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in

Lamaddalena N. (ed.).
Annual Meeting of the Mediterranean Network on Collective Irrigation Systems (CIS_Net)

Bari : CIHEAM
Options Méditerranéennes : Série B. Etudes et Recherches; n. 31

2000
pages 33-44

IRRIGATION IN EGYPT AND ROLE OF NATIONAL WATER RESEARCH CENTER

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1- Introduction

Rainfall is scarce in Egypt, even the small amount which normally occurs over the Delta comes during the winter when crop demands are low. Consequently, the nation's farmlands are and have been since an immemorial time, almost entirely dependent on irrigation from the Nile River. These farmlands include approximately 6 million feddans of alluvial soil along the Nile and in the Delta, They are so-called " old lands''. Some additional land has been and is being reclaimed from the bordering

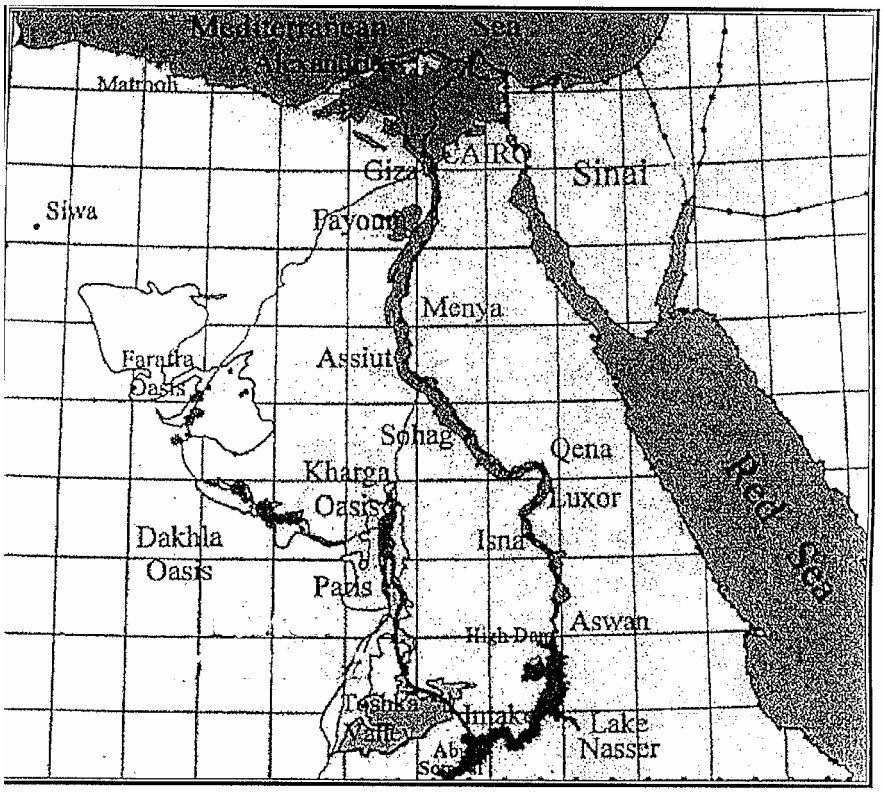

Fig. 1 Map of Egypt

[1] Secretary General of National Water Research Center in Cairo-Egypt.

desert, the tidelands along the northern coast, in Sinai and in south of Egypt, Figure (1).

The last century witnessed a radical change in Egyptian irrigation methods. The ancient system of basin irrigation and cultivation of one crop per year, which prevailed since the dawn of civilization, has been superseded by perennial irrigation. Due to the construction of many control structures, including the High Aswan Dam, water is now available for a year-round crop cultivation.

Perennial irrigation has provided new opportunities for more intensive crop production, but at the same time, it has generated new problems. The use of more water on a relatively fixed area of land has caused waterlogging, buildup of salts in the soil and excessively high water tables in various farming areas.

Management of the delivery and drainage systems has become more difficult under conditions of year-round irrigation and changes in cropping patterns. The challenge is to minimize or solve these problems while fully exploiting the new opportunities for the benefit of the nation.

2- Irrigation systems in Egypt

The High Aswan Dam presently ensures Egypt's annual quota of 55.5 milliard cubic meters of water for irrigation and other purposes. The discharge of water from the High Aswan Dam is under full control. The release of water for irrigation is adjusted throughout the year to provide all agricultural areas with sufficient water for crops needs. Distributary canal cross sections are designed to serve command areas according to specified water duties. Mesqas (private canals) are served from the distributary canals which are on a two or three – turn rotation. The time interval between the periods when water is turned off and when it is later turned on depends on the cropping patterns and the seasonal climatic conditions.

