Promotion of water saving policies and options for water use in improved areas in Egypt

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Promotion of water saving policies and options for water use in improved areas in Egypt

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Abstract. The problem of water scarcity is complex, as it includes climate change, desertification, as well as increased demand by different water user sectors. The concept of sustainable water use is based on three main issues, economic efficiency, social equity and environmental integrity. The vision of the Ministry of Water Resources and Irrigation is that a new approach of water management is needed to consider the diverse range of resource-use features and its interactions to elaborate sustainable water resources management strategies. The study presented here concentrates on these aspects in general and gives some findings on water saving options in the improved areas of Egypt. It reflects on the actual approaches to water saving strategies. Therefore the current state of water management policies, indicator development and participation approaches was investigated. The implementation of an effective integrated strategy or policy for water management, and water saving, needs also to be based on a comprehensive and integrated assessment of the water bodies. At the same time, successful practices of water use need to be disseminated. It is essential to enable a quantification and qualification of system aspects for successful evaluation.

Key words: Water – Price policies – Water management – Water availability

Promotion de politiques et d'options d'économie des ressources en eau dans les régions en progrès d'Egypte

Résumé. *La raréfaction des ressources en eau est un problème complexe qui associe le changement climatique, la désertification et une demande accrue de la part de différents secteurs consommateurs d'eau. Le concept de l'utilisation durable de l'eau procède de trois enjeux majeurs : l'efficacité économique, l'équité sociale et l'intégrité environnementale. L'idée du Ministère des ressources en eau et de l'irrigation est qu'une nouvelle approche de la gestion de l'eau est nécessaire pour appréhender la diversité des aspects liés à l'utilisation des ressources et ses interactions, dans le but d'élaborer des stratégies de gestion durable des ressources en eau. L'étude présentée ici porte sur tous ces aspects en général et rassemble quelques résultats relatifs à des options d'économie d'eau dans les régions en progrès d'Egypte. Elle propose une réflexion sur les approches actuelles en matière de stratégies d'économie d'eau. A cet effet, l'état actuel des politiques en matière de gestion de l'eau, du développement d'indicateurs et des approches participatives a été étudié. La mise en œuvre d'une stratégie ou d'une politique intégrée efficace pour la gestion de l'eau et l'économie des ressources doit en outre se baser sur une évaluation étendue et intégrée des plans d'eau. Les pratiques d'utilisation de l'eau qui ont fait leur preuve doivent en même temps être diffusées. Pour une évaluation efficace, il est essentiel que les différents aspects du système puissent faire l'objet d'une quantification et d'une qualification.*

Mots clés: *Eau – La politique des prix – Gestion de l'eau – Eau disponible*

I – Introduction

During our participation in the WASAMED meetings and the discussion on the harmonization and integration of water saving options for the Mediterranean Countries, some of the presented theoretical techniques appeared to be applicable for the case of Egypt. This paper presents some of the relevant applications for the current Irrigation Improvement Project (IIP) in operational irrigated areas in Egypt.

Egypt lies in the north-eastern corner of the African continent, stretching over an area of about 1 million km² (fig.1). The total cultivated land estimated to be 3.5 million ha, or about 4% of the total area. About 88 % of the total cultivated area consisted of annual crops and 12% consisted of permanent crops.

Agriculture accounted for about 17% of Egypt's GDP and provided employment to 38% of the labour force (Ministry of Economic Development, n.y.).

In its long term agricultural strategy (until 2017) (Ministry of Agriculture and land Reclamation) the government emphasizes the need to considerably increase the water use efficiency. The agricultural sector uses more than 80% of the total demand for water.

Figure 1: Location of Egypt *(MOED-Egypt 2007*).

Water is one of the most precious resources in Egypt. Much has been done, but still a lot remains to be done in the field of water resources development and management. The water scarcity in Egypt is, most of the time, related to a lack of management capacity. In the case of Egypt the main constraint to agricultural development will not be the availability of land, but of water. The demand for water will increase in the near future while the physical availability of water remains constant. The major challenge facing water planners and managers will be to balance demand and supply of water. The rising demands of water have necessitated the improvement of the performance of irrigation systems and increasing water use efficiency. The less the water resources are, and the more the demand is, the more valuable water is. This is the case in Egypt, where rainfall is rare and deserts cover most of the country's area, except for a narrow strip of cultivated land and urban areas along the Nile river course and Delta.

Egypt needs to formulate water saving strategies and action programs at larger scale for irrigation projects. They need to be integrated with operational programs, to have the maximum benefit. The integration of water saving policies includes developing appropriate mechanisms of water management and the establishment of water resources authorities, or other institutional arrangements. National programs that improve the institutional capacity to manage water resources are likewise needed.

The Ministry of Water Resources and Irrigation, MWRI, formulated a water policy program to assist the ministry in identifying, evaluating, and implementing policy adjustments and institutional reforms that lead to improved water use in agriculture. The examined issues are diverse and complex, ranging from legislative reform and measures to protect water quality, to increased private sector involvement in the management of Egypt's irrigation systems.

