# Chapter 6: Role of current policies and institutions Egypt in improving irrigated agriculture

# Chapter 6: The role of current policies and institutional setups in Egypt in achieving improved and sustainable irrigated agriculture

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## 6.1 Evolution and history of water policies in Egypt

The objective of any national water policy is, normally, to 'Generate the maximum possible economic value for the nation'. Under water scarcity situations, water should be allocated so that users who generate a higher income per unit volume of water are given priority over those who generate less income. This applies not only to water quantity, but also to water quality. The above statements are valid when water is considered as an economic commodity.

If other dimensions, such as social, political, and security ones, are added, the objective of the national water policy remains unchanged, while water allocation and use between different activities will have a different meaning. Although water is almost universally regarded as a public property, economic instruments provide ways and means through which to achieve maximum welfare in the sense that each user must compare the value of water he is using with the 'opportunity cost' of other or alternative users.

Unfortunately, this understanding is not common in most of the developing countries because of the following factors:

- Cultural and historical beliefs that water is free for all citizens
- Land fragmentation which causes extremely low water productivity
- Lack of water measuring devices and tools
- Poverty and low standards of living among farming communities
- Increased taxation for other reasons
- Aging irrigation systems of a primitive nature
- Large percentage of man power involved in farming activities
- Low prices for agricultural products at the farm gate
- Centralization of irrigation and agriculture at all levels
- Poor participation of farmers in system management
- Outdated institutions and slow renovation
- Domination of supply management at the expense of demand management and market-driven mechanisms.

'Economically efficient allocations' are defined as allocations that maximize the value derived from water use. These can only be achieved if a user's demand for water and willingness to pay compare to the willingness of other users to pay the cost of supply. That is, full economic allocation is achieved by open markets where individuals, groups, and companies of a private or public nature can trade water according to cost and benefit. This requires two institutional arrangements.

- Water allocations must be clear and secure
- Transfer of allocations must be feasible and of low cost.

However, allocations may prove to be inefficient for one or more of the following reasons:

- Natural monopolies caused by the market mechanism and directing allocations to activities which are not necessarily in accordance with the priorities of society

- Free of charge water, or tariffs lower than market value encouraging misuse by the users and result in the total benefit to society being less than it could be if the water was allocated according to its real value
- Revenues are often less than the cost of operation and maintenance which results in a budget deficit and deterioration of the water facilities
- Failure to determine the levels of pollution that are associated with optimal production or, in other words, failure of regulatory bodies to force the polluter to pay (the polluter pays principle) and to be accountable for the damage they cause.

The above economic considerations are substantially needed to frame water policies. However, when the water supply was in excess of population needs, a relaxation of governing rules used to prevail. Most of the countries around the world and, in particular, the countries of the WANA region (Egypt is one of these) have experienced sharp increases in their populations, increased standards of living and fixed or even reduced availability of water. As a consequence they felt it necessary to review their strategies, policies, and programs in order to cope with the existing conditions as well as to prepare themselves differently for the future by adopting policies which lead to higher 'water productivity' and higher 'water use efficiency.

## 6.2 Review of previous water policies in Egypt

A policy is defined as a course or principle of action designed to achieve particular goals or targets. Historically, water policies in Egypt started with the dawn of civilization. The Egyptian Pharaohs surprised the world with their ability to manage the Nile water, maximize food production, and use the local population to generate the revenues needed to run the first well organized state in the history of mankind.

In recent history, it was Napoleon Bonaparte who stressed the need for storage in the Egyptian system. He is quoted as saying; "Si je devrais gouverner ce pays, pas une goutte d'eau ne se perdait dans la mer." (If I am to rule this country, I will not permit a drop of water to flow to the sea.).

The Egyptian ruler Mohamed Ali (1805-1845) extended water management to the remodeling (widening and deepening) of the Nile branches in the Delta (there were six branches). He also constructed two major head regulators on the two main branches at Rosetta and Damietta. In this age, agricultural development flourished, the area of cultivated land doubled, cropping intensity increased from less than 100% (one crop per year) to more than 150%, through the introduction of summer (cotton and maize) and perennial crops (sugarcane and fruit trees).

Water policies based upon sound scientific principles started as early as the 1920s and continued throughout the century until the last policy was introduced in 1997 to cover four plans each lasting five years, i.e., ending by 2017. The summary of these policies can be briefly spelled out as follows:

- Following the construction of the Delta barrages (1830-1840), a number of superstructures were raised starting with Aswan Dam (1898-1902). These were followed by the Isna, Nag-Hammadi, and Assiout barrages on the main Nile, and the Zefta and Edfina barrages on the Damietta and Rosetta branches. The construction of the high Aswan Dam in the mid 1960s heralded the era of full management of water in Egypt.
- Throughout history, Egypt has enjoyed a surplus in the amount of water required to meet regular demand, except of some cycles of drought, the last of which badly hit the African continent and lasted for about ten years (1977-1987).
- Known as an agricultural country, agricultural activities expanded

horizontally and vertically in order to meet the expanding demand for food and natural fiber both in the local market and for export. This expansion enlarged the workforce in agriculture until it included almost 40% of the manpower in the country.

Industry started on agri-products such as sugar, textiles, oil, leather, paper, fertilizers, wood, etc.

The first water policy cited in the last century was the 1928 policy, which fixed the limit of horizontal expansion at 7.17 million feddan. This figure was realized by the end of the century, seventy years after the policy was issued.

The fast growing population, forced successive governments to direct the economy towards industrial development in order to meet the needs of the increased population and raise their standards of living. Heavy industry was then started, followed by tourism and services as high priorities.

At present, the amount of potable water produced is about 24 million $m^3$/day, or about 9 billion $m^3$/year. If the existing trend in population growth and consumption continues, by 2020 the number of Egyptians is expected to reach 100 million. By that time, the demand for potable water would be around 11 billion $m^3$/year, about 20% of the Egyptian quota of the Nile waters.

In the meantime, other activities, such as industry and tourism, are flourishing. Egypt is expected to be the world's cement factory (production has risen from 9 million t/year to 24 million t/year in just a few years). Other industries, such as fertilizers, steel, aluminum, chemicals, pharmaceutics, and many others, are providing significant temptations to regional and international investors. The real estate industry is moving fairly fast to occupy the empty quarters in the existing cities, to fill the space in the wide deserts, and to urbanize huge areas in the Nile valley and Delta. This pressure for development arises mainly because of population pressures and the need for summer and winter resorts and recreation areas. Tourism, which provides the country with good part of its hard currency revenues – 11 million tourists per year, spending more than 100 million nights – is expected to exceed 14 million guests in the near future.

Obviously tourism is not limited to hotel hospitality, but extends to golf courses, swimming pools, lakes specially established for immigrant birds, and luxurious fountains in addition to the high consumption of tourists in a temperate country. All these increases in water consumption are expected to subtract from the quota for agriculture for two simple reasons:

- The economic return of a unit volume of water in agricultural production is lower than that of other activities.
- A high proportion of the losses in agriculture are irrecoverable unlike other activities where the majority of losses can be recovered, treated and recycled.

This state of affairs can only be overcome if new water resources are developed, mainly via cooperation with Nile Basin countries. This is not expected to be achieved, at least in the near future.
The second and more realistic option is for agriculture to modernize its on-farm irrigation system and change cropping patterns. Both actions should be developed to use less water for the production of high return commodities.

## 6.3 Interpretation of successive water policies

A detailed review of water policies in Egypt covering the period 1928 to 2017 is given in the report entitled Policies and Institutional Setups, October 2006. Interpretation of these policies is given below:

Successive water policies in Egypt marked historical events in the country's development plans:

The 1928 policy came just one year before the introduction of the 1929 agreement in which Britain, as an occupying country

of Kenya, Uganda and Tanganyika, (Tanzania after being unified with Zanzibar), and Sudan; agreed with Egypt to stop abstraction of Nile water during the period of peak demand (May to July) for the purpose of securing enough water for the irrigation of cotton fields in the Nile Delta in Egypt. This rule was even extended to Upper Egypt where Nile water was restricted during this period. Obviously the British government was formulating this agreement from the perspective of an advantage to the textile factories in Yorkshire, Manchester, and Liverpool. The consequence of the 1929 agreement was the distribution of the natural flow of the Nile, estimated at 52 billion $m^3$/year, between Egypt (48 billion $m^3$/year) and Sudan (4.0 billion $m^3$/year). The remaining 32 billion $m^3$ of the natural flow at Aswan (estimated as 84 billion $m^3$ per year) was allowed to flow unused to the Mediterranean every year. The policy was meant to show the potential of land reclamation in Egypt and concluded that more than seven million feddan could be brought under economic cultivation. This was the sum of the existing land area under perennial irrigation, plus the lands which could be converted from basin to perennial irrigation, plus desert lands located on the fringes of the flood plain in the Nile Valley and Delta and/or the waterlogged lands running parallel to the Mediterranean in the northern part of the Nile Delta.

The 1933 water policy marked the second increase in height of the Aswan Dam, (increasing its storage capacity to 2.5 billion $m^3$) and the start of the construction of the Gabal Awlia Dam in Sudan which made about 2.0 billion $m^3$ of water per year available for use in Egypt. These two events took place in the year 1932. The additional quantities of water enabled the country to convert more than half a million feddan in Upper Egypt from basin to perennial irrigation, reclaim more than 400,000 feddan in the east, middle, and west Delta, and increase rice cultivation from 200,000 to 350,000 feddan annually.

The 1953 water policy was developed to make use of the additional quantities of water made available following the increase in height of the Owen Dam in Uganda. The construction was partially financed by Egypt. The plan was to increase the cultivated area from about 6.1 million feddan in 1952 to 6.5 million feddan in 1959.

The 1959 water policy came as an immediate result of signing the Nile Water Agreement with Sudan in preparation for the construction of the High Aswan Dam which started in 1963. As a consequence the 32 billion $m^3$ of flood water which use to flow to the Mediterranean was divided – 7.5 billion $m^3$ for Egypt (bringing its quota to 55.5 billion $m^3$) and 14.5 billion $m^3$ to Sudan (to make its quota 18.5 billion $m^3$). The remaining 10 billion $m^3$ was left for evaporation from the reservoir (Lake Nasser) every year.

Following the complete exploitation of the Nile Water, all the policies which came later concentrated on groundwater abstraction and reuse of drainage water. Shallow, deep, renewable, and fossil groundwater was exploited and the amount of recycled drainage water was increased year-on-year. It has to be stated here that the first reuse project started immediately after construction of the High Aswan Dam by allowing the drainage water of Upper and Middle Egypt to flow directly to the main course of the river. Reuse projects in the southern part of the Nile Delta followed suit.

The latest water policy of 1997-2017 took an unprecedented step towards the future. Almost the entire water budget was allocated for the irrigation of an area of almost 11.0 million feddan with any remaining water being allocated for other activities. This was a reversal of the previous policies in which allocation was made first to other activities and the remainder passed to agriculture by default. The 1997-2017 policy marked the desire of the country to use water for the development of new areas which

could be used for integrated activities (i.e. agro-industry, mining, energy, industry, tourism, services, etc.). In the meantime the economic dimension was overruled by other social dimensions, such as creating job opportunities and reducing the high population densities in most villages, towns, cities, and urban centers in the country. However, the 1997-2017 policy was criticized on the basis that most of the water budget items listed were considered as paper savings – they had no realistic value on the ground. For instance, savings were assumed to come from the following interventions:

- Change of cropping patterns (mainly reduction of rice area)
- Increased reuse of drainage water
- Increased area covered by irrigation improvement projects
- Reduced amount of drainage of water flowing to the Mediterranean
- Increased exploitation of deep groundwater
- Increased use of treated sanitary sewage
- Increased use of treated industrial effluent
- Increased production of desalinated water.

Horizontal expansion in Egypt followed vertical expansion. This started with the conversion of basin irrigation areas (one crop per year) into perennial irrigation zones (two crops per year). Basin irrigation was practiced with the flood water which used to arrive during the months of September and October. The winter crops were sown after the water receded. Perennial irrigation was accomplished by providing an appropriate irrigation system which enabled cultivation of a summer crop as well as a winter one.

Other vertical expansion measures were practiced according to progress in research and the building of capacities.