The on – days of a canal rotation are considered 24 hour periods (starting at sundown) without any adjustments between daytime and nightime use. The number of on-days in a turn is sometimes modified

to meet farmers' requests for more irrigation water.

The water supply for any given area is monitored by observing water surface levels in delivery canals. The water is typically delivered from 50 to 75 cm below the ground surface of the fields, so irrigators must lift the water onto the land. Delivery canals are closed for approximately one month during the winter to permit maintenance and construction of structures. In general, the winter closure is preceded and followed by a general irrigation for ten days.

Farmers are not required to pay for water. Its use along the mesqa is determined by custom, which usually favors the farmers at the head of the mesqa. Similarly, mesqas at the head of a distributary canal have an advantage over those at the tail end.

After lifting water from the mesqa, a farmer is free to distribute over his fields by his own methods. Generally, he distributes the water through a marwa (filed ditch) to small bunded units called basins. The surface of the fields may be furrowed for row crops or smoothed for basin crops. Excess surface water may be drained – off into open field drains or, in some cases, back into the mesqa.

The best environment for crop production is achieved when the plants' root zones are kept adequately moist. Either inadequate or excess water in the root zone causes plant stress and reduces yields. Good irrigation management should maintain optimum root zone moisture conditions without using excessive water. Poor irrigation management wastes water, sometimes wastes plant nutrients, contributes to potentially harmful high water table conditions, and tends to overload drains. It may also waste labor and energy required for lifting excess water to the fields and from the drains.

Good on-farm water management requires levelled fields, appropriately designed on-farm distribution systems, and knowledge of when to irrigate and how much water to apply. It also requires a dependable source of water, available when needed, in quantity and quality which can be distributed efficiently over the farmer's field. Consequently, there must be close communication and interaction among all farmers served by a mesqa and with the district

irrigation engineer who regulates the water, upstream from the mesqa intakes.

The potential for achieving benefits from better water management is substantial. Approximately half of the water resources available are presently required for evapotranspiration by crops. Of the remainder, most is lost from the system in the delivery process through seepage, evaporation, and flow –through. Some , of course, must be allocated for domestic, industrial and navigation uses. Any measure which conserves water and reduces losses provides an opportunity for increased agricultural production through horizontal expansion as well as reducing drainage costs.

3 - Irrigation Practices

3.1 - Traditional System

Egyptian farmers have traditionally irrigated by dividing their field into small basins of not more than 10m x 10m served by a within-field marwa. These basins provided the farmer with fairly good water control and allowed application of fairly uniform amounts of water even when fields were somewhat unlevelled. The small basins with internal marwas also allowed surface drainage when the soil sealed. However, these basins hindered mechanization, particularly operations of large four-wheel type tractors commonly used in Egypt.

The lifting of water at the farm level was usually done by animal-powered saqias, hand-operated tambours and increasingly by diesel-powered pumps.

The farmers frequently had prolonged "irrigation gaps" between the last irrigation of one crop and the first irrigation of the next. The duration of the irrigation gaps depended on the two crops involved. Even though these irrigation gaps were prolonged, the individual crops received appropriate final and initial irrigations when viewed separately. The irrigation gaps represented periods of general decline in the irrigation demand, even though crop consumptive use and potential evapotranspiration remained relatively high. When large volumes of water are released during these periods, much of the water flowed through the system was discharged directly from mesqas into the drains. Irrigation planning,

therefore, had to be based on the entire cropping pattern rather than individual crops.

4. The Distribution of Waters

The system of water distribution from the High Dam lake to meet the water requirements through out the year for different agricultures, in old and reclaimed lands is not as easy as someone expects. It is a matter of high sophistication in which many integrated and joint factors participate due to the varying soil characteristics, whether natural or chemical, weather conditions, crop water requirements in fluctuation levels, irrigation system used, method of cultivation , and the difference in groundwater levels, in addition to the natural , ecological, social and other aspects.

This can not be performed except through the management and operation of a great number of structures to ensure the control and the distribution of water according to the actual water requirements throughout the country.