Performance improvement of irrigation systems is not only accomplished by technical interventions. More importantly the institutional framework needs to be improved in to order improve the effectiveness and efficiency of system management, operation and maintenance. Enhancing farmers and private sector participation in operation and maintenance of the irrigation system is now being adopted as policy by the MWRI.

This paper highlights the efforts towards improving the water use policies and efficiency through harmonization and integration of water saving options and the promotion of water saving policies and guidelines in innovative projects in Egypt. One of the main goals of such projects is water saving through the introduction of the new techniques at all operational levels (tertiary, distribution, branch and main levels). At the same time, the research highlights the need to introduce the concept of integrated water management and the accompanying operational techniques at the district level in the command area of the project. The study investigated the state of policies and the possibilities for integrated approaches of water management and the required collaborative development. Moreover, it studied the selection process of indicators for the assessment of water saving options at different operational levels.

Irrigation History in Egypt

In the past, the problem of irrigation in Egypt was the large variation in water supply (fig.2). The amount of supply was more than enough, however, most of this supply comes during a short period (August- October) and so a large part goes to the sea. During spring and summer periods

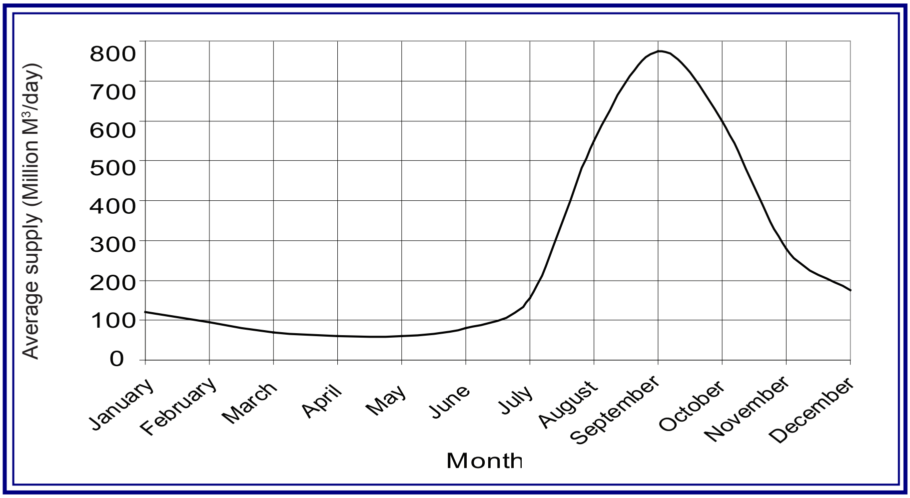

Figure 2: Average supply of Nile river *(WMRI Technical Report-2009)*

Even before constructing the High Aswan Dam (fig. 3), the main barrages on the river were built (Delta Barrage upstream of the two branches of the Nile and other barrage on the Nile itself in Upper Egypt) and many new canals were excavated. There was a big risk during high flood years and during low flood years, as the system did not enable the operator to control the excess of water during the high floods or to store the water to be used during the low flood year period. A better distribution between years was achieved by the construction of High Dam during the 1960's. Due to these efforts, cultivated land could increase from 3.05 Million acres in 1821 to 8.0 Million acres in 1997 and the cropping areas also increased from 3.05 Million acres to 15 Million acres. (WMRI Technical Report, 2009)

Figure 3: High Aswan Dam *(MWRI,2006).*

II – Water resources in Egypt

As water demand from sectors such as municipalities and industry is increasing, the development of Egypt's economy strongly depends on its ability to conserve and manage its water resources. The Nile River is the main source of water for Egypt. Under the 1959 Nile Waters Agreement between Egypt and Sudan, Egypt's share is 55.5 km³/year. Figure 4 shows the water balance for 1993-1994.

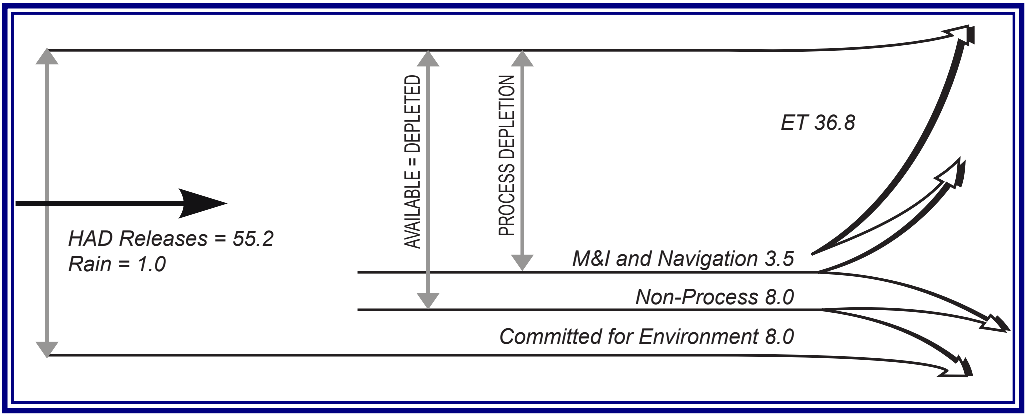

Figure 4: Water budget for Egypt's Nile River based on 1993/94 water balance data. *Source: Molden et al., 1998.*

