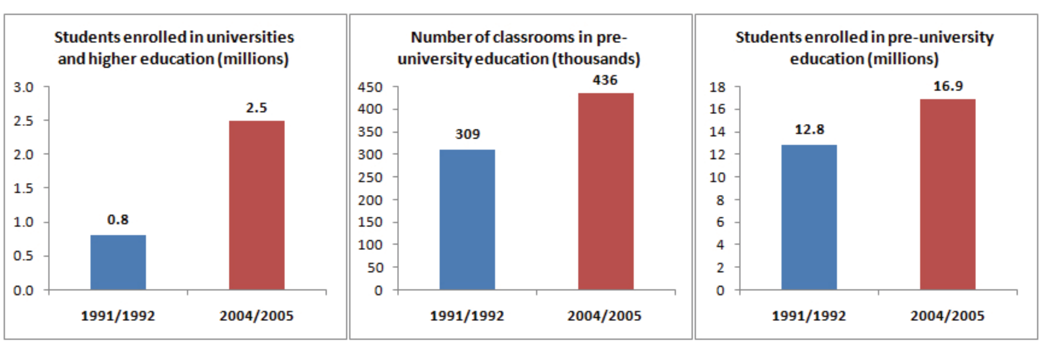


Figure 7: Education indicators
(Sources: Ministry of Higher Education, Ministry of Education & Ministry of Planning)

MAJOR ECONOMIC CHARACTERISTICS

Between 2000 and 2003, the national economy has had an average 3% annual GDP growth rate, experiencing a decrease, as a result of the September 11th 2001 events, recent regional political instability and economic reforms. This growth was insufficient to boost local economy and unemployment (officially equal to 10.7% and unofficially over 20%), has maintained its increase. However, a moderate recovery started in 2004, when GDP grew at a rate of 3.7%. In 2005, economic growth reached 4.8%. The appreciation of the Egyptian Pound has contributed to the drop of the inflation rate (8.8% in 2005 vs. 11.3% in 2004).

Table 4: GDP Indicators

Indicator	1991/1992	2004/2005
Inflation rate - Annual average (%)	21.1	4.7*
Annual real GDP growth rate (%)	2	4.9**
Private sector's contribution to the GDP (%)	61.2	72***
Budget deficit / GDP (%)	6.4	5.9****
GDP at market prices (L.E. billion)	139.1	558**

** July 2005 - the base year is 1999/2000 ** expected *** targeted **** estimated*

Source: Ministry of Planning, Central Bank of Egypt (CBE), Ministry of Finance and CAPMAS

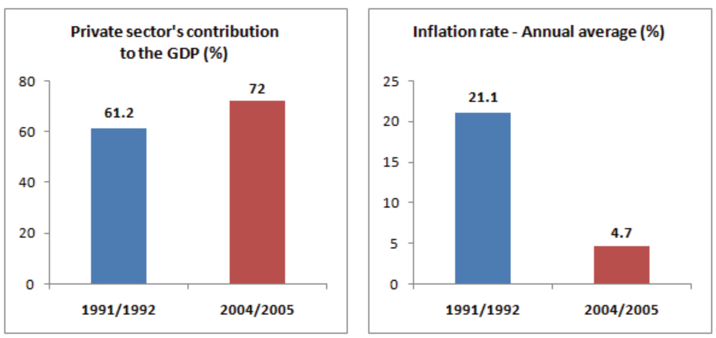


Figure 8: GDP Indicators (Sources: Ministry of Planning, Central Bank of Egypt - CBE, Ministry of Finance and CAPMAS)

Agriculture employs 35% of the active population and contributes to 17% of the GDP. The main crops are cereals, cotton and sugar cane. Egyptian hydrocarbon reserves are significant, and in the long run, gas could replace oil, whose reserves are declining. In the manufacturing sector, the food processing industry has developed considerably and now accounts for 17% of the GDP. Maritime freight ensures 80% of the country's exchanges. Tourism and rights of passage on the Suez Canal are the country's main sources of foreign currency.

Table 5: Other Economic Indicators

Indicator	1991/1992	2003/2004
Foreign currency reserves in the Central Bank (US$ billion)	10.6	14.8
Total outstanding debt (US$ billion)	32.6	28.9
Total external debt service / exports of goods & services (%)	21	10.8*
Current account balance (US$ billion)	2.7	3.4*

** Preliminary Figures*

Source: Ministry of Planning, Central Bank of Egypt (CBE), Ministry of Finance and CAPMAS

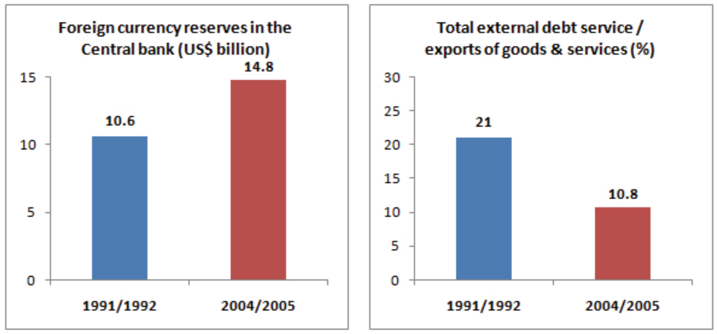


Figure 9: Other economic indicators (Sources: Ministry of Planning, Central Bank of Egypt (CBE), Ministry of Finance and CAPMAS)

The Egyptian market has been gradually opening up, especially after the signature of the EU-Egypt Association Agreement in June 2001, which became effective in 2004. The country's top export partners are India, the United States and the United Kingdom. Its top import partners are the United States, Italy and Germany. Egypt mainly imports consumer and capital goods, cereals and chemicals. Overall, the national economy is based on agriculture, industry, income from the Suez Canal and tourism, as well as petroleum.

In 2003, the **agricultural sector** accounted for 16.81% of Egypt's GDP and employed about 31% of the total labour force, of which 49% were female. In 1997, 99.8% of the total agricultural land was irrigated, as irrigation to produce reasonable yields is required even in the more humid area along the Mediterranean coast. The agricultural sector is characterized by small holdings: about 50% of holdings have an area of less than 0.4 ha (1 feddan). The areas under cultivation include arable lands and those with permanent crops, and represent a total area of 3,300,000 ha. The agricultural sector faces a serious threat from farmland urbanization. Currently, it is prohibited by law to construct buildings on farmland without a license from the Ministry of Agriculture and Land Reclamation. Violators are prosecuted and face serious penalties.

With regard to fisheries, the production of shellfish, mollusks and cephalopods is estimated at 12,176 tons, whereas the production of saltwater fish is estimated at 129,896 tons. Production from aquaculture is equal to at 309,576 tons.

Table 6: Agricultural sector indicators

Indicator	1991/1992	2004/2005
Cultivated area (million feddan)	7.1	8.3
Cropped area (million feddan)	12.5	14.6
Wheat productivity/feddan (ardab)	14.72	18.2
Agricultural sector share of GDP (%)	16.5	13.9
Value of agricultural production (L.E. billion)	30.1	96.5
Value of agricultural exports(L.E. billion)	1.4	5.8

Source: Ministry of Agriculture and Land Reclamation & Ministry of Planning

Throughout the years, farming has drawn significant attention from authorities. This has led the implementation of policies encouraging investments for improving food sufficiency. With regard to irrigation, investments are constantly increasing. In 1997, President Moubarak inaugurated the project for the development of the Nile Valley. This zone, with a total area of 100,000 ha, was formerly desert and unexploited. Foreign investments in the agricultural sector are exempted from taxes for a period of 20 years, starting from the early beginning of the exploitation.

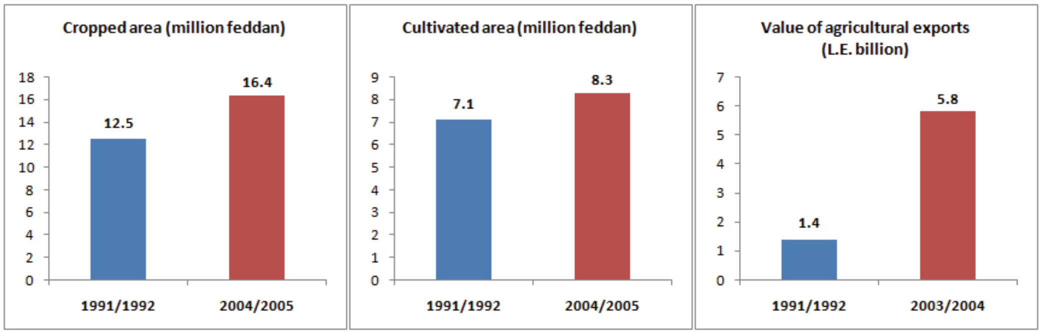


Figure 10: Agricultural sector indicators (Sources: Ministry of Agriculture and Land Reclamation & Ministry of Planning)

Egypt is self-sufficient in almost all agricultural commodities with the exception of cereals, oil and sugar. However, these exceptions make the country one of the world's largest food importers. Agricultural imports in 2001 included 4.4 million tons of wheat and wheat flour, 4.7 million tons of yellow maize, 0.6 million tons of vegetable oils and 0.4 million tons of sugar. On the other hand, the main export crops were cotton (53,000 tons), rice (444,000 tons), potatoes (176,000 tons) and citrus fruits (37,000 tons).

Table 7: Crop yield Indicators

Crop	Yield (Metric Tons)	Surface (hectares)	Yield (hectograms/hectares)
Wheat	6,564,050	1,050,000	62,515
Rice Paddy	5,996,830	660	90,861
Corn	6,394,830	730	87,6
Potatoes	1,783,640	83	214,896
Watermelons	1,506,960	56	269,1

Source: Ministry of Agriculture and Land Reclamation

Table 8: Livestock Indicators

Livestock type	Headcount
Ovine races	4,450,000
Goats	3,300,000
Buffaloes	3,200,000
Cattle	3,180,000

Source: Ministry of Agriculture and Land Reclamation

The geographic position of Egypt, its natural assets and old civilization have been the basis for the development of **tourism**, where the combined effort of the State and the public was concentrated. In 2005 the total number of visitors was estimated at 8.7 million. The main tourist sites are Cairo, Alexandria, Luxor, Aswan and Sinai.

Table 9: Tourism Sector Indicators

Item	1991/1992	2004/2005
Number of hotels, tourist villages and floating hotels (hotel & village)	663 *	1207**
Number of rooms in hotels, tourist villages and floating hotels (thousand)	54.7	136.5***
Number of tourists (million)	3	8.7
Number of overnight stays (million)	20.2	85.7

** 1992 ** until Dec.2004 *** until Dec.2003*

Source: Ministry of Tourism

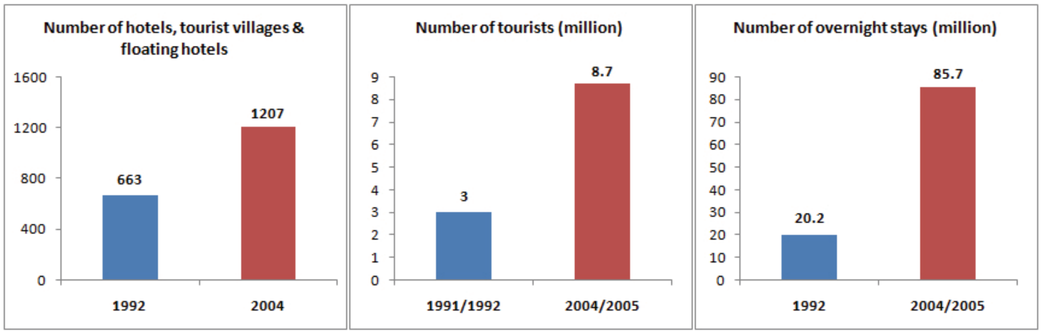


Figure 11: Tourism indicators (Source: Ministry of Tourism)

Egypt is endowed with significant quantities of important metals such as phosphates, raw iron and oil. The manufacturing **industry** comprises textiles, food processing, construction material and glass, ware, mechanic and electric products and chemicals. The non-manufacturing industry comprises mining, energy, electricity and water production, constructions and public works.

Table 10: Industrial Sector Indicators

Indicator	1991/92	2004/2005*
Actual cement production (million tons)	14.9	32.5*
Actual reinforced steel production (million tons)	0.94	4.7*
Industrial sector share of GDP (%)	16.6	19.3**
Exports of manufactured commodities (L.E. billion)	5	21.7*
Number of industrial zones	26	90*

** estimated ** targeted*

Source: Ministry of Foreign Trade and Industry and Ministry of Planning, CAPMAS

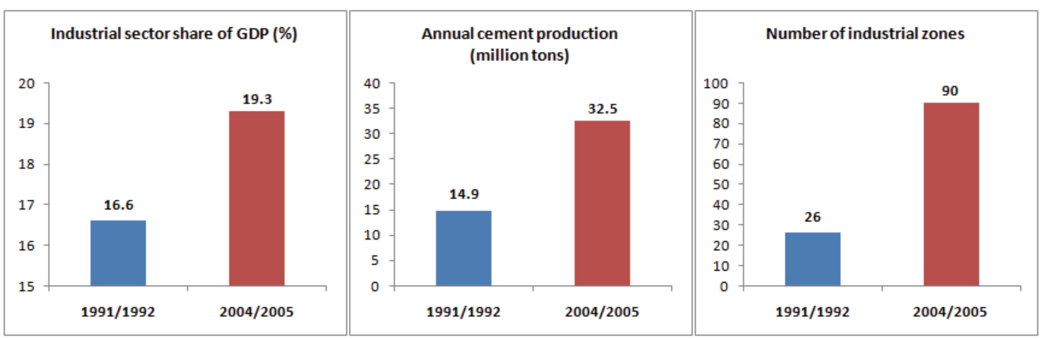


Figure 12: Industry indicators (Source: Ministry of Foreign Trade & Industry and Ministry of Planning, CAPMAS)

HYDROLOGICAL BALANCE

Overall, water resources are becoming increasingly scarce. Surface water resources originating from the Nile are now fully exploited, while groundwater resources are limited. Furthermore, the country is facing increasing water needs, demanded by a rapidly growing population, increased urbanisation, higher standards of living and an agricultural policy which emphasises production growth in order to ensure food security and sufficiency.

Water supply

Surface water resources are limited to the country's share of the flow of the River Nile. In accordance with the terms of the 1959 Nile water agreement between Egypt and Sudan, Egypt's present annual share downstream of the Aswan Dam is 55.5 billion m³. The High Aswan Dam, commissioned in 1968, provides inter-annual storage to guarantee regulated water supplies, and this Nile water discharge constitutes more than 95 % of the total national water supplies.

The Nile enters Egypt at its southern boundary with Sudan and runs through a 1000 km long narrow valley, which varies between 2 and 20 km in width. Then, it is divided into two branches (Damietta and Rosetta) at a distance of 25 km north of Cairo, forming a delta resting with its base on the Mediterranean shores (Figure 13). The lengths of the Damietta and Rosetta Branches are 250 km and 239 km, respectively. The Delta expands from south to north for about 200 km and its base is about 300 km long, from Alexandria to Port Said.

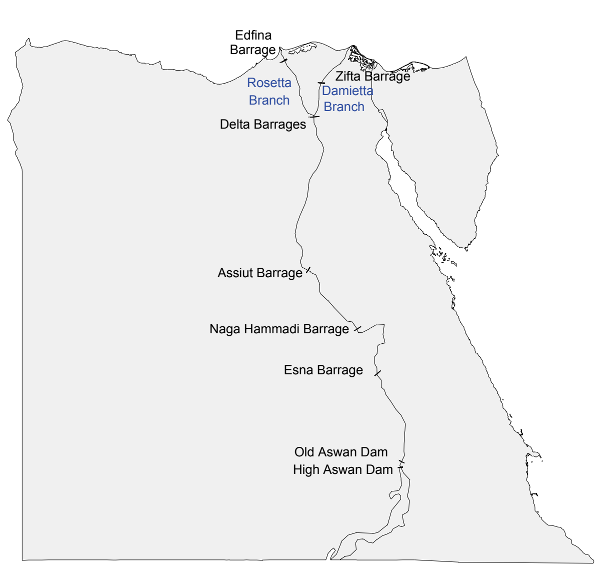


Figure 13: The Nile, its branches and main hydraulic infrastructure

The rainfall is typical of arid regions, limited, irregular and unpredictable. This means that in the north, a few days of rainfall are distributed from November to March. The mean annual rainfall of 18 mm ranges from 0 mm/yr in the desert to 200 mm/yr in the northern coastal region (Figure 14).

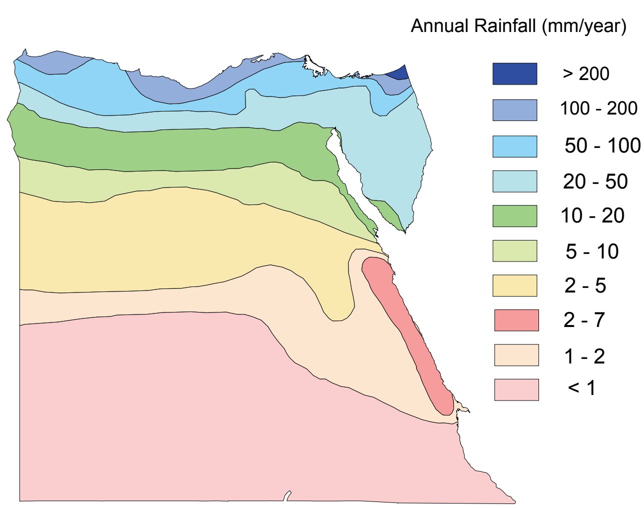


Figure 14: Annual rainfall (mm/year)

Rainfall on the Mediterranean coastal strip decreases eastward from 200 mm/year at Alexandria to 75 mm/yr at Port Said. It also declines inland to about 25 mm/yr near Cairo and 1 mm/yr at Aswan. Significant rainfall intensity is recorded on parts of Red Sea coast, and the most southern part of the country, on the border with Sudan, is marked with those phenomena. Rainfall intensity of 500 mm/yr in the neighbouring area has also been observed. The total water crop is equal to 1.8 billion m^3/yr in the aforementioned regions.

The aquifer underlying the Nile Valley and the Delta is entirely recharged and dependent on deep percolation of irrigation water and seepage for the irrigation system. Some limited renewable and non-renewable groundwater reserves within the Western Desert and Sinai are currently used and the potential for future water supply depends on economic feasibility.

The Nile system below Aswan can be considered a closed system, receiving inflow only from the High Aswan Dam. Outflows comprise crop evapotranspiration, non-recoverable municipal and industrial water consumption, evaporation, drainage of agricultural water to the sea, and non-recoverable inland navigation water released to the sea. In this perspective, groundwater extraction and reuse of drainage water can be considered as options for increasing the overall efficiency of the system and not as additional resources. The exact nature and details of these interrelations are not clear yet. A new factor that adds to the complexity of the issue is the change in water quality, which is the focus of research studies that are currently undertaken by the National Water Research Centre (NWRC).

Table 11: Water Resources

Source	Available water resources (km^3)
Nile Water (including Jonglei)	57.50
Groundwater (Nile aquifers)	07.50
Groundwater (in desert and Sinai)	03.77
Drainage reuse in delta	08.40
Savings due to changes in cropping patterns	03.00
Irrigation improvement	04.00
Waste water use	02.20
Flash flood harvesting	01.50
Total	**87.67**

Source: Ministry of Water Resources and Irrigation (MWRI)

Water demand

Most of the cultivated lands are located near the Nile banks and its main branches and canals. Currently, the inhabited area is about 12.5 million feddans, and the irrigated agricultural land is about 7.85 million feddans (1 feddan = 1.04 acres). In 2000, the average annual water for **agricultural use** was estimated at 59.9 km^3. Future agricultural water requirements will address two types of needs: those for the irrigation of existing lands and those for their expected expansion.

In 1997, two main land reclamation projects were launched: (a) in El-Salam Canal (west of Suez Canal) and El-Sheikh Jaber (east of Suez Canal), aimed at reclaiming about 620,000 feddans and (b) in El-Sheikh Canal for reclaiming about 500,000 feddans at the south of the New Valley. For 2025, agricultural water requirements have been estimated at 69.43 km^3 in total.

The total **municipal water requirements** were estimated to 4.5 km³ in 2000. A portion of this water is actually consumed. The rest returns back to the system (either to the sewerage system or by seepage to groundwater). For 2025, domestic water needs have been estimated at 6.6 km³. **Industrial water requirements** in 2000 were equal to 7.8 km³ and are expected to increase to 10.56 km³ in 2025.

The River Nile and part of the irrigation network are also used for **navigation**, when the discharge for meeting other agricultural demands is too low but provides the minimum draft required by ships and boats. At present, there are no particular releases for **hydroelectricity** production; releases to support irrigation, municipal, industrial and navigation purposes are regulated by the High Aswan Dam, where the hydroelectric power plant is located. The water requirements for the different water uses are presented in Table 12, which also summarizes the corresponding projections for 2025.