Horizontal expansion started in locations where reclamation was easier and less expensive. Most of the low lying lands in the strip running parallel to the Mediterranean were reclaimed first.

Desert lands on the fringes of Nile Valley and Delta were given priorities according to the lifting head – the lower the lifting head, the better.

Water quality was also an important factor. Fresh water was the only source up to the years 1920-1930. When a water deficit was experienced (most probably because of a series of years of low natural flow), drainage water was used to fill the gap. It has to be noted that Upper Serw pumping station was constructed in 1928 to lift water from Upper Serw drain to the Damietta branch for reuse downstream.

Following the introduction of drainage water as part of the water budget, shallow groundwater was included as part of the budget as early as the 1950s.

Exploitation of both drainage and shallow groundwater became a fixed policy until pollution problems appeared. Shallow groundwater was under the threat of sea water intrusion caused by over pumping, especially from the northern aquifers. Drainage water reuse was hampered when some mixing locations were closed as a result of the heavy pollution from domestic sewage and industrial effluent. Some of the water downstream from these mixing locations was used for domestic purposes.

With the restriction imposed on drainage water and shallow groundwater, deep groundwater was included for the irrigation of 500,000 feddan in the 1997-2017 plans. This area requires a minimum of 2.5 billion $m^3$/year for its irrigation.

Upper Nile Projects were always part of the plans and policies. The first phase of the Jongeli canal project was 80% complete before it stopped in 1982. In this first phase 4.0 billion $m^3$ of water would have been saved and divided equally between Egypt and Sudan. A similar quantity would have been saved if the second phase had been completed. It is now hoped that the fruits

of Nile Basin Initiative, which came to light in 1999, can be made available to all the Nile basin countries. Rainfall in the Nile basin is estimated at 1600 billion $m^3$/year. Of this, only 84 billion $m^3$/year reach Egypt and Sudan. A huge amount of water is lost in the swamps and marshlands of Bahr El Ghazal, Mashar, and other areas. Again, the return to peace in southern Sudan could revive water projects and agricultural development in this important part of the Nile basin

The 1997-2017 policy is stretching the Egyptian requirements to the limit of the possible regular supply – no water would be left for emergencies – which is not a 'comfortable' situation until and unless an extra supply is made available.

For this reason, summer and winter resorts on the north, east, and west coasts, and on the Red Sea produce their own water by depending on small desalination plants. The transport of Nile water to these places proved to be extremely expensive.

Desalination is looked at as a favorable alternative if desalination is practiced on brackish water rather than sea water with a high salt concentration. If renewable energy is used (solar, wind, waves, etc.) the cost of desalination would be comparable to the opportunity cost of transporting Nile water, especially if the distance to be moved is long.

Brackish water could always be used in the cultivation of mangroves and halophytes of economic value, or any other salt-tolerant crops for making desert lands green and productive.

It has to be mentioned that the ultimate objective of this report is to review the measures taken by the Ministry of Water Resources and Irrigation (MWRI) and the Ministry of Agriculture in Egypt. It draws on previous experiences and regional and international lessons for improving these measures and enriching the future polices and institutional setups of the country. The objective is always increased water productivity for different activities.

## 6.4 Worldwide experience in water policies

Having reviewed the Egyptian water policies of the last eighty years, it can be said that successive policies were 'development' based, seeking to satisfy all existing and expected future requirements, with extra quantities of water allocated directly by default to agricultural expansion.

Following the introduction of the 1997-2017 water policy, the budget was stretched to the maximum limit by adding 3.4 million feddan to the cultivated area. This brings the total area to something like 11 million feddan, or a cropped area of more than 20 million feddan. However, development based policies can no longer be adopted because the last policy was, in reality, much too ambitious.

The problem with this type of ambition is that, with the existing level of water requirements (about 6000 $m^3$ of water per feddan per year), 11 million feddan require 66 billion $m^3$/year which is far beyond the country's water budget. Decision makers assume that the deficit can by compensated for from i) the application of water saving measures, ii) improvement of irrigation in the old lands, iii) strict application of modern irrigation systems in the new lands, iv) intensive reuse of agricultural drainage and treated sanitary sewage and industrial effluent, v) a change of management options (from supply to demand, from upstream to downstream control and from rotation to continuous flow), and vi) by adopting strong reform policies.

The above tools do not include the acquisition of an extra supply of water from external sources, mainly from the Upper Nile region. However, most indicators (almost ten years after the introduction of the 1997-2017 water policy) show that the above expectations were more like paper wishes than realistic interventions that can be practically implemented on the ground.

The present situation, therefore, requires a switch from the conventional 'Water Development Policy' to a more

sophisticated 'Water Allocation Policy' which requires a number of actions/ interventions which affect the distribution of the given quantities of water among different uses and different users. However, before getting to this point the country has to decide about a number of policy issues, which include:

## 6.5 Food self sufficiency and food security

This policy issue is a subject of debate at different levels up to the highest rank in the decision-making arena. Food security is defined as 'a situation in which all households have both physical and economic access to adequate food for their all members, and where households are not at risk of losing such access (World Food Summit, 1996)'.

Food self sufficiency means the satisfaction of food needs from domestic supply as far as possible, with minimal or nil dependence on trade. The concept of food self reliance takes into account the possibilities of international trade. It implies maintaining a level of domestic production plus a capacity to import, in order to meet the food needs of the population by exporting some major or minor products. It can be said that food self sufficiency and food self reliance supported by requisite governance (i.e. conduct of national affairs on various fronts) leads to food security. (See the International Commission on Irrigation and Drainage status paper on Global Issues Related to Food Production, Security and Trade, Sept. 2003). Other definitions of food security adopted by different international organizations are as follows:

### a) World Bank (WB) definition

The definition for food security adopted by the World Bank is, 'The possibility of providing every citizen at all times with the food sufficient to carry out his/her normal activities and to maintain good health.' Food security in a country is realized when the country is capable of supplying all citizens with sufficient food through the country's trade and marketing systems even in times of development crisis, times of deteriorating production, and in spite of changes in world markets. This definition combines the holistic approach of the equal rights of all citizens to be covered, the time factor represented by the availability of food on a continuous basis, and the fact that the source of the food is not necessarily local or imported or both. It requires that there should be a strong system of marketing and trade both locally and externally.

### b) Food and Agriculture Organization (FAO) definition

The FAO defines food security as, 'The realization of all citizens at all times of the physical, social, and economic capability to obtain the amount of food necessary for them to meet their human need for energy according to their nutrition preferences and to guarantee an active and healthy life.' The only difference between the FAO and WB definitions is the condition of food being a basic factor in a healthy and active life, the consumer preference, and taking the social and economic dimensions into consideration.

### c) Arab Organization of Agricultural Development (AOAD) definition

The Tunis Declaration on Arab Food Security (1996) spells out the definition of food security as, 'Making available food in the quantity and quality needed for continual health and activity of every Arab citizen depending upon local production first, according to the relative experience of each Arab country to produce food commodities and making the same available for Arab citizens at the prices which are proportional to their incomes and financial capabilities.' This definition adds the quality of food to other definitions, puts the condition of giving local production a priority, and brings integration between Arab countries as a relative advantage.

**d) United Nations (UN) definition**

The UN defines food security as, 'The guarantee that all individuals in the community at all times are able of obtain their basic food needs both from the financial and economic points of view.' This means that, according to the UN, there should be a minimum of basic food supplies and the economic capability of all individuals to purchase their requirements of these commodities.

## 6.6 National and individual food security

'Total loss of food commodities' takes place when a country fails to secure its total food needs either from local production, imports, storage, or reserves. Food security can, therefore, be realized through imports or production or both, while self sufficiency is only based on local production.

National food security can be realized even though part of the population is not able to obtain enough food. Individual food security can, therefore, only be attained through fair income distribution, a rise in the standard of living, creation of employment, economic development, and other developments.

Food self sufficiency is a national indication which shows that national production is sufficient for the country's needs without imports. This does not mean that some of the sectors of the society are not able to obtain their basic needs, given their low incomes or high purchase prices or both. Food self sufficiency can be imposed through the control of imports. This may imply that average individual consumption is less than is needed. Self sufficiency is measured by the quantity of production regardless of the quality, while food security puts healthy food as a precondition.

There are three dimensions implicit in the definition of food security (and consequently food self sufficiency/reliance). These are availability, stability, and access. Adequate food availability means that, on average, sufficient food supplies should be available to meet consumption needs. Stability refers to minimizing the probability that, in difficult years or seasons, food production might fall below consumption requirements. Surplus stocks may help tide over the deficit. Accessibility draws attention to the fact that even with plentiful supplies, many people may still go hungry because they do not have the means to purchase the food they need or the public distribution system is inadequate in moving food to within reach of the needy and making it accessible. Affordability is closely related to poverty, which is often defined as 'a function of the inability to consume and invest'. Poverty in monetary terms is the threshold, responding to a minimum income level required to fulfill basic food needs food. In this way poverty is directly related to individual or household food security.

Worldwide, expansion of cultivated areas roughly kept pace with population growth until the middle of the 20$^{th}$ century. But, in the last 40 years cereal output doubled as a result of i) expansion of the cropped and irrigated areas, ii) increased intensity of land use (cropping intensity), and iii) increased yields as a result of improved management and high yielding varieties.

The next doubling of food production is still to come, since water and land potential is available, particularly in several developing countries. The challenge is to realize this type of increase while sustaining the natural resources base. This means that Egypt will be in a position to increase its own ability to produce food commodities and to have comfortable access to world markets where food production is increased.

Of the 53 countries on the African continent, 35 are considered as least developed countries (LDC). Nineteen of them have 35% or more of their populations undernourished. The number of LDC in Asia is only 13 and in Latin America is just one.

The total irrigated area on the African continent is about 12.7 million ha,

representing 6.2% of the arable land. Egypt has almost 100% of its cultivated land under irrigation. Countries like Uganda and Ghana have only between 0.1% and 0.2% of their arable land under irrigation. Five countries, Egypt, Sudan, South Africa, Madagascar, and Morocco, account for almost 72% of the total irrigated land in Africa, while a further 17 countries include just 1% of the irrigated land. North Africa has already reached more than 75% of its potential. There is a large untapped potential in central Africa where water resources are relatively abundant, which means that substantial water resource development is still possible.

A special session, 'Integrated Water Resource Management for Ensuring Food Sufficiency and Security', of the International Commission on Irrigation and Drainage was organized during the Third World Water Forum held in Kyoto, Japan in March 2003. The recommendations of this session were as follows:

- Increased crop production by adopting an integrated water resource management approach
- Increased water availability by means of water resource development to meet demand in all sectors, especially irrigated agriculture in developing countries
- Increased area under cultivation by reclaiming waste lands and areas under irrigation by increasing storage capacities, by improving water use efficiency, and by recycling wastewater
- Adopting better and effective wastewater management for rain fed areas
- Establishment of strategies for improving water and land productivity in irrigation and reduction of the gap between irrigation potential developed and utilized
- Improved governance to elevate food sufficiency to food security status
- Introduce guidelines to involve all stakeholders in the process of integrated water resource management
- Integration of the principles of equity, adequacy, flexibility, efficiency, and economy in integrated water resource management
- Increased investment by international funding agencies and local governments for modernization, rehabilitation, replacement, and new water structures is strongly needed
- Private sector should be encouraged to invest in irrigation projects by allowing reasonable profit making mechanisms in the business.

## 6.7 The role of trade in food sufficiency and food security

Global trade is a dynamic and highly complicated process. It is well known that there are positive links between economic growth, openness of trade, local productivity, farm mechanization, size of land holdings, costs of production, subsidy systems, and world food prices. Trade positively impacts a number of economic and social factors, such as growth rates, income distribution, employment, life expectancy, infant mortality, and poverty in general.

A comparison of world cereal trade shows a trade surplus (export) of about 13% in the total production of developed countries, whereas developing countries show a trade deficit (import) of about 6% of their total requirements. The situation of least developed countries is serious – they import almost 29% of their requirements. They have to increase their production to keep pace with their rising populations, food self sufficiency needs, and maintain the 18% reserves needed for unforeseen circumstances. If land, water, finance for infrastructure, management capacity, and knowledge base are the constraints, then these countries will continue to be in a difficult situation.