The water resources include conventional and non-conventional water resources

- Conventional resources such as:
  - annual rainfall,
  - surface runoff and
  - groundwater
- Non-conventional resources such as
  - Shallow groundwater
  - Drainage reuse
  - Treated Sewage
  - Desalinated water

Figure 5 shows the shares of the various sources to Egypt's total water availability. Egypt has about 2,400 km of shorelines on both the Red Sea and the Mediterranean Sea. Desalination could, therefore, be used as a water source for domestic use in many locations. However, desalination of seawater in Egypt has been given low priority so far, because the cost of treating seawater is high compared with other sources, even unconventional sources such as drainage reuse. In remote areas where the cost of constructing pipelines to transfer Nile water is relatively high, desalination is sometimes feasible to provide domestic water.

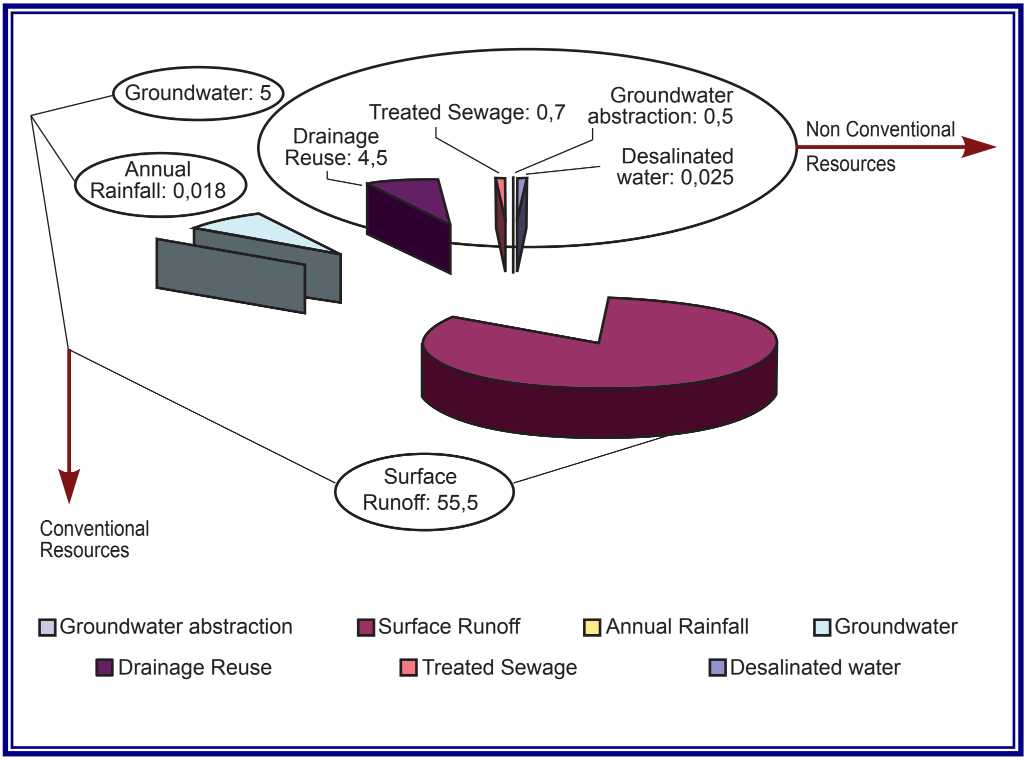

Figure 5: Conventional and non-conventional water resources in Egypt. *Source: Elkassar, G. 2008*.

The future use of such resources for other purposes (agriculture and industry) will largely depend on the rate of improvement in the technologies used for desalination and the cost of required energy. If solar and wind energy can be used as the source of power, desalination can become economic for other uses. It may be crucial to use this resource in the future if the growth of water demand exceeds the available other water resources. Brackish groundwater with a salinity of about 10,000 ppm can be desalinated at a reasonable cost and can have potential for use in agriculture.

Non-conventional Water Resources

Other sources of water can be used to meet part of the water requirements. These sources are called non-conventional sources, which include:

- The renewable groundwater aquifer in the Nile basin and Delta
- The reuse of agricultural drainage water
- The reuse of treated sewage water

These recycled water sources cannot be considered independent resources and cannot be added to Egypt’s fresh water resources. These sources need to be managed with care and their environmental impacts evaluated to avoid any deterioration in either water or soil quality.

Water Challenges in Egypt

There are a number of government institutions engaged in the development of the water and land use in the country. The water and agricultural policies and strategies are affected by different natural conditions and human activities.