Table 12: Water Requirement for Different Sectors

Sector	Demand in 2000 (km³)	Demand in 2025 (km³)
Agriculture	60.7	69.43
Domestic water	4.5	6.6
Industry	7.8	10.56
Navigation	0.3	0.3
Total	**73.3≈73**	**86.89≈87**

Source: Ministry of Water Resources and Irrigation (MWRI)

MAIN WATER INFRASTRUCTURE

Dams

The High Aswan Dam (HAD) has been implemented as a long-term storage reservoir to ensure a constant and regular inflow for both Egypt and Sudan. However, the drought period that prevailed in the region from 1979 and lasted for nine years, uninterrupted, has seriously affected the storage in the High Dam Lake Reservoir. This motivated the State to develop different scenarios for facing the probability of a similar catastrophe.

The High Aswan Dam (HAD)

Some of the alternatives were to consider reducing, as much as possible, rice and sugar cane cultivation, to minimize water requirements for different uses, and to generate electricity during the winter closure period.

Furthermore, the Government is studying alternatives for storing freshwater, which is discharged to the sea during the winter, and reusing it for irrigation purposes. Along these proposals and plans, new laws and regulations for water use and for the coordination between Ministries, authorities and end-users are being considered. In order to discuss future water policies, a Ministerial Committee was formed, headed by the Minister of Water Resources and Irrigation, and including representatives from all agencies concerned.

Irrigation systems

The farmland of the Nile Basin is dissected by a complex network of irrigation canals and drains. The major irrigation canals originate from the Nile or its Damietta and Rosetta branches, and are repeatedly divided, in order to bring fresh water to every field. Smaller drains collect excess irrigation water from farm plots and discharge it to larger drains which release their water into depressions, such as the Wadi Rayan in the Western Desert, or into the brackish lakes of the northern Delta.

There are several institutions for supporting the implementation of drainage programmes and relevant research and training. The Drainage Research Institute of the National Water Research Centre supports research in the field of drainage, whereas the Drainage Training Centre deals with drainage technologies and applications. The Egyptian Public Authority for Drainage is the main organization dealing with the implementation of drainage projects.

Irrigable land is estimated at 4,420,000 ha. The total area equipped for irrigation was 3,422,178 ha in 2002; 85% of this area is located in the Nile Valley and the Delta. Rainwater harvesting is practiced in about 133,500 ha in Matruh and North Sinai. All irrigation is of full or partial control. In 2000, surface irrigation was practiced on 3,028,853 ha, while 171,910 ha were under sprinkler irrigation and 221,415 ha were equipped for drip irrigation.

Surface water was the main supply source used for 83% of the irrigated area in 2000, while 11% (361,176 ha) of the area was irrigated with groundwater, mainly in the provinces of Matruh, Sinai and the New Valley. The remaining 6% (217,527 ha) was irrigated with other supply sources.

Table 13: Irrigation infrastructure data

Indicator	1991/92	2004/2005
Length of uncovered canals (thousand km)	29.1	23.2
Area served with covered drainage systems (million feddan)	3.8	5.5
Length of drainage network (thousand km)	16.7	21.5

Source: Ministry of Water Resources and Irrigation (MWRI)

With regard to drainage, the system of open drains has been under construction since the start of the 20th century, but the network did not solve the problem of water logging and salinity. To overcome these problems, sub-surface drainage was found necessary to control groundwater, and a corresponding National Drainage Programme has been carried out over the last 4 decades. At present, the drainage system consists of open drains, sub-surface drains and pumping stations. In 2003, slightly over 3 million ha of the total irrigated area were drained, of which about 2.2 million ha with sub-surface drainage. The sub-surface drained area represents more than 65% of the total cultivated area. Currently, there are 99 pumping stations for the pumping of drainage effluent. The gravity-drained area was estimated at about 1.65 million ha in 2000. Drainage water from agricultural areas on both sides of the Nile Valley is returned to the River Nile or main irrigation canals in Upper Egypt and in the southern Delta. Drainage water in the Delta is pumped back into irrigation canals for re-use or into the northern lakes, or discharged to the Mediterranean Sea.

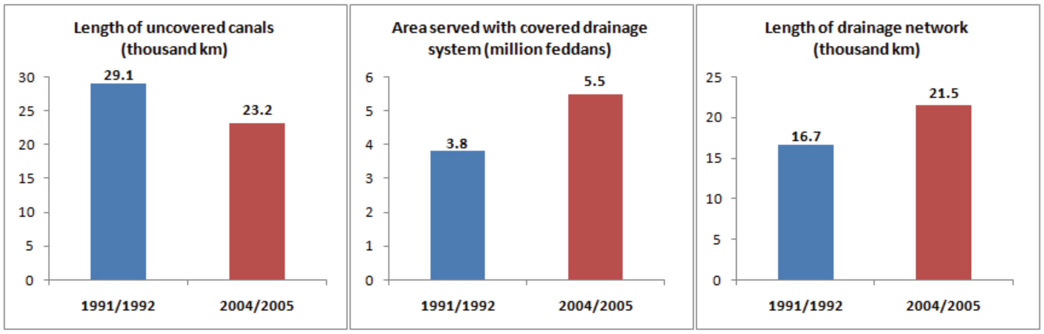


Figure 15: Length of uncovered canals, area served with covered drainage systems and length of drainage network (Source: Ministry of Water Resources and Irrigation)

TRANSBOUNDARY WATER MANAGEMENT

Under the 1959 Nile Waters Agreement between Egypt and Sudan, Egypt's share of the Nile flow is 55.5 km³/yr. The agreement was based on the average flow of the Nile during the period 1900-1959, which was equal to 84 km³/yr in Aswan. Average annual evaporation and other losses from the Aswan High Dam and reservoir (Lake Nasser) were estimated at 10 km³/yr, leaving a net usable flow of 74 km³/yr. Of this amount, 18.5 km³/yr was allocated to Sudan and 55.5 km³/yr to Egypt. If conditions permit the completion of the development projects on the Upper Nile, Egypt's share in the Nile water will increase by 9 km³. This amount includes 1.9 km³ and 1.6 km³ respectively from the first and second phases of the Jonglei canal project in southern Sudan. Two other projects in the upstream swamps are expected to provide 5.5 km³.

In 1998, and recognizing that cooperative development was the best way to bring mutual benefits to the region, all riparian countries (except for Eritrea which had an observer status) initiated dialogue for creating a regional partnership, with the goal to facilitate the common pursuit of sustainable development and management of the Nile waters. This mechanism, the Nile Basin Initiative (NBI), was officially launched in February 1999 in Dar es Salaam, Tanzania, by the Council of Ministers of Water Affairs of all the Nile Basin States. The shared vision of the NBI is *"to achieve sustainable socio-economic development through the equitable utilization of and benefit from the common Nile Basin water resources"*.

The first meeting of the International Consortium for Cooperation on the Nile (ICCON) took place in 2001 in Geneva, Switzerland to celebrate cooperation between the 10 countries of the Nile Basin and to establish partnerships leading to sustainable development and management of the Nile River for the benefit of all. This ICCON's first meeting was a major milestone for the NBI as it brought together, for the first time, Ministers and senior officials from Nile Basin countries, a broad range of bilateral and multilateral donors and other interested parties from civil society, professional organizations, the media and NGOs.

In addition to the Nile River, transboundary water resources also include the vast Nubian Sandstone aquifer, which is shared with the Libyan Arab Jamahiriya, Sudan and Chad.

SHARING WATER: ISSUES & CHALLENGES

WATER SHORTAGE

Egypt, when examined as a single geographic entity does not appear to face water shortage problems. Similarly, the Governorates that are located near the River Nile do not experience water deficit. However, some areas have been identified as having a crucial situation regarding water supply. These areas concern Sinai, the Red Sea coast and Northern Desert Coast (Figure 16), where economic development is primarily based on water availability.

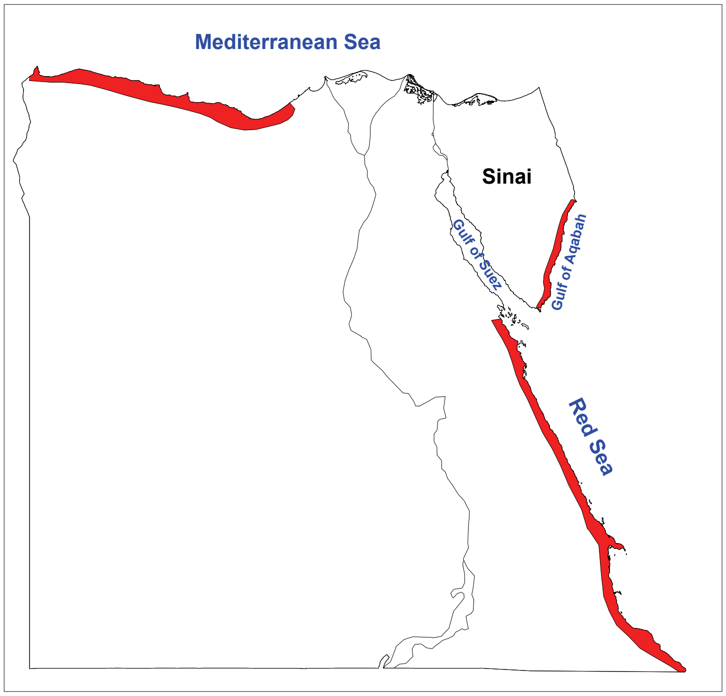


Figure 16: Areas facing water shortage

WATER QUALITY AND POLLUTION

Overview

Water quality problems in Egypt vary with location and depend on factors such as water flow rates, water uses, population density, existence of sanitation systems, industrial discharge, demand for navigation and agricultural runoff. Discharge of untreated, or partially treated, industrial and domestic wastewater, leaching of pesticides and residues of fertilizers, and navigation are often factors that affect the quality of water. Egypt's major water quality problems are related to the presence of pathogenic bacteria/parasites, heavy metals and agrochemicals in water supply sources.

Currently, there is increasing concern over the rising costs of environmental degradation in the country, which extend to the issues of water allocation and declining water quality. Table 14 represents some preliminary estimates associated with a range of environmental problems. The presentation of data does not aim to provide specific, accurate values, but rather to give an indication of the potential magnitude of social costs associated with environmental degradation, and the importance of actions required for reducing these pressures.

Each year a total of about 5 billion m³ of drainage water is reused in the Delta, and another 4.7 billion m³ of agricultural drainage water returns to the Nile, upstream of Cairo. Official reuse in the Delta is expected to rise to about 7 billion m³ in the short term and 9 billion m³ by 2017. In addition to threatened agricultural water supplies, unauthorized use of polluted drainage water to irrigate fields also contributes to growing health concerns. Farmers illegally remove approximately 3 to 4 billion m³ of drainage water annually to irrigate their fields. When contaminated with human waste, toxic elements and heavy metals, this can impose great health risks, and also adds to rising salinity and pollution levels in the agricultural drainage water of the Delta. This represents one of the most important water management challenges faced in the country today.

Table 14: Costs of environmental degradation in Egypt

Sector	Economic Loss (L.E. billion)	Percent of GDP (%)
Air		
Morbidity and mortality	8.4	2.3
Aesthetics (including tourism)	2.9	0.8
Water		
Water pollution	4.6	1.3
Water allocation inefficiencies	18.0	4.9
Water system losses	2.6	0.7
Land		
Productivity losses	5.8	1.6
Urban encroachment	4.0	1.1
Waste		
Solid waste	2.2	0.6
Hazardous waste	0.1	0.0
Amenity and tourism impacts	1.3	0.3
Biodiversity losses	2.4	0.7

Irrigation canals in the Nile Delta region are becoming increasingly polluted, particularly those passing through villages, towns and residential areas. Because of lack of alternative disposal options, both solid and liquid wastes are routinely dumped into irrigation canals, in violation of existing laws. Canals also receive increasing volumes of polluted drainage canal water, under official drainage water "reuse" programs meant to supplement irrigation supplies.

The principal purpose of the agricultural drainage system is to maintain proper soil moisture levels in fields and to remove accumulated salts. In Upper Egypt, the drainage network discharges directly to main canals of the Nile Valley and to the Nile River. In the Nile Delta, the network collects irrigation drainage water and transfers salts (as well as sediments and other accumulated pollutants) from the soils of cultivated lands to the Northern Lakes in the coastal region and through the Rosetta Branch Canal to the Mediterranean Sea.

Since the 1980s, efforts have been undertaken to extend available irrigation water supplies, by mixing drainage water in the Delta with fresh water. When this policy was first conceived, the principal goal was to supplement irrigation canal waters with drainage water of low enough salinity levels to allow, through mixing, for better and additional irrigated lands. Salinity of drainage water upstream of the Delta is relatively low (below 1,000 ppm), but increases in downstream drains to 2,000-5,000 ppm. Since the uses for irrigation water with salinity levels exceeding 2,000 ppm are quite limited, the Delta drainage water must be "mixed" with "fresh" canal water before use.

In practice, however, many drains in the Delta region are used to collect not only irrigation and stormwater run-off but also industrial and municipal wastes, and this has seriously complicated the implementation of the drainage water reuse policy.

For example, untreated and partially treated municipal and industrial wastewater from the Giza area is discharged directly into the Muheet and Rahway Drains. Toxic chemicals are discharged by industries at the Kafr El-Zayat Drain, which takes the effluent down the Rosetta Branch to be discharged to the sea above Alexandria. Furthermore, many villages discharge raw or partially treated sewage into irrigation and drainage canals. The Damietta Branch receives nutrients (primarily in the form of ammonia) and organics from the Delta Company for Fertilizer and Chemical Industries (in Talkha) and saline agricultural drainage water in the vicinity of the Faraskour Dam. Raw sewage from Al-Kholei village also drains into the Damietta Branch. Water quality in the Damietta and Rosetta Branches deteriorates rapidly downstream of Cairo, and this is especially acute during low flow conditions. At about 120 km downstream from the Delta Barrage, the Rosetta Branch receives polluted inflows from five drains (El Rahawy, Sabel, El-Tahreer, Zaweit El-Bahr and Tala). In Shoubra El-Kheima, a heavy concentration of industry (including metals and food processing, textiles, paper production and detergent and soap manufacturing) discharges large volumes of wastewater into agricultural drains. The water contains chemical and biological pollution that can seriously limit its potential for reuse in agriculture.

Groundwater in the Delta, largely a shallow underground aquifer fed by of the River Nile, receives pollution from a variety of sources. The excessive withdrawals, especially from coastal aquifers, increase groundwater salinity with negative long-term impacts on water use and soil pollution. Along the Mediterranean coast, high salinity levels occur from seawater intrusion when groundwater withdrawals exceed recharge. In the newly reclaimed areas of the Delta's fringes, shallow soils cannot effectively protect the aquifer from pollution, leaching from agricultural drains and irrigation canals. Groundwater salinity in reclaimed lands (e.g. El Busstan, North of Tahreer and El Salhyiah) is more than 1,500 ppm. Salinity levels along the coast are even higher. Industrial waste sometimes is discharged into unlined lagoons, where it easily seeps into shallow aquifers. Bacterial contamination of groundwater from raw sewage also is common in many parts of the densely populated Delta. Nitrate concentrations in reclaimed areas range between 70 and 100 ppm, a fact which poses additional health concerns.

The Drainage Research Institute has established 140 stations for monitoring agricultural drains. Monthly samples taken at these stations are analyzed for 32 elements such as salinity, BOD, COD, organics, heavy metals and DO. Levels of COD and BOD exceed national ambient water quality standards at every monitoring station, and there also is a deficiency of DO in relation to these standards. Certain locations have been deemed so polluted as to pose hazards to public health.

The consequence has been the closure of some drainage canal mixing stations or of water treatment plants with intakes on main canals receiving polluted drainage water. An extensive network of 25 mixing stations has been established in the Delta to transfer drainage water back into irrigation canals for reuse, but five reuse stations have had to be closed due to these excessive pollution levels (Table 15). Several others are threatened with closure.

Table 15: Mixing Stations for Drainage Water Reuse in Nile Delta

Pumping Station	Drain	Mixing Location	Annual Discharge (million m^3)	Current Status
East Delta				
Wadi	Qaliobia	East Wadi	200	Shut down
Bahr Elbaqar	Bahr Elbaqar	Elbateekh	20	Operating
Belad Elayed	Belad Elayed	East Wadi	150	Operating
Hanout	Hadous	Bahr Mouis	250	Operating
Geneina	Emoum Elbeheira	Elbahr Elsaghir	215	Operating
Saft	Saft Elbahry	Daffan	130	Operating
Elmahsama	Elmahsama	Ismailia	200	Shut down
Upper Elserw	Serw	Damietta Branch	275	Operating
Elsalam 1	Lower Serw	Elsalam	650	Operating
Elsalam 3	Hadous	Elsalam	1350	Operating
Middle Delta				
Upper (1)	Number 1	Damietta Branch	60	Shut down
East Menoufia	Elqarenein	Abbasi Rayah	50	Operating
Mahalet Rouh	Mahalet Roh	Mit Yazid	90	Operating
Elhamoul	Gharbia Main	Bahr Tira	400	Operating
Elgharbia Drain	Gharbia Main	Bahr Tira	800	Operating
Elmahalla Elkobra	Omer Bey	Damietta Branch	100	Operating
Boteita	Gharbia Main	Elzawia	100	Shut down
West Delta				
Elemoum	Elemoum	Nobaria	1000	Shut down
Itay Elbaroud	Itay Elbaroud	East Khandak	60	Operating
Idkou	Idkou	Mahmoudia	90	Operating
Dalangat	Dalangat	Elhager	235	Operating
West Khandak	West Khandak	Abou Deyab	60	Operating
Bostan	Bostan	Nobaria	55	Operating
Dalangat Extension	Dalangat Ext.	Nobaria	80	Operating
Mariout	Elemoum	Nobaria	60	Operating

Analysis of local issues

Water quality status of the River Nile from Aswan to Cairo

Since the construction of the High Aswan Dam, the water quality of the Nile became primarily dependent on the water quality and ecosystem characteristics of Lake Nasser reservoir and less dependent on the water quality of the upper reaches of the Nile.

The total distance from the High Aswan Dam to the Delta Barrage is about 950 km. In this reach, about 67 drains enter the Nile either directly or indirectly, discharging about 4.7 billion m^3/yr of agricultural drainage water containing salt, nutrients, pesticides, and municipal effluents from all towns and villages of Upper Egypt into the Nile. In addition, 40 industries discharge directly to the Nile high loads of organic matter, oil and grease, heavy metals and toxic chemicals.

Around the Greater Cairo area, the situation seems more critical. There are 23 chemical industries, 27 textile industries, 7 steel and galvanizing industries, 32 food processing industries, 29 engineering industries, and 9 mining industries. There are considerable wastewater discharges from these factories, partly to the Nile, but mostly to drainage canals.

Water quality status of the Damietta and Rosetta Branches

The deterioration in water quality of the two branches occurs in a northward direction due to disposal of municipal and industrial effluents and agricultural drainage, as well as decreasing flow.

The Damietta Branch receives nutrients, organic loads, and oil and grease as a result of discharges from the Talkha fertilizer industry, as well as drainage water from a number of drains especially near Faraskour dam. The Rosetta Branch receives high oil and grease concentrations, nutrients, organic loads, and solid waste through the Muheet and Rahawy drains that receive large parts of the wastewater of Cairo, as well as some pesticides and toxic chemicals from the Kafr El-Zayat industrial area. Salts and herbicide residues from agricultural drains also contribute to local water pollution.

Water quality status in irrigation canals and drains

Most of the drainage water from the Nile Valley (Upper Egypt) flows back by gravity to the Nile as return flow. This volume is estimated at about 2.3 billion m^3 annually. This slightly affects the quality of the Nile water from Aswan to Cairo. In the Nile Delta, the drainage system is rather intensive and the drainage water is discharged into the northern lakes or the Mediterranean Sea.

In the southern part of the Delta, drainage water salinity ranges between 750 and 1000 mg/l, while in the middle part, salinity may reach 2000 mg/l, because of soil salinity and influence of saline groundwater. In the northern part of the Delta, the salinity of drainage water reaches values ranging between 3,500 and 6,000 mg/l.

Water quality status of coastal and inland lakes

The main coastal lakes, Mariut, Idku, Burullus and Manzala, are separated from the Mediterranean Sea by narrow splits and are not more than 2 m deep. The lakes are used for fishery and fish farming, but receive the drainage water from the Nile Delta and major inputs of municipal and industrial wastes from Cairo, Alexandria and other cities. Lake Mariut receives agricultural drainage and domestic and industrial wastewater from 5 agricultural drains, in addition to direct discharges from 40 industrial units. Lake Manzala serves as a depository for much of the municipal and agricultural wastewater of the Eastern Delta, including the wastewater of most of Cairo. Lake Mariut and Lake Manzala have been identified as the most alarming examples of water pollution in Egypt.