As a large number of countries all over the world become industrialized, trade becomes inevitable. The earlier General Agreement on Tariffs and Trade (GATT)

and the present World Trade Organization (WTO) were established to facilitate trade between countries.

GATT provided rules for much of the world trade between 1948 and 1994 only as a provisional agreement and a provisional organization. After 1990, the United States agricultural exports faced a steep decline. It also became apparent that the decline in agricultural commodities exports arose from the protectionist policies initiated by the same countries that started supporting an agreement that would enable free trade in these commodities. The GATT vision was found to be weak and the need for a stronger trade regime was keenly felt. Following seven and half years of negotiations, an agreement on agricultural products was finalized in the Uruguay Round (1994) and signed in Marrakech, and the World Trade Organization was set up in Geneva in January 1995. Two major features were introduced into the rules of the WTO, Trade Related Intellectual Property Rights (TRIPS) and Dumping.

**TRIPS**

By the middle of the 20th century, a limited form of plant variety protection (PVP) was given to breeders of a new crop. With the hybrid industry evolving, they requested exclusive rights to their research results. TRIPS now fall under WTO. It obliges all parties to make available, by 2000 for developing countries and by 2006 for least developed countries, patents for any invention – whether a product or a process, in any field of technology – without discrimination. Developing countries need to take advantage of the provisions under the TRIPS agreement to protect their genetic resources, products, and technologies as well as other interests. Developing countries need to investigate if the implementation of the TRIPS agreement would directly affect the farmers and food security of their countries.

**Dumping**

Markets in developing countries are often subjected to a flood of cheap consumer goods dumped by foreign producers. This raised fears that even food products may be dumped in the markets of developing countries. Under WTO rules, anti-dumping duties can be levied on those countries from which the actual imports originated during the course of an investigation, provided the domestic producer of the particular product can prove that dumping has taken place.

**Developing countries** adopted the following positions for negotiations:

- Resist introduction of hidden subsidies
- Initiate a proactive, not a passive role
- Request international norms on sanitary and phyto-sanitary safeguards
- Insist on closer scrutiny of the non-product specific subsidies in developed countries
- Ask for better market access for products
- Give priority to food self sufficiency as long as 50% or more the labor force depend on food production for their livelihood.

Policy-makers from developing countries should address the following three issues from the perspectives of trade and the WTO

- Current agricultural policy for agricultural development in the context of WTO
- Impact of WTO provisions on agricultural policy in the future for a given country
- Impact on small and marginal farmers and benefits derived from the current developments.

The above argument explains the necessity of taking a national stand on what the country requires, taking into consideration its water status. In the absence of clear policies, like food security, food self sufficiency, and food self reliance and the steps required for the implementation of the selected policy, people will be moving in a vicious circle. Trade agreements come at the top of the agenda; meaning that each country has to make good use of

the available facilities and agreements. It is not necessary that developing countries go directly to international trade, bilateral agreements and regional agreements, like the Community of Sahel-Saharan States (Africa) experience, may offer better alternatives.

### 6.7.1 Present production and consumption of food in Egypt

- The Egyptian citizen gets almost 4000 calorie, 120 gm of protein, and 61 gm of carbohydrates daily. This compares very well with the actual needs of 2350 calorie and 35 gm of protein per day.
- Egypt is self sufficient in the production of rice and sorghum, but imports wheat, maize, and barely on a large scale.
- Before the last outbreak of avian flu, Egypt was self sufficient with respect to white meat, eggs, vegetables, and fruit.
- Major imports in Egypt are wheat, maize, barley, sugar, legumes, oil, red meat, fish, and milk.
- The deficit in processed food trade is about US$ 370 million, excluding raw food imports (wheat, maize, barely, legumes, etc.).
- The annual per capita share of food in Egypt is about 735 kg, of which 600 kg are agricultural crops, 120 kg are animal products and 15 kg are fish.
- Production increased continually between 1981 and 2003
    - Wheat production from 1.938 million t to 6.485 million t
    - Rice production from 1.543 million t to 4.274 million t
    - Maize production from 3.308 million t to 6.431 million t
    - Sugar production from 0.624 million t to 1.285 million t
    - Red meets production from 0.294 million t to 0.840 million t.

Food production and consumption in Egypt is generally subject to three features:

- A large and expanding deficit in the production of basic commodities, such as wheat, maize, sugar, and edible oil
- For affordability reasons, 40% of the population is not able to obtain its basic food needs. Mal-nutrition caused by lower food quality is another problem for low income citizens
- Food markets are generally unstable because of the effects of fluctuations in international prices on the local markets and the consequences of these price variations on the purchasing power of citizens with limited incomes.

## 6.8 Other policy options

Water policies can be based on social, economic, political, and security options.

Following are some of these options.

### 6.8.1 More crop per drop

In view of the increasing population and the need for a higher standard of living, yields per unit volume of water and per unit area of irrigated land need to be considerably increased. However, the 'more crop per drop' approach implies also 'more revenue per drop' which means:

- Each country has to raise crop production according to its relative advantage in order to maximize returns per unit volume of water and unit area of farm land.
- Water-saving techniques, such as lining earth canals, precise land leveling, long furrows, night irrigation, use of modern irrigation systems, change of planting and harvesting dates, change of planting methods (dry seed/ transplantation), use of one point lift, and change of management system (supply vs. demand, upstream vs. downstream, rotation vs. continuous flow, etc.) should be adopted.

- A minimal area should be cultivated with high water consuming crops especially rice, sugarcane, and banana.
- Integrated water resources management, including the integration of sources, integration of demand activities, integration of different water qualities, integration of management and control, etc.
- Strong participation of users at different levels starting from the planning stage and continuing through concept design, pre-feasibility, feasibility, detailed design, construction, operation, management, and maintenance stages.
- Change of cultivated lands from high temperate regions to less temperate ones and from regions of high conveyance and distribution losses to regions of lower losses. Manipulation of different crops to better suit different regions in these respects is also a possible option.
- If land fragmentation is a major limitation for irrigation systems in developing countries, land consolidation schemes may provide a reasonable alternative. Obviously, consolidation cannot be implemented without a number of technical, financial, economic, and social consequences taking place. These factors should be taken into consideration.

**More jobs per drop**

Food security depends on the strength and diversity of the economy. The economies of the WANA region that began to import increasing volumes of staple grains in the second half of the 20th century have also enjoyed extraordinarily favorable terms of trade. Water rich North America, Europe, and Australia forced down the world price of stable grains as a consequence of EU and American subsidies. For much of the last three decades of the 20th century, staple grains were imported at prices reflecting only half of their production cost in the developed countries due to this strong competition.

As an example, Egypt addresses a substantial proportion of its food needs by importing water intensive commodities. These items would have required 20 billion $m^3$ of water if produced locally. Egypt exports crops and livestock products which use about 1 billion $m^3$ of water in their production. The net virtual water in these transactions is almost 40% of the current water used in agriculture.

The main benefits of this international trade are that it is economically efficient and at the same time invisible. It is also politically acceptable because it is silent. The solution is politically controversial in that it is more effective than extending crop production horizontally. But as the solution is silent and invisible, neither the process nor its advantages enter public discussion.

The process actually enables public discussion to be controlled, as there is no evident strategic shortage of water, which is not, in fact, the case. The diversification and strengthening of the economy via more 'jobs per drop' is the main solution to the strategic water deficit. Further, socioeconomic development will be associated with a useful reduction in the rate of population increase.

An agricultural livelihood, which is often a poor livelihood, requires on average 10,000 $m^3$ of water/year. Livelihoods in other industrial and service sectors, which may be better or even much better than an agricultural livelihood, require very small volumes of water. The vast numbers employed in education, the health service, other government services, the military, police, transport, and retail services use negligible amounts of water – of the order of 1 $m^3$ per employee per year. Nevertheless, their incomes, often modest, enable families to be housed and fed, sometimes able them to pay for additional education and services, and otherwise operate in society and generally contribute transaction cost managing inputs to the political economy.

Industrial jobs, increasingly in the private sector, are also modest in their water

requirements. Those working in these sectors use much more water at home than they do at work. A good example is Egypt where agriculture consumes 80% of the country's water budget, accounts for 20% of the GDP, and 40% of the labor force, while industry accounts for 20% of the GDP, 13% of jobs and uses less than 10% of the nation's water resources with a high proportion of this water being returned to the system.

The above argument is meant to emphasize two important facts. Under conditions of water scarcity:

Agriculture is not the most favorable consumer of water with respect to job creation. Other activities could be very much better. However, if other activities are not demanding labor, while agriculture is, then agricultural employment is certainly better than unemployment.

If agriculture is the only available choice, preference should be given to labor intensive crops, labor intensive irrigation systems, less water consumption, and less energy consumption. The preference should include the choice between farm crops, livestock, and fish farming.

**More stake per drop**

The 1990s witnessed a rapid rise in global concern regarding the economic and environmental value of water. This concern followed from the 1992 World Summit on Environment and Development, held in Rio de Janeiro, the associated preparatory meeting in Dublin, and, eventually, the Johannesburg meeting of 2002. Subsequent international meetings led to agreement on the principles captured by the phrase Integrated Water Resources Management (IWRM). While IWRM is, to a small extent, a technical and economic process, it is largely political. Integration in itself is very political since it may be possible, with great difficulty, within one organization, but between organizations, it is extremely difficult.

Management is also political, as it is often about the allocation of resources. It is the opinion of some experts that IWRM should be called Integrated Water Resources Allocation and Management in order to signal its non-technical nature and its association with transaction cost management rather than with technical measures.

An important element of IWRM is that it includes the principle of participation which enhances stakeholder involvement and commitment and, as a result, the collective good.

Attracting stakeholders to IWRM will add power to the water policy equation. A misleading starting point is to assume that solutions lie mainly in the water sector. There is clear evidence that, strategically, water issues can only be solved outside the water sector and in the economy at large. This conclusion strengthens the idea that the larger the number of stakeholders the more effective and efficient will water use be.

**More care per drop**

The main impacts on the water environment, on water quality, wetlands, and coastal waters are the consequences of water consumption in agriculture. In an arid environment it is normal that more than 80% of the water be diverted to irrigated farming. It is also normal for those managing the water resources in arid zones to assume that water which is not used in crop production and productive livestock is water lost and, therefore, an economically negative outcome. Taking more 'care per drop' requires that the services provided by water in the environment are given a certain priority. Good examples are:

- Water quality in lakes, pools, and natural lagoons
- Sea water intrusion issues and their effects on soils and groundwater
- Minimum environmental flows especially under closed basin conditions
- The status of migrating birds in relation to inland water bodies

- Leaching of pollutants and toxic elements from soils, canals, and rivers
- Separating high quality water networks from low quality water ones
- Preservation of natural wetlands and other water bodies.

Part of the water budget needs to be allocated for recreation and green parks, cleaning dusty streets, washing buildings, and generally improving the scenery of villages, towns, and cities.

## 6.9 Benchmarking

Benchmarking is defined as, 'A systematic process for securing continual improvement through comparison with relevant and achievable internal and external norms and standards.' Benchmarking seeks to bring about improvements in the performance of organizational processes using experience gained from the study of similar organizations or processes. The target is to identify the gap between current and achievable performance and make the changes necessary to realize higher standard of performance. This can be driven by several factors, some of which are:

- Increases in population leading to a need for greater agricultural production
- Growing water scarcity leading to a need for irrigated agriculture
- Higher expectations for crop yields
- Higher expectations for the level of irrigation service
- Change of perceptions, attitudes, and practices within government agencies with respect to the provision of public services
- Change of perceptions within society on the role and standard of government service.

Benchmarking originated in the corporate business sector as a means of gauging and subsequently improving the performance of some companies in relation to their key competitors. By studying key competitors' outputs and the processes used to achieve those outputs, many organizations have been able to adopt best management practice and enhance their performance.

In some cases, organizations have done so well that they have, in turn, become the organization that others use as a benchmark. Irrigation and drainage are mainly services for irrigated agriculture. They provide or remove water to suit the crops' needs. Therefore, it is in the best interest to improve the level of service provision to water users, thereby enabling them to maintain or increase agricultural production. Three characteristics need to be borne in mind with respect to benchmarking of the irrigation and drainage sector:

- Service providers operate in a natural environment
- Irrigation and drainage entails complex and interacting physical social, economic, political, technical, and environmental processes
- Performance of irrigation and drainage schemes is site specific.