These challenges and gaps in the current operation of water and land sectors include:

- Securing water and food supplies
- Meeting basic needs
- Valuing water & land
- High population growth rate
- Increased industrial activities
- Lack of governmental funds to achieve proper maintenance and rehabilitation of system components
- Enforcement of water related laws and regulations
- Protecting the ecosystems
- Managing operational risks
- Lack of users' participation in system planning, design, operation, and maintenance

These challenges delay the improvement of the system management and result in low water use efficiency, and increase conflicts among water users to resolve these issues. The challenge of water management in Egypt is to convert the management approach from a single sector supply based approach to an integrated water resource management strategy which considers all different water use sectors, the different driving forces and their impacts. Furthermore, it should manage both the supply of water and the demand. Hence, water can only be managed effectively if all the uses of the resource become better known. Subsequently, it will be possible to implement water saving strategies and policies to implement them. The present policy approach reacts to increased demand by increasing the supply. In the future, the aim is to reduce the demand and introduce water saving policies at all levels. Figure 6 gives an overview of the main water policy domains and the related stakeholders and issues.

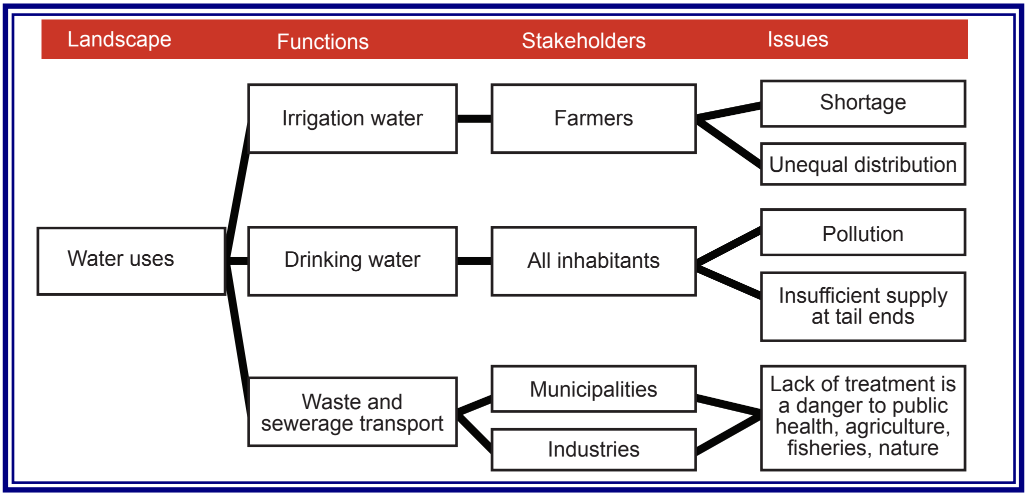

Figure 6: Water policy domains. *Source: Elkassar, G. 2008.*

III – Water use promotion policy

Agro and Hydro-Ecological Zones in Egypt

The rapidly growing population in the country puts considerable pressure on the scarce natural resources and there is an urgent need to develop agricultural production and water use systems that are more efficient and sustainable. These should be based on an initial assessment of the physical and biological potential of natural resources, which can vary greatly. 'The hydro-ecological zonation (HEZ) and the agro-ecological zonation (AEZ) approach present a useful preliminary evaluation of this potential, and ensures that representation is maintained at an appropriate bio-geographic scale for regional sustainable development planning' (Elkassar, 2008).

The Food and Agriculture Organization (FAO) produces this AEZ in each country to assess the crop production potential and length of the growing period zones. It is very useful as it describes the area within which rainfall and temperature conditions are suitable for crop growth for a given number of days in the year. These data, combined with the information on soils and known requirements of different crops, can be used to assess the potential water requirement and hence crop productivity.

Such an approach would facilitate the investigation and identification of appropriate techniques, capacity building needs, participating stakeholders, required legislation, economic tools, incentives, finance, as well as social implications. Egypt has a total area of about one million square kilometers, under arid and hyperarid climatic conditions, of which only a small portion (3% of total area) is agriculturally productive (source?) The country can be divided in 4 main agro-ecological zones having specific attributes of resources base, climatic features, terrain and geographic characteristics, land use patterns and socio-economic implications.

Such main zones could be identified as follows (see figure 7 and table 1):

1. North Coastal Belts: including North West Coastal Areas and North Coastal Areas of Sinai.
2. The Nile Valley: Encompassing the fertile alluvial lands of Upper Egypt and the Delta and the reclaimed desert areas in the fringes of the Nile Valley.
3. The Inland Sinai and the Eastern Desert with its elevated southern areas.
4. The Western Desert, Oases and Southern Remote Areas: including East Owenat Tock and Drab El Arabian Areas and Oases of the Western Desert.

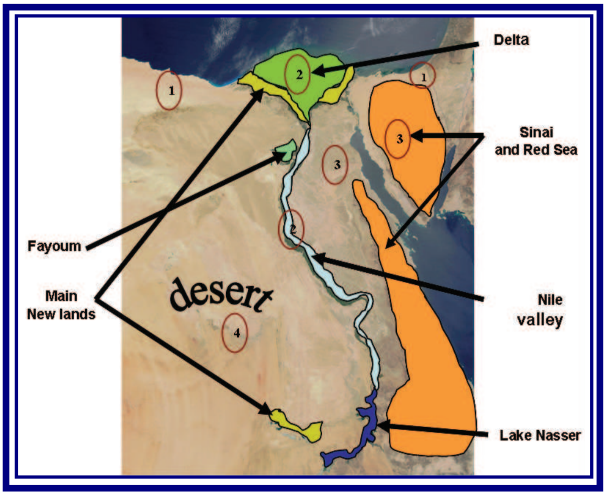

Figure 7: Map of Agro-ecological zones in Egypt. *Source: Elkassar, 2008.*

Table 1: Agro-Ecological Zone Parameters and water management issues in Egypt.