4.1 Characteristics of the water Delivery system

The Nile River is the main source of Irrigation water in Egypt . This water is delivered to farms through an extensive system of channels. The delivery system, which contains some large canals discharging up to 1000m^3/sec, has a combined length of 30,300 km. Canals are classified according to size and functions as follows :

1 Principal canals receive water directly from the Nile River for conveyance to main canals. No direct irrigation from these canals is permitted.

2 Main canals receive water from principal canals for conveyance to branch canals. (Some main canals may take water directly from the Nile River). No direct irrigation from main canals is permitted.

3 Branch canals receive water from the main canals for conveyance to Distributary canals. Direct irrigation is permitted along the lower reaches of these canals, where they are comparable in size to a Distributary canal.

4 Distributary canals receive water from branch canals for distribution to mesqas. Direct irrigation along all distributary canal banks is permitted through legal farm outlets. Rotations are normally applied at this level.

5 Private ditches (mesqas) receive water from Distributary canals for distribution to marwas or directly to basins and / or furrows on private farms.

To control the proportional distribution of water to the canals, seven main barrages have been built on the Nile River. These main control structures are at Aswan, Esna, Nagga Hammadi, Asyut, Delta, Zifta and Edfina. Additional structures in the delivery system include:

Type of structure	*Number*
Intake regulators	5623
Head regulators	2887
Weirs	162
Tail Escapes	1761
Spillways	153
Bridges	9955
Crossing Works	567

4.2 Drainage system

Public drains in Egypt comprise a system of large open channels having a combined length of 17,497 km. Private drains consisting of small open channels for removal of excess surface water and / or closed tile drains for removal of ground water, convey water to the larger drains. Drains are classified according to function and size as follows:

a Principal drains receive water from main drains mainly by lifting (sometimes by gravity).

b Main drains receive water from branch drains mainly by gravity (sometimes by lifting).

c Branch drains receive water from collector drains.

d Collector drains receive water from field drains.

e Field drains are either small open channels, zawariq, for drainage of surface water from farms, or subsurface tile drains, sometimes called laterals , for drainage of groundwater.

f Principal, main, and branch drains are public drains constructed and maintained by the MPWWR while, collector and field drains are private drains constructed and maintained by farmers.

5. Role of National water Research Center

Since the eighteenth century, the irrigation authorities in Egypt have collected data on the Nile Basin. This enabled investigators to carry out many studies related to the irrigation and to the means of utilizing and developing Egypt's water resources.

Numerous studies and research works were conducted to make the best use of every drop of Nile water and to avoid the crises of flood occurrence.

In an attempt to cope with the rapid worldwide development in the field of water resources management, the Ministry of public works and water Resources (MPWWR) endeavored to upgrade its research units. With this aim in mind, the Ministry requested the establishment of the "Water Research Center", by the Presidential Decree No. 830 issued in 1975.

Owing to the pioneer role of the WRC in solving the unique combination of water resources problems on both national and regional scales during the past two decades, a second Presidential Decree, No. 316, was issued in 1994, by virtue of which the WRC was re-organized as "National water Research center" (NWRC).

5.1 Major objectives of NWRC

The main objectives of NWRC are to :

1. Study, outline and propose long-term policies for managing water resources in Egypt.

2. Solve technical and applied problems associated with general policies for irrigation, drainage and water resources.

3. Carry out investigations and research work connected with the extensions of agricultural lands.

4. Find the means for utilizing the water resources of the country in the most efficient and cost-effective way.

5. Propose measures for environmentally sound development of the irrigation and drainage systems.

5.2 Activities of National Water Research Center

The main activities of NWRC are:

1. Technical consultations advisor to all the governmental agencies and to the private sector in the context of water.

2. Developing skills by high professional training for water resources specialist in Egypt and other countries.

3. Developing information about water resources in Egypt and awareness for water conservation.

4. Develop scientific research for as to increase the capabilities and skills of human resources (NWRC Staff).

5. Going by research from national level to international standards, and participating to the international forums.

6. Transfering and adapting new and special technologies in the area of water resources for the research and the development of national programs.

7. Avoid the imbalance of thinking across all existing research organizations and integrate the efforts in the area of water resources.