### 6.9.1 Benchmarking principles

Benchmarking can be divided into two parts – part one involves finding out and part two involves taking action. The two parts are divided into the following six stages:

For part one

- Identification and planning: determining the purpose of the benchmarking, the areas to be benchmarked, against whose performance is the benchmarking to be conducted, and what are the performance indicators
- Data collection: day-to-day data, data for comparison, and data collected for diagnoses
- Analysis: gaps, causes of gaps, action required to close gaps.

For part two

- Integration: introducing changes into the operational processes and procedures
- Action: processes and procedures put into place to bring about the desired change
- Monitoring and evaluation: measurement of performance against target norms and standards.

## 6.9.2 Use of artificial neural networks (ANN's)

The previous discussions revealed that reaching a single water policy which provides the optimum solution for all problems appears to be extremely difficult, if not impossible. Several attempts to reach such a solution using mathematical modeling, decision support systems, and many other techniques, which are based on predefined rules or equations that give a clear definition of the problem, were carried out. The problem must be presented in a way which explicitly defines step-by-step the tasks to be performed to achieve the required results. However, there are many practical cases for which the rules are either not known or are extremely difficult to express mathematically because there are too many factors involved and a large number of alternatives that need to be simulated. Reaching a preferred water policy which satisfies the needs of different stakeholders and fits with the requirement of the existing generation and the ambitions of future generations appears to have these types of characteristics.

An ANN is an information processing technique that is inspired by the way biological nervous systems, such as the brain; process information. The key element of this technique is the novel structure of the brain as an information processing system. It is composed of a large number of highly interconnected processing elements (neurons) working in harmony to solve specific problems. ANNs, like humans, learn by example. An ANN is configured for a specific application, such as pattern recognition and data classification, through a learning process. Learning in biological systems involves adjustment to the synaptic connections that exist between neurons; this is true for ANNs as well.

ANNs have received increasing attention in the last two decades. They comprise one part of the spectrum of the computational tools of artificial intelligence, but in many ways can be viewed as pattern recognition systems or as an extremely powerful multi-dimensional surface filling tools. They are extremely helpful in situations where the rules are either not known or are very difficult to specify, i.e. where it is not feasible to formulate a traditional predictive mathematical model. The major attributes of an ANN are:

- Their capability to generalize by being trained on a series of examples without knowledge of the underlying rules and to produce meaningful solutions.
- Data used for training can be theoretical, experimental, empirical, or a combination of these, derived from good and reliable past experience. Training data can be evaluated, verified, or modified by human experts to inject human intelligence and experience.
- They takes account of factors which are not easily quantifiable (non-numeric).

The above attributes are part of the reason that ANNs have become the favored tools for producing a water policy, which can be trusted by all stakeholders and meets the requirements of the Egyptian population, not only those of the present generation, but those of coming generations as well.

The ANN technique was used to predict the expected local production, the expected consumption, and the expected gap between production and consumption for three major grain crops, wheat, maize, and rice for the period 2006-2021 based upon estimates of population and crop productivity. Local, regional, and

worldwide changes in trade surpluses and deficits, technology transfers, cost of labor, seeds, agro-chemicals, etc., water duties, and many other variables were all taken into consideration. Training data included records covering the period 1986-2000.

A previous exercise had shown that if Egyptian policies followed the 'business as usual' format, the problems would never be solved; more probably they would be exacerbated. Therefore, non conventional policies had to be thought of. Some of these policies are structural and some are nonstructural, some need hard interventions and others need soft interventions.

### 6.9.3 Structural policies

Structural policies include continuing with the existing programs of renewal of major infrastructure, including grand barrages, major control structures, conveyance and distribution systems, and the implementation of irrigation improvement projects at the farm level.

The implementation of the Upper Nile projects needed to capture the water lost by evaporation and seepage could certainly add to the overburdened water budget. In the absence of full cooperation with Nile riparian countries, there can be no positive movement in this direction.

Desalination of sea and brackish water stands as one of the most favorable tools in satisfying national needs, at least for domestic and industrial use at the present time and for the near future. When the technology is mature enough, agriculture may also be added to the list.

Rain and flash flood harvesting structures should also be provided in relevant areas, such as the northwest and east coasts, the Red Sea, and the Sinai peninsula.

Groundwater in desert areas should be used only for domestic purposes, the production of high return cash crops, mining, energy, tourism, industry, and any other services. The use of such a precious, non-renewable resource for irrigation of farm crops appears to be a very modest output. Ideas, like intermediate reuse of drainage water; and merged irrigation and drainage systems which limit drainage reuse on the local (farm) level, appear to solve some of the problems of deteriorating water quality. This idea requires the provision of a large amount of infrastructure. It is simply an attempt to keep pollution within the boundaries of well defined commands and not to export it anywhere else. The alternative is to completely separate clean and dirty water. The requirement in this case will be mainly for closed networks of open channels or closed conduits plus the control structures. The two separate networks would run both north-south and east-west, which appears to be fairly expensive solution.

Increase storage capacity by deepening and widening the Toshka depressions, Lake Qaroun, Wadi El Rayan lakes, Lake Wadi El Natroun, Qattara depression, and the coastal lakes (Manzala, Borollos, Edko, Mariout, and Lake Bardawil). This would help in receiving any additional flows from any source.

### 6.9.3 Non-structural policies

Non-structural policies are based on soft interventions at the top of which comes change of cropping pattern. Egypt, as explained earlier, can never reach self-sufficiency in food and fiber commodities. The country's relative advantage lies in the production of high value proxy and export commodities. In such a case, food security and food reliance can easily be attained since high value cash crops cultivated on small areas of land can cover the cost of large amounts of other farm crops available in plentiful supply in the world markets. The decision here would be on the required area of crop and the ability to market the production in a professional way. Reserves of strategic commodities have to be built up according to market circumstances in order to cater for any

unforeseen variations in international market prices. This has to be done through government circles with close cooperation between politicians and senior experts in the relevant ministries.

Matching irrigation supply and demand comes second in the list of priorities since it is one of the major water saving measures and is very low cost. All it needs is accurate mapping and computer sets. The estimated initial and running costs for these are very modest. However, it gives decision maker in the master station (MWRI) a clear picture of the required water supply to agricultural land on a day-to-day basis, obtained from actual conditions on the ground. Again, full cooperation between the staff of the MWRI and that of the Ministry of Agriculture is of paramount importance.

There should be more in-depth investigation of the possibility of increasing winter cultivation at the expense of summer crops, which consume twice as much water as the winter ones. This simply means that the cultivated area in winter could be doubled if half this area is not cultivated with a summer crop. The consequences of such an intervention should be investigated in-depth (soil salinization, labor, etc.).

Crop pattern modifications should also be expanded to the south/north criteria. Optimization should be in favor of drought tolerant crops being raised in the temperate south and salt tolerant crops in the north. This might cause a drastic change in sugarcane/sugar beet cultivation. It might also concentrate winter vegetables in the south and summer vegetables in the north. Winter oil producing crops are badly needed. Whether canola can be of use, remains an important question to be answered. Revolutionary ideas about changes in cropping patterns are a must.

Maintaining a healthy relationship with African countries, in general, and Nile basin countries in particular, may lead to agreements enabling some countries to raise some crops, with the help of Egyptian expertise, under the favorite conditions of an ample water supply and open space.

Land consolidation in general, or crop consolidation as a minimum, appears to be badly needed. Mixing crops on small areas of land results in the worst conditions for each crop in those cases where crop water requirements and soil moisture conditions vary especially if a rotation irrigation system is applied to all crops.

With dramatically increasing population growth, agriculture has to accept leaving a part of its share of water for other activities. It is obviously much better if such decisions are well planned ahead of time. If these decisions are delayed until the last moment, then the wrong actions might be taken.

The operating rules of the High Aswan Dam reservoir (Lake Nasser), particularly those governing the optimum storage elevation, could affect positively or negatively the amount of evaporation from the lake, thus saving or losing large amounts of fresh water. The storage of crops may prove to be more feasible than the storage of water, in the opinion of some experts.

Conventional water-saving techniques have to be applied and, whenever possible, improved. These include precise land leveling, night irrigation, long furrows, modern irrigation in old lands, converting irrigation of vegetable fields and orchards from gravity to pressurized systems in old lands, and introducing short duration varieties of crops, etc.

## 6.10 The proposed water policy

Estimates of the Egyptian population by 2050 suggest that it will exceed 100 million. At the present level of per capita share of municipal and domestic water supplies, the country will need a minimum of 10 billion $m^3$/year. Growing industrial development will require an almost similar quantity. Agriculture will be left with between 30

billion $m^3$/year and 35 billion $m^3$/year. If, by 2050, the area of cultivated land is as planned (11 million feddan at a cropping intensity of 200%) this amount of water will not be sufficient unless drastic changes take place. This is because the average irrigation water quantity per feddan would be 3000 $m^3$/year; half as much as the existing level of 6000 $m^3$/feddan/year.

It seems as if now is the right time to take important decisions with respect to the country's future water policy. Certainly, Egypt cannot continue with a water development policy defined as, 'Actions affecting the increase in the quantities of water available for distribution and use', which has applied until now and was geared at satisfying all the expected future requirements with extra quantities of water allocated directly by default to agriculture. This is simply because agricultural requirements have now reached the limit where, unless additional quantities of water are made available to increase the water budget, agriculture has to allow for other activities to take from its share. In other words, the country will move in the direction of a water allocation policy where actions will be taken to distribute the given quantity of water among different users and uses.

Allocation will be based on IWRM and in this case slogans like 'more crops per drop', 'more jobs per drop', 'more stakes', and 'more care per drop' will come into the picture. For the 'more crop per drop' approach, the country has to consider seriously questions of the following nature. How can the cropping pattern be divided between different agro-climatic regions, between human nutrition, animal feed, and fish farming, and between old lands and new lands?

Egypt is one of the few countries in the world where a large variety of crops can be raised. A good example is the production of sugar from beet in the north and from cane in the south. The southern part of the country is known for its high evaporative demand, which adds almost 50% to crop water requirements. However, the region is known for its perfectly clean water. It is very close to the source of the water, meaning that conveyance and distribution losses are minimal. It is possible to raise the cropping intensity, especially of some vegetables. It is suitable for raising off-season crops which can be marketed as a monopoly with very little competition from neighboring countries. Yet, the distances involved in transporting agricultural commodities to markets are too long. The export of such commodities requires Red Sea transportation to the Gulf area or air freight to other parts of the world. The area of cultivated land in Upper and Middle Egypt stands now at 2.5 million feddan which will be increased to 4.0 million feddan after the reclamation work of the South Valley Project comes to an end (expected by 2017).

The climatic conditions in the Nile Delta are much more favorable than those in the Nile valley. The maximum temperature of 35°C is a lot less than that in the south which may reach 42°C. Support and infrastructure in the Delta are much better and the area is connected by an excellent network of roads, seaports, airports, and railroads. Again, it has to be emphasized that Egypt is located in the middle of the world between east and west, between Europe and Asia, and between Asia and Africa. Probably, this makes the distances to be travelled to the other parts of the world shorter than those from any other country. However, being a long way from the water source means that transport and distribution losses are higher and, most importantly, the water is partially polluted when it reaches its destination. The continuous recycling of water in the Delta results in it being of unacceptable quality at the end of the system in many cases.

This comparison shows how important it is to answer the following questions:

- Is the existing cropping pattern the best for the country?
- Is the distribution of this cropping pattern between north and south and between east and west optimal?