Name	Land parameters	Water parameters	Main management concerns
Lake Nasser	n.a.	• volume; • water level;	• storage and release of water; • spilling peak flow
Nile Valley	• rather flat • clay soils • impervious subsoil	• artificial water supply; • medium groundwater depth; • fresh groundwater;	• pump irrigation • Preventing drainage to river • new crop Varieties
Fayoum	• steep slope; clay soils	• shallow and stagnant groundwater; • inflow of surface irrigation water;	• irrigation by gravity • drainage to lake Qarun • water quality • environmental activities
Delta	• flat; clay soils	• fresh to saline groundwater • most surface water from Nile	• pump irrigation • improvement of old land • on-farm management • sub-surface drainage • water quality management • salinity control • water depth for navigation
New Lands	• flat to heaving • sandy soils	• saline groundwater • all surface water from Nile	• Irrigation practices and improvement of new land • on-farm management • sub-surface drainage and expected problems • water quality management
Sinai and Red Sea	• hilly to mountainous • steep slopes • sandy/rocky soils	• some rain • flash floods	• storage and release of water; • spilling peak flow
Desert	• sand dunes	• deep ground water • fresh or saline	• deep wells for irrigation; bottled water • Industrial activities

Source: Elkassar, G. 2008.

IV – Water distribution system improvement

To achieve on-time water deliveries, Egypt started a national program on improving the main delivery system (branch canals). This involved improvement of the main delivery system through:

- Rehabilitation of water structures along these canals such as intakes, cross regulators and tail escapes to minimize water losses from canal.

- Replacement of the old control structures with new ones with radial gates to provide automatic control for the downstream water levels to cope with farmers demand and abstraction.
- Re-modelling the canal cross-section to improve the canal hydraulic characteristics and conveyance efficiency, and to bring the cross section back to the standards of the original design. The re-model-ed cross section was made to allow for water storage during the non-irrigation times, particularly during night time.
- Turn-outs and off-takes are also planned to be installed along the branch canals such as facilities at the head of each mesqa (the ditch at tertiary level), pumps, pump stands, and pump sumps. Energy dissipation basins are also constructed at the head of each mesqa.

One of the main targets of this paper is to review and analyze water saving options included in the application of the Irrigation Improvement Project (IIP package), (MWRI, 1997). The IIP consists of a combination of physical and institutional improvements of the main irrigation delivery system and the farm level irrigation delivery and application systems. These improvements include renovation and improvement of canals, downstream water level control, conversion from rotational flow to continuous flow, mesqa improvements, organization of farmers into water users associations and technical assistance through the Irrigation Advisory Service (IAS) (Shalaby *et al.,* 2007).

There were significant improvements in mesqa conveyance efficiencies before and after IIP measures were implemented. Conveyance efficiencies appear to increase from an average of around 60-65% to around 90-95% as a result. These ‘local water savings’ are translated into reduced deficits of water supply at the farm level and reduced degradation of the water quality (Shalaby *et al.,* 2007).

While it appears that water delivery efficiencies and distribution uniformities along the canals and mesqas have improved significantly as a result of IIP, on-farm water application efficiencies have not been equally improved. As part of IIP, efforts were made to demonstrate precision land levelling on demonstration fields in each command area. The implementation of a full package of on-farm water management improvements is be expected to gradually result in additional ‘local water savings’. These savings can be captured and distributed locally in the system. In addition, improved on-farm water management supports higher crop yields and crop quality. (Shalaby *et al.,* 2007).

Organizational and regulatory framework

The performance of the irrigation system significantly depends on the capacity of the organization that manages and distributes water. Poor performance of irrigation schemes can often be traced back to organizational structures. They are characterized by the empowerment and delegation of responsibilities and the clarification of the line of command within an organization and between organizations. The water management organizations are mainly governmental (Shalaby *et al.*, 2007).

Water User Associations (WUA), ‘is a private organization owned, controlled and operated by member users for their benefits in improving water delivery, water use and other organizational efforts related to water for increasing their production possibilities’, (MWRI, Irrigation Improvement Sector, 1997). Within the context of institutional reform in the irrigation water sector, establishing Water Users Associations allows farmers to perform activities which are more difficult, or impossible, for them to do individually. These associations perform functions which allow the farmers to manage parts of the irrigation system more effectively (Shalaby *et al.,* 2007).

In terms of administrating the irrigation system, a WUA can mobilize local resources to reduce the costs of managing the system for the government. A WUA can provide the procedures and mechanisms to have the canals and other tertiary channels cleaned, maintained, and operated on schedule. In addition, such associations can act as arbiters to local conflicts in the area.

