Water Quality Management in the Nile Delta, Egypt

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1. Background
1.1 Egypt

**Location:** Northeastern Africa

**Surface Area:** 1,000,000 km² (only 4% is inhabited)

**Population:** 85x10⁶ (1.64% increase/yr)

**Cultivated Area:** 3.276 Mha (3.15% of the gross area)

**Main Water Source:** The River Nile (1545 km including the two branches)

**Per Capita Share of Water =** 650 m³

**Per Capita Share of Agricultural Lands =** 0.05 ha
1.2 Water Resources

Water Resources

1) The River Nile (55.5 BCM/yr)
2) Rainfall and flash floods (about 2 BCM/yr)
3) Groundwater in Sinai and western deserts (2 BCM/yr)
4) Non-conventional water resources
   - Desalination of sea water (cost 1 m$^3 \approx 7$ LE)
   - Use of brackish water
   - Reuse of drainage water (5 BCM/yr)
   - Treated sewage effluent (0.7 BCM/yr)

Agricultural Practices

- Two or three crops each year
- Reduction of much water-consuming crops like sugar cane and rice
- Establish suitable cropping patterns and crop rotation
- Extend cultivated area by horizontal land expansion for $\approx 1.75$ MHa by the year 2017
Functions of the water Resources

- Irrigation in agriculture
- Drinking water (production)
- Domestic uses (laundry, washing, bathing, washing, food preparation, etc.)
- Industries (cooling, manufacture, dyeing, etc.)
- Transport, navigation and disposal
- Fisheries and aquaculture
- Recreation and nature development
- Evaporation
1.3 Water availability/capita
### 1.4 Water Supply 1997 and 2017 (NWRP, 2005)

<table>
<thead>
<tr>
<th>Water Resource</th>
<th>Water Supply (BCM/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1997</td>
</tr>
<tr>
<td>Nile Water</td>
<td>55.5</td>
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<tr>
<td>Jonglie Canal Project, Phase (1)</td>
<td>--</td>
</tr>
<tr>
<td>Groundwater in the Nile Valley and Delta</td>
<td>4.8</td>
</tr>
<tr>
<td>Reuse of drainage water in Nile Delta</td>
<td>4.4</td>
</tr>
<tr>
<td>Reduced fresh water to the sea</td>
<td>0.2</td>
</tr>
<tr>
<td>Shifts in the cropping patterns</td>
<td>---</td>
</tr>
<tr>
<td>Irrigation improvement savings</td>
<td>0.2</td>
</tr>
<tr>
<td>Deep groundwater in desert aquifers</td>
<td>0.6</td>
</tr>
<tr>
<td>Treated wastewater</td>
<td>0.2</td>
</tr>
<tr>
<td>Rainfall harvesting</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>66.9</strong></td>
</tr>
</tbody>
</table>
## Water Demands for the Years 1997 and 2017

<table>
<thead>
<tr>
<th>Sector</th>
<th>Water Demand (BCM/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1997</td>
</tr>
<tr>
<td>Agriculture</td>
<td>52.1</td>
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<tr>
<td>Evaporation losses from the Nile and canals</td>
<td>2.1</td>
</tr>
<tr>
<td>Municipal uses</td>
<td>4.5</td>
</tr>
<tr>
<td>Industrial uses</td>
<td>7.4</td>
</tr>
<tr>
<td>Navigation</td>
<td>0.2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>66.3</td>
</tr>
</tbody>
</table>
2. Ministry of Water Resources & Irrigation Responsibilities

- How to develop and manage Egypt’s water resources to face the increased demands of different sectors

- Strategy
  - Develop additional water resources
  - Better use of existing resources
  - Protecting water from pollution & save environment
  - Strengthen communication with Nilotic countries
2.1 Irrigation & Drainage Systems

- Water distribution through the Nile system (55.5 BCM/yr)
- Irrigation Canal length: 37000 Km (most of these canals are major sources for drinking water)
- Drains length: 29,000 km
- Open or subsurface drainage systems covers all the agricultural land
Schematic of Responsibility Borders for Egypt’s Irrigation System

- Mediterranean Sea
- Rosette Nile Branch
- Damietta Nile Branch
- Irrigation Directorate
- Field
- Quaternary Canal
- Saqia or Pump
- Tertiary Canal (Mesqa)
- Farmers’ Responsibility
- 2nd, 3rd, 4th order Branch Canals
- Principal/ Main Canal
- General Directorate for Water Distribution
- Barrage/ Head Regulator
- Aswan High Dam
2.2 What are the challenges (Quantity and Quality)?