- What are the changes that can be made in order to achieve the maximum economic return from a unit volume of water and a unit area of land?
- Is this going to change the status of the country from self sufficiency or self reliance to only food security?
- What is the effect of continuously encroaching on agricultural land?
- How can the country make better use of the export facilities given by the European Community on the one hand, and by the rich Gulf area on the other?
- How can the country attract both local and foreign investment for the production of food commodities?
- How can the country employ modern techniques to increase productivity and raise production standards?
- How can the country reduce the pollutant loads in soil and water?
- How can the country use the Nile basin, the Common Market for Eastern and Southern Africa, and the African continent as a whole as markets for its commodities?
- Is it possible for Egypt to sign agreements with other countries to cultivate land in those countries given that they have a plentiful water supply and Egypt can offer expertise of manpower and possibly part of the investment?
- Is it possible for Egypt to expand horizontally and allow for winter crops in an area larger than that allocated for summer crop as one summer crop consumes enough water sufficient for two winter crops? If this is the case, what would be the effect on soils and manpower?
- Can Egypt make use of the food industries migrating from Europe as a result of EU regulations applied to the new member countries and how can the country make good use of these changes?
- How can the country benefit from WTO rules and is it possible for all local production be exported (obviously only the first class products, while other grades would be marketed locally) while the requirements for commodities in which the country has no relative advantage are met through imports? How can the country establish this balance?
- How can the country use agricultural products as the basis for a stronger agro-industry, which adds value to raw products and increases their market prices, and which employs more domestic labor?

Having reviewed the previous water policies, experiences, and practices, adoption of a new policy is simple because of the rich heritage of knowledge. Yet, it is also difficult because of the complexity of the problem and the huge number of factors it includes. However, in order to reduce the level of complexity of the problem, it is worthwhile splitting the factors involved into groups as follows:

- Development of new water resources

**Upper Nile conservation projects**

- Jongeli canal
- Bahr El Ghazal
- Mashar
- Ocabo Oboco

**Desalination plants**

- Sea water
- Brackish surface (drainage) and groundwater
- Solar energy
- Wind energy

**Rain harvesting**

- Northwest coast
- Northeast coast
- Flash floods in the Red Sea and Sinai peninsula

**Groundwater**

- Shallow, renewable reservoirs (Nile valley and Delta)

- Deep, non-renewable reservoirs (limestone and Nubian sandstone)
- Coastal reservoirs
- Brackish water reservoirs

**Savings resulting from increased efficiency**

- Improvement of irrigation networks (lining, aquatic weed, gates)
- Improvement of on-farm irrigation efficiency
- Reduction of tail end losses (night irrigation)
- Reduction of evaporation losses (night irrigation)
- Official and non-official reuse of drainage water
- Improvement of the efficiency of potable water supply networks (treatment plants, pipelines, in-house)
- Change of irrigation methods (improved surface, sprinkler, drip)
- Control of horizontal expansion

**Management policies**

- Operating rules of Lake Nasser
- Allocation rules among stakeholders
- Conjunctive use of surface and groundwater
- Supplementary irrigation in marginal lands
- Integrated water resource management
- Establishment of independent hydrological basins

**Agricultural policies**

- Matching irrigation supply and demand
- Cropping pattern modifications
- Uncontrolled urbanization
- Subsidy and taxation
- Marketing and trade (exports)
- Pricing of agricultural products
- Cost recovery
- Incentives and penalties
- Capacity building

**Environmental management**

- Sanitary drainage treatment plants
- Potable water treatment plants
- Improvement of land drainage
- Restricted use of chemical fertilizers and agro-chemicals
- Water quality management plans

Strategic decision making for sustainable development should select the policy that best satisfies a number of criteria namely:

- Maximize standard of living and quality of life
- Achieve social equity and peace; benefits are uniformly spread over the population
- Maximum economic efficiency; maximum output of cost-benefit ratio
- Guarantee environmental sustainability; smallest ecological footprint
- Country security (water, food, fodder, fiber)
- Financial and political feasibility (least public expenditure and political discontent)
- Maximum macro-economic attractiveness; higher gross national production growth.

In order to tackle this large number of conflicting objectives, it is necessary to use a multi-criteria decision support technique within a powerful tool, such as a decision support system (DSS). Such a system can handle the large number of parameters relevant to decision makers, the socioeconomic life of the population, and the technical system performance.

The proper use of the DSS should be to support and enhance the logical thinking that policy and decision makers inevitably apply, as well as predicting the future using an integrated evaluation of alternative plans.

Unfortunately, time only allowed for the first steps in the development of a DSS for the

complete hierarchy of the irrigation and drainage systems. The following phase may result in a detailed study in this direction.

## 6.11 Institutional setup of the water sector in Egypt: the past, the present and the future

### 6.11.1 The past

Since the dawn of history, Egypt has established institutions capable managing, distributing, and equitably dividing water which facilitated creation of the first regular state in the world. In the age of King Minus, who united Upper and Lower Egypt, the left embankment of the River Nile was raised. Later, in the age of King Sizostrees, the right embankment was also raised. The two embankments protected the country from floods and enabled the use of flood water to fill the basins and enrich the cultivable land with the fertile sediments that had been transported by the river. Storage of water in the Fayoum depression was also reported during this age. All related activities were only possible because of the involvement of the Egyptian population, which was obviously, in some cases, forced to provide free labor to the pharaoh, the king, and even the gods.

Recent history talks about storage in the Aswan reservoir which was constructed at the beginning of the 20$^{th}$ century. This was followed by a series of control structures, vast network of conveyance canals, the use of water lifting devices, and the first set of legislation needed to regulate water abstraction, maintenance of irrigation canals, and penalties against those who misuse water, pollute it, or generally break irrigation laws. This was applied by qualified personnel who belonged to a central organization sub-divided into smaller authorities covering the whole country, but following the instructions of the central leading entity, what is now called the Ministry of Water Resources and Irrigation (MWRI).

In late 18s, a Royal Decree was issued stating that all men between 15 and 50 years of age were required to assist in canal cleaning. Exempted from this service were students, teachers, religious leaders, skilled labor, security officers, soldiers, and inhabitants of cities and towns who do not own land or practice agriculture. If anybody wanted to be exempted from this obligation he had to offer a substitute or pay 120 piaster (EGP 1.2), if he was a Delta resident or EGP 0.80 for Upper Egypt residents.

In 1920, the Egyptian Government issued a proposal to raise the water supply to 50 billion m$^3$ to Egypt and 6 billion m$^3$ to Sudan. In order to reach these figures, the Aswan Dam was to be raised and its storage capacity increased to 5 billion m$^3$, (from 1 billion m$^3$ at the time of construction to 2.5 billion m$^3$ when its height was first increased). Included in the proposal was construction of the Gabal Awlia Dam on the White Nile south of Khartoum and the Sennar Dam on the Blue Nile, storage in Lake Tana, and the implementation of the Junglei canal project in southern Sudan.

The 1929 Agreement between Britain, as an occupying authority of the Nile basin countries (Sudan, Kenya, Tanzania, and Uganda), and Egypt came to an end as suggested by joint teams representing the two parties and an international consultant, which confirmed the historical right of Egypt to Nile water. There was also a clear objection to the building of any structures on the river which might restrict the flow of water to the north (i.e. to Egypt).

The first official institution was established in 1844 and named 'Diwan El Ashghal', that is, the Department of Works. Twenty years later, the name was changed to 'Nezarat Al Ashghal Al Omomiah' – the Department of Public Works. A few years later, it was changed to the Ministry of Public Works. In 1964, it was replaced by the Ministry of Irrigation. In 1987, the name was again

changed to the Ministry of Public Works and Water Resources and finally the name was changed to the Ministry of Water Resources and Irrigation (MWRI).

These frequent changes in the name of the ministry give the impression that the mandate and duties of the ministry were not fixed, but were subject to continuous modifications, alterations, and amendments.

As examples of this consider the following:

- The Department of Survey, formed as part of the ministry in 1898, was transferred to the Ministry of Finance in 1905, back to the Ministry of Public Works in 1953, to the Ministry of Defense in 1973, and finally to the Ministry of Irrigation in 1975.
- The Department of Railways was transferred to the Ministry of Finance in 1912 and to the Ministry of Transportation after that.
- The Department of Agriculture became the Ministry of Agriculture in 1913.
- The Alexandria sea port was transferred to the Ministry of Finance in 1919.
- The Department of Ancient Monuments and the Opera House was transferred to the Ministry of Education in1929.
- The Egyptian Zoo and Fish Park was transferred to the Ministry of Agriculture.
- The Department of Electricity and Gas was transferred to the Ministry of Electricity and Energy in 1864.
- The Department of Sewerage was transferred to the Ministry of Municipalities in 1950.
- The Department of Construction was transferred to the Ministry of Housing in 1950.
- The Department of Deserts was transferred to the Desert Development Authority in 1959.
- The Department of Inland Navigation was transferred to the River Transport Authority in 1959.
- The Meteorological Office was transferred in 1971 to the Ministry of Defense and to the Ministry of Transportation after that.

The idea behind the previous inventory of Departments, Divisions, and Sections which used to belong to the Ministry of Irrigation for various periods shows that the ministry was responsible for almost all utilities, works, projects, and programs of major activities – irrigation, agriculture, housing, roads, potable water supply, sanitary drainage, electricity, energy, etc.

This reflects the large degree of centralization which characterizes the performance of the ministry and which continued to influence this performance throughout the years.

## 6.11.2 The present

At present, the MWRI consists of the following main departments

**Irrigation Department)**

This comprises the following major sectors of the ministry:

- Irrigation sector
- Horizontal expansion and projects sector
- The sector of grand barrages
- The groundwater sector
- Nile protection sector
- Irrigation improvement sector.

About 2000 engineers are involved in the activities of the Irrigation Department and they are in charge of water distribution, maintenance, renewal and rehabilitation of water structures, irrigation improvement, infrastructure of new reclamation projects, etc.

**Mechanical and Electrical Department (MED)**

The MED is the body responsible for lifting irrigation and drainage water in addition to the lifting devices needed for groundwater abstraction. The number of pumping stations which fall under the responsibility of MED is of the order of 1600 and they are

spread all over the country. MED is divided into five departments, Upper Egypt, Middle Egypt, Eastern Delta, Middle Delta, and Western Delta.

**Drainage Department**

The Egyptian Public Authority for Drainage Projects (EPADP) is responsible for the implementation of open and subsurface drainage projects as well as the maintenance, rehabilitation, renewal, and replacement of existing ones. Around 700 Engineers are employed in EPADP.

**High Aswan Dam and the Aswan Reservoir Department**

The responsibility of this department is the operation of High Aswan Dam and Old Aswan Dam governing the storage in Lake Nasser and power generation. A daily inspection of the bodies of the two dams and their surroundings is also part of the department's obligations.

**Department of Survey**

Responsible for the establishment of topographic survey maps and benchmarks and sharing the development of land use maps, etc.

**Department of Shore Protection**

This department is responsible for research, studies, design, and implementation of all coastal zone management and protection in the Egyptian territories.

**Planning sector**

This sector is responsible for planning for all ministry departments with reference to both water and financial issues.

**Nile water sector**

The Nile water sector is in charge of the Nile levels from external sources up to Lake Nasser It is responsible for negotiation with the Nile basin countries, planning for future Nile projects, and coordinating with local organizations associated with Nile water (Ministry of Foreign Affairs, etc.).

**National Water Research Centre (NWRC)**

The NWRC is the research arm of MWRI and includes twelve institutes specializing in: drainage, development of water resources, hydraulics, channel maintenance, water management, construction, groundwater, Nile survey and shore protection, mechanical and electrical, environment, and climate change. A first class central laboratory is part of NWRC as well.

**Training center**

The Regional Center for Training and Water Studies (RCTWS) is the organization in charge of continuous and on-the-job training within MWRI. All levels of engineers, technicians, administration, and personnel staff are trained on different aspects of water covering almost all the activities carried out by the ministry. In the meantime RCTWS acts as the training body for water engineers from Nile basin countries, the Middle East, and North Africa.

It is clear from the large number of departments, divisions, authorities and organizations in MWRI, and the large number of engineers involved in water conveyance, distribution, management, and operation and maintenance, that the system is extremely complex. It requires a clear understanding of the role of each institution and how the different roles can be changed, upgraded, and/or improved to be compatible with the latest developments in the water sector in Egypt while, at the same time, coping with the rapid developments and changes occurring in the world.