Lake Qarun in the Fayoum Governorate receives agricultural drainage and domestic wastewater from Fayoum. The lake suffers from continuous rise of its level and increasing salinity. Records show that the lake levels are continuing to rise at 0.1 m per year, while salinity increases by 0.5 g/l annually.

ACCESS TO WATER SERVICES - MUNICIPAL POTABLE WATER SUPPLY

Despite the rapid population growth, the percentage of the population with access to municipal water supply has increased substantially over the past two decades. According to estimates, 95% of households in urban areas and almost 70 % of households in rural areas have currently access to piped water (Table 16). However, this remarkable extension of the municipal water and wastewater systems has not been accompanied by adequate attention to maintenance. In turn, this has resulted in very high seepage losses, in the range of 40 to 50%, which further caused a rise to the water groundwater table, creating considerable environmental problems.

Table 16: Municipal Potable Water Systems in Egypt, Rates and Customer Base

System	NOPWASD[1] (Municipalities)	GOGCWS[2] (Cairo)	AWGA[3] (Alexandria)
L.E. per m³			
Estimated Capital and O & M costs	1.0	1.1	NA
Subsidy	0.8	0.9	NA
Average User Fee[5](tariff)	0.2	0.2	0.3
Rate: piastre per m³ [4], [5]	15–25	15–25	25–35
Distribution of Customers Base (% Of Customer Base)			
% Served by House Connections5	Urban: 92; Rural: 70	95	96
% Multi–Unit Meters	Urban: 55; Rural: 30	50	48
% Single–Unit Meters	Urban: 20; Rural: 10	33	40
% Not connected legally or connected but meters are not working [5], [6]	Urban: 18; Rural: 30	12	8
% Served by Stand posts / donated	Urban: 2; Rural: 14	1	1
% Unserved[7]	Urban: 6; Rural: 16	4	3

A recent review of the municipal water supply sector identified three primary causes of piped water service deficiencies: (a) inadequate water treatment capacity and deteriorating condition of treatment plants, (b) inadequate storage capacity, and (c) deteriorating condition of conveyance and distribution networks that cannot withstand the pressures needed to provide reliable water service. High system losses increase the stress on an already overburdened wastewater collection system and are a waste of costly treated water. Leaks also allow contamination of the water delivered.

[1] National Organization for Potable Water and Sanitary Drainage

[2] General Organization for Greater Cairo Water Supply

[3] Alexandria Water Authority

[4] Wastewater tariff is 20% of the water tariff for Cairo and 35% for Alexandria

[5] These are applicable to residential units that have water meters. Those who do not have meters, or their meters are not working, pay a fixed monthly charge for water consumption (L.E. 5–20 monthly/unit). The charge changes with house area.

[6] No service charge for meters' maintenance if meters are not working, it is difficult to repair. In Alexandria there is monthly maintenance charge for meters (a lump sum of 50 piaster). The life span of a meter is 7 years and costs L.E. 300 for ½ inch pipe. In most cases when meter is not working, the client pays an estimated fixed charge.

[7] Unserved people extract either polluted groundwater or surface water from the Nile, canals or drains.

Municipal water and wastewater services are heavily subsidized by the Government. In the municipal areas outside of the Greater Cairo and Alexandria metropolitan areas, the subsidy level is almost 75%. The low recovery of costs from consumers reduces revenue that water and wastewater agencies could use to repair leaks and improve the services provided.

GOVERNING WATER – THE CONTEXT

Water management falls under the responsibility of several Ministries, the most important ones being the Ministry of Water Resources and Irrigation (MWRI), the Ministry of Agriculture and Land Reclamation (MALR), and the Ministry of Housing, Utilities & Urban Development (MHUUD). Other ministries with a role in water policy formulation and secondary water management operations are the Ministry of Health and Population (MoHP), the Ministry of State for Environmental Affairs, and the Ministry of Local Development (MoLD)

The Government has indicated its intention to shift emphasis from its role as the central (or sole) actor in developing and managing water supply systems, by fostering participatory approaches in which water users have an active role in the management of irrigation systems and cost sharing. In this perspective, important institutional and legislative measures were recently implemented, in order to promote the establishment of sustainable Participatory Irrigation Management (PIM) associations. However, despite those efforts, the development of water users' associations (WUAs) as effective partners in irrigation management remains at an early stage. In the newly reclaimed lands, the concept of PIMs is not yet fully operational for a variety of economic, financial and institutional reasons. While most parties involved recognize the importance of WUAs in the equitable distribution of available supply, the uneven water availability, either due to deficiencies in infrastructure design or to the slack enforcement of rules against excess abstraction by front-end water users, has in many cases been an impediment to the successful operation of WUAs.

Water-related legislation consists of several laws and decrees, approved by the Egyptian Parliament, the Cabinet of Ministers and the President. They mostly aim at organizing the work of the MWRI and the allocation of water among different users. New laws and regulations were recently adopted for environmental protection and water pollution abatement.

The Government invests considerable resources in land reclamation programmes. Investment is primarily directed for irrigation and drainage infrastructure, construction of agglomerations, and provision of potable water, electricity and transport infrastructure. Very little is invested in social services (education and health), and no investment is made in the provision of agricultural services (technology, water management and rural finance). Consequently, the poor face difficulties in settling and farming, and a considerable percentage returns to the old lands, abandoning their new farmland. Both MWRI and MALR activities are considered public services and their water and land development projects are budgeted in the national economic and social development plan.

INSTITUTIONS & RESPONSIBILITIES

This section presents in detail the institutions involved in water management in Egypt and their responsibilities. A summary is provided in Tables 17 and 18. Furthermore, Figure 17 illustrates the framework for water quality management in the country.

Table 17: Responsibilities in Water Management

AUTHORITY	RESPONSIBILITY
Actors under MWRI	
Water Sector (WS)	Distribution of surface water among different users
Groundwater Sector (GWS)	Monitoring of the exploitation of the different aquifers
Dams and Grand Barrage Sector (DAGBS)	Safety and operation of dams and grand barrages
Water Quality Units (WQU)	Water quality monitoring
Central Laboratory for Environmental Quality Monitoring (CLEQM)	Water sampling and analysis, data processing and interpretation
Drainage Authority (DA)	Assessment of the quantity of water to be reused Development and maintenance of drainage networks
National Water Research Center (NWRC)	Research concerning water resources development and management
Planning Sector (PS)	Follow-up with the Ministry of Planning to ensure budget availability for different activities
Other Actors	
National Organization of Potable Water and Sewage Disposal (NOPWASD)	Provision of drinking water and treatment of municipal wastewater

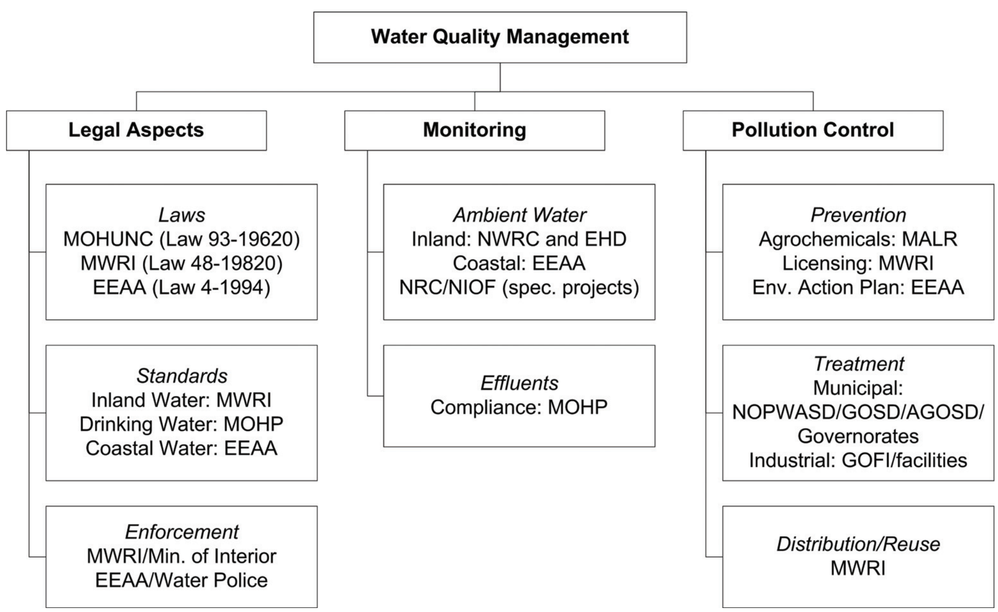


Figure 17: The institutional framework for water quality management in Egypt

Table 18: Water Resources Planning Matrix

ACTIVITY			
Surface waters			
Use	WS		
Storage	WS	DAGBS	
Groundwater recharge	GWS		
Diversion	WS		
Quality monitoring	WS	WQU	CLEQM
Assessment	WS		
Groundwater			
Use	GWS		
Storage	GWS		
Recharge	GWS		
Quality monitoring	GWS	WQU	CLEQM
Assessment	GWS		
Well permits	GWS		
Irrigation network			
Rehabilitation	WS		
Modernisation	WS		
Reuse			
Drainage water	DA	WS	
Wastewater	DA	WS	NOPWASD
Desalination			
Introduction of technology	NWRC	HH	
Efficient water utilisation			
Domestic	WS		
Industrial	WS		
Agricultural	WS		
Legislation			
Regulation and codes	MWRI	EEAA	MOHP
Standards	MWRI	EEAA	MOHP
Policy setting	MWRI		
Water allocation	WS		
Project financing	MOP	PS	
Project design	MWRI		
Project implementation	MWRI		
Operation and Maintenance	WS		
Pricing (tariffs)			
Enforcement	MOI		
Water data records	WS	GWS	

The Ministry of Water Resources and Irrigation (MWRI)

The Ministry of Water Resources and Irrigation (MWRI) plays a key role in the development and management of the water system throughout the country. The Ministry is in charge of water resources research, development and distribution, and undertakes the construction, operation and maintenance (O&M) of irrigation and drainage networks.

Specifications and permits for well drilling are also among the responsibilities of the MWRI. The Ministry also undertakes tasks for the collection and disposal of agricultural drainage water, the monitoring and assessment of the quality of various water sources, and for the protection of the coastal zone and lakes. The Ministry's organizational chart is presented in Figure 18.

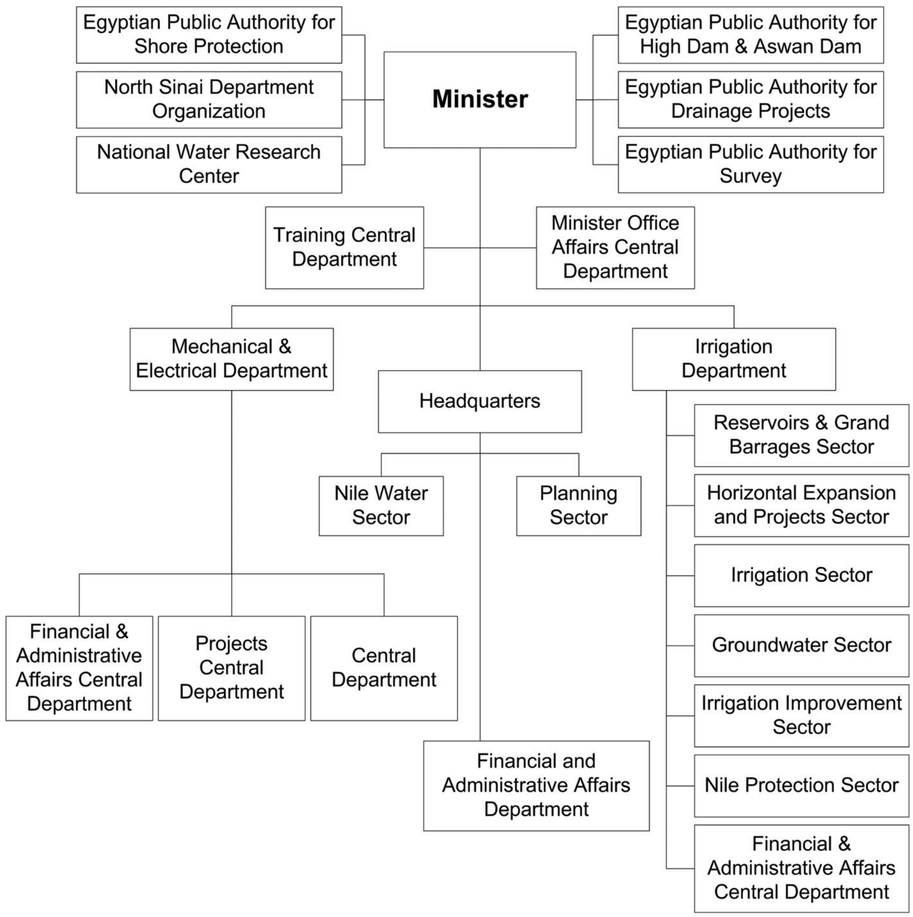


Figure 18: The organizational chart of the Ministry of Water Resources and Irrigation

There are two major departments and four main authorities responsible for the day-to-day operation of the water system, irrigation water delivery, and drainage water disposal. Each of these entities has a wide coverage along the Nile irrigation network and there are several entities within each administrative governorate to carry out all activities related to water distribution and drainage.

The two major departments of the MWRI are the **Irrigation Department (ID)** and the **Mechanical and Electrical Department (MED),** which have the widest spatial coverage through their representing bodies as irrigation directorates, inspectorates, and districts. Within the MWRI, the following sectors and departments are of importance:

- The **Planning Sector** is responsible at the central level for data collection, processing and analysis, for planning and monitoring investment projects.
- The **Sector of Public Works and Water Resources** coordinates water resources development.

- The **Nile Water Sector** cooperates with Sudan and other countries sharing the Nile River Basin.
- The **Irrigation Department** provides technical guidance and monitoring of irrigation development, including dams.
- The **Mechanical and Electrical Department** is in charge of the construction and maintenance of pumping stations for irrigation and drainage.

Further to the above, other public authorities directly related to the MWRI are:

- The **National Water Research Centre (NWRC)**, which is the research institute of the MWRI and acts as scientific body for all aspects related to water management. It consists of 12 research institutes, a Central Laboratory for Environment Quality Monitoring (CLEQM) and the Strategic Research Unit (SRU).
- The **Egyptian Public Authority for Drainage Projects** (EPADP), which is in charge of all drainage activities within MWRI, and has representing directorates in the entire Nile network. EPADP is responsible for the construction and maintenance of closed and open drainage systems.
- The **High Dam Authority** is responsible for the operation of the Aswan dam.

The responsibilities of the above institutes are outlined in the following paragraphs.

The MWRI also represents Egypt in international meetings of the Nile Basin countries on common water issues. There are several joint projects between all countries for the development of the Nile Water system, which, if completed, would significantly increase the water shares of member countries.

The National Water Research Center (NWRC)

The National Water Research Centre is a national institution with an international outlook. Its main objectives are the following:

- Study, outline and propose long-term policies for the management of Egypt's water resources;
- Solve problems associated with the technical application of the national policy for irrigation, drainage and water resources;
- Carry out investigations and research work relevant to the reclamation of agricultural lands;
- Elaborate on options for exploiting the water resources of the country in the most efficient and cost-effective way; and
- Propose measures for the environmentally sound development of irrigation and drainage systems.

At the national level, the NWRC has worked to strengthen the research programmes of its research institutes, which are further presented below. This has been possible through the establishment of linkages with relevant Egyptian Universities and other research centres, such as the Agricultural Research Centre, the National Research Centre and the Egyptian Academy of Scientific Research and Technology. Further assistance has been offered to the NWRC institutes to implement their programs from internal and external sources of funding.

On a regional scale, the NWRC acts as the Coordinating Unit for the African Water Resources Network and is a member of other international networks established in Europe and other countries. Moreover, in view of the expected water scarcity, the NWRC has taken the lead in setting a general framework for future cooperation between Arab countries. The aim is to maximize water-related benefits, while conserving Arab water rights and developing appropriate techniques for implementing a joint water plan. A proposal for establishing an "Arab Network for Water Research (ANWAR)" has been initiated by the NWRC, with the aim of creating Arab-driven solutions and promoting technologies for sustaining Arab water resources for economic growth. At the international level, the NWRC has established wide-scale communication with several international organizations and bodies.

The NWRC supervises a significant number of institutes and research centres dealing with various water management issues: the Water Management Research Institute, the Water Resources Research Institute, the Nile Research Institute, the Hydraulic Research Institute, the Construction Research Institute, the Channel Maintenance Research Institute, the Groundwater Research Institute, the Mechanical and Electrical Research Institute, the Drainage Research Institute, the Central Laboratory for Environment Quality Monitoring, and the Survey Research Unit. The following paragraphs outline the corresponding role and responsibilities of the NWRC research centres.

The **Water Management Research Institute (WMRI)** deals with research in the fields of crop water requirements, water distribution, water losses, on-farm irrigation systems and water quality. Its main activities cover the following topics:

- Definition of crop water requirements;
- Development of existing irrigation networks;
- Improvement of irrigation rotations to achieve optimum water distribution;
- Development of better irrigation methods and improvement of irrigation outlets; and
- Study of evaporation and seepage losses from waterways, lakes and reservoirs.

The institute owns twelve experimental research stations dispersed all over the country. Their location was selected to represent the variation in climate, soil types, crops and agricultural and irrigation practices. In addition to the above experimental stations, the institute carries out research programmes on fields owned and managed by individual farmers. The institute has six sites laboratories, equipped to carry out analyses of water, soil and crop samples. It further has the capacity of developing training programmes in various themes and for different target groups.

The main objectives of the **Water Resources Research Institute (WRRI)** include the assessment of the amount of water available in the Nile Basin and in Egypt, including the Sinai Peninsula, and the definition of policies and development of projects required to maximize water availability.

The **Nile Research Institute (NIR)** undertakes activities relevant to the monitoring of the quality of the River Nile waters, the protection of existing small-scale dams, the development of navigation, the protection of river banks from erosion and the utilization of sediments deposited in the Aswan High Dam reservoir.

The main goals of the **Hydraulic Research Institute (HRI)** are to undertake research relevant to the river bed and banks of the Nile and irrigation canals, to perform hydraulic model studies for infrastructure development, as well as coastal areas, and develop and implement specialized training programmes on river hydraulics.

The main responsibilities of the **Construction Research Institute (CRI)** institute are to: (a) carry out basic and applied research on hydraulic infrastructure, soil mechanics and foundation engineering, (b) provide the MPWWR with comprehensive laboratories and field testing services and facilities, (c) train the personnel of MPWWR on the operation and handling of advanced equipment for monitoring and (d) provide advice to MPWWR on issues relating to infrastructure design and development.

The **Channel Maintenance Research Institute (CMRI)** has been established with the aim to address problems associated with the maintenance of irrigation and drainage networks and to investigate alternative solutions from the technical and economic perspectives. The institute's activities cover the following main topics:

- Determination of the magnitude of aquatic weed problems;
- Design of canals and drains to meet hydraulic and irrigation requirements; and
- Implementation of experiments and formulation of recommendations on artificial grass carp in different canals.

The **Coastal Research Institute (CoRI)** was established in 1972 in the Academy of Scientific Research and Technology. Since 1982, the institute has been operating under the control of the NWRC. The main goal of the institute is to monitor the evolution of Egyptian Northern coast, to study coastal dynamics and to investigate efficient and cost-effective control works to protect the coastal zone from erosion. It also provides expert advice to the Egyptian Government on problems associated with coastal instability and coastal zone management for the Mediterranean and the Red Sea. Principal activities include the: (a) monitoring of the evolution of the Mediterranean shoreline, (b) collection and analysis of meteorological, coastal and marine data, (c) development of physical and numerical models to predict future changes in the coastal zone, (d) offer of expert advice on problems associated with coastal instability, and (e) coastal zone management for the Mediterranean and Red Seas.

The main goals of the **Groundwater Research Institute (GRI)** are to study the quality and quantity of groundwater in the Egyptian desert areas, as well as the conjunctive use of the surface and groundwater water in the Nile Valley.

The main research fields of the **Mechanical and Electrical Research Institute (MERI)** include:

- Energy management in pumping stations;
- Improvement of the performance of motors and pumps;
- Testing and calibration of hydraulic and electrical machinery;
- Utilization of renewable energy for water pumping;
- Automation, control and instrumentation in water schemes and plants;
- Telecommunication and telemetry for water management;
- Development of new mechanical weed control equipment.