- Limited Water Resources
- Population increase (about 85 M in 2014, with 1.64% yearly change)
- Limited cultivated areas (8.5 M Fed/2007, add more 3.4 MFed./2017)
- Human intervention and Water pollution
- Institutional and Policy issues
3. Water Quality Challenges & Issues
3.1 Water Pollution

Sources and types of pollutants
(Mainly due to human intervention)

• **Domestic**
  Municipal and rural domestic wastewater which contain pathogens, detergents, and oxygen demanding materials

• **Agriculture**
  Agrochemical residues and metabolites: e.g. fertilizers (N &P), pesticides (herbicides, insecticides, rodenticides, etc.), drainage water reuse

• **Industries**
  Organic and inorganic substances. (e.g. heavy metals, bleaching agents, nutrients, trace metals, suspended solids, salts, etc.)
Sources of Surface Water Pollution

- Illegal polluting practices (e.g. dumping garbage)
- The riverine fleet (9000 units)
- Agricultural activities
- Domestic sewage effluent
- Industry disposals

Water Pollution

Agro-chemicals
Industrial effluent to the river Nile
Industrial effluent to the river Nile
Industrial effluent to the river Nile
Electric Power Stations use water for cooling: discharge of high temperature water affects the ecosystem
Tourism

- 357 floating and moveable boats + 400 commercial + only 42 sludge receiving sides
- Source: EEAA minister presentation
Fish cages
Bathing and Washing in Streams
Drainage Water Reuse

- Upstream from Cairo all drainage water returns to the Nile. There are 72 drains on both sides of the river which discharge water into Nile by gravity, or to the lower reaches through pumping.

- In the Delta, some drainage water is pumped into irrigation canals where it mixes with fresh water for further downstream use.
Drainage Water Quality

- Drainage is mainly designed to receive land drainage water
- But, due to dumping domestic and industrial waste effluent, and due to leaching of pesticides and fertilizers from agriculture land, drains became polluted
3.2 Policy and Institutional Issues(1)

Involved Institutions

- MWRI: M. of Water Resources and Irrigation
- MALR: M. of Agriculture and Land Reclamation
- MHUUD: M. of Housing, Utilities and Urban Development
- MOI: M. of Industry
- MHP: M. of Health and Population
- MSEA: M. of State for Environmental Affairs
- MEE: M. of Electricity and Energy
- MLD: M. of Local Development
- MOTR: M. of Transportation
- MOT: M. of Tourism
- MOI: M. of Interior
Legislative framework

Water quality management

Legal aspects

Laws
MoHUNC (Law 93-1962)
MWRI (Law 48-1982)
EEAA (Law 4-1994)

Standards
Inland water MWRI
Drinking water MoHP
Coastal water EEAA

Enforcement
MWRI/Min. of Interior
EEAA / Water Police

Monitoring

Ambient water
Inland: NWRC and EHD
Coastal: EEAA
NRC/NIOF (spec.projects)

Effluents
Compliance: MoHP

Pollution control

Prevention
agro-chemicals MALR
licencing MWRI
env.action plan EEAA

Treatment
Municipal: NOPWASD/GOSD/AGOSD/Governorates/ORDEV
Industrial: GOFI/facilities