5.3. Research Institutes

The variety of water-related problems in Egypt requires specialization in many different fields. The center has therefore established twelve research institutes that read like a list of

problems facing Egypt's irrigation sectors. These are:

1. *Water Management Research Institute (WMRI)*
2. *Drainage Research Institute (DRI).*
3. *Water Resources Research Institute (WRRI).*
4. *Nile Research Institute (NRI).*
5. *Hydraulics Research Institute (HRI).*
6. *Channel Maintenance Research Institute (CMRI).*
7. *Groundwater Research Institute (GRI).*
8. *Construction Research Institute (CRI).*
9. *Mechanical and Electrical Research Institute (MERI).*
10. *Survey Research Institute (SRI).*
11. *Coastal Research Institute (CORI).*
12. *Climate, Water and Environment Research Institute (CWERI).*

1- Water Management Research Institute

The Institutes activities cover the following main topics:

1. Determination of water requirements for crops in different regions.
2. Development of the existing irrigation networks in Egypt.
3. Improvement of irrigation rotations to achieve optimum water distribution.
4. Development of better irrigation methods, improvement of irrigation outlets.
5. Study of evaporation and seepage losses from waterways, lakes and reservoirs.

2- Drainage Research Institute

The main responsibilities of the institute are:

1. Develop and test appropriate methods and technologies for planning, design and implementation of drainage system.
2. Identify the most convenient and economic methods of operation and maintenance of subsurface drainage systems.

3. Develop specifications for drainage material.
4. Determine and evaluate the technical and economic effectiveness of drainage projects.
5. Determine drainage water quantity and quality.
6. Develop criteria and guidelines for reusing drainage water in irrigation.

3- Water Resources Research Institute

The main goals of the institute are:

1. Determination of the amount of water available for development in the Nile basin and in Egypt including Sinai Peninsula.
2. Determination of the policies and development of projects required to maximize the water available for Egypt's use.

4 - Nile Research Institute:

The main objectives can be summarized as follows:

1. Control of the quality of the River Nile water.
2. Protection of the existing barrages.
3. Development of navigation.
4. Protection of bank erosion.
5. Utilization of sediment deposited in the Aswan High Dam reservoir.

5- Hydraulics Research Institute

The main goals of the institute aim to:

1. Conduct research to determine methods of protecting the bed and banks of the Nile River and irrigation canals.
2. Perform hydraulic model studies of the structure.
3. Perform coastal hydraulic.
4. Develop and execute specialized training programs on river hydraulic.

6 - Channel Maintenance Research Institute

The institutes activities cover the following main topics:

1. Determine the magnitude of aquatic weed problems.
2. Design canals and drains to meet hydraulic and irrigation requirements.
3. Conduct experiments and make recommendations on artificial grass carp in different canals.

7- Ground Water Research Institute

The main goals of the institute aim to:

1. Study the quality and quantity of groundwater in the Egyptian desert.
2. Study the conjunctive use of the surface and underground water in the Nile valley.

8 - Construction Research Institute

The main responsibilities of the institute are:

1. Carrying out basic and applied research related to the field of hydraulic structure, soil mechanics, foundation engineering.
2. Providing MPWWR with comprehensive laboratory and field testing services and facilities.
3. Training the staff of MPWWR on the operation and handling of available advanced equipment in monitoring and controlling construction.
4. Providing advice to MPWWR in fields of construction design and execution.

9 - Mechanical and Electrical Research Institute

The main research fields of the institute are:

1. Energy management in pumping stations.
2. Improvement of the performance of motors and pumps.
3. Testing and calibration of hydraulic and electrical machinery.

4. Utilization of renewable energy for water lifting.

5. Automation, control and instrumentation in water schemes and plants.

6. Telecommunication and telemetry for water management in Egypt.

7. Development of new mechanical weed control equipment.

10 - Survey Research Institute

The main goals of the institute aim to:

1. Adapt, develop and incorporate modern methods of computer-aided field surveying.

2. Serve as a central organization to develop and apply all modern aspects of geodesy, photogrammetry, remote sensing and geographic information system.

11- Coastal Research Institute

The main goals of the institute are:

1. Monitoring the evolution of the Mediterranean shoreline.

2. Collecting and analyzing meteorological, coastal and marine data.

3. Conducting physical and numerical models to predict future changes in the coastal zone.

4. Providing expert advice on problems associated with coastal instability.

5. Coastal zone management for Mediterranean and Red Seas.

12- Climate, Water and Environment Research Institute

The institute aims to:

1. Study long-term impact of climatic fluctuations on optimal management of surface water and

groundwater in terms of both quantity and quality.

2. Carry out environmental impact assessments for water resources projects.

3. Develop effective methodologies for optimal management of water resources.

4. Identify environmental problem area and their implication.

5. Prepare national, regional and issue-specific assessments of climatic conditions affecting water resources.