The **Drainage Research Institute (DRI)** is also affiliated to the National Water Research Centre (NWRC), and carries out applied research to support national plans for developing land drainage in Egypt, and implementing technically effective and economically sound drainage systems. It also develops tools for planning and managing the reuse of drainage water for irrigation. The main responsibilities of the institute are to:

- Develop and test appropriate methods and technologies for planning, design and implementation of drainage systems;

- Identify the most convenient and economic methods of operation and maintenance of subsurface drainage systems;
- Develop specifications for drainage materials;
- Determine and evaluate the technical and economic effectiveness of drainage projects;
- Determine drainage water quantity and quality;
- Develop criteria and guidelines for reusing drainage water in irrigation.

The **Central Laboratory for Environment Quality Monitoring (CLEQM)** undertakes tasks for: (a) studying the long-term impact of climatic fluctuations on the optimal management of surface water and groundwater in terms of both quantity and quality, (b) carrying out environmental impact assessments for water resources projects, (c) developing effective methodologies for the optimal management of water resources, (d) identifying environmental impacts and their implications, and (e) preparing national, regional and issue-specific assessments of climatic conditions affecting water resources.

Finally, the **Survey Research Unit (SRU)** adapts, develops and incorporates modern methods of computer-aided field surveying. The Unit acts also as the central organization for the development and application of all modern aspects of geodesy, photogrammetry, remote sensing and Geographical Information Systems.

Egyptian Public Authority for Drainage Projects (EPADP)

The Egyptian Public Authority for Drainage Projects (EPADP) is affiliated to the Ministry of Water Resources and Irrigation (MWRI). The authority was established in 1973, with the aim of controlling and preventing water logging and salinity, which pose threats on crop production. The main focus of EPADP’s activities is new surface and sub-surface drainage projects, as well as maintenance and rehabilitation of existing ones. In more detail, the tasks of EPADP comprise: (a) the study of drainage conditions in order to set priorities for the installation of new drainage systems, (b) the design of drainage systems and the preparation of corresponding tenders, (c) operational research regarding the installation of such systems, (d) the supervision of the installation, operation and maintenance of drainage systems, and (e) the training of personnel on all the above tasks.

Egyptian National Committee on Irrigation and Drainage (ENCID)

The ENCID is a semi-governmental entity, also affiliated to the MWRI. The 30 members of the National Committee are Senior Governmental Engineers, Professors from Engineering Universities and Research Centres.

The Ministry of Agriculture and Land Reclamation (MALR)

The Ministry of Agriculture and Land Reclamation (MALR) is involved in improving agricultural activities and land reclamation, including water management at the farm level. Furthermore, the MALR is in charge of agricultural research, land reclamation and agricultural, fisheries and livestock development.

The Agricultural Research Centre, controlled by the MALR, comprises 16 institutes and 11 central laboratories and is the scientific body of the Ministry for all aspects related to agricultural development. Furthermore, the Land Development Authority is in charge of contracting and monitoring land development projects and manages land allocation to investors and individuals.

Finally, the Agricultural Development and Credit Bank provides credit to farmers for the financing of various production requirements and projects.

The Central Administration for Soils, Water and the Environment (CASWE)

The CASWE is mandated to design programs for farmers on optimum irrigation methods, irrigation scheduling and irrigation water quality and implement methods for the rehabilitation and maintenance of irrigation and drainage canals in order to reduce water losses, as well as water harvesting techniques in rainfed areas and methods of supplementary irrigation. In addition to the above, the CASWE deals with the field application of technologies developed in research organizations and the elaboration of training programmes aimed at enhancing the capacity of agricultural engineers working in soil, water and environmental management. As part of its activities, the CASWE identifies practical problems that need to be addressed through research, and assesses and monitors the environmental impact of various agricultural practices.

The Soils, Water & Environment Research Institute (SWERI)

The Soils, Water & Environment Research Institute (SWERI) undertakes studies and research on soil-water-crops interrelations, soil survey and classification, improvement and conservation of cultivated soils, soil fertility and plant nutrition, organic farming, crop water requirements, water suitability for irrigation, designing and evaluation of field drainage networks, and reuse of marginal water in irrigation and environment. The SWERI also provides technical recommendations on water-related issues.

The General Authority for the Development of Lake Nasser

The Authority is responsible for the development of natural resources in the region of Lake Nasser. Its tasks include the monitoring/implementation of programmes for:

- Exploiting the Lake for the production of cheap protein products, and the increase of fish production.
- Exploiting the significant amount of mineral resources (e.g. marble, granite, caoline), by promoting the establishment of industries according to the availability of resources and energy.
- Exploiting the tourist potential of the region, which is also considered a major tourist site.
- Reclaiming and cultivating the area around the Lake, and fostering the development of new urban communities in the vicinity.

The Ministry of Housing, Utilities & Urban Development (MHUUD)

The **Ministry of Housing, Utilities & Urban Development (MHUUD)** is responsible for the provision of water supply and sanitation services to the municipal and industrial subsectors. Under MHUUD, the National Organization for Potable Water and Sanitary Drainage (NOPWASD) and its affiliated agencies are responsible for planning, designing and supervising the construction of municipal drinking water treatment plants, distribution systems, sewage collection systems, and municipal wastewater treatment plants.

The **NOPWASD** assumes these responsibilities throughout the country, with the exception of the cities of Cairo, Alexandria, and of the Suez-canal cities. For Cairo, Alexandria, and the Suez Canal area, such services are provided by the General Organization for Sanitary Drainage in Cairo (GOSDC), the General Organization for Greater Cairo Water Supply (GOGCWS), the Alexandria General Organization for Sanitary Drainage (AGOSD), the Alexandria Water General Authority (AWGA), and the Suez Canal Authority. Operation and maintenance responsibilities are delegated to the local governments, which supervise the local agencies. The latter are classified into economic/general authorities and public/private enterprises or utilities, established in 9 Governorates (private companies assume wastewater treatment in Damietta, Kafr El Sheikh, and Beheira).

The **General Authority for Potable Water and Sanitary Drainage (GAPWSD**) is the central body subsuming these governorate entities. The Presidential Decree 135 (2004) authorizes the creation of a Holding Company for Drinking Water and Sanitation and its affiliated companies that include the General Economic Authorities for Drinking Water and Sanitation operating in the Governorates. In order to meet the required operation and maintenance expenses and relieve the burden on the Government, the company will seek new financial resources.

Moreover, the Presidential Decree 136 (2004) provides for the creation of the **Central Authority for the Drinking Water and Sanitation Sector and Protection of the Consumer**. This decree aims at the regulation and monitoring of the quality of water services and the control of water tariffs. According to the provisions of the Decree, the authority reports to the Minister of Housing, Utilities and Urban Communities, and is the liaison body between the Government, the society and the Holding Company to ensure that national policies and regulations are abided. The Minister of Housing heads the Governing Board, which includes external members (two technical experts and a representative of the consumers). The Ministries of Finance, Health and Population and of the Environment are also represented in the Board, whereas NOPWASD acts as technical advisor.

The National Organization for Potable Water & Sanitary Drainage (NOPWASD)

As mentioned above, the NOPWASD is responsible for the planning, designing and supervising the construction of municipal drinking water treatment plants, distribution systems, sewage collection systems, and municipal wastewater treatment plants. The organization is structured in two main sectors, the Potable Water Sector and the Sanitary Drainage Sector.

The current main goal of the **Potable Water Sector** is the provision of water services to 100% of the population during the next two years. For achieving this goal, the following projects are currently being implemented:

- National Project for drinking water provision in 240 unserved villages. The project's estimated cost is about 2 billion L.E., and is partially funded by the Arab Fund for Economic and Social Development, with KD 47M. This project is due for completion at the end of the 2002-2007 plans.
- 55 Integrated Projects (plants and networks) for villages that are insufficiently served. The total capacity is 3.5 million m^3/d and the project's cost is about 5 billion L.E.

- 40 Extension Projects for existing plants, with total capacity of 1.2 million m³/d and 2.2 billion L.E. investment cost. The implementation of these projects was awarded to specialized companies, giving priority to severely deficient areas and villages.

The current goals of the **Sanitary Drainage Sector** are to:

- Achieve, by 2022, full sanitation coverage in rural areas, using advanced techniques depending upon:
  - New, innovative systems and surface networks, complying with the rural conditions for the safe disposal of treated water.
  - Use, whenever possible, of local materials for reducing investment costs.
  - Prioritization of villages located near water streams.
- Install self-treatment drainage, in areas where the completion of sanitary drainage projects is pending, in full co-ordination with competent ministries and research entities for enhancing the self purification capacity of open drains.

LEGISLATION AND CURRENT POLICIES

Several laws and decrees have been approved by the Egyptian Parliament, the Cabinet of Ministers and the President to organize the work of the MWRI and the allocation of water among different users. Recently, emphasis has also been placed on the protection of the environment and water systems from pollution. The main laws of relevance to the water sector are:

- Law 12 of 1984 for the Irrigation and Drainage,
- Law 213 of 1994 for farmer participation and cost sharing,
- Law 93 of 1962 for the discharge to open streams, which was amended in 1982 and 1989.

Additional legislation includes Law 27 of 1978 for the Regulation of water resources and Treatment of Wastewater, Law 48 of 1982 Regarding the Protection of the River Nile and Waterways from Pollution, Decree 380 of 1982 for Industrial Water Pollution Control, Law of Local Administration 43 of 1979, and Law 4 for the year 1994 for Environmental Protection. A detailed description of all water-related legislation and its current status is included in Egypt's National Water Resources Plan (NWRP).

The main water and irrigation strategy focuses on the development and conservation of water resources. This is effected through water rotation for irrigation canals, decrease of the rice growing area, lining of irrigation canals in sandy regions and prohibition of surface irrigation in the newly developed agricultural areas outside the Nile Basin.

Recent water management policies include different structural and several non-structural measures. Structural measures address the rehabilitation of irrigation infrastructure, irrigation systems improvement, installation of water level monitoring devices linked to a telemetry system and expansion of the tile drainage system. Non-structural measures address the establishment of water user associations (WUAs) for irrigation canals, of water boards for branch canals, the promotion of public awareness programmes and the fostering of the involvement of stakeholders.

The legal basis for irrigation and drainage is set in Law No. 12/1984 and its supplementary Law No. 213/1994, which define the use and management of public and private sector irrigation and drainage systems including main canals and drains. The laws also provide legal directions for the operation and maintenance of public and private waterways, and specify arrangements for cost recovery for irrigation and drainage services.

The most recent water policy was drafted in 1993. It included several strategies to ensure satisfying the demands of all water users and expanding the existing agricultural area (7.8 million feddans, about 3.12 million ha at that time), by an additional 1.4 million feddans (about 560,000 ha).

Water use legislation and standards

In Egypt, “water use standards" are sets of laws and regulations enforced under the responsibility of the Ministry of Housing and the Ministry of Health. The legal framework for water resources management is established in a number of laws and decrees, the most important of these being:

- **Law 48/1982**, described below, provides the “effluent-standards” as well as "ambient standards" for inland waters with the Ministry of Water Resources and Irrigation (MWRI) as the authority primarily responsible for enforcement. The main goal of the Law is the protection of the River Nile and waterways from pollution.
- **Law 12/1984** on irrigation and drainage regulates the use of water, including groundwater. It controls water rights, sets priorities between users, defines beneficial and harmful water uses and regulates financial aspects and penalties.
- **Law 4/1992** sets “effluent standards” for solid and hazardous wastes and for discharges to the marine environment. The law designates the Ministry for the Environment as the competent authority on those issues.
- **Law 213/1994** amends the irrigation and drainage law 12/1984 and legalizes private Water Users Associations at the mesqa level. It further includes provisions for the recovery of capital costs for improved irrigation facilities at the mesqa level over a period up to twenty years.

Other laws and decrees are more specific, e.g. Law 27/1982 regulating public water resources used for drinking and domestic use and Ministerial Decree 2703/1966 of the Ministry of Health, establishing the Supreme Committee for Water. This Committee is mandated to (re)define standards for drinking water, swimming, etc., and to approve water treatment projects. The Ministerial Decree No. 380/1982 of the Ministry of Industry requires new industries to install equipment to prevent pollution in relevance to the technical specifications of each establishment.

It should be noted that the “effluent-standards” for inland waters distinguish between industrial and domestic wastewater and between the Nile and irrigation systems on the one hand and the drainage systems and lakes on the other.

Since 1982, Egypt has changed and developed. Environmental awareness and education has grown in society. The environmental bureaucracy is maturing with the establishment of the Ministry of the Environment and the former Ministry of Irrigation becoming truly a Ministry of Water Resources and Irrigation (MWRI), emphasizing its role in integrated management.

Legislation on water pollution control

A legal basis for controlling water pollution exists through a number of laws and decrees. Law 48/1992 regarding the protection of the river Nile and other waterways from pollution, and Law 4/1994 on Environmental protection are the most important ones and are discussed below.

- **Law 48/1982 and Decree 8/1983**: Law 48 of 1982 specifically deals with discharges to water bodies. This law prohibits discharge to the Nile, irrigation canals, drains, lakes and groundwater without a license issued by the MWRI. Licenses can be issued as long as the effluents meet the standards of the corresponding laws. The license includes both the quantity and quality that is permitted to be discharged. Discharging without a license can result in a fine. Licenses may be withdrawn in case of failure to immediately reduce discharge, in case of pollution risk or failure to implement appropriate treatment within a period of three months. Under the law, the Ministry of the Interior has police power while the Ministry of Health and Population is the organization responsible for giving binding advice on water quality standards and to monitor effluents/discharges. Although some standards are given, Law 48 does not cover ambient quality monitoring of recipient water bodies. The law recognises three categories of water body functions:
    - Fresh water bodies (Nile River and irrigation canals);
    - Non-fresh or brackish water bodies (drains, lakes and ponds);
    - Groundwater aquifers.

  Ambient quality standards are set for water bodies that are intended for raw drinking water supply.

  The implementing Decree 8 of 1983 specifies water quality standards for the following bodies and activities:
    - The Nile river and canals into which discharges are licensed (article 60);
    - Treated industrial discharges to the Nile river, canals and groundwater;
    - Upstream the Delta barrages, for activities discharging more than 100 m^3/day (article 61);
    - Downstream the Delta barrages, for activities discharging more than 100 m^3/day (article 61);
    - Upstream the Delta barrages, for activities discharging less than 100 m^3/day (article 62);
    - Downstream the Delta barrages, for activities discharging less than 100 m^3/day (article 62);
    - Drainage waters to be mixed with the Nile river or canal waters (article 65);
    - Treated industrial and sanitary waste discharges to drains, lakes and ponds (article 66);
    - The drains, lakes and ponds into which discharges are licensed (article 68).

  Discharge of treated sanitary effluents to the Nile River and canals is prohibited (article 63) and sanitary waste effluents discharged to other water bodies should be chlorinated (article 67). Water quality standards are generally based on the drinking water standards and are not linked to all other functions a water body may have. The use of agrochemicals for weed control is also regulated.
- **Law 4/1994:** Through Law 4 of 1994, the EEAA is defined as the authority responsible for preparing legislation and decrees on environmental protection. The agency has the responsibility for setting standards and for carrying out compliance monitor-

ing, and it should further participate in the preparation and implementation of the National Programme for environmental monitoring and utilisation of data (including water quality). The agency is also mandated with the establishment of an "Environmental Protection Fund" which would include water quality monitoring. With respect to the pollution of the water environment, the law states that all provisions of Law 48/1982 are not affected. Additional provisions of Law 4 cover coastal and seawater aspects.

Nevertheless a number of issues remain unclear:

- The MWRI remains the responsible authority for water quality and water pollution issues, although the definition of "discharge" in Law 4 specifically includes discharges to the River Nile and waterways. However, the EEAA is responsible for coordinating pollution monitoring networks.
- In Law 4 it is stated that all facilities discharging to surface water are required to obtain a license and maintain a register indicating the impact of the establishment's activity on the environment. The register should include data on emissions, efficiency and outflow from treatment units and periodic measurements. The EEAA is to yearly inspect the facilities and follow-up any non-compliance. This provision is confusing or creating duplication, because Law 48/1982 also includes certain standards for effluents, and designates the MoHP as the organization in charge of compliance monitoring and only MoHP laboratory results are considered official.

Both laws establish funds where fines are collected and further used to finance monitoring and other activities.

FINANCIAL FRAMEWORK

Currently, the Ministries entrusted with the financing of the public expenditures are the Ministry of Finance, the Ministry of Water Resources and Irrigation, (MWRI), the Ministry of Housing, Utilities & Urban Development (MHUUD) and, to a limited extent, the Ministry of Agriculture and Land Reclamation (MALR), for the improvement of on-farm water management and fisheries.

Almost 90% of the development, operation and maintenance (O&M) costs for water service provision in the country are funded by public sources. The public financing of O&M in the irrigation sector amounts to about 4% of the total public recurrent expenditures. On the investment side, since 2000, some 12 billion LE of public finance were spent on national irrigation infrastructure and water-resources related programs. On average, this corresponds to 15% of the average annual public investments of the period. Currently, cost sharing for irrigation services is mainly effected through land property taxes levied at 30 LE/feddan/year on average, which are collected by the local authorities. The land property taxes amount to only 20% of the recurrent budget appropriations allocated through the MoF to the MWRI.

A review on Public Expenditures, conducted by the World Bank in 2005, depicts that the country's total public spending on new investments is much less than the total recurrent spending (ratio is 20% on average since the 2001 fiscal year). However, this pattern is reversed for the water sector, where the ratio of investment-to-recurrent spending has been ranging from 200% to 300% since 2001. There is a generally declining trend in recurrent expenditures and debt repayment, while investment expenditures are relatively steadier. This suggests that new investments are prioritized instead of maintaining existing assets and repaying debts. Figure 19 illustrates the water sector public expenditures.

The budget of MWRI is mainly allocated for the administration of irrigation and drainage networks in Egypt that meet the needs of all water-use sectors. The irrigated agriculture subsector consumes about 85% of the budget of the MWRI. A mere 10% is allocated to services for water supply and sanitation, and 5% is attributed to the industrial sector. The latter distribution is based on the sub-sectoral water usage ratio. The Ministry of Agriculture and Land Reclamation (MALR) contributes to the water sector by about 20% of the annual budget of its administrative agency and service authorities, in addition to 50% of the annual budget of the General Authority for Reconstruction Projects and Agricultural Development (GARPAD).

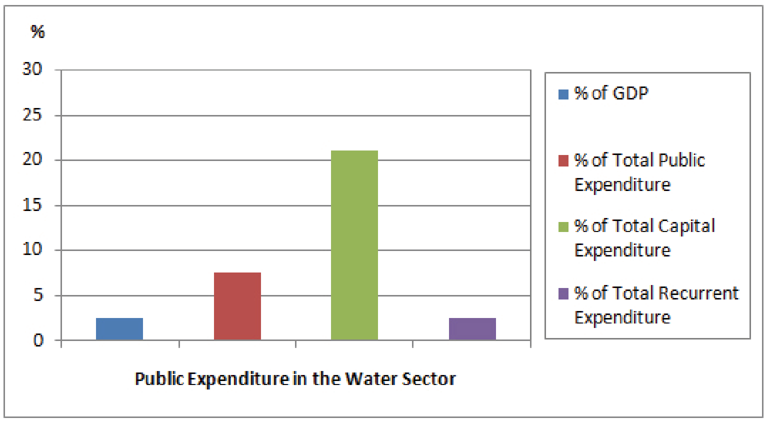


Figure 19: Water Sector Public Expenditures in Egypt

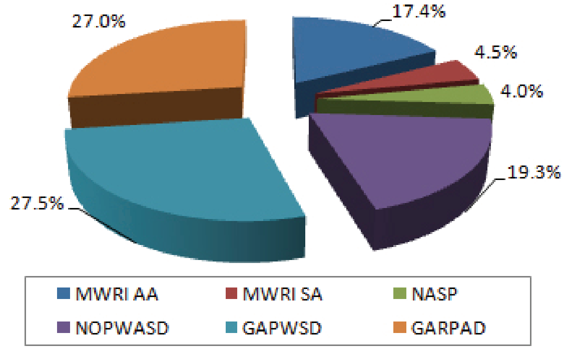
An overall view of the financing of the water sector is illustrated in Table 19, which provides estimates for investment costs for water projects and O&M costs for each institution and subsector (irrigated agriculture, drinking water supply and sanitation, industry), and environmental degradation cost estimates. The distribution of total expenditures among the major agencies within the water sector is shown in Figure 20.