Since there is a need for the government to interact with the farmers, the WUA can act as a representative for the farmers. Through the association, various extension programs can operate. Such organization can also serve as a means to channel the needs and desires of farmers to the relevant government agencies. They can provide such services by acting as a communication channel between the government and the farmers. (Shalaby *et al.,* 2007)

Water control and automation

One of the objectives of irrigation system improvement is to increase the reliability of irrigation water supply to meet the water demand more efficiently and effectively. Water supply that meets demand could be provided either by rotational or continuous flow. Continuous supply requires stable water levels in the main and secondary canals (Elkassar, 2007). The gate hoisting mechanism on the canal control structures are operated manually. This causes difficulties to adjust gate openings in response to rapidly changing demand. As a result, there was often too much or too little flow in the canal. Fluctuation of water levels in the canal would promote bank instability and unreliable supply to the secondary canals. To resolve this issue, the government initiated certain programs and pilots to introduce automated operation of water structures (Shalaby *et al.,* 2007).

Irrigation automation is the use of mechanical gates structures, valves, controllers, and other devices and systems to automatically divert water in the desired amount and sequence. Automated systems can reduce labor energy and water inputs and maintainor increase farm irrigation efficiency, Labor saving and convenience are often major considerations in mechanizing irrigation. While convenience and labor saving are major consideration in many countries, better water control and increased farm irrigation efficiency may be the primary considerations in countries where labor is both plentiful and relatively low cost. Automation also enhances the use of tail water return or reuse systems and can reduce overall energy costs by making surface irrigation more attractive compared to alternative systems that use more energy.

Water Saving Strategy in IIP

Water saving has come to be seen as one of the main objectives of IIP, (Elkassar, 2007). It is expected that continuous flow will contribute to this by enabling and encouraging farmers to take water in a more rational way, without over-irrigation (although in the absence of conclusive evidence from a fully working example there has been a concern among operating staff that it might have the opposite effect). So far as it is a pre-condition for implementing mesqa improvement, continuous flow also contributes indirectly to water saving by eliminating losses from traditional low-level mesqas. However, it should be noted that the aim of improving equity implies that at least part of any savings will pass directly to tail farmers who suffer from water shortages at present. Many of these farmers re-use water which is ‘lost’ at present by irrigating from the drains. In some areas, there is also semi-formal re-use at secondary level, implemented by the Irrigation Districts. The overall saving at the branch canal level may therefore be rather limited. IIP interventions are relevant to all of these. The physical improvements should largely eliminate the possibility of direct losses from canals and mesqas (especially tail losses).

Harmonization and Integration of Water Saving Options

As presented in the paper by Shalaby *et al.* (2007), different water saving options could be integrated to save water in the water distribution system:

- Improving the water delivery system,
- Using the Telemetry system to improve the system of real-time information and management,
- Reuse the drainage water to increase water use efficiency,
- Conjunctive use of surface water and groundwater,

- Using optimal crop pattern,
- Automation of the irrigation structures.

In the meantime, different water saving options could be integrated to save water on the farm level by:

- Leveling the farm land,
- Improving of farm ditches and mesqas,
- Cultivating crops which are suitable to the climate of the area,
- Using gated pipes in the areas where sugarcane is cultivated,
- Using sprinkler/drip irrigation in the newly reclaimed land,
- Cultivate short duration rice varieties,
- Maintain the field ditches, and enhance farmer's involvement,
- Enhancement of continuous flow strategies with night irrigation concept
- Establishment of WUAs and encouragement of private sector participation (Shalaby *et al.,* 2007).

The (MWRI, 2006) in its summary report for the National Water Resources Plan until 2017, has identified several specific situations that give rise to mismatching, which can be grouped into three general categories:

1. Under- or over-estimating crop water demands under free cropping choices, including cropping patterns and calendars.
2. System constraints, such as canal capacity, system storage capacity, and lag time.
3. External factors, such as climatic change and unanticipated drainage water reuse.

Water shortages have resulted from lack of information about cropping patterns and calendars. Furthermore, some cropping pattern and calendar choices by farmers were unsuited the Nile system delivery capacity. Information on crop selection and the dates of planting and harvesting is essential for good water management. However, there is no routine, accurate, and systematic transfer of this information from farmers or the Ministry of Agriculture and Land Reclamations (MALR) to the MWRI. Both ministries recognize that matching real-time irrigation water demands with water deliveries is an important step toward an efficient, demand-driven irrigation system.

Concept of Integrated Water Management at the Operational Level

The smallest management unit of the MWRI structure is the district; irrigation district and drainage district, where engineers are in direct contact with users.

This level of management is the most important level to introduce innovations for the improvement of performance of water allocation and management. MWRI is now implementing the integrated water management concept in a number of pilot districts. To implement this concept, reorganization at the district level is carried out. The new organizations are called Integrated Water Management Districts (IWMD) (see figure 8), which integrate all MWRI activities in each district (Elkassar and Abou ElFotouh, 2008).

The objectives of such policy were shown in the (USAID, 2008) report for the IWRM at District level and can be summarized as follows:

- Devolution of operation and maintenance responsibilities and decision-making to the local

MWRI entities at the district level.