## 6.11.3 The future

For ten years MWRI worked on an institutional reform plan directed mainly at strengthening the involvement of stakeholders in the water sector and reducing the responsibilities of the ministry on the following levels:

- In the old lands: establishment of water boards at the district level or higher

- In the new lands and mega projects: various modes of private sector participation
- Privatization of some parts of MWRI (e.g. pipe factories)
- Coordination of decentralization and privatization projects and programs in such a way that:
    - These projects and programs are a coherent part of the overall institutional reform process
    - These projects and programs support each other
    - These projects and programs work together.

The vision and strategy for MWRI institutional reform as issued in May 2005 are as follows:

The MWRI is charged with ensuring the sustainable, equitable, and efficient use and development of Egypt's water resources. Traditional methods of supply augmentation, and centralized finance and administration enabled MWRI to serve Egypt's water users well in the past. However, emergent challenges call for new approaches to water management. These challenges include:

- Reduced availability per capita, as population and demand grow, with few prospects for additional supply
- Diversion of Nile supplies to large and ambitious new lands development projects
- Increasing water pollution
- Increasingly individualized cropping patterns, which call for more finely-tuned allocation and distribution
- Significant needs for rehabilitation and improvement
- State budgetary constraints.

While there remains room for efficiency and equity improvements through the application of information systems, technology, and communications, water management in the 21st century also requires fundamental institutional reform. Institutional reform is change in the distribution of responsibilities and authority among stakeholders. Water sector institutional reform is necessary because the challenges of 21st century Egypt's water resource management (WRM) can only be met by a greater involvement of water 'end-users' and an increasingly multi-sector approach to water resources planning and control.

The purpose of this MWRI Institutional Reform Vision/Strategy document is to set out MWRI's vision of the 'shape' of future sector institutions in a manner which clarifies the new stakeholder roles. The approximate horizon for the reform is 15 to 20 years. The document also sets out the major implications for the sector's legal and financial frameworks, and lists key milestones and implementation steps.

Vision and strategy development was managed by the MWRI's Institutional Reform unit, with technical assistance provided through Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ) and the Royal Netherlands Embassy in Cairo. The vision and strategy were developed in the course of three 3-day workshops with a large group of senior MWRI officials, between August 2004 and January 2005. The vision/strategy document is intended to provide a basis for discussion and is subject to modification as necessary by the wider stakeholder community, including other Government of Egypt ministries, various categories of water user, and for orientation and implementation planning within MWRI.

The objectives of the reform are:

- To ensure that the quantity and quality of Egypt's water resources are sustained for use by future generations
- To achieve a more equitable allocation of the benefits and costs of water service provision
- To achieve greater efficiency in the

allocation, distribution, and application of water.

Strategy development was guided by eight principles:

- Participation – increased responsibility and authority for users
- Decentralization – delegation of MWRI's operational responsibilities to horizontally integrated local MWRI administrations
- Basin organization – adoption of hydrological unit boundaries for management and administrative units wherever possible
- Water quality – pollution control and prevention as an integrated dimension of water management
- Private sector participation – increasing the demand for private sector investment and services and facilitating their supply
- Privatization – divestiture, where feasible, of non-essential MWRI assets and activities
- Cost recovery – transfer of financial responsibility to users along with management responsibility, recovery of selected main system operation and maintenance (O&M) costs, and partial recovery of selected local land improvement costs
- Inter-ministerial coordination – establishment of a National Water Council to ensure policy and program coordination, strengthen laws, and improve enforcement.

The eight strategies are applied to different degrees and in different combinations in Egypt's three main water management contexts, the old lands of the Nile valley and Delta, the groundwater-based areas of Egypt's deserts, and the 'new lands' developments of Toshka and north Sinai.

The old lands consume most of Egypt's water, have the largest number of users, the greatest diversity and inter-penetration of water uses, and face the greatest threats from pollution. Given the complexity of the old lands' WRM issues, the reforms have been designed as a two stage process. The first stage of the reforms involves:

- Formation of water users organizations (WUOs) at branch canal, district, and directorate levels to propose water distribution plans, participate in O&M activities, resolve internal conflicts, and assume responsibility for selected O&M costs
- Horizontal integration of MWRI administrations at district, directorate, and regional levels, and implementation of information systems for allocation, planning, flow, and quality monitoring and cost accounting
- Increased private sector participation in O&M
- Formation of the National Water Council.

The second stage of the old lands reforms involves:

- Transfer of O&M management and financial responsibilities to WUOs
- Restructuring of MWRI local administrations into Regional Water Management Authorities of the public service authority type with inter-ministerial boards of directors
- Increase private sector participation in the financing and operation of large irrigation and drainage works.

The reform in the desert lands is oriented toward the need to adopt practical regulatory, economic, and awareness based controls over groundwater abstraction and to ensure adequate maintenance of often dispersed water schemes. Key strategies include:

- Vertical organization of the MWRI administration into central, regional (aquifer-based), and district levels
- Creation of WUOs at the level of the individual water scheme
- Licensing and regular monitoring of aquifer levels and withdrawals

- Implementation of low cost projects and programs to support water conservation
- Encourage and facilitate user-based and/or private sector involvement in maintenance and in the installation of pumping facilities as the latter become necessary
- Adoption of full cost recovery principles.

The framework of new lands water management, which begins with a clean slate, involves radically modern water management institutions including:

- Full transfer to investors of water infrastructure, management, and costs at the secondary canal level and below
- Adoption of either technology based or economic regulatory instruments to ensure water conservation
- Development of a regulatory framework to ensure that water is distributed equitably and that charges for water management are not exploitative.

Several legal adjustments are necessary or advisable to implement the reforms:

- Law 12/1984 needs amendment to enable management transfer to, and cost recovery by, WUOs in the old lands and desert areas. Clear and detailed executive regulations need to be developed in order to ensure that the WUOs are both enabled and compelled to carry out their responsibilities
- Amendments to Law 48/1982 may be necessary to devolve water quality protection authority to regional water management authorities
- Amendments to Law 129/1947 on Public Concessions and Law 61/1958 are advisable to encourage the private sector to risk capital in significant infrastructure investments
- Presidential decrees will be needed to establish the National Water Council and the Regional Water Management Authorities.

The reform also entails changes in the financial framework of the sector. The framework involves three types or levels of user contribution:

- Cost transfer: this is simply the financial dimension of management transfer. Charges for various WUO services are assessed, retained, budgeted for, and spent by the WUOs
- Cost recovery**:** users pay for certain MWRI services, for example the O&M costs of the High Aswan Dam and the main canals.
- Cost sharing**:** users pay a share of the capital costs of MWRI investments which provide identifiable local benefits, such as branch canal continuous flow projects.

For equitable cost recovery, MWRI will adopt cost accounting systems which identify and disaggregate costs at lower and lower levels of the irrigation and drainage system down to the individual branch canal. Such accounting will enable not only more equitable charges, but also better comparison of the efficiency of MWRI units at similar levels.

Although the 'Vision and Strategy' was issued in May 2005, the Ministry released, in August 2008, a 'Development and Implementation Plan' for forming 'Regional Water Management Administrations (RWMAs)' in which a clear statement of the shortcomings of the water system management within the present MWRI institutions was given as:

- 'Redundant' and 'conflicting' decisions and work instructions due to the 'complicated' administrative structure
- 'Poor' decisions due to the disaggregated nature of the data and information needed for the decision making process and the many administrative barriers or conflicts of interest within organizational units
- 'Lack' of coordination between the water resources maintenance and development projects

- Higher costs of O&M due to 'redundant' activities, manpower, equipment, and facilities
- 'Low' participation of water users in water system management due to the 'lack' of and need for enabling awareness and involvement mechanisms
- 'Little'ownership of water systems by water users leads to significant violations and encroachments
- Increased deterioration of water quality through contamination by solid and liquid wastes.

The report goes on to suggest that, "The above problems can only be overcome by a fundamental change in the existing arrangements of the water system management." Potential solutions must include the integration and optimization of 'scattered' and 'interrupted' business processes as well as their related organizational structures.

In order to reach this target, a two phase plan was suggested:

- The first phase required the establishment of basic organizations and entities and horizontal and vertical expansion within ONE hydrologic (integrated) region.
- The second phase is meant for up-scaling and development towards a powerful entity that could strengthen integration, participation, and partnerships (at all institutional levels involving all stakeholders).

The idea behind forming a Regional Water Management Administration is to lead to the integration and combination of existing organizational units, such as the irrigation, drainage, mechanical and electrical, irrigation advisory service, groundwater, water quality, and telemetry directorates. Moreover, the RWMA will promote the creation of branch canal Water Users Associations and District Water Boards, and other expanded units, in order to fulfill its mission (regional and central).

It has to be stated, in conclusion, that the MWRI was historically, is at the present time, and will continue to be in the future, one of the most important organizations in the country. Initially its role was too large, with involvement in irrigation, drainage, housing, railroads, paved and earth road works, potable water supply, sanitary drainage, municipal activities, inland navigation, sea and river ports, public works, survey, mechanical and electrical aspects, and even the supervision of the Royal Opera House.

The nature of such a historical, central organization was maintained even after a good number of the tasks were stripped from the ministry at different times. The complicated organizational structure of the ministry at the present time, the large number of personnel involved, and the level of detail with which the ministry staff are dealing shows that institutional reform is not only appropriate, but is also imperative.

The reform is expected to address three major points:

a) How to simplify the organizational chart of the ministry based on the following assumptions:

- Reduce the number of sectors, departments, divisions, and authorities within the ministry to a minimum. A good example of this is the reduction of the research institutes in the NWRC by one-half as a first step and then to one-third
- The role of each new organization should be clearly stated
- Jobs within each organization should be clearly described
- Overlap and duplication between organizations should be brought to a minimum both within the ministry and with similar organizations in other ministries
- The role of the ministry should be limited to the tasks which cannot be done by the participation of stakeholders, private sector, and volunteering, non-governmental organizations, etc.

- The ministry should strengthen coordination with other ministries and organizations, especially those concerned with water – mainly agriculture, industry, tourism, electricity, potable water supply, sanitary drainage, media, health, security police, and justice.

b) How to reduce the number of employees in each sector, department, etc.

- This step can be implemented before the reduction in the number of sectors, departments, etc., or in parallel with it. This type of action requires the following:
- Selecting the right candidates to the right jobs according to the specified job descriptions identified earlier. This process has to be carried out in a transparent manner and the employees should be consulted and advised at different stages of the selection.
- Employees who do not have the opportunity to get a position should be posted to other divisions both within and outside the ministry, trained for other positions, or offered a fair early retirement option

c) WUAs should be strengthened through the appointment of some of the ministry staff who are in excess to actual requirements

- Egyptian expertise in water-related issues should be made available to neighboring countries, especially the Nile basin countries.
- The role of MWRI in water management has to be reviewed and modified on the following basis:
- MWRI should bear responsibility for major delivery works. Smaller canals and control structures, which can be managed by users, should be handed over to them in good condition. MWRI should continue with technical and financial assistance until farmers are capable of running the show on their own.
- Users should take over tasks like water distribution, cleaning of *mesqas* and branch canals, and the resolution of disputes
- If service providers are appointed to the boards of WUAs, the levels of participation can be raised from the *mesqa* to the branch canal, main canals, and irrigation districts
- MWRI institutions should be prepared to accommodate each step in the development and the laws have also to be compatible with each stage
- Awareness campaigns should be organized in parallel with every stage of development.

It can be concluded that institutional reform in the water sector is still a slogan. Very little has been achieved so far – little more than an awareness exercise. The big issues of decentralization, participation, public-private partnership, privatization, private sector participation, etc., are still just titles with very few facts on the ground.

The process appears to take too long a time because of the old nature of the ruling institute, their fear of losing authority and power, and the weakness of civil societies (NGOs, syndicates, members of parliament, media, etc.).

Institutional reform is part of a comprehensive reform that hits every corner and every activity in the country, including political, economic, social, and cultural.

The result of reviewing the existing institutions within the MWRI and other ministries reveals that the number of organizations in the structure of the ministry is too large and the number of employees within each organization is also too large.

It is, therefore, advisable to start with a new organizational chart in which the role of each department, division, sector, authority, etc., is well identified. In the meantime, the jobs in each of these entities need to be well described. This process may frighten those employees who may

have to be transferred to other places, take early retirement, or undertake re-training to occupy other jobs which are needed by the ministry or the country.