Table 19: Investment, O&M and environmental degradation costs in the Water Sector

All values are in Billion L.E./yr	Stakeholder (Budget provision)		Investments in water projects		Operation and Maintenance		Total Costs
			97/98	03/04	97/98	03/04	
Irrigated Agriculture Sector	MWRI		1.555	2.771	0.442	0.662	3.433
	MALR		0.275	0.489	0.111	0.165	0.652
	Sub-total		1.830	3.260	0.553	0.827	4.087
Water Supply and Sanitation Sector	MHUNC	Water supply	0.991	1.65	0.580	1.027	2.677
		Sanitation	1.490	2.480	0.870	1.54	4.020
	Sub-total		2.481	4.130	1.450	2.567	6.697
Industrial sector	Private Sector		1.140		1.180		2.320
Environmental Degradation	State Budget		Damage Cost ≈ 1.62-3.24% of GDP				

The estimated investment costs for water services from the three ministries have increased from 4.31 billion L.E. in 1997/98 to 7.4 billion L.E. in 2003/04. The estimated O&M costs increased from 2.0 billion L.E. to 3.38 billion L.E. during the same period.

The NWRP has predicted a total of 145 billion L.E. worth of investments within the water sector during the period 2003-2017. The Ministry of Housing, Utilities and Urban Development is foreseen to contribute by 63% and the Ministry of Water Resources and Irrigation will provide 32%. The private sector, based on current scenarios, will assume about 5% of these investments.



MWRI AA	= Ministry of Water Resources & Irrigation Administrative Agencies
MWRI SA	= Ministry of Water Resources & Irrigation Service Agencies
NASP	= National Authority for Sanitary Projects
NOPWASD	= National Authority for Potable Water and Sanitary Drainage
GAPWSD	= General Authority for Potable Water and Sanitary Drainage
GARPAD	= General Authority for Reclamation Projects & Agricultural Development

Figure 20: Distribution of total expenditures among the major agencies of the Water Sector

For the same period (2003-2017), the total recurrent costs are estimated at 44 billion L.E. These costs include the operation and maintenance costs of the system but exclude the personnel costs of the government agencies. The municipalities (Ministry of Local Development) assume by far the biggest share of costs (70%) for the operation and maintenance of the drinking water and wastewater treatment plants. In this case, it is estimated that the Ministry of Water Resources and Irrigation will cover 12%, while the private sector will contribute about 15% of the cost.

As presented above, municipal water supply and sanitation services are undertaken by a group of authorities controlled by the MHUUD and to a less extent by the Ministry of Local Development (MoLD). The analysis of the budgets of these authorities of MHUUD showed that the total annual budget allocated increased from L.E. 4.73 billion in year 1997/98 to L.E. 8.45 billion in 2003/04. During the period 1982-2004, a total of 25.0 billion L.E. worth of investments have been channelled from the State Budget to potable water supply services. Moreover, a total of 40 billion L.E. were invested in sanitation services. Accordingly, potable water production increased from 5.8 million m^3/d in 1982 to 18.2 million m^3/d in 2000. Similarly, the per-capita rate of potable water use increased from 130 l/d in 1981 to 275 l/d in 2000. The capacity of sanitation stations increased from 1.0 million m^3/d in 1982, to 8.3 million m^3/d in 2000, and is planned to reach 20.0 million m^3/d by 2017. Even today, rural sanitation still is a major challenge and an impeding factor for achieving environmental sustainability.

With regard to the industrial sector, the private sector is mainly responsible for providing the investments and O&M costs required for water services. The Government provides incentives for industries to comply with environmental regulations.

Governmental authorities & foreign sources of financing

The authorities involved in the allocation of the State budget towards the water sector include the Ministry of Finance, the Ministry of Health and Population, the Ministry of Trade and Industry, the Ministry of Transportation, the Ministry of Local Development (MoLD), the Ministry of Electricity and Energy, the Ministry of the Interior, the Ministry of Tourism, the Ministry of Water Resources and Irrigation, the Ministry of Agriculture and Land Reclamation, the Ministry of Housing, Utilities & Urban Development (particularly the National Organization for Potable Water and Sanitary Drainage), the Ministry of State for Environmental Affairs (particularly the Egyptian Environmental Affairs Agency), and the Ministry of State for Economic Development, previously known as Ministry of Planning.

International agencies that have been involved comprise the Dutch Ministry of Foreign Affairs, the Finnish Government, the Rural Development Department of the World Bank, ARCADIS EUROCONSULT, the German Cooperation Agency (GTZ), the Egyptian Dutch Advisory Panel Project on Water Management, etc.

Private sector and NGOs

The establishment of Water Users' Associations

During the last decades, and in the frame of the overall effort to improve the effectiveness of irrigation systems, emphasis has been given to the potential role of Water Users' Associations (WUAs). The WUAs are voluntary organizations of farmers. In the past, associations comprised of a few farmers along a single tertiary distributor (mesqa). Usually, individual water users associations are expected to elect representatives to higher level associations reflecting the water delivery system.

It is expected that the establishment of WUAs will significantly contribute to the equity and sustainability of the system. The overall rationale is that organized farmers can contribute towards more equitable water distribution and to greater water use efficiency to resolve conflicts, thereby increasing agricultural productivity.

The establishment of WUAs spans six main objectives. The primary objective is to provide a basis for collective action of farmers along tertiary canals, to maintain and improve their share of the system, by reducing seepage losses and improving control over water supply. Secondly, WUAs will provide means for communicating farmer needs and expectations to irrigation system authorities, both prior to contraction or improvement projects and during their operation. Thirdly, WUAs can assist the irrigation authority with revenue collection. Additional objectives concern the equitable allocation of water supply among farmers and the development of a mechanism for resolving conflicts among individual users at local level. Finally, it is also considered that WUAs could coordinate cropping patterns and planting dates more effectively, thus maximizing benefits from water usage. The role and functioning of WUAs can be considered quite distant from the goal of financing irrigation systems. However, through the establishment of the WUAs, the State hopes to shift a part of the burden of running the system off-budget. To the farmers, this policy is an attempt to shift a larger part of the costs to farmers, conserving scarce State funds.

A pilot project for irrigation improvement has demonstrated specific benefits stemming from the establishment of WUAs, particularly with regard to the effective management of improved mesqas, where efficiency increased from 69% to 92%. The main objectives of the Irrigation Improvement Projects (IIP) are to contribute to increasing irrigation water use efficiency and agricultural production and to help the users in the production process, in order to enhance the corresponding benefits for both the users and for the society as a whole. In order to meet these goals, new technology and institutional changes were introduced. The major physical improvements belong to delivery and tertiary systems and concern the following:

- Introduction of continuous flow, through improved canal control structures for distribution (automatic downstream-level control gates) and rehabilitation of the delivery systems.
- Introduction of single point lifting with raised-lined or pipe line mesqas.

Other interventions included demonstration projects for introducing improved on-farm irrigation techniques (including land levying, improved farming systems, etc.). The establishment of the WUAs at the mesqa and branch canal level can be the most important instrument in implementing improved technologies and techniques in irrigated agriculture. WUAs can be the instrument that ensures water distribution, and the operation of systems at the farm level in as efficient conditions as possible, under the varying conditions and constraints faced by the irrigator. Efficient water use over time is what is important. Users' participation can also function as means of implementing government policies designed to increase food production, advance rural, economical development, and improve resource management. This is accomplished in one or two ways:

- First, by providing services and technological assistance, which users are unable to secure as individuals.
- Secondly, by providing to users the guidance and training required to exploit appropriate technologies and advanced agricultural practices.

The resulting changes in the functioning of the irrigation system are expected to contribute to improvements in crop yield and beneficial changes in cropping patterns, leading to an overall positive impact in terms of increased farm income.

The Fayoum Governorate Irrigation Department is currently testing this different model, by implementing, on a pilot scale, two different organizational models for Branch Canal Water Users Organizations (BCWUOS). The first involves only farmers, whereas the other includes also an executive board, with the participation of government officials. The organizations have prioritized the required structural improvements in the canals and have assumed responsibility for their maintenance since 1996.

From the experience of the Fayoum Governorate, it became evident that the WUA contributed substantially to the improvement of relations between the Fayoum Irrigation Department and local farmers. Water distribution has become more equitable, after the works suggested by farmers were implemented. At the same time, farmers are willing to assume increasing responsibilities for water management at the branch canal level if they are provided with the opportunity. Overall, it is expected that this will not only lead to improved water management, but it will also be attractive to the irrigation department from a budgetary point of view.

The involvement of the private sector – BOT and Joint Venture schemes

There are several options for negotiating contracts that place responsibility for operation and maintenance directly to the concession company, leaving at the same time direct control to the public utility.

However, for major capital investments (e.g. significant water and sewage treatment projects) the most common scheme is the Build, Operate, Transfer arrangement or BOT. In BOT-type projects the private sector organization has the responsibility for the design, construction, operation and maintenance and for project funding. In many cases, public utilities in addition to controlling charges and establishing their own standards of service, want to retain a direct involvement in the design, construction and operation of their water infrastructure. It is possible to achieve this objective and at the same time, through a joint venture, introduce the latest "private sector" technology, operational and design know-how into the utility company, together with the shared funding of capital investment for new works and infrastructure. This type of arrangement links the public sector utility to a private company, or group of companies, in order to develop water services through both operational and capital investment projects.

VALUING WATER – COST RECOVERY ISSUES AND CONSIDERATIONS

The market-based water conservation generally refers to using the incentive principle for encouraging farmers to practice less water-consuming agriculture. Incentives can entail drawing on the economic value of water to induce farmers to adopt conservation measures. Few experiences of irrigation water pricing have been carried out worldwide with varying indicators of success. There are cases where incentive pricing and cost recovery are practiced, such as cost recovery for irrigation improvement projects, sub-surface drainage systems, in new lands, for operation and maintenance of irrigation systems and for new projects.

The issues of cost recovery and pricing have started receiving increased attention. Water pricing is considered as an approach to generate additional revenue, which could be used to operate and maintain irrigation systems, and even repay some or all of the investment costs. It could also help to promote water conservation, especially in irrigated agriculture. However, the effectiveness of a cost recovery policy in achieving its expected objectives depends on many factors. These include the system through which water consumption is measured and the relation between existing taxation, water subsidies and proposed water charges. Farmers' reactions to such changes are not easy to predict. Furthermore, the identification of beneficiaries and the possibilities of charging external costs, e.g. those associated with environmental damage, should be further explored.

Consideration has to be given to what type of system could be instituted that would be equitable, generate revenue and simultaneously promote more efficient water usage. In July 94 the Egyptian people's assembly passed a law to charge the MPWWR to implement a cost recovery law at the Mesqa level. The same law sets the procedures to establish farmers' water users association and the irrigation advisory services.

As mentioned above, Irrigation Improvement Projects comprise the improvement of control structures, the use of modern methods in land levelling, on-farm development, rehabilitation of main and branch canals and in most mesqas. Costs relating to the improvement of mesqas comprise investment costs for:

- Mesqa pumps, which are repaid over a period not exceeding 5 years.
- Civil works, including mesqa remodeling, PVC pipes, lining etc.

Costs are paid to the Government over a period not exceeding 20 years, at no interest, whereas fees for the recovery of operation and maintenance costs are paid by farmers directly to the WUAs.

However, the overall governmental policy is against irrigation water pricing. This attitude is supported because of several technical reasons, such as:

- The generally small ownership of agricultural land in the Nile Valley and the Delta, which renders the issue of metering water supplies to a large number of small farms rather impractical.
- It is not expected that the high overall efficiency of the Nile irrigation system will be significantly improved as a result of water pricing. This is due to the fact that most water that is lost via canal/drain seepage. Furthermore, irrigation water applied onto agricultural fields replenishes the underlying closed aquifer, and can subsequently be retrieved by pumping. Moreover, water drained from agricultural lands in the Nile Valley is routed back into downstream reaches of the Nile.

Finally, water pricing will be of insignificant impact in parts of the Nile catchments where soil has a physical structure that allows the cultivation of specific crops only. It will thus decrease the opportunity for the choice of alternative crops.

PART II: THE INECO EGYPT CASE STUDY:
WATER QUALITY DETERIORATION IN THE BAHR BASANDEILA REGION

BACKGROUND AND MOTIVATION

Water quality degradation is becoming alarming in Egypt. A recent study revealed that industrial facilities are directly discharging polluted wastewater in the Nile at an annual rate of 100 million m^3. These facilities produce fertilizers, chemicals, oil, soap, iron, steel, sugar, cement, and petroleum products. The uncontrolled discharge of polluting effluents has caused serious deterioration in the quality of Nile water. As it can be expected, the mid-stream conditions of the Nile are still, on average, at a fairly clean level due to the dilution and degradation of the discharged pollutants. The riverbanks, however, are much more polluted. Inefficient production in some industries (e.g. oil and soap) generates waste that contains raw material as well as products, a costly burden to the national economy and the consumer. Evidently, efficient production would reduce pollution. Cleaner production, defined by UNEP's Industry and Environment Program Activity Center as "the continuous application of an integrated preventive environmental strategy to processes and products to reduce risks to humans and the environment", is emerging as the primary solution to industrial pollution in Egypt.

The problem of water quality degradation is exacerbated by the alarming increase of discharge rates of municipal and domestic waste. In the rural areas, which accommodate about half of the population (35 million persons), 95% of households does not have access to sewer systems or wastewater treatment facilities. Septic tanks are the most common disposal facility, where excreta and a limited amount of sludge water can be collected for biological digestion. The digested excreta leach into the soil surrounding the tank, thus subjecting shallow groundwater to pollution.

In urban but also in rural areas, the occasional primary treatment of urban sewage is currently considered insufficient to prevent further deterioration of vital water streams. Furthermore, secondary treatment cannot be satisfactory to provide the quality of wastewater required for reuse or for preventing further pollution with pathogenic bacteria and other microorganisms. In the Nile Delta, Bahr-El-Baqar is an example of highly polluted waterways. Furthermore, the mixing of drainage water with freshwater for irrigation purposes imposes risks to public health.

Admittedly, the unused drainage water led into the lakes and the sea transfers its pollution burden to the coastal and marine ecosystems. Typhoid, paratyphoid, infectious hepatitis, and infant diarrhea are some endemic diseases indicating deterioration of water quality in Egypt. Despite the assiduous endeavours for public awareness through the media, the prevalence of Bilharzia substantiates the lack of rural sanitation against the traditional contamination of surface waters with human waste.

In the above context, the INECO project pursued the development of Case Study on water pollution in the Bahr-Basandeila region, located in the Dakahlia Governorate. In this, rather small, area there is increasing concern over the degradation of water quality in the local canal, which is used for drinking water supply. Lack of infrastructure for sewage treatment, inefficient provision of water services, pollution from industrial effluents, and possibly excessive use of agrochemicals have led to water quality issues similar to those encountered throughout the Nile distribution network.

WATER QUALITY DETERIORATION IN THE BAHR BASANDEILA REGION: AN ISSUE OF LOCAL CONCERN

The Basandeila Region is located in the Dakahlia Governorate, and includes three large villages: El Hawadaia, Damlash and El Gawadia, in addition to 16 smaller ones (Figure 21). The total area of the region is 5739 feddans, whereas the cultivated area is 5524 feddans, representing 96.3% of the total. Currently, the area hosts around 45,000 inhabitants.

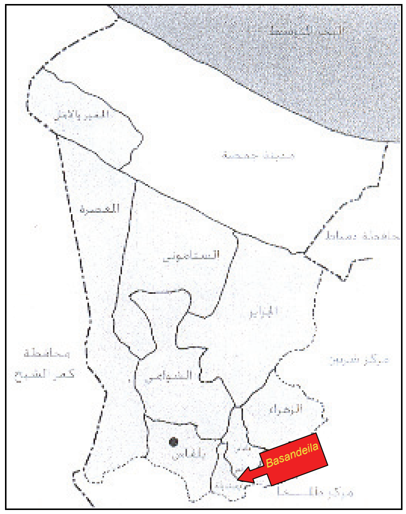


Figure 21: The location of the Basandeila Region

The canal network that covers the region originates from the Bahr Basandeila Canal and has a total length of 12 km, whereas the drainage network length is about 8 km. The main water supply source is the Bahr Basandeila Canal, which receives water from Bahr Shibin, from El Rayah El Abbassy Canal, and from the Damietta Branch of the River Nile. The Bahr Basandeila Canal is located at the end of Bahr Shibin Canal (Figure 22). This canal irrigates a cultivated area of around 3000 acres in Basandeila village, which, according to recent estimates, has a population of 25,000.

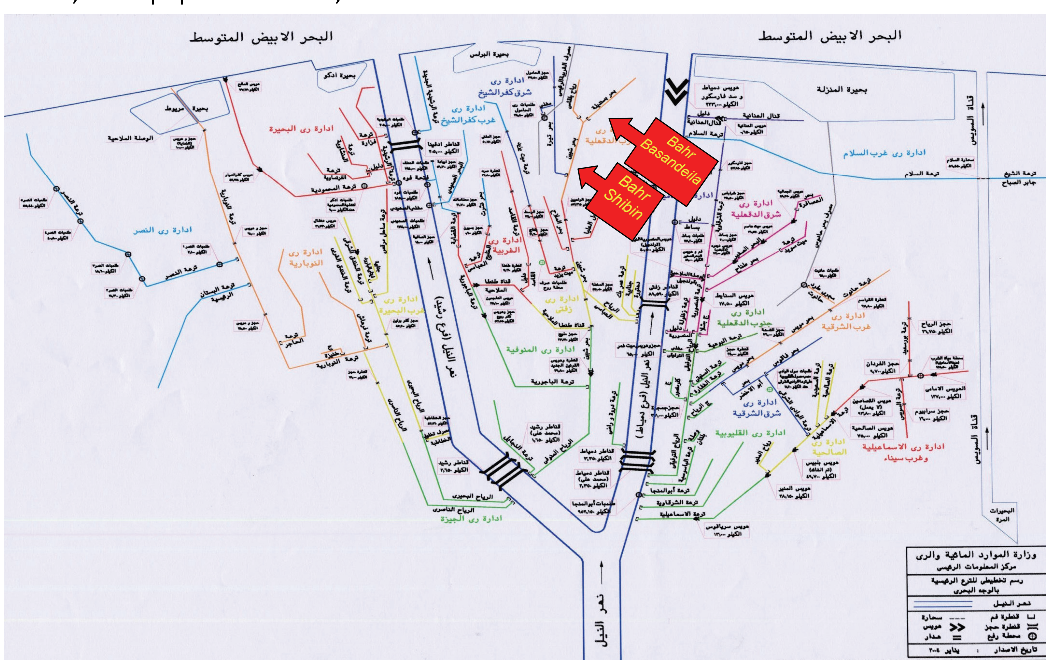


Figure 22: The location of the Bahr Shibin and Bahr Basandeila Canals

The area experiences significant water quality problems. Concentrations of BOD and COD in canal water range between 4 and 12 mg/l and 10 and 14 mg/l respectively. Pollution from nutrients, originating from agricultural activities is not as important: measured concentrations are in the range of 0.02 to 0.2 mg/l, depending on the season. Quality measurements reveal that current water quality degradation results from pollution of domestic/industrial origin. Figure 23 presents the water quality index (Reference value of 1), whereas Figures 24a and 24b present the detailed measurements of water quality parameters for the canal surface water.

Currently, 84% of the total population of the area is connected to the sewerage network. 15% is served by septic tanks, while 1% of the total population discharges its sewage to open drains. However, it should be noted that houses that have been built illegally in the area cannot be connected to the sewerage network, and are not included in the estimation of the above indicators.

Although sewerage coverage is acceptable according to the above official data, the current capacity for sewage treatment is inadequate. In fact, the proportion of the wastewater generated by the community that receives acceptable levels of treatment prior to discharge is only 27%. Furthermore, the peak volume of wastewater produced corresponds to 364% of the total capacity of wastewater facilities. It is additionally estimated that only 2% of all the manufactories that need to implement wastewater treatment is actually equipped with the corresponding facilities.

The degradation of surface water quality has a serious impact on population health. With regard to health incidents linked to inadequate water treatment and lack of sanitation, only in 2007 there were four outbreaks (typhoid, diarrhea and gastroenteritis), each represented by more than 200 cases. Incidents were more acute during the summer. Overall, and despite the current efforts to provide safe drinking water through the installation of purification stations, it is estimated that only 65% of the total population has access to safe drinking water. The local water utility regularly performs the tests required according to existing regulations. However, only 80% of the total tests of treated water per year comply with the applicable standards.