- Integrate the different water resources within the district into the district water budget and allocation programs. These water resources would include canal water, drainage water, groundwater, rainfall, etc.
- Involvement of water users and non-governmental organizations in water management decision-making at the district level.

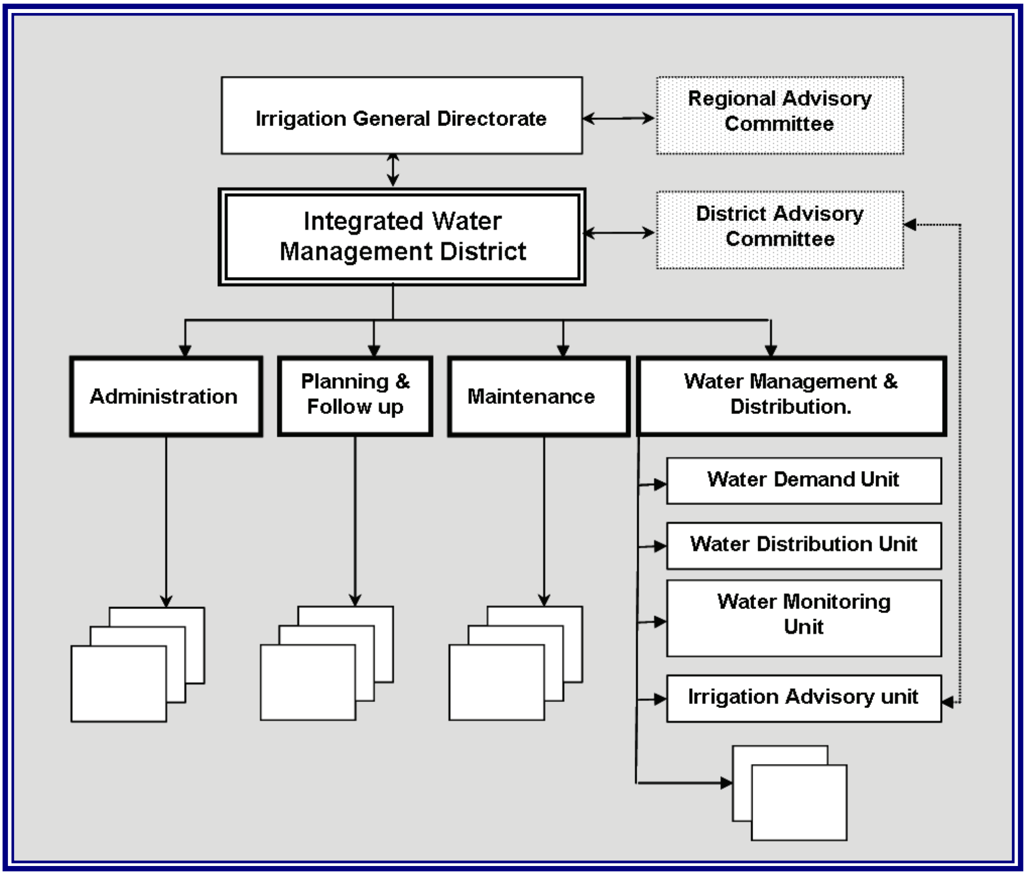

Figure 8: Organizational Structure of Integrated Water Management District *(Elkassar and Abou ElFotouh, 2008).*

Hence, it is expected that the IWMD will have an important role in water allocation and water saving. The IWMD will be responsible for scheduling, through consultation with water users (represented by water users associations) the pre-set quota of water for the district.

V – Main findings

The IIP may contribute indirectly to reducing surface run-off and percolation losses both by avoiding over-irrigation by farmers at the head of the system and by improving on-farm water management. Drainage re-use is not a core intervention of IIP, and it must be borne in mind that in general any increase in irrigation system efficiency reduces the scope for drainage re-use by a corresponding amount.

The IIP will not directly lead to reduced crop water consumption, but it is obvious that any changes in the agricultural system can be more easily implemented in a well-regulated irrigation system providing reliable, flexible and equitable water deliveries. The net overall effect of IIP in achieving water savings is difficult to predict. This is partly because the distribution of water losses in the existing system between the different components (e.g. canal tail losses, percolation losses etc...) is not well known. More importantly, any savings due to local increases in water use efficiency in IIP areas will be used to supply water to tail areas that suffer water shortages. At present they rely on direct irrigation from drains for part, or all, of their supplies. This substitution of water previously lost to the drains, for water previously taken from the drains, will be neutral in terms of overall water savings (FAO)

Action Plan Strategy and Expected impacts:

- Development of strategies to balance irrigation water demand with water supply.
- Establishment of better collaboration between farmers, the MWRI and MALR for determining actual real-time irrigation demands at the directorate and district levels.
- Establishment of a national policy for managing the transfer of real-time information about water supply and demand.
- Improvement of the Nile system operations, which are critical to the Egyptian agricultural economy.
- Movement toward a real-time, demand-driven water distribution system.