Decentralization, as represented by the division of the country into five independent regions, is still in a very early stage of development. Although the idea is sound, the application will be rather difficult given the need to change the structure in each 'region'. This is contrary to the general position of the government, which calls for 'cuts' rather than 'changes'. For this reason the proposal to reduce the number of sectors, etc., and cut the number of employees in each sector appears to be more in line with official attitudes. The problem which remains unsolved will be that of the employees who are in excess of the actual needs of the ministry.

As long as water remains as a commodity that is given free to farmers, the idea of privatization and private sector participation in water projects will continue to be avoided. The simple reason is that private business is only successful when it is profitable. A profit cannot be made unless water is treated as an economic good.

Many countries, with conditions similar to those in Egypt (China, India, Bangladesh, Pakistan, Morocco, Tunisia, and Jordan), have a variety of water pricing systems. It appears to be common not to charge farmers the actual cost of water conveyance and distribution and the actual cost of O&M. The minimum consumption is normally charged at a very 'symbolic' tariff, which escalates with increases in consumption to a 'cross subsidy' point – charging more for higher consumption to cover the subsidy for the lower consumption. In these cases the state ends up putting no public money into the system.

The participatory irrigation management (PIM) approach is discussed in detail in a separate section of this report. The division of the country into five hydrological basins is not only important with respect to decentralization, but also with respect to the creation of self-contained catchments in which water is recycled inside each catchment and little, or no water, is exported to other catchments. The idea is to prevent or at least reduce the accumulation of salts and other pollutants and toxins through the water's long journey from south to north.

Last but not least, the establishment of a supreme committee for water provides an opportunity to superimpose general policies on different stakeholders, i.e. irrigation, potable water supply, industry, inland navigation, fish farming, and hydropower generation. Meanwhile only water of standard quality should be permitted to be disposed of to drainage canals. Ultimately it would be possible to allow for certain minimum environmental flows to be drained to the Mediterranean Sea and the coastal lakes in direct contact with it.

## 6.12 Participatory irrigation management (PIM): local, regional and international experience

One of the fundamentals of increasing water use efficiency is the maximum possible involvement of all stakeholders in the various management activities As water is essential to all forms of life and prosperity, competition for water among users is already escalating as growing needs outstrip the limited resources. The objective should be to convert the competition between stakeholders into a form of integration and cooperation that achieves the largest overall revenue with the least harm to the sector and division. Private stakeholder associations can act as counterweights to the government department's own technical agencies to enhance water use efficiency. Most of the developed countries adopted PIM policies a long time ago, as a matter of fiscal necessity. Farmers in developed countries have a high level of education and access to strong support

services through both the private market and the public sector. It is the opposite for farmers in developing countries who are less educated, their standard of living is far below average, and their ability to hire service providers is extremely slim.

This section comprises a group of case studies and experiences in different countries to achieve the following objectives:

- Consolidate national experience in participatory approaches to irrigation management
- Learn from the experiences of countries that have successfully adopted policies to transfer management to WUAs
- Come up with suggestions on how to use regional and worldwide experience to improve the situation at the national level, upgrade the idea, and tempt both the government and users to adopt it and benefit from it.

## 6.12.1 Egypt

The involvement of users in water issues in Egypt is as old as the country itself. Major informal forms of participation include the following:

- *Munawba* and *mutarfa* are organizational units at the *mesqa* service area with an off take from a branch canal. A leader, the *Rais El Munawba* (the chief), has considerable authority and responsibilities for the allocation of water on a time basis, the settlement of disputes, and the carrying out of regular maintenance of the *mesqa* system. Water is allocated by time and the area served according to fixed delivery schedules, which not only change from one year to the next, but also from one generation to the next.
- The *saqia,* or water wheel, is an animal-powered lifting device. Other primitive devices, such as the *shadout* and *tambour,* were operated by humans for a much smaller lifting head than that possible with *saqias*. The *saqia* organization comprises between 8 and 12 families who own land near the *mesqa* from which the water is lifted. The land area allocated for the *saqia* installation is purchased collectively by the members who also purchase the *saqia* .The cost of operation is divided into shares according to land ownership, the cost of feeding and taking care of the operating animal, and the cost of repair and maintenance of the *saqia*. Water is allocated to members according to a fixed rotation and conflicts are resolved by the members.
- *Haqul Arab*, is a concept based on Islamic principles of fairness and equitable distribution held through informal justice, rights of appeal, detailed investigation, and stipulation of fines and sanctions. Micro system problems are resolved locally while cases involving theft, sabotage, and deliberate damage to properties or crops are transferred to the local police.

Private associations in Egypt are represented on the tertiary and branch canal level. Associations established on the tertiary level include water users associations (WUAs) on the improved *mesqas* (total number, 20,000), water users unions (WUUs) in newly reclaimed lands, and collector drain users associations (CDUAs) in tail drainage projects.

The WUAs, through regular meetings and discussions, identify the roles and responsibilities of the *mesqa* heads and set up rules to resolve conflicts, establish linkages for coordination with other agencies concerned with agriculture and irrigation, as well as with other WUAs. Members of a WUA also help in building the financial resources of the association in order to improve operation and maintenance. Nevertheless, legislation is still required to define the structure of the Water Boards and their responsibilities, especially when the members are not only farmers.

The Egyptian parliament issued Law No. 213 in 1994, where WUAs were defined as legal private organizations at the *mesqa* level in the improved irrigation systems, which are owned and operated by their members for their own benefit in the old lands.. The same Law No. 213 also introduced the water users unions, (WUUs), which are more or less defined in the same way except that these are applicable for the (old) new lands. The bye-laws of Law 213 (Decree No 14900 of 1995) detail the rights and duties of the WUAs and WUUs. In 1995, a Dutch-funded project established the first experimental WUO at the branch canal, and called it a 'local water board'

Some of the benefits achieved from the improved irrigation systems and the participation of farmers in the operation and maintenance of the irrigation system can be listed as follows:

- Increasing efficiency of water distribution in most command areas by 30% to 40% as well as maintaining equity of water distribution among all the farmers on the *mesqa*, including eliminating the tail end problem
- Reducing irrigation time by 50% to 60%
- Reducing pumping cost by EGP 25 to EGP 40 per crop (per season). Reducing the number of working pumps from 10 to 30 on the old mesqas and from 1 to 3 on the improved *mesqas* by adopting the one point lift approach on elevated and lined *mesqas* as a substitute for multiple lift points on conventional earth *mesqas*
- Reducing maintenance costs
- Transferring new irrigation technologies to the farmers through the Irrigation Advisory Services of MWRI
- A very important benefit gained is that the farmers have a better chance for resolving conflicts among themselves as they have to share a common resource
- Most important is the creation of a new spirit of cooperation between farmers through the introduction of the WUAs.
- The main functions of WUAs as listed in the Irrigation and Drainage law are as follows:
- Participation in the planning, design, and construction of improved *mesqas* (one point lift, elevated, lined)
- Operation, maintenance, and management of improved *mesqa*
- Improvement of water use activities at the *mesqa* level
- Identification of the tasks and responsibilities of *mesqa* leader and setting up rules for conflict resolution
- Establishment of links with agricultural and irrigation agencies, other WUAs, and higher level organizations on the branch canal
- Development of financial resources, operation of a bank account, and agreement on the rules for the collection and expenditure of the money.

The law defines WUAs as 'private organizations' owned and operated by members for their own benefit and work in the field of water use and distribution and all related organizational activities for the purpose of raising agricultural productivity.

In order to enable WUA members to better understand their duties and responsibilities in the early stages of their inauguration and to help them achieve the objectives of involvement, groups of technical members, named 'Irrigation Advisory Services' were established. The main functions of these groups were:

- To help farmers to setup WUAs
- Provide support in the planning, design, construction, operation, and maintenance of improved mesqas
- Assist in management transfer and conflict resolution
- Transfer technology, such as precision land leveling (by laser) and automatic gates
- Encourage farmers to develop links with Extension Services, the Agriculture

Credit Bank, Cooperative Irrigation and Drainage District Offices, pump maintenance bodies, and other local authorities.

The development of water users' participation is structured through two channels:

- CDUAs, or
- Branch canal WUAs

The CDUAs are associations which are meant to carry out routine maintenance on collector drain manholes and pipelines. They have never received legal recognition and remain as voluntary organizations.

The branch canal WUA is the next step up in the hierarchy of the irrigation system. It represents an upgrading of the WUA to a higher level. The, major differences between both levels are:

- The *mesqa* is a private property owned by farmers, while higher level canals are public property
- Mesqa organizations have legal status, others are not yet legally recognized
- Social control at the *mesqa* level is a highly effective management tool; such a tool needs to be replaced by more effective rules, regulations, and sanctions at the higher levels
- Users at the *mesqa* level generally have common interests; those at the higher levels have diverse interests
- At the *mesqa* level coincidence with tile drain boundaries does not normally exist, while at higher levels the chance of coincidence is greater
- The number of stakeholders at the *mesqa* level is much smaller than at the level of the branch canal, this makes holding meetings and seeking agreements more possible

- *Fayoum,* 'local' water boards, are a joint management model whereby water users and government staff (mainly the Irrigation District Engineer) are represented
- Water boards.

Water boards formed with *mesqa* leaders at the branch canal level are still in the pilot-stage and have not yet received any legal recognition. The government's rationale for the development of water boards is that i) they reduce the burden on the state, ii) promote efficient water use, and iii) ensure better water distribution. The farmers' rationale is that they i) provide effective maintenance, ii) ensure equitable water distribution, and iii) prevent conflicts.

The actual role of the water boards should be:

- Maintenance of tertiary and secondary canals
- Irrigation scheduling and water delivery
- Installation, operation and maintenance of lifting pumps
- Conflict prevention versus conflict resolution
- Cost reduction versus cost recovery
- Adherence to agreed upon cropping patterns versus patterns imposed and policed by the state.

The sustainability of water boards depends upon the credibility and role given to them by the state in the context of participatory water management. In order to achieve sustainability the question is whether to expand horizontally with the number of boards or vertically by proceeding to the level of the irrigation district.

It is important at this stage to review the orders of magnitude of the irrigation hierarchy from the bottom up.

- The number of private *mesqas* is about 100,000. They serve an area of between 10 feddan and 100 feddan. The average number of farmers on each *mesqa* is 150.
- The number of branch canals is between 4000 and 5000. Each

one serves an area of between 500 feddan and 3000 feddan. The number of farmers on each canal is between 1000 and 5000.

- The number of main canals is between 400 and 600. Each serves an area of between 15,000 feddan and 25,000 feddan. The number of farmers on each canal is between 10,000 and 20,000.
- The approximate number of irrigation districts is 300. Each serves an area of from 20,000 feddan to 60,000 feddan. The number of farmers in each district is between 40,000 and 80,000 living in from 30 to 100 villages.
- There are 26 governorates. Each serves an area of from 200,000 feddan to 500,000 feddan. The average number of farmers in each governorate is about one million living in about 2000 major and satellite villages,

In view of the difficulties experienced in transferring just O&M responsibilities, it is likely to be rather difficult to introduce a finance policy that imposes burdens on farmers, compromising their limited income. In the irrigation improvement areas, as equity and yields improved, partial self-financing of WUAs has been successfully implemented and accepted by farmers and the public. For water boards and other farmers groups, equity and yield improvement may, therefore, be pre-requisites for introducing cost recovery measures. As MWRI reduces its investments and involvement at the branch canal level, the money saved could be made available to water boards and WUAs to finance contracts for private sector involvement.

The pre-requisites for successful task transfer include i) a firm policy decision to transfer a meaningful level of responsibility for the management of irrigation systems to private associations, and ii) enhance the capability within public irrigation agencies to provide technical and institutional support to the associations.

The existence of capacity, autonomy, effectiveness, accountability, relevance, legality, and mission in the associations at the branch canal level is necessary to guarantee a successful task transfer.

In conclusion, after more than three decades of experience with user participation at different levels of the irrigation hierarchy, it has to be said that the picture is not very bright. The handing over of responsibility from a very strong bureaucracy is, as expected, very slow given the reluctance in official circles to risk a management transfer, which may or may not be successful. In addition there is reluctance on the part of the users to take the risk of managing a system which may not be easy to operate. In this type of situation it is necessary to raise the level of assurance of both sides and to strengthen their will and determination to make the transfer a success.