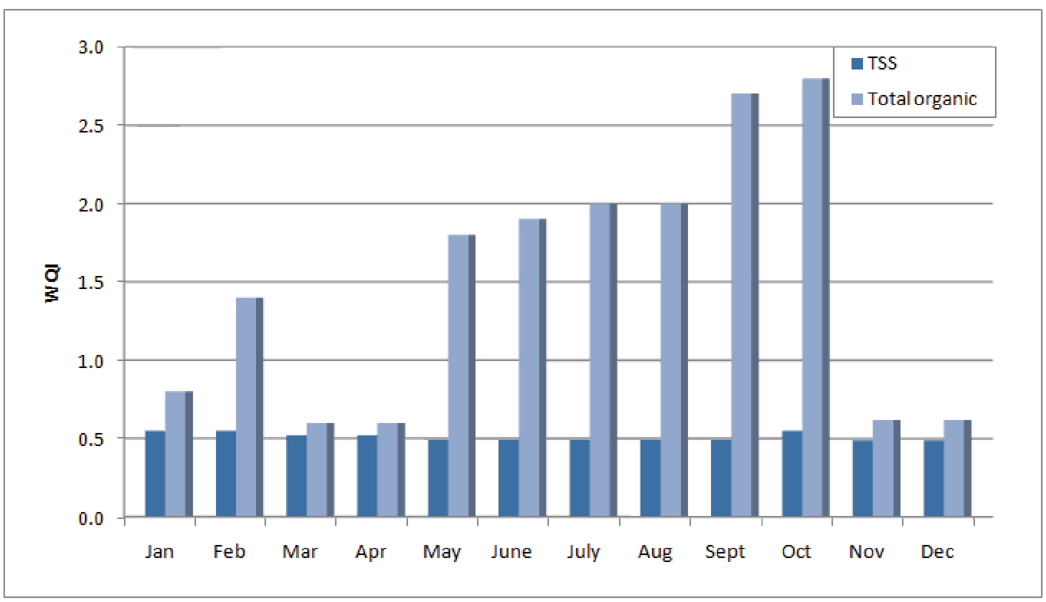
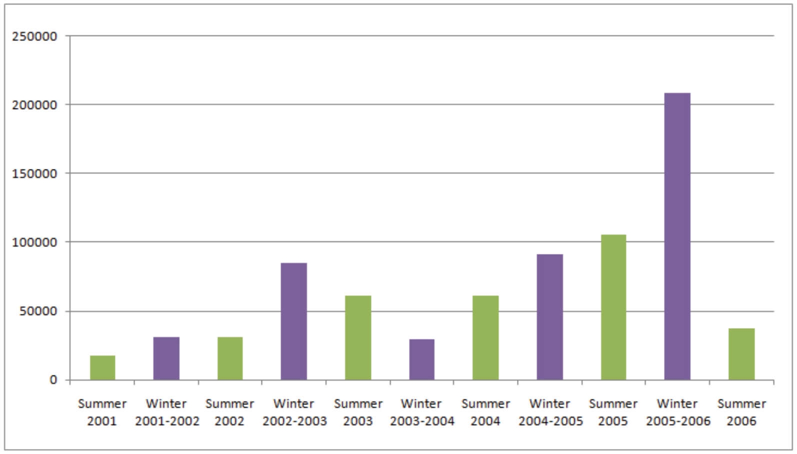
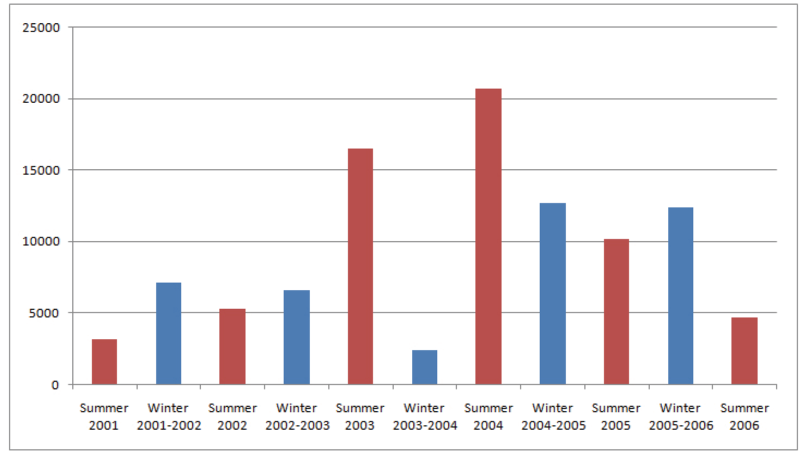


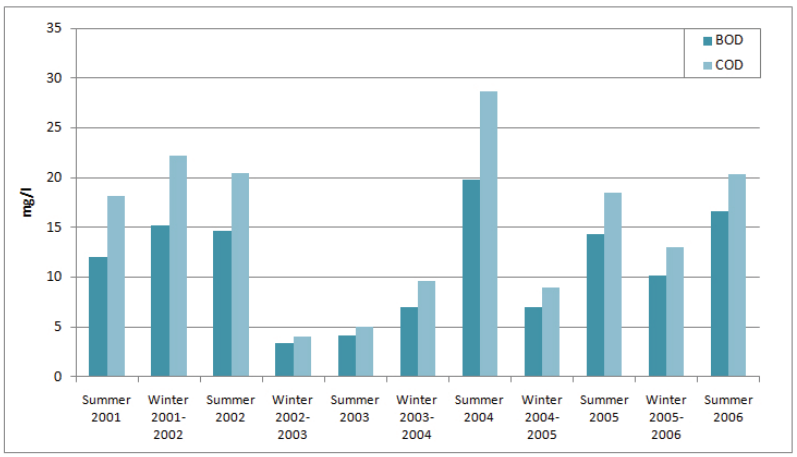
Figure 23: Water quality index for the Bahr Basandeila Canal



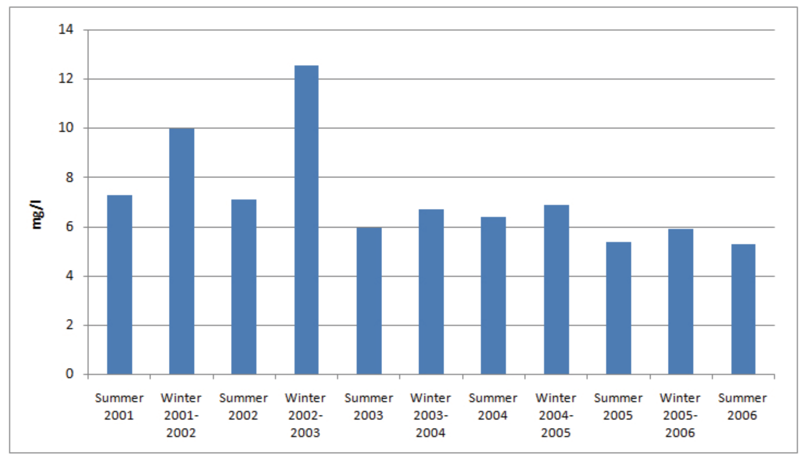
(a) Coliforms (CFU/100ml)



(b) Fecal matter (CFU/100ml)

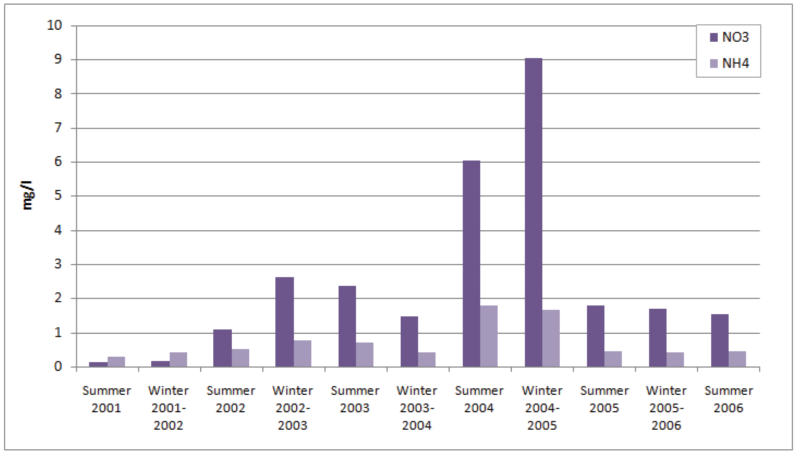


(c) Average BOD and COD concentrations

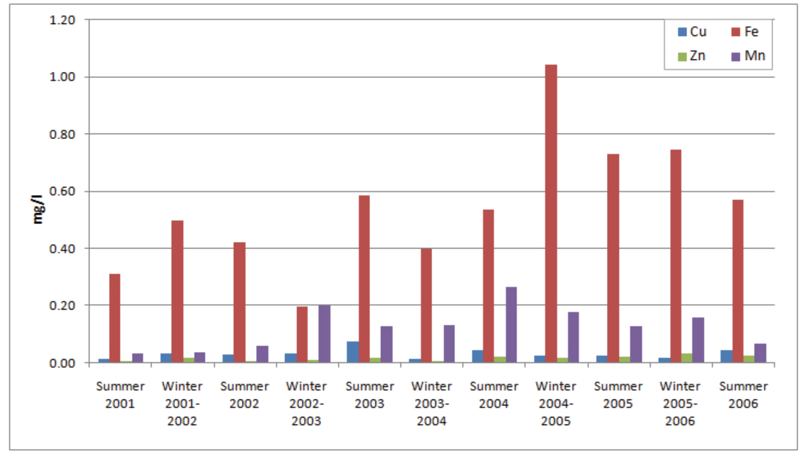


(d) Dissolved oxygen

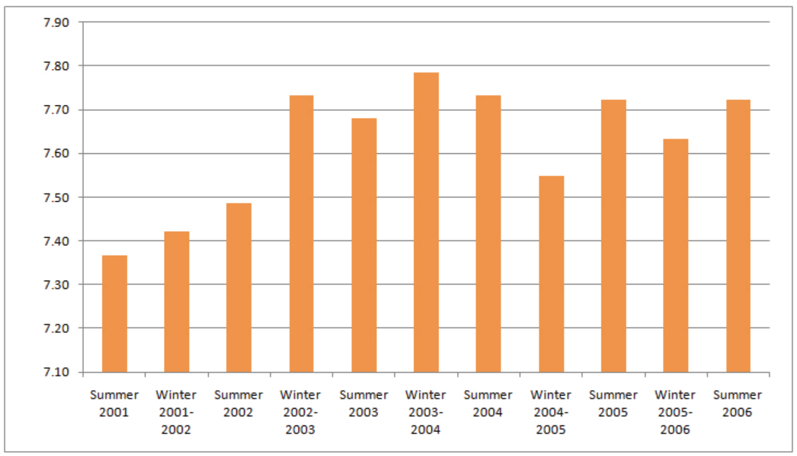
Figure 24a: Measured water quality parameters in the Bahr Basandeila Canal (Coliforms, fecal matter, BOD, COD and DO)



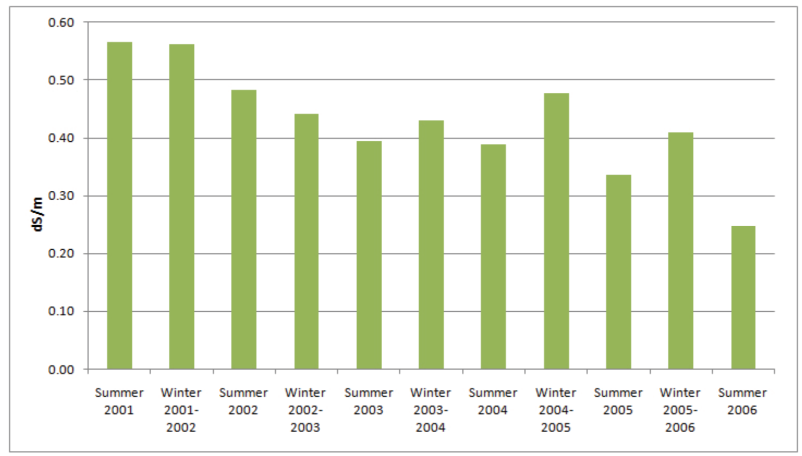
(e) NO_3 and NH_4 (Reference values: NO_3 <45 mg/l, NH_4 <0.5 mg/l)



(f) Cu, Fe, Mn, Zn (Reference values: Fe <1mg/l; Mn <0.5 mg/l)



(g) pH (Reference value: between 7 and 8.5)



(h) Electric conductivity

Figure 24b: Measured water quality parameters in the Bahr Basandeila Canal –cont'd (NO_3 and NH_4, Cu, Fe, Mn. Zn, pH, conductivity)

DISCUSSING WITH LOCAL STAKEHOLDERS – THE APPROACH

The INECO approach towards the development of a participatory process for discussing alternative institutional and economic instruments to address water management issues was based on the Objective Oriented Project Planning method.

The method, which is similar to the Logical Framework Approach, has been suggested as a tool to support urban participatory decision-making. In INECO, this method has been used to frame discussions with stakeholders, focusing on a water management problem that is commonly perceived as significant (focal) in the region of interest.

The followed approach was divided in three stages (Figure 25):

1. The first stage, **Problem Analysis**, involved the identification of stakeholders and the mapping of their key problems, constraints and opportunities, and the definition of the key water management issue in the region of interest. Furthermore, this stage included the identification and analysis of cause and effect relationships between threats and root causes of the issue at hand;
2. Next, the **Analysis of objectives** concerned the development of policy objectives from the identified problems, and the identification of means-to-end relationships;
3. The final stage, **Option analysis**, concerned the identification of different options that can contribute to the achievement of the agreed objectives. Options were subsequently evaluated by stakeholders to formulate the most suitable strategy for problem mitigation.

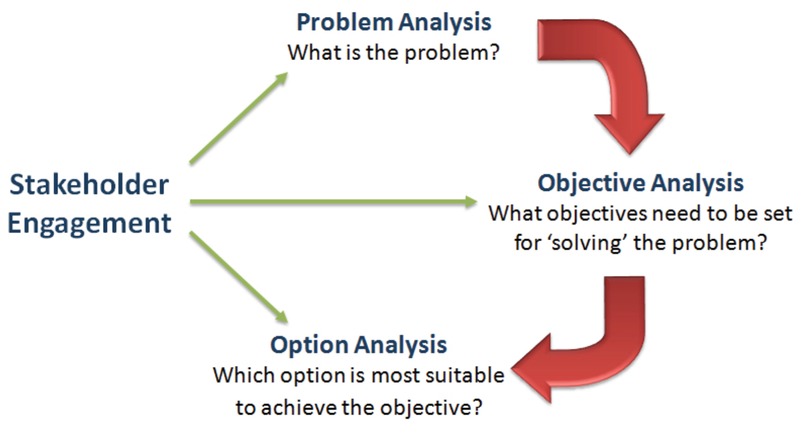


Figure 25: The framework for public participation and engagement in INECO

The overall process was articulated through individual (preparatory or consultation) meetings with key stakeholders (decision and policy makers, representatives of key water users), workshops and public meetings open to stakeholders and all citizens concerned, surveys, discussion fora, and dedicated questionnaires. Emphasis was given to the openness of the process; special care was given to inform stakeholders of all outcomes and replies of other parties, whereas all information collected was made accessible to the public through the distribution and web uploading of material.

The following paragraphs describe the overall implementation of this approach for deriving regional policy recommendations for addressing water quality degradation issues in the Bahr Basandeila Canal.

PROBLEM ANALYSIS

From the early stages of the development of the INECO Case Study in the Bahr Basandeila area, it was realized that awareness and cooperation with local actors are milestones for addressing the alarming dimensions of water quality degradation in the area. For this purpose, and in order to foster the overall process and integrate existing research efforts from local institutions, three major events were implemented within the framework of INECO:

- The "Integrated Management Symposium for the eradication of Nile water pollution" was held at the Mahalla National Democratic Hall, in the Gharbia Governorate, on 12/03/2007. The event was attended by a total of 86 participants, and involved an extensive debate on the importance of water pollution and actions that need to be taken.
- The "Water and Health" Symposium held on 23/05/2007 in the Conference Hall of the Mansoura University Children's Hospital, in Mansoura, was addressed to local residents and students. It was primarily aimed at raising awareness and disseminating the outcomes of current research efforts on water quality improvements. The event was attended by 164 persons.
- The "Women awareness symposium on the importance of preserving water resources" was primarily aimed at highlighting the role of women in water management and sanitation, and at motivating local actors to support women towards the protection of water resources and water saving. The event was held on 19/06/2007 at the Conference Hall of the Mansoura University Children's Hospital and was attended by 87 persons.

Following from these stakeholder mobilization efforts on water quality degradation, the main workshop event of INECO was organized in Mansoura, on July 21st 2007. The event was attended by 120 persons and was primarily aimed at discussing the issue at hand. The discussion involved the consolidation of a "Problem Tree" diagramme, illustrating the causes and effects of the issue of "water quality deterioration".


The INECO Egypt Stakeholder Workshop on "Building a common vision for the mitigation of water pollution in the Dakahlia Governorate", Mansoura, July 21st 2007

The results of this validation exercise, aimed primarily at the exchange of views and experience, are presented in Figure 27. According to this qualitative analysis, in the region of the Bahr Basandeila Canal, water pollution is mostly due to the discharge of industrial and municipal effluents without prior treatment. Furthermore, it was considered that current agricultural practices, which entail the excessive application of fertilizers and pesticides, result in high nutrient concentrations in the canal surface water, and exacerbate eutrophication and water quality deterioration. Large amounts of wastewater (domestic, industrial, and agricultural) are discharged onto land, and through run-off are transferred to the Damietta Branch of the River Nile, posing a threat on human health, agricultural production, and the local ecosystem.

Replies to the dedicated questionnaire that was distributed during the workshop were also a helpful tool in revealing the perceptions of stakeholders as to the significance of causes and effects to the problem and possible options for its mitigation. The most significant results of the survey were the following:

- Among the 64 participants who responded to the survey, water pollution is perceived as extremely significant (86.5%) and a domain where action is needed immediately.
- Opinions were diversified as to the primary causes of the problem. Thirty six percent (36%) of respondents believe that water quality deterioration is due to agricultural practices, while 24% perceives the discharge of untreated industrial effluents as the primary cause.
- The majority of respondents link water pollution to increased health risk, direct (64%) or indirect (28.5%), through the consumption of agricultural products that are irrigated with polluted water.
- The primary area where action is considered as needed is industry (39%), followed by municipal wastewater collection and treatment (24%) and disposal of solid waste (24%). Agriculture groups only 13% of replies.

As industry was perceived the major contributor, participants were also asked to rank four instruments using a scale ranging from 1 (least effective) to 5 (most effective). Ranking results are presented in Figure 26, below, from where it is clear that the most favoured options concern the introduction of pollution charges and the stricter enforcement of legislation.

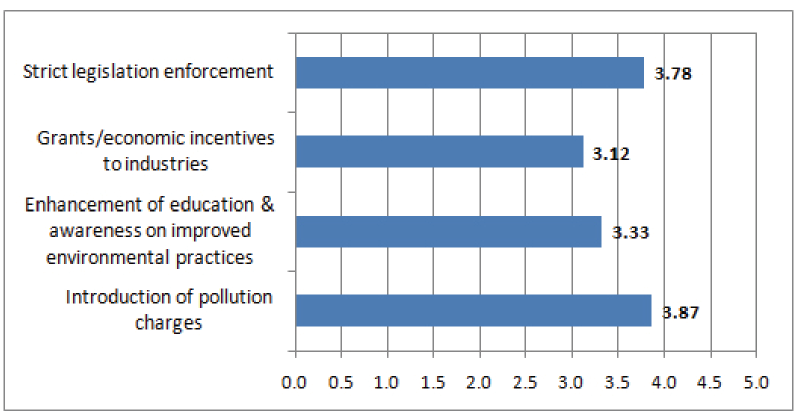


Figure 26: Ranking of options for industrial pollution prevention and control in the Dakahlia Governorate

Furthermore, stakeholders participating in the event suggested the following action points:

- A permanent dialogue should be established among official bodies responsible for health and pollution prevention and control, and the corresponding beneficiaries, with the aim to analyze the factors that contribute to the problem and try to address them.

- Views of all people concerned should be collected; this can be effected by encouraging stakeholders to fill the corresponding online questionnaire at the INECO web site.
- Potable water supply should be enhanced.
- There is need for the rehabilitation of distribution networks in order to prevent contamination with sewage.
- Active carbon can be used for absorbing toxic substances, as well as other substances produced from the interaction of chlorine used for disinfection, and organic materials.
- A survey of distribution networks should be undertaken, in order to map the problems per village, assess their severity and inform people on water conservation.
- In areas of high risk, provisions must be made to provide bottled water at very low prices.
- Egyptian standards for drinking water must become stricter. Mechanisms for real control of water quality should be developed, including trained personnel and laboratory equipment.
- Simple, traditional ways should be sought in order to enable citizens to access safe water when (a) they do not have access to public water services or (b) there is a failure in the water supply system.
- Instead of using drainage water for irrigation, new water supply sources should be sought.
- Awareness on water resource protection and conservation should be enhanced, also through the organization of educational programmes on polluting activities and practices and on the current, significant environmental issues.
- Practices that have adverse effects on water quality should be prohibited.
- All sewage treatment stations should be equipped with modern technology.
- Laws that allow for the disposal of industrial waste only after full treatment should be activated.
- Disadvantaged villages must be serviced with sanitation and water supply services.

The workshop event was followed by a visit in the village of Basandeila, on July 22nd 2007, in order to discuss the pollution of the Basandeila Nile Branch with citizens and involve social actors and water management authorities. The meeting was held at the local hospital, and was attended by 21 persons, including leaders of the National Democratic Party, hospital employees and officials of the Drinking Water Treatment Plant of Basandeila.