Reducing the water consumption by agriculture can be seen as an effective measure for increasing water productivity. The gradual replacement of sugarcane with sugar beets; the reduction of areas where rice is grown; the replacement of currently used varieties of rice with varieties that have a shorter lifecycle, higher productivity and less water requirements; the development of new crop varieties using genetic engineering that have higher productivity and less water consumption, and the design of indicative cropping patterns are effective means for increasing water productivity. The following diagram (figure 9) can assist in planning for securing water need and assessment of crop production, also illustrating different management levels. The following diagram illustrates possible interventions at each project stage to ensure obtaining the expected outputs and to have a sustainable project’s benefits.

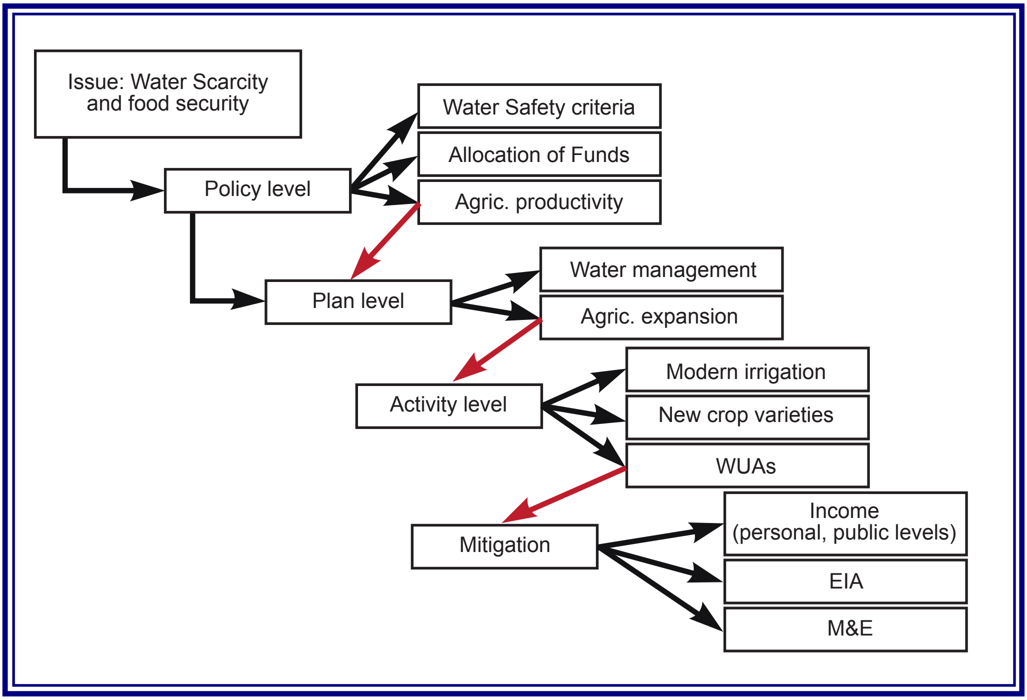

Figure 9: Layout of possible interventions at each stage of project *(Elkassar and Abou ElFotouh, 2008).*

VI – Conclusions and recommendations

The paper describes the integration of water saving measures into a water management policy by drafting a logical framework for future policies and new guidelines for water saving in the country. This logical framework aims at providing a tool for researchers and decision makers to enhance their capacity to analyze and evaluate the effectiveness of the current water saving policies, Furthermore, it also supports identifying measures and priority actions for strengthening and improving integrated management policies for water saving, in particular for the case of Irrigated Agriculture Projects in Egypt.

Different water saving options have been considered, and integrated, to stimulate optimal water savings and crop productivity at different operational levels. Integrating and harmonizing all the water saving options will result in optimal water saving and management on the national level. It could be concluded that implementing of the irrigation improvement project did not result in obvious water saving although the preliminarily results indicate that the application of continuous flow may amount to a large amount of water saving.

The proposed work focuses on the quantification of the changes that are anticipated by the technical interventions through a set of criteria at delivery and on-farm levels, e.g. equity of water distribution, water availability/sufficiency, agricultural practices, project management, agricultural productivity etc.

The following system management innovations could be addressed:

- Sustainability of water sources (durability, quantity and quality)
- Physical improvement of the delivery system
- Implementation of integrated water/land management

- Improve agronomic practices
- New operational techniques
- Farmers participation (WUAs), and institutional reform
- Decentralisation of decision making
- Improve socio-economic return and marketing
- Private sector participation

The study demonstrates that effective water saving policies, in the framework of an integrated water management approach, requires institutional changes and capacity building in the sense of an opening of participation processes to all relevant stakeholders. This can be reached relatively easily by allowing not only water users to participate in the water boards, but also other interested and affected stakeholders (private sector).

Integrated water-resources management should be linked to social and economic development and should address land and water uses and conservation. The results and recommendations presented can help in reviewing, coordinating and updating national water policy, legislation, and institutions to guide the preparation of water-resources assessments and to promote the use of sustainable management practices to meet the growing needs for water. The participation of all relevant stakeholders is essential for IWRM and also for an effective implementation of the necessary water saving strategies.

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