Past experience suggests a number of important issues:

- The government should not be very optimistic in assuming that farmers will be able to operate the system from day one on their own, and thus relieving the state budget of a burden. The funds allocated for each O&M item should be fully or partially allocated to the relevant farmers' organizations and gradually withdrawn when they are self financing.
- Farmers' organizations do not necessarily have the technical experience needed. Service providers are required to fill the knowledge gap. Retired irrigation engineers provide an excellent resource; their cost should be borne at the beginning by the state and gradually transferred to the farmers' organizations when they can afford them.
- The social, legal, and political status of farmers' organizations should be clearly identified in order for them to operate and be accountable to the state. This requires amendments in the laws and bye-laws.

- The state has to decide whether to expand the farmers' organizations horizontally (by increasing the number of WUAs) or vertically (by going to the level of branch canal WUA, water boards or district level water boards). Obviously with the higher level, the technical problems will increase and the number of government stakeholders (drinking water supply, inland navigation, industrial requirement, fish farming, etc.) will likewise increase. It is the government that has to decide on the level at which the whole process of user participation has to come to an end.
- The worst scenario would be to progress one step and retreat. It is, therefore, strongly recommended to move slowly, but surely, when moving from the pilot level to the policy scale.
- The Irrigation Advisory Services has operated as an organization different than the farmers' organization; they should merge into one body. Employment of multi-disciplinary teams (sociologists, agronomist, groundwater specialist, water quality engineers, etc.) in this respect is a must.
- Measurable indicators and well prepared time schedules should always be the first step towards the implementation of plans.
- Opportunities for the formation of WUAs inside irrigation improvement projects, or in areas where irrigation improvement is not taking place, should be identified and retained in the implementation plans.
- Transparency in the presentation of a well defined cost recovery program, giving farmers the opportunity to know what they have to pay, how, and when in advance of the opening of new *mesqas*, is essential. Cost recovery and an inability to answer farmers questions continue to be major constraints to the irrigation improvement project and create doubt and suspicion in farmers.

This state of affairs makes it very difficult for the Irrigation Advisory Service staff, who are on the firing line every day.

## 6.12.2 Regional experience

**Tunisia**

The transfer of irrigation development projects to beneficiaries is based on technical, economic and social criteria. The participatory approach introduced in 1988 helped to speed up the transfer procedure, deal with the maximum number of projects, and make beneficiaries contribute to the technical selection of these projects. The simplest water distribution plan is that related to rural drinking supply; then came small and medium scale irrigation networks whose areas vary between 30 ha and 300 ha. At the level of these developments, user associations had progressively taken care of the energy costs first. Their financial involvement then extended to the salaries of pump attendants. This relieved the state of all energy and personnel costs. The Agricultural Regional Development Commission (ARDC/CRDA) still supports weak associations for major maintenance works and the replacement of equipment. In the major irrigated public areas, mainly centered in the northern regions of the country and having areas ranging between 1000 and 30,000 ha per plot, associations are formed for homogeneous irrigation entities. The average area of such an association may reach 1000 ha.

Since 1986, the idea of a collective interest association (CIA/AIC) was re-activated. It assumed responsibility for the management and use of the water of state-owned property and of the modern irrigation infrastructure set up by the state in activities related to the provision of drinking water and irrigation. This reform of the state disengagement policy led to the merger of two existing agricultural bodies and the creation of a single administrative body. The years 1987 and 1988 witnessed the appearance of

regulatory texts which helped to set up the present legal and institutional framework with slight modifications. These included a law modifying some Articles of the Water Code of Law 87-3 5 which outlined the official status of CIA/AICs and stipulated the conversion of existing owner and user associations, within one year, into collective interest associations, and three decrees:

- Governing the organization, mode of establishment and functioning of the Collective Interest Association (Decree No. 87-1261)
- Concerning those of hydraulic interest groups (Decree No. 87-1262)
- Concerning the elaboration of standards and statutes of association (Decree No. 88-150).

A national strategy for the establishment and follow-up of CIA/AICs was laid down in 1990 defining the objectives and modes of support for their creation and functioning. The dissolution of development offices in 1991, whose set objectives had not been fully achieved due to the transfer of their powers to the Agricultural Development Regional Commissariats, (ADRC/CRDA), was an attendant measure urging the revitalization of the association movement. This sought to enable user groups to bear the remaining operation costs of irrigation facilities. In 1999, the new Law No. 99-43, replaced the name CIA/AIC with collective interest group (CIG/GIC) and laid down the possibility for these groups to extend their scope of activity to fulfill any mission aimed at strengthening the members' collective interests. In 2001, procedures related to the establishment of a CIG/GIC were simplified by Law No. 01-28. There had been 350 traditional associations before the institutional and legislative reforms. In 1990, 187 associations were reorganized. At present there are more than 1000 CIG/GICs, grouped mainly in the central and the southern parts of the country. They are responsible for the maintenance of water distribution networks and drinking water supply networks in rural areas, the oases, and in small and medium scale irrigated areas. These groups run 56% of the irrigated areas equipped by public investments, including some major areas. The remaining 44%, which operate in major irrigation areas, are still run by ADRC/CRDA. The Tunisian experience shows that despite their short experience, developments are moving fairly fast through the continuous modification of laws. It should be said here that system of water pricing in Tunisia is one of the most advanced in the whole MENA region. Cross subsidy is practiced on large scale.

**Yemen**

The participatory approach by the users generated a sense of responsibility that had not existed before. They were committed to a better use of the resources and facilities and to protecting them. Water use is more reliable and equitable to the extent that the plots situated upstream or downstream of the irrigated land are equally served. Irrigation management rules are developed and implemented by the users whereas before the transfer they were simply followers of rules imposed by the government. This self-regulation led to more reliability and less conflict among the users. All farmers are members of the WUAs, and, regardless of their political affiliation, they are served equally, which means that political influence does not play a role in service provision. The fact that users pay their bills, not the state as previously, means that equitable service and users' rights are key issue. If these are not provided the leader of the WUA is not re-elected or is obliged to resign, which means that there is social pressure against unfair application of the rules. The 'user pays approach' has increased awareness of water saving. The collection rate increased from 42% (under government control) to more than 80% (under the control of the WUOs). In 2001, the WUOs had a budget of US$ 31.7 million for expenditures on personnel (32%), energy (19%), gas, leasing, rehabilitation, and maintenance of machinery and

equipment (12%), repair and maintenance of the scheme (11%), procurement (10%), and other costs (16%). Energy consumption for pumping decreased after the transfer. Having to pay the bills leads to less water use and encourages good care to be taken of the facilities. The reduction in energy use is estimated at between 25% and 45%. Some of the retired O&M staff find jobs with the WUAs. The WUOs employ 5240 persons at the minimum wage. The WUOs have managed to successfully handle conflicts among the farmers caused by the inadequacy of service roads and distribution canals.

At the end of the 20th century, the Yemeni government introduced new criteria to implement sustainable development schemes to recover the capital costs of the project's rehabilitation and to decrease the government's commitment to the O&M budget. In each *wadi*, the surface water is free and available to the stakeholders according to the rule of *Al-A'ala Fal-A'ala* (upstream users take their quota and pass water downstream). Each area adjacent to the *wadi* course permits the traditional free *wadi* off-take (FWO) system, from which farmers irrigate their lands and manage the water distribution according to its availability. For each FWO, there is one person in charge who has the power to turn the water outlets on and off and supervise the operation and maintenance of the canals and the spur in the *wadi*. The area of responsibility for the FWO varies from 10 ha to 1500 ha depending on the topography of the area and the ownership of the land. The project was launched in February 2001. The strategy for establishing the WUOs commenced in 2002 with the assistance of an international consultant. Some of the water user groups have already been formed.

Yemen is facing severe water scarcity which forces successive governments to follow whatever practice allows for better management of water as a scarce resource. The introduction of knowledgeable personnel as service providers among the members of the WUOs is an important step towards training other members in solving the water problems these organizations face.

**Morocco**

Voluntary, WUAs can be established either on the initiative of the government or on the initiative of two-thirds of the owners or tenants of the land served by the same irrigation system. The procedure for establishing the WUA depends on who is responsible for the initiative. Where establishment is at the government's initiative, all owners and tenants of the area under consideration are called to a general assembly by the local authorities. The government presents a program of action for the WUA and details how it would function. The WUA is legally established when the assembly adopts the program proposed by the government. The law specifies the requirements for the deliberations to be valid. If the WUA is being established at the initiative of interested owners and tenants, the general assembly submits to the government a program of action. The WUA is legally established only after the government has approved the proposed program. Existing agricultural associations (Associations Syndicates Agricoles) that are involved in water resources management for agricultural purposes are transformed into WUAs, following the procedure for the establishment of WUA at the initiative of the government.

The functions of the WUAs are specified in an agreement stipulated between each association and the government. The agreement indicates i) the area of jurisdiction of the WUA, ii) the works to be carried out and any related studies, iii) the funds necessary for implementation of maintenance and repair works, iv) the resources required for financing the works, v) the different contribution rates for the WUA and the government to cover the costs of maintenance and repair works, and vi) the responsibility of the WUA to

carry out all works and to cover all costs related to the delivery of irrigation water and O&M of canals. The council of each WUA has authority to settle disputes among members. However, in case of failure, the parties can refer their case to the courts.

The WUAs impose annual dues on their members plus a special contribution to be paid for the establishment of the WUA. Annual dues are in proportion to the rights of each member and the general assembly establishes the basis for estimating dues. The government can delegate WUAs to collect government charges from their members, but the WUAs are not entitled to impose fines on members without the consent of government agencies. The implementation of PIM in Morocco has encountered several problems in the large irrigation systems. These include:

**a. A lack of training**

The abrupt transition from a non-participatory management system to a participatory one is being carried out with little preparation of the technical staff involved or the users. There is a problem in helping the two sides – the government administrative staff and the users – to assimilate the new set of duties and responsibilities.

**b. Defining what to transfer**

The management level and the specific tasks to be transferred to the Association of Agricultural Water Users (AUEAs) are still not clearly defined. The tendency is toward a progressive strategy that consists of proceeding step by step to adapt to the specificities of each case in the best way possible and to ensure the understanding and support of the irrigation users.

**Cost recovery and financial sustainability**

The establishment of a treasury fund for the AUEA and its renewal by the simple collection of users' contributions is not accepted by all AUEAs. In particular, asking farmers to pay for tasks previously provided by the government is problematic. Moreover, the increase in the price of water and the overall decrease in prices for agricultural products threaten the viability of farming enterprises. One possibility is for the government to provide the AUEA with the necessary technical and administrative staff until such time as the AUEA has sufficient financial resources to cover these or equivalent staff. Assuring durable finances for the activities of the AUEA is an issue that is being actively investigated at the present time.

Although the small and large scale irrigation has been practiced for a long time in Morocco, user participation is still lagging behind. The establishment of WUOs needs time and effort that can only be made available if users realize that they are going to get better a deal than that offered by the government, or when they are not happy with government service. In both cases, government agencies have to provide users with all possible support to help them help themselves.

## 6.13 Conclusions

In conclusion, the formation of WUOs in Egypt, their role, their merits, their limitations, and the constraints they are facing can be summarized as follows:

- User participation has been historically practiced on a wide scale through different forms of voluntary contribution including free labor and, recently, to shared facilities, such as wells, sakias, and diesel pumps.
- The state has not yet decided on the optimum level of user participation: the mesqa, the collector drain, the branch canal, the main canal, or the irrigation district.
- Both side, the users and the state, are still reluctant to move the experience from pilot to policy. From the government point of view, the possibility of the experiments failing may be the reason. From the users'

point of view, the need for an external and neutral arbitrator may be the reason.

- Despite the fact that many thousands of associations are already registered, they still do not have the appropriate legal status. For example, they cannot enter into cleaning contracts, they cannot officially stand in court cases as a recognized entity, etc. Unless this matter is resolved, such organizations cannot operate in an acceptable fashion.
- It is not yet decided, whether membership in the associations is compulsory.
- Whether or not associations are formed in irrigation improvement projects or on unimproved lands has not yet been decided.