Photos from the Basandeila visit and meeting, July 22nd 2007

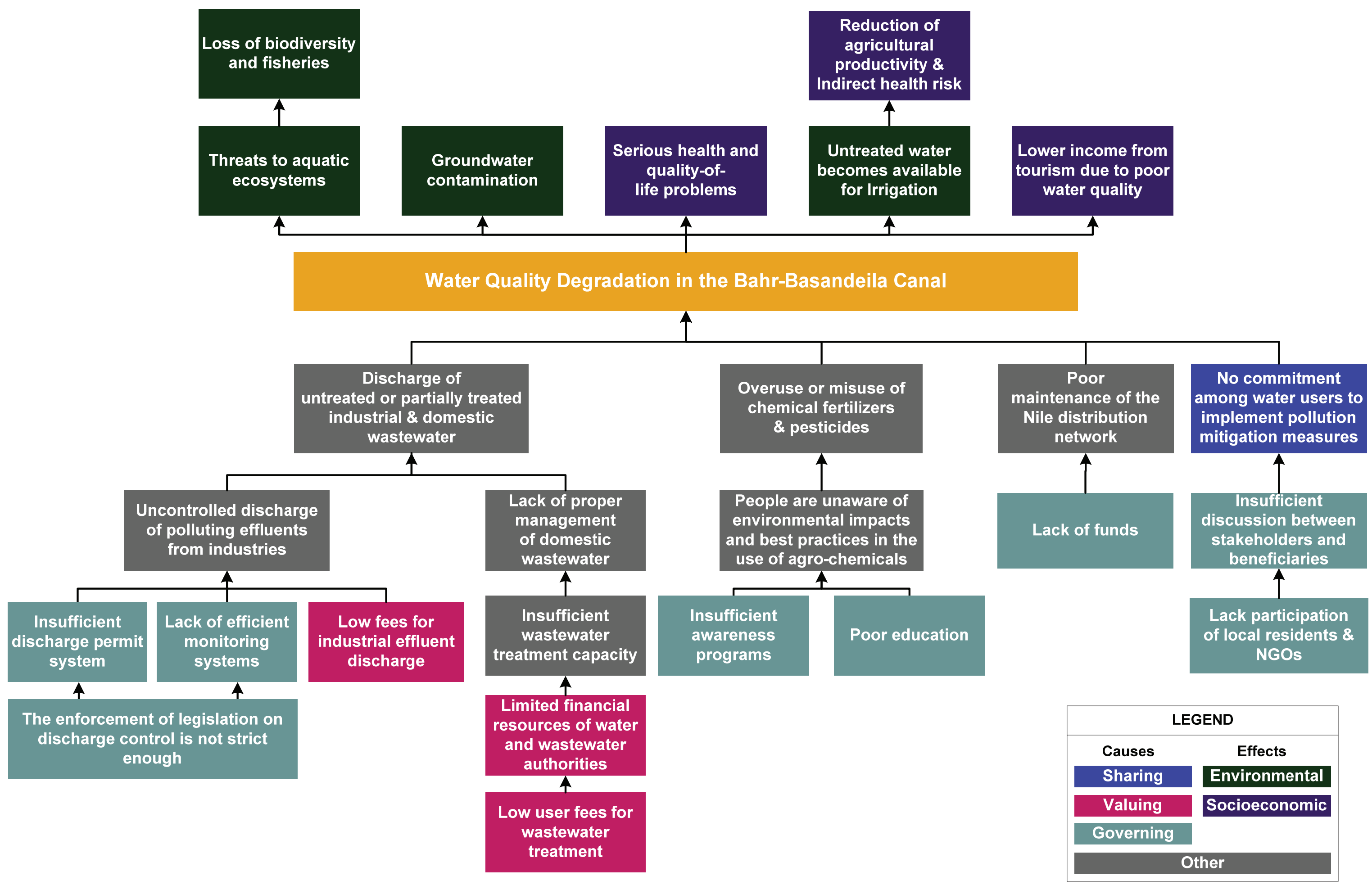


Figure 27: Problem tree analysis of the effects and causes of water quality degradation in the Bahr-Basandeila Canal

During the visit, it became evident that drinking water quality problems exist and can be associated with the state of the water distribution network. Participants jointly decided that local initiatives are required for addressing the quality problem, and discussed the following course of action:

- The Water Utility would check connecting pipes along the distribution network to ensure that there is no leakage or contamination of potable water with domestic sewage.
- Residents and local actors should help in identifying problematic areas and inform the Water Utility on the future needs of the region in potable water, so that the local capacity expansion plan is updated correctly.
- All actors should work to enhance awareness among local residents on ways to protect the waters of the canal (water intake), and discourage the disposal of domestic waste, sewage and residues from animal husbandry activities.

Suggestions, comments and issues raised formed the basis for the discussion on policy objectives and potential options, discussed in the following sections.

DEFINING POLICY OBJECTIVES

Following from the participatory consolidation of the "Problem Tree", individual consultation and discussion sessions were held with all local stakeholders and actors that participated in the events of 21-22 July 2007. These meetings were aimed at: (a) defining the key policy objectives that should be pursued for problem mitigation; (b) collecting additional suggestions on options that could be applied to attain the defined objectives.

Firstly, the results of the previous stage ("Problem Analysis") were used to draw a preliminary "Objective Tree", translating the original cause-effect diagram to means-to-ends relations (Figure 28).

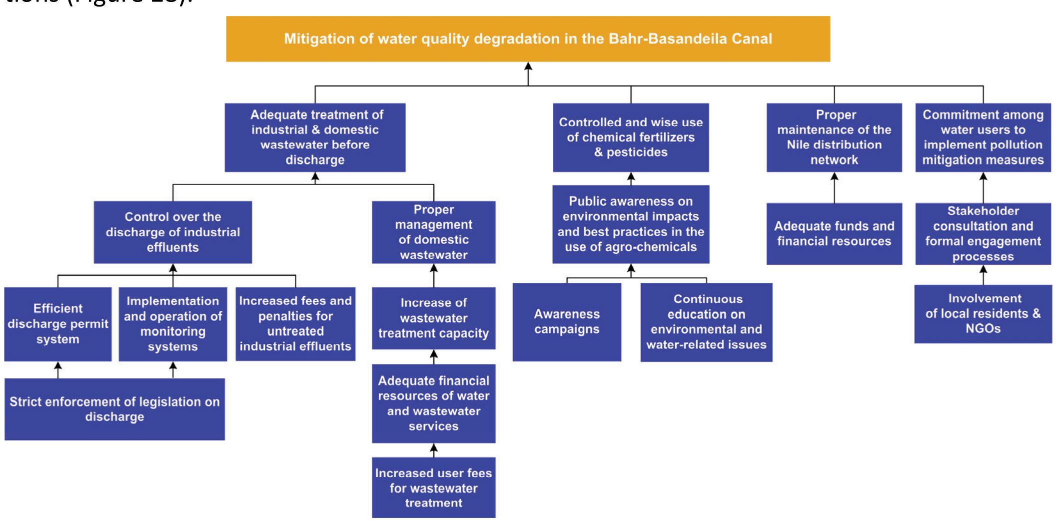


Figure 28: The "Objective tree" for addressing water quality deterioration in the Bahr Basandeila area

This "tree" was then further elaborated to define a set of key policy objectives to achieve the main goal, incorporating the views of all stakeholders.

Three main policy objectives were defined:

- **Objective A:** Control over the discharge of industrial effluents;

- **Objective B:** Regulated use of chemical fertilizers & pesticides;
- **Objective C:** Commitment among water users to implement pollution mitigation measures and community empowerment.

Furthermore, and as significant health risks are reported and raise concern among the consulted stakeholder groups, an additional objective was defined in relation to the reliable provision of water supply and sanitation services in the area (**Objective D**).

IDENTIFICATION AND ANALYSIS OF OPTIONS

The work towards deriving policy recommendations focused on the identification of alternative (institutional and economic) options to achieve the aforementioned objectives. These suggestions, subject to evaluation, were used to develop a roadmap towards strategies, suitable for achieving the wider goal, i.e. the mitigation of water quality degradation in the Bahr Basandeila Canal. To facilitate discussions with local stakeholders, and in accordance with the objectives defined above, potential policy instruments were grouped into four (4) categories, as follows:

(1) Options for industrial pollution prevention and control;
(2) Options for regulating the use of agrochemicals;
(3) Options to improve the technical and financial sustainability of water services;
(4) Options to strengthen the socio-economic and institutional environment (enhancement of coordination and integration of policies among institutions involved, and of user involvement and commitment in environmental protection and water conservation).

The following paragraphs present the suggested options in more detail. The analysis also outlines barriers that have inhibited the (effective) implementation of potential responses, as well as associated issues that need to be considered and evaluated to achieve sustainable solutions to the problem at hand. Identified issues pertain to the three main functions: (a) water service provision (Operational function); (b) River Basin level/Aquifer management (Organizational function); (c) National water policy and law (Constitutional function).

INDUSTRIAL POLLUTION PREVENTION AND CONTROL

As presented in the corresponding Indicators' table (end of this section), there are several major industries operating in the wider area of the Bahr-Basandeila region, which discharge their effluents to the canal. Industrial activities encompass a wide range of processes and products, including chemicals, textiles and food processing. Figure 29 summarizes potential options that could be applied to address the issue.

Currently, discharge permits for industrial premises are obtained from the Ministry of Health and Population (MoHP), which also periodically checks conformity to the terms of the permit. In case that violations are identified and there is no immediate danger for human health, the industry is given a 3-month grace period to comply with standards. All discharge to the Nile, irrigation canals, drains, lakes and groundwater requires obtaining a discharge license from the Ministry of Water Resources and Irrigation. Licenses can be issued only for the discharge of effluents that meet standards and each license specifies the quantity and quality permitted to be discharged. Fines are levied for unlicensed discharges and licenses can be revoked if industrial facilities fail to comply with standards after a grace period of 3 months. However, in spite of the considerable efforts undertaken, the actual enforcement for cases involving public facilities (state-owned industries and municipal wastewater), which are the majority of all pollution sources, is almost non-existent due to: (a) lack of funds to comply with standards and (b) other economic and employment considerations. As Environmental Impact Assessment (EIA) laws are gradually being introduced, major industries are being visited due to non-compliance with wastewater treatment regulations. Compliance Action Plans (CAPS) are being agreed upon to obtain a grace period for compliance.

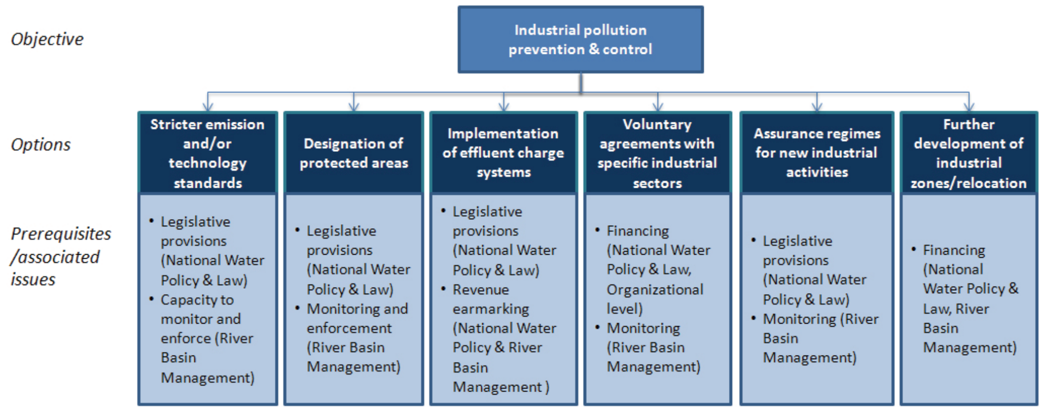


Figure 29: Suggested options – Industrial pollution prevention and control

With regard to the particular area of Bahr Basandeila and the Governorate of Dakahlia in general, efforts and pilot actions can primarily concentrate on:

- The development of voluntary agreements, which have never been introduced or considered in the study area. In the Damietta branch, the major water pollution sources comprise the Talkha Fertilizers Factory, the High Serw Drain and the High Serw Power Station. It is noteworthy that industries would be willing to participate in an eventual voluntary scheme, if they are advised to its importance as a potential tool for water quality improvement.
- The designation of protected areas, especially in the vicinity of drinking water abstraction points, where specific polluting activities should be prohibited. The measure can be combined with an effort to relocate industries to industrial sites, and develop collective wastewater treatment schemes. Similar efforts are being pursued in many areas of Egypt.
- Additional economic incentives can be provided through the Environmental Fund, from where money from different sources is made available for environmental protection projects. Regarding the water sector, the fund provides soft loans to industrial firms for pollution abatement projects, such as recycling and reuse of treated effluents, as well as for setting up small-scale pilot demonstration projects.

Currently, and with regard to the overall National Policy for water pollution abatement, legislative efforts concentrate on the reform of the system for effluent charges. Effluent fees are about to be increased fifteen-fold, according to a proposal awaiting legislative approval. It should be noted that the driving principle behind all reforms and efforts is that the strict enforcement of regulations would mean very large investments by industry and municipalities. Their enforcement is currently considered unrealistic and even counterproductive. In this regard, efforts are mostly concentrated on providing the appropriate combination of incentives to the industrial sector to comply with standards, rather than enforce these, regardless of wider socio-economic implications and costs.

REGULATION IN THE USE OF AGROCHEMICALS

Pollution from agrochemicals, and especially fertilizers, does not seem relevant for the Bahr Basandeila area, as the corresponding water quality parameters do not show significant contribution of agriculture to water quality degradation. However, during the consultation meetings and the workshop discussions, stakeholders showed particular concern over the excessive use of agrochemicals. In this regard, this section presents considerations on how the agricultural pollution can be prevented.

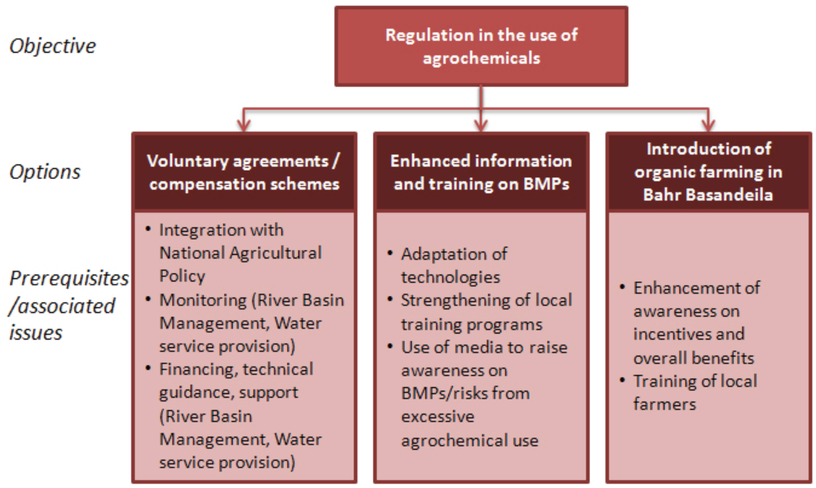


Figure 30: Suggested options – Agricultural pollution prevention

The overall approach is based on the building of management practice systems (i.e. combination of management practices), including structural works, such as waste treatment lagoons, terraces, sediment basins, fences to prevent run-off from the field, and agronomic measures, such as prescribed grazing, nutrient, pest and residue management etc. The main concern is how farmers can be encouraged to adopt such systems. In this regard, the introduction of voluntary or compensation schemes can be considered a promising option. Economic incentives can involve sharing of the corresponding costs with the local government or the water utility. The key consideration however concerns education, training and awareness on best management practices, through information and education programmes, awareness campaigning on environmental issues and how they impact on own quality of life, and broader community support. It should be noted that voluntary schemes or specifically designed financial assistance (e.g. grants, compensation payments, tax reductions/exemptions) have never been implemented in the past.

To that end, an additional option for the protection of the canal could involve the introduction of organic farming. The country has a well-developed and still rapidly growing organic sector. About 24,548 ha of land are under organic management, accounting for 0.72% of the country's total agricultural area. Organic production presently concentrates on about 500 farming enterprises. Major obstacles to that end can comprise the lack of education and training, to overcome the traditional practice of intensive cultivation on a relatively small agricultural area with a high rate of pesticide and fertilizer use.

TECHNICAL AND FINANCIAL SUSTAINABILITY OF WATER SERVICES

A major issue of concern in the Bahr Basandeila area and the Dakahlia Governorate is the quality of drinking water supply and the reliability in its provision, as there are frequent interruptions. Ensuring access to water supply and sanitation is a national policy goal; however, in small urban centres and rural areas similar to Basandeila, the sustainability of these systems is questionable if they are not further subsidized by the State. Full recovery of costs would have a vast impact on individual bills and may lead to serious social problems. It is estimated that recovery of operational costs only would require an increase of about 300% in water utility revenues. In this regard, all costs related to the rehabilitation and expansion of drinking water supply networks are provided through State funds.

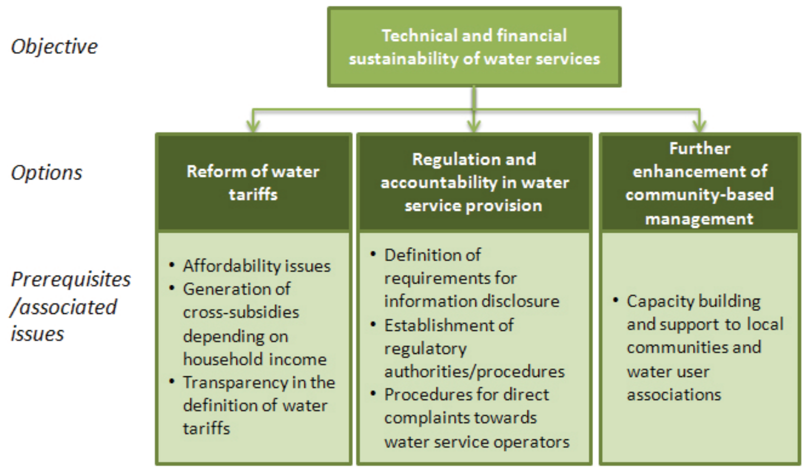


Figure 31: Suggested options – Improvement in water service provision

Although tariff increases for generating adequate revenue to ensure the technical sustainability of the system cannot be fully considered, there are options for improving cost recovery at the level of water providers. A maximum level of tariff increase that would be tolerable is 25% of the current tariff. Furthermore, and despite the fact that presently all decisions related to water tariffs are under the control of the Government, there can be possibilities in differentiating among customers (e.g. depending on household income) and generate cross-subsidies, thus alleviating pressures from the poorer households.

Another important issue that requires further attention is accountability in water service provision and disclosure of all information related to potable water quality. Presently, the complaints by customers regarding the provision of drinking water supply and sanitation services are submitted to local authorities and the People Council and not directly to the operators. Usually however, there is a positive reaction, depending on financing ability. Possibly a more direct approach would facilitate communication and allow more immediate response to technical and quality problems.

STRENGTHENING THE SOCIO-ECONOMIC ENVIRONMENT

Incentive-based approaches towards water pollution prevention and control are based on three milestones: (a) user and consumer awareness, (b) training and education and (c) financial/fiscal incentives. With regard to points (a) and (b), several actions are undertaken such as information campaigns regarding pollution from industrial sources, best management practices in agriculture, and the general public at large. All these efforts have proven effective in the reduction of water pollution and water saving.

Furthermore, recent efforts have been undertaken for the establishment of user associations, especially in agriculture (e.g. Water User Associations, Water Boards etc.). However, further strengthening the role of water users and communities and support to community participation in the management of water services, especially in rural areas can be a policy priority.

OPTION EVALUATION

PRIORITIZATION OF SUGGESTED INSTRUMENTS

The first step towards the evaluation of suggested responses was their prioritization by local stockholders, on the basis of a set of predefined criteria, common to all the INECO Case Studies. The step was implemented from February to June 2008, and involved:

- Distribution and completion of a survey for ranking ten (10) broad categories of instruments. The survey was aimed at evaluating the feasibility and applicability of economic and institutional instruments, taking into account the local and national water management context, current conditions and priorities, and future challenges;
- Further discussion sessions with key user groups and decision-makers to discuss the outcomes of the prioritisation “exercise” and elaborate on potential options.

The overall process was supported by the Water Management Research Institute of the Ministry of Water Resources and Irrigation, and by the Soils, Water and Environment Research Institute of the Ministry of Agriculture and Land Reclamation. Overall, 20 responses were received, by key decision-makers and representatives of key user groups (industries and farmers) of the Dakahlia Governorate.