Distribution/Reuse
MWRI
## Overlapping Responsibilities

### Ministries and organizations responsible for water quality management in Egypt

<table>
<thead>
<tr>
<th>Ministry/Organization</th>
<th>Responsibilities</th>
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<tbody>
<tr>
<td>Ministry of Water Resources &amp; Irrigation (MWRI)</td>
<td></td>
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<tr>
<td>Ministry of Health (MOHP)</td>
<td></td>
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<tr>
<td>Ministry of Environment (MOE)</td>
<td></td>
</tr>
<tr>
<td>Ministry of Housing &amp; New Communities (MHNC)</td>
<td></td>
</tr>
<tr>
<td>Ministry of Industry (MOI)</td>
<td></td>
</tr>
<tr>
<td>Ministry of Interior (MI)</td>
<td></td>
</tr>
<tr>
<td>Ministry of Agriculture (MOA)</td>
<td></td>
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<tr>
<td>Ministry of Local Development</td>
<td></td>
</tr>
<tr>
<td>Ministry of Scientific Research</td>
<td></td>
</tr>
<tr>
<td>Irrigation Department</td>
<td>Monitoring</td>
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<tr>
<td>Water Research Center</td>
<td>Monitoring</td>
</tr>
<tr>
<td>Environmental Health Department</td>
<td>Monitoring</td>
</tr>
<tr>
<td>Central Laboratories</td>
<td>Monitoring</td>
</tr>
<tr>
<td>Environmental and Occupational Health Center</td>
<td>Compliance</td>
</tr>
<tr>
<td>Law 4/94, Monitoring coastal, standards, coastal preservation: action plan</td>
<td></td>
</tr>
<tr>
<td>National Organization for Potable Water &amp; Sanitary Drainage (NOPWASD)</td>
<td>Treatment</td>
</tr>
<tr>
<td>General Organization for Industrialization (GOFI)</td>
<td></td>
</tr>
<tr>
<td>Water Bodies Police</td>
<td></td>
</tr>
<tr>
<td>Agricultural Research Center</td>
<td>Monitoring, Studies</td>
</tr>
<tr>
<td>Organization for Restructure &amp; Development of Egyptian Villages</td>
<td>Monitoring, Researches</td>
</tr>
<tr>
<td>Academy of Science National Research Center</td>
<td></td>
</tr>
</tbody>
</table>
3.2 Policy and Institutional Issues (2)

- WQM in Egypt is a complex problem with large economic components
- Lack of a policy integral approach which takes into accounts the WQ priorities and apply standards according to the use of water
- There is no joint strategy or action plan that coordinates between different tasks of the involved ministries and institutions (overlapping between responsibilities)
- Legislation & enforcement (We have but..)
  (Standards, responsibilities, enforcement, reality, ...... horizon)
3.2 Policy and Institutional Issues

- Insufficient awareness for water users and polluters
- Different disciplines are required
- There are gaps between:
  - Policy preparation
  - Research objectives/outputs
  - Implementation procedures in reality
- Data availability and exchange of information are difficult
- Many stakeholders are involved, no central body to communicate with stakeholders
3.3 Water Quality Situation
Water Quality Evaluation

Seven potential water quality variables are used as evaluation indicators. They are evaluated in terms of their effect on public health, agriculture and the environment.

- Pathogens, parasites and viruses (E. Coli)
- Nutrients (nitrates, phosphorus)
- Trace metals (Hg, Cd, Pb, etc…)
- Salinity and physical properties (SAR, salinity)
- Oil, grease and petrochemicals, hydrocarbons
- Pesticides (e.g., organo-chlorine compounds)
- Oxygen consumption (BOD and COD)
Findings

• Water quality hazards gradually increase downstream (Upper Egypt to the northern Delta)
• The environment was rated as most affected in all regions except Upper Egypt
• Agriculture was rated as least affected, followed by health
• Pathogens generally have the highest scores in all regions, followed by trace metals (target organ-bioaccumulation)
• Pesticides still limited, oil and grease scores are similar for most regions
The River Nile

- Still considered a relatively clean river because:
  - Pollutant loads are diluted through high water discharges
  - The self cleaning capacity of the river seems adequate to manage pollution problems on most occasions
Groundwater Quality

- GW quality in the Nile system (Still fairly good; used directly for drinking)
- WQ in the Nile Delta is better than in the Nile valley
- Few wells have salinity problems (brackish in northern Delta)
- Major problem is dissolution of iron and manganese from sedimentary formations
4. MWRI Activities and Efforts
4.1 National Water Quality Monitoring Program

Water quality data are collected through:

- Intensive monitoring program which currently comprises 245 locations for surface water and 188 locations for groundwater
- More than 34 variables are regularly analyzed in the Central Laboratory for Environmental Quality Monitoring (CLEQM/NWRC)
- Data analysis, interpretation, and coordination are presented in a yearly book
245 monitoring locations
4.2 Policy and Strategy Level

- Formulated the National Water Policy (2007 - 2017) to face the challenges of water scarcity and water quality
- Draft water quality and pollution control priorities and strategies
- Identified the national protection measures for the agricultural sector, municipal sector, industrial sector, and navigation sector
- Reconsider the reuse mixing policy
- Identified the required budget for NWRP (145 MLE)
- Formulated the National Water Council headed by the Prime Minister
- Start implementing NWRP
4.3 Institutional Level (1)