Replies from stakeholders revealed consensus on potential instruments that could contribute towards the mitigation of the focal problem, both at local and at regional level. Instruments and approaches that seemed to be most relevant and applicable comprise decentralization, public participation and increased liability of polluters. Instead of indirect taxes, preference was articulated for direct and indirect forms of financial aid, but also for voluntary schemes, including State support for building the required human and technical capacity for pollution prevention and control.

FURTHER CONSIDERATIONS TOWARDS OPTION IMPLEMENTATION

The overall process of evaluating potential policies for mitigating water quality deterioration and water stress were complemented through a last step, aimed at mapping perceptions and sharing views on prerequisites and further considerations for the implementation of proposed approaches.

The process was articulated through individual interviews and meetings with representatives from local user associations, NGOs, representatives of local and regional authorities, and researchers and professionals dealing with the water management issues experienced in the area and their socio-economic impacts. In addition to individual communications, the outcomes of this step were presented and discussed in a Symposium, which was held at the premises of the Local Council of the city of Belkas on April 1st 2009. This event was attended by 111 persons, including representatives from the Ministry of irrigation and Water Resources, the Ministry of Education, the Ministry of Health, Ministry of Al Awqaf, the Egyptian Parliament, the National Democratic Party, the Local Council of Belkas City, the Local Council of the Basandeila Village, the local water supply company, NGOs located in Dakahlia Governorate and other local leaders.

The following paragraphs describe in more detail the outcomes of this last evaluation step, elaborating on issues relating to: (a) industrial pollution prevention and control, (b) approaches towards water saving, and (c) ways of enhancing public participation and involvement in decision-making.

Industrial pollution prevention and control

Water quality degradation issues in the Dakahlia Governorate, but also throughout Egypt, are linked to excessive pollution loads of agricultural and industrial origin. Although industry is not considered the primary water pollution source in the area of interest, relevant issues receive significant attention by the majority of local stakeholders. It is generally perceived that there is need to enhance the weight given to environmental protection, by enabling industries to comply with the pertinent legislation, whereas at the same time efforts should also be made for developing the capacity required for enforcing the relevant legislation, without compromising wider socio-economic interests.

In this regard, the last evaluation step concerned ways through which the industrial sector could be incentivized towards cleaner production practices. Furthermore, questions set forth to the different decision-makers and user groups also concerned possibilities and impacts relating to the introduction of tighter effluent standards, taking into account both the technical, but also the economic and managerial capacity of the industrial sector. Results are portrayed in Figure 32.

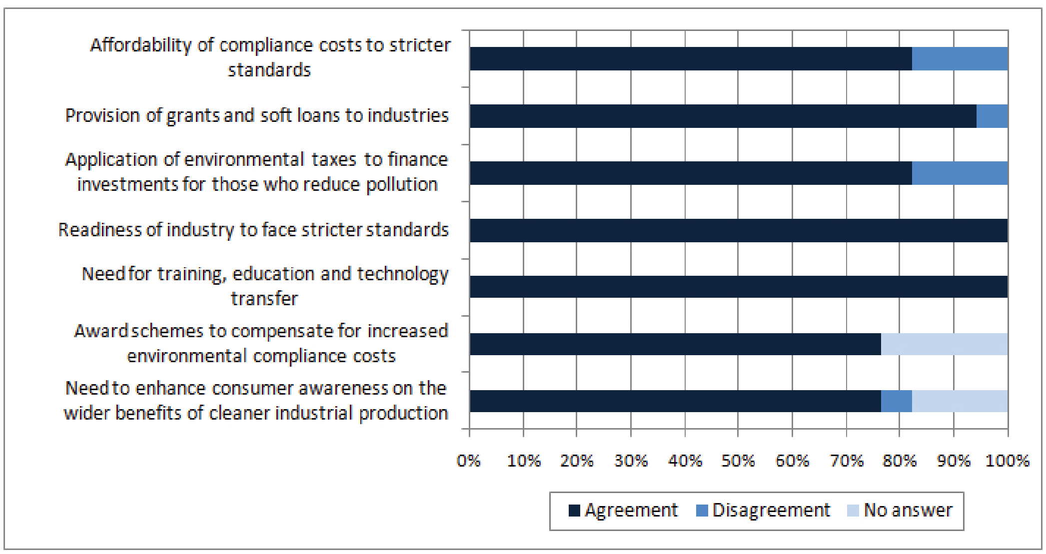


Figure 32: Stakeholder views on alternative approaches to foster improved environmental performance in the industrial sector

The majority (almost 82%) of respondents considers that tighter effluent standards would be affordable by the majority of industries, and that the capacity exists for their implementation. However, forms of financial assistance, as well as other means of support (e.g. training programmes, managerial support) are perceived important, in order to facilitate compliance and at the same time safeguard the competitiveness of the industrial sector, especially with regard to SMEs and public industries. The application of dedicated environmental taxes is also perceived as an appropriate mechanism for raising the funds required for the provision of grants and subsidies to aid those who invest in pollution reduction.

The implementation of award schemes to signal efforts for improved environmental performance to society are perceived as equally important. However, and despite the considerable efforts undertaken in the past few years, it is also underlined that there is need to invest in raising societal awareness on the wider benefits of cleaner industrial production, stressing also the role of mass media, primary education and civil organizations in the endeavour.

The effective implementation of command-and-control regulatory approaches for discharge into water streams or onto land is being advocated as a priority solution for mitigating different causes contributing to water quality deterioration in the in the Bahr Basandeila area. Questions set forth to the different groups were aimed at collecting views on the:

- Feasibility ,applicability and effectiveness of regulatory approaches to industrial pollution;
- Empowerment and political willingness of State authorities to strictly enforce the pertinent legislation, despite potential socio-economic impacts;
- Compensation for environmental damage through the setting of relevant environmental taxes and charges, and ways through which these could be defined ;
- Development of collective schemes for wastewater treatment for the industrial sector, so as to prevent individual discharges, examining also ways through which the costs for the development of such schemes could be recovered.

Responses on the above issues are presented in Figure 33.

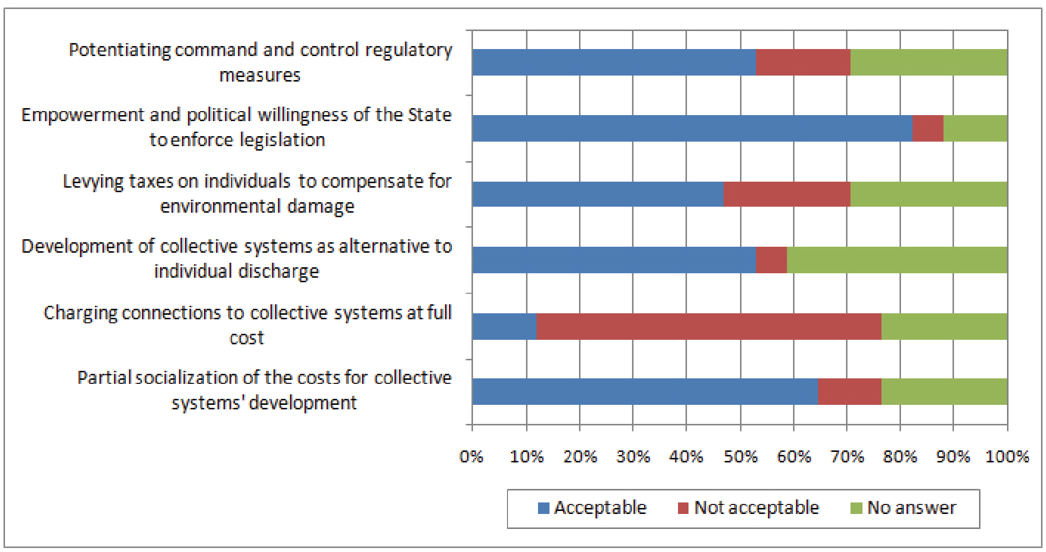


Figure 33: Stakeholder views on alternative approaches to regulating discharges

Most stakeholders (53%) support the implementation of command-and-control measures, as an effective way to environmental protection. The vast majority further underlines the capacity and willingness of the State to develop and implement such approaches. Rather reluctant support is provided to taxes as means of compensating for environmental damage incurred by specific activities: stakeholders consider that this would require an in-depth assessment of the current situation and it would probably incur significant economic burden to low-income groups and activities.

Overall, the alternative of developing collective schemes for industrial (and domestic) wastewater treatment is accepted by most stakeholders. It is also considered that the costs for the development of these schemes need to be partially socialized, as this would provide incentives to individual users to join and maintain affordability. On the other hand, few stakeholders (20%) consider that it would not be socially equitable to subsidize the development of these schemes, and that connections need in several cases to be charged at full cost, particularly in the case of high-income industries.

As also outlined above, the introduction of special-purpose environmental taxes receives some support (Figure 34). Despite the significant objections, stakeholders perceive that water users could reach agreement on the appropriate level of these taxes through participatory processes.

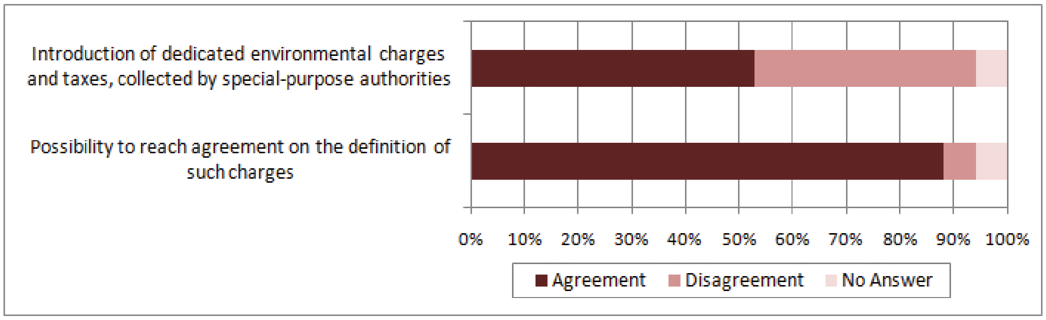


Figure 34: Stakeholder views on environmental taxation

The mitigation of industrial pollution issues faced at local level could be effected through the relocation and/or the phasing out of specific, low-value and highly polluting industrial activities. Appropriate incentives could entail the offer of compensation or other forms of financial aid. On the other hand, a potential increase of water and pollution charges could be put into practice, so that high-value uses can continue while low-value ones will give up or urged to relocate.

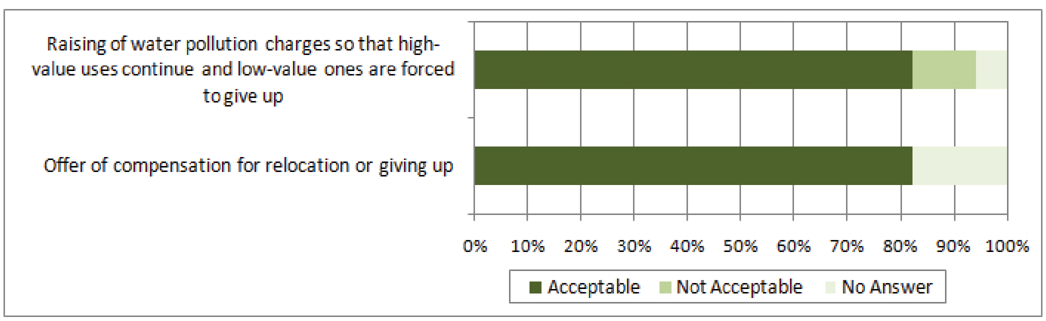


Figure 35: Stakeholder views on alternative approaches towards relocation and phasing-out of water uses

Both alternatives are viewed equally positively by the interviewed stakeholders, implying that potential policies could employ both approaches to effectively incentivize water users. However, and in accordance to responses received to similar questions, the raising of water or pollution charges for specific industrial activities also receives some opposition, due to socio-economic concerns and reluctance towards potential incentives that could be offered through water pricing policies.

Incentives for water saving

Means employed for providing incentives towards the adoption of improved water use practices could involve: (a) the reinforcement of the incentive function of water tariffs, e.g. through the enhanced application of volumetric charges; (b) the development of financing mechanisms for providing aid to those who decide to invest in water saving, as well as (c) the establishment of mandatory technology standards for new buildings and irrigation projects. Stakeholder responses to these alternative policy approaches are presented in Figure 36.

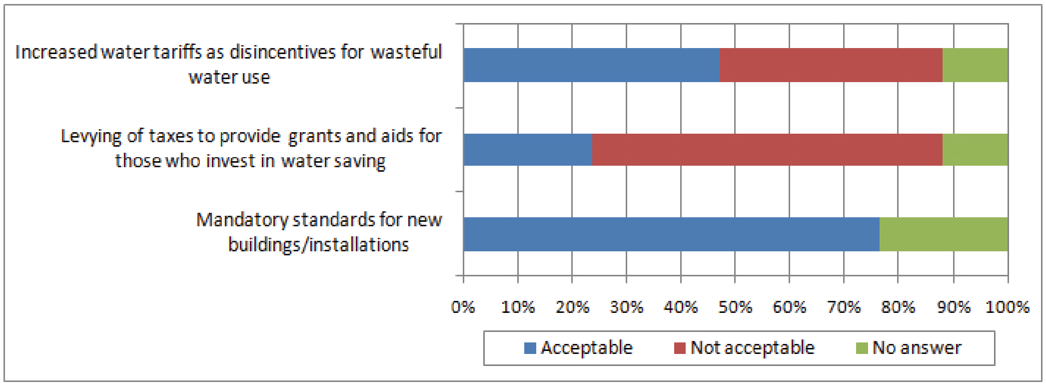


Figure 36: Stakeholder views on mechanisms to provide incentives for water saving

Results indicate that there is controversy concerning potential pricing policies for water conservation: 40% of respondents consider unacceptable an increase of water tariffs justified solely by the need to provide disincentives for wasteful water use. Similarly, the levying of dedicated taxes, to generate the funds required for providing financial aid for water saving investments is not accepted, as it is broadly considered that it would significantly impact on low-income users. On the other hand, the enforcement of water saving standards, at least for new buildings or irrigation projects is largely accepted. However, in this case, several consulted parties question the effectiveness of this approach, as it would require introduction of relevant standards and strong regulatory capacity.

Public participation and stakeholder involvement

During the past years, significant efforts have been invested in building the capacity required to enhance the involvement of water users in infrastructure management and in decision-making. As presented in several parts of this report, the creation of Water Users Associations is gradually progressing in several areas, whereas awareness campaigning and citizen mobilization for the protection of water resources are gaining momentum. In this context, questions set forth to interviewed stakeholders were aimed at assessing:

(a) Perceptions of users on public participation and joint decision-making;
(b) Ways through which water users could be further involved;
(c) Willingness of decision-makers to consider the outcomes of participatory planning processes.
(d) Actual accessibility to information on water management issues of common interest.
(e) Impartiality and objectivity of decisions taken, as decisions could often be perceived as being subject to political pressure from specific user groups.

Responses on points (c) and (e) are presented in Figure 37.

Overall, public participation is broadly supported, with all stakeholders underlining its importance for sustainable water management and reinforcement of civic responsibility and engagement. Stakeholders stress the need to further involve user associations and local authorities in decision-making processes, to share information on planned projects and reinforcing public education initiatives, through training and the mass media. Despite the above, there is some reluctance on whether the outcomes of participatory planning would be considered by traditional decision-makers, whereas there is also belief that the interests of some stakeholder groups receive more weight than those of others in the decision-making process.

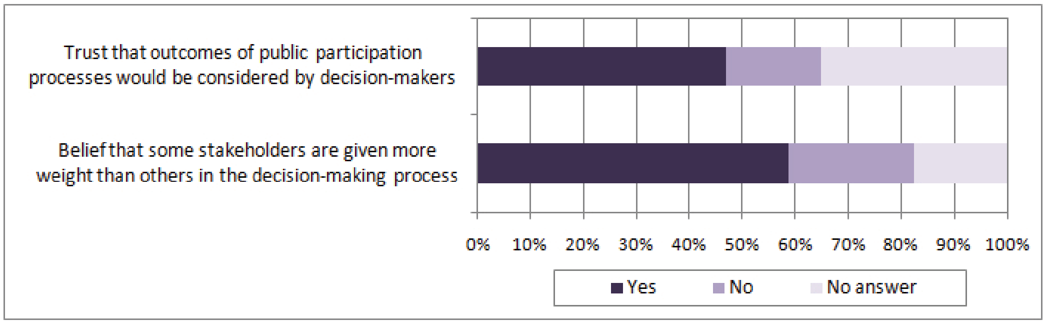


Figure 37: Stakeholder views on major inhibiting factors to public participation

Further to the above, and in line with current broader national policy objectives, stakeholders underline the need for: (a) training of users and user associations on new technologies; (b) organization of intensive awareness campaigns and fostering of public education initiatives and (c) cooperation with public authorities for demonstrating and implementing sustainable solutions in the agricultural, domestic and industrial sectors.

CONCLUDING REMARKS

The statement of the Greek historian Herodotus that "Egypt is the gift of the Nile" is still true, even though 3000 years have passed since then. However, the future availability of water resources in Egypt remains highly uncertain, and projections for the next 30 years reflect factors most uncertain and important, such as population growth, economic development patterns and climate change impacts on water availability. Currently, the country uses 120% of its renewable water resources, meaning that 20% of freshwater supply is recycled and used several times. Along the same line, the main directions of the medium-term 2022 National Water Management Strategy comprise:

- The recycling of agricultural drainage waters and their further use for irrigation purposes, with strict quality control to reduce risks for the degradation of agricultural lands;
- The use of shallow groundwater tables for irrigation;
- The exploitation of the Nubian Aquifer for reclaiming lands in isolated areas;
- The modernization of irrigation methods to reduce water use by 50%;
- The change of cropping patterns to cope with reduced water availability, an issue that is currently researched by institutes undertaking agricultural research.

As evident, the implementation of this strategy requires the in-depth assessment of water quality problems, as these impact both on potential recycling projects and on the quality of groundwater extracted from shallow groundwater tables. In this regard, the INECO Egypt Case Study was oriented at analysing water quality degradation issues at the appropriate, micro-level, focusing on problems experienced in the Bahr Basandeila Canal. The problems of the area, in terms of canal water quality and water service provision, are considered representative of many similar situations experienced in areas located at the end of irrigation canals and semi-urban agglomerations.

The articulation of the INECO process in the area, which involved extensive awareness campaigning and organisation of a total of 8 stakeholder events during the 3-year course of the project, managed to mobilise both local and regional authorities, research institutes, user and social groups for discussing water management problems, deficiencies of current policies and potential courses of action.

The main outcomes of the Case Study, stemming from the outcomes of this participatory process and surveys undertaken in the area underline the pertinence of strict enforcement of the environmental law, and of the development of an Integrated Water Management plan addressing also the problems and needs of the local society. To that end, programmes need to be established for enhancing coordination and cooperation among the different institutions dealing with water management and use issues but also for strengthening awareness and participatory processes at local level, and ensuring representation of the interests of rural societies at higher decision-making levels.

INDICATORS FOR THE BAHR BASANDEILA REGION

General data (profile)	Total population: around 45,000 inhabitants
	Population growth rate: around 1.8% (overall estimate for Egypt)
	Major industries discharging to the Bahr Basandeila Canal : • Delta Company for Fertilizer and Chemical Industries (in Talkha) • Food processing industries in Aga • Textile industries (Mehala El Kobra) • Wood Industry in Dakahlia • Oil and soap industry in Mansoura • Abu Quir – El-Tabia region (gas production, shipyard, cotton mill, rayon fiber plant, paper and cardboard, fertilizers, food canning, dying materials), • Kafr El-Dawar (textiles, chemicals and dying materials)
	Total agricultural area: 5524 feddans
Access to water services	Access to safe drinking water: 65% of population
	Drinking treatment capacity as % of total surface water supply: 80%
	Population receiving water supply service: 90%
	Sewerage network coverage (indicative, as illegal houses cannot connect to the sewerage network): % Population served by sewerage network: 84% % Population served by septic tanks: 15% % Population served by open drains: 1%
	Wastewater treatment coverage: 27% Peak volume of wastewater produced (m^3/d)/Total capacity of wastewater facilities (m^3/d) x100%: 364%
	Health incidents linked to inadequate water treatment and lack of sanitation: 4 outbreaks in 2007 mainly in the summer where each outbreak corresponded to more than 200 cases (typhoid, diarrhea and gastroenteritis)
	Withdrawal of groundwater for potable water supply: 20%
Cost recovery	Cost per sewerage connection (average for Egypt): 2150x106 EL/840,000 connection
	% Cost recovery for sewage collection and wastewater treatment services: 37.5%
	%Cost recovery for potable water supply: 43%
Monitoring	Number of tests of treated water, performed during a year and complying with the applicable standards and legislation/Total number of tests: 80%
Participation	Percentage of decisions (%) taken by authorities with stakeholder involvement (national average): 30%