- Water user organizations at various levels
  - Participation in water quantity & quality management

- Integrated districts/irrigation, drainage, groundwater, etc...
  - Integration and decentralization of water management system

- Actively participate in adjusting Law 48
  - A lot of emphasis on the POLLUTER PAYS Principle which has been accepted by the government
(4.3) Institutional Level (2)

- **Institutional Reform Unit**
  - Reform & restructure MWRI towards IWRM
- **The Water Quality Management Unit**
- **The National Water Awareness Strategy**

**Tools:**

- **Water Communication Unit**
  - Increase public awareness about the need to protect water resources and water quality
- **Egyptian Water Partnership**
  - Information platform for water issues
  - Promote IWRM through partnership among various stakeholders
4.4 The Advisory Panel on Water Management/APP(1)

• The project started in 1975 to provide technical advices on land drainage. Throughout these years, APP has been developed from technical advice orientation into policy and institutional aspects.

• The main objective of APP is: to assist, in an advisory capacity, the MWRI in carrying out its responsibilities towards managing the quantity and quality of Egypt’s fresh water resources more efficiently and effectively.

• Panel Structure
4.4 The Advisory Panel on Water Management/APP(2)

- Organized a task force to draft the water quality and pollution control priorities and strategies
- Addressed a note to the cabinet explaining the situation of water quality and offering to strengthen the cooperation with other ministries
- Actively participate in adjusting law 48
- Put a lot of emphasis on the term **POLLUTER PAYS** principle which has been accepted by the Government
- Addressed a note to the cabinet on how to cope with future water scarcity
- Prepared a note on water: Key to prosperity and Stability
4.4 The Advisory Panel on Water Management/APP(3)

- **Establish the Egyptian Water Partnership/EWP** *(informal platform to discuss water issues and policies, exchange information and start joint activities between different stakeholders)*
- **Establish the MWRI Institutional Reform Unit** *(Restructure to IWRM, decentralization, reforming)*
- **Establish the Water Boards** *(Participation at various levels, Water Quality Management)*
- **Initiate the NWRP project** *(Future strategy, plans, water management, implementation process)*
- **Establish the Water Quality Management Unit (WQMU)** to serve as a focal point for coordination at MWRI level and other concerned Ministries
- **Mission on Water awareness program**
4.5 Water Quality Management Unit(1)

- Policy preparation (in co-ordination with all stakeholders, while using a.o. results of researches.
- Policy implementation (action plan, allocating budget, etc.)
- Recruiting legislation and enforcement
- Preparing and executing a national integrated monitoring network inclusive the dissemination of its results to all parties concerned
4.5 Water Quality Management Unit (2)

- Providing information and methods of communication between different stakeholders (to enlarge awareness, disseminate knowledge and prevent misuse of water)

- Guiding the different research programs of the research institutes to cope with the ministry requirements. This should be after close dialogue with the concerned parties

- Developing a mechanism of interaction between information and research procedures as well as information and research users

- Advocating co-operation and collaboration between different projects and the Ministry (NWRP, NAWQAM, WBP, etc...)
5. Conclusion

- Egypt has limited water resources and is facing water scarcity problems.

- Pollution reduction actions are the responsibility of more than one ministry. Overall coordination of country programmers is the primary requirement for success.

- The limited available budget for water quality management requires careful analysis of the priorities which must be identified.

- According to the NWRP, water quality problems could be solved by 2017.
6. Lessons Learned(1)

- Water quality management is a very long process and requires cooperation between various institutions and disciplines.
- Public awareness is part of the process, (a national awareness program should be developed).
- WQM is not one ministry’s problem.
- The role of the private sector and NGOs is essential.
6. Lesson Learned (2)

- Need to involve politicians in water issues debate
- Need to get water high on the Agenda of all decision makers
- A National Water Quality Protection plan should be developed which need cooperation and effective ways of communications at all levels
7. Required Actions

- Prevention and/or reduction of domestic, agricultural and industrial waste generation;
- Treatment of those wastes that cannot (yet) be prevented;
- Control of those wastes that cannot (yet) be treated (and which can also be prevented) so that least harm done;
- Draw a general strategy in the form of a package of fundamental (long term, problem solving) measures like adjustments of legislative framework, determination of functional use of for each type of water body and priorities;
- Draw intermediate (temporary) actions like controlled reuse of drainage (and domestic wastes) water and identification of alternatives for reuse.
THANK YOU