Ministry of Water Resources and Irrigation US Agency for International Development

Egypt Water Policy Reform
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Task Order 815

WATER ALLOCATION POLICY AND DATA SYSTEM OPTIONS

Report No. 69

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Development Alternatives, Inc.
INTERNATIONAL RESOURCES GROUP

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1. Introduction

This study of water allocation policy and practice in Egypt reviews present practice and identifies issues that are expected to emerge over the next 15 to 20 years[1]. The initial findings on water allocation and delivery issues primarily relate to the irrigated agriculture sector, which is by far the largest water user. The report contains information on the following aspects of water allocation policy and practice.

Section 1: The basic nature of policy analysis and its linkages to past efforts
Section 2: Primary emphasis, ideas and framework for policy analysis
Section 3: Criteria for water allocation
Section 4: Assessment of constraints in water delivery system
Section 5: Data and information systems for field operations
Section 6: Data and information systems for central planning
Section 7: Recommendations

Our basic sources of information and ideas include:

- Review of reports of past projects and studies;
- Interviews with key officials in the Ministry of Water Resources and Irrigation (MWRI) and the Ministry of Agriculture and Land Reclamation (MALR);
- Interviews with USAID officials; and
- Interviews with water users and observations during field visits.

Reports and data from the MWRI National Water Resource Policy Project, the Agricultural Policy Reform Project, the Strategic Studies Project, and the Irrigation Improvement Project provided useful information. Interviews with the Ministry staff, both in Cairo and in the field, and guidance of the WPAU staff were useful sources of information for the study.

1.1 Problem Statement

The Ministry of Water Resources will face major challenges in the future if it is to its primary objective of managing water resources to support the socio-economic activities of the country. The most obvious challenges are:

- the expected population growth,
- related increase in industrial and agricultural activities,
- the resulting increase in demand for water, and
- possible deterioration of water quality.

The increased demand for water, in view of its limited supply, will result in water stress in the agriculture sector. The National Water Resources Planning Project (NWRP) estimates that the amount of water per feddan will decrease by 27% from 4,510 m^3 to 3,272 m^3, if the

[1] The study is sponsored by the Water Policy Advisory Unit (WPAU) of the Ministry of Water Resources and Irrigation and USAID.

planned horizontal expansion program is fully implemented (NWRP, *Facing the Challenge*, 2002). With reduced horizontal expansion scenario, available water supply is expected to decrease by 18%. Given the strain on water supply as demand increases, water allocation decisions have the potential to cause conflict. In the future, therefore, water allocation decisions must be derived from a policy that is effective and efficient in allocating available resources, and it transparent and fair to all users. A brief discussion of available water supply and demand is presented below. Refer, also to Annex 1 for detailed description of the present water supply and demand balance.

The population of Egypt is expected to grow from the current 68 million to 83 million in 2017, and the government wants to increase the inhabited area from 5.5% to about 25%. Also, the government wants to increase the irrigated area from some 8 million feddans to about 11 million feddans by year 2017. As a consequence, the demand for water will increase very significantly.

Comparatively, the available supplies will basically remain the same since the Nile is by far the largest source of water, and Egypt's allocation is fixed at 55.5 billion m^3/year. The government estimates that about 3.4 billion m^3 can be developed from groundwater in the western desert oasis areas. Assuming this goal can be achieved, it will still not help to alleviate water stress in the old lands. Also, available groundwater is deep fossil water, which is a non-renewable resource and its exploitation must be approached very carefully. Farmers are increasingly using groundwater in the delta region, and the Ministry is also installing public wells to alleviate water shortage in downstream reaches of the canal commands. However, this is not "new" water, since the wells are pulling water from the shallow aquifer connected to the river and main canals.

Table 1: Water Balance for Nile system (Bm^3/year)

	Current (1998)	Future (2017)
Inflow	**57.1**	**56.8**
Nile	55.8	55.5
Rainfall	1.3	1.3
Outflow	**16.3**	**17**
To Sea & Lakes	16.3	14.4
Expansion Areas	0	2.6
Non-Agricultural Use	**5.1**	**6.1**
Evaporation	3.5	3.6
M&I	1.6	2.5
Agricultural Use	**35.7**	**33.7**
Area (million feddan)	7.9	10.3
per feddan (m^3/year)	4,510	3,272

The other available option is to increase water supply in the old lands by increasing the reuse of drainage water. The Ministry already pumps drainage water from the main drains for mixing with fresh water in the main irrigation canals. In the future, one might consider the feasibility of using drain water from the intermediate drains. However, this reuse option has limited scope because of serious environmental concerns. First, the quality of water in agricultural drains has deteriorated in the recent past due to domestic and industrial discharges. Second, the increased use of drainage water will reduce outflow to the northern lakes and the sea. NWRP (2002) estimates that, due to drainage water reuse, the maximum reduction in outflow to the sea will correspond to an outflow of 10.8 billion m^3 in the year 2017, compared to the present outflow of 14.5 billion m^3.

1.2 Basic Nature of Policy Analysis

This study to assess water allocation and delivery options initially trys to define the foundation and starting point for policy reform initiatives aimed at achieving more efficient and effective water management. It seeks to stimulatet a thought-process and dialogue among all stakeholders, and will not, at this point in time, provide definitive answers. The study will also serve as a step toward implementing an integrated information and data management system for water allocation and delivery decision-making.

In short, the aim of the study is to provide the data, the framework, and identification of key perspectives for an on-going policy analysis. Given the significance of water allocation in Egypt—where supply is essentially constant and demand ever increasing—it is important to not lose sight of all different options. The process of identifying options and prioritizing them, will not, at this juncture, result in the formulation of concrete policy. Much additional work, including analysis and field-testing, is required before we can formulate policy and associated strategies and instruments.

1.3 Current Policy

Current policy is largely defined by actual water distribution and delivery practices, and a large amount of information is available on these topics, both written and verbal. However, little information is available on the underlying policy for water allocation. For example, in response to the question "what criteria is used to allocate water to users in various sectors and within agriculture sector?" the most frequent answer is that there is a priority scale, whereby city and industrial water use has the first priority. Information related to water allocation policy and practice is summarized below, and the reader is referred to Annex 2 for a more detailed description.

- Municipal and industrial water requirements are met first. The remaining water is allocated to agriculture based on information about the anticipated cropping pattern provided by the Ministry of Agriculture.

- Adjustments to water allocation are made in response to requests from users. That is, "allocation" in reality is used to refer to actual day-to-day operation of the delivery system.

- Water allocation and adjustment decisions are made at the central level of the MWRI. Water allocation is volume-based at the main system where each directorate can get its water quota. Downstream, water is allocated to agricultural users on a full demand basis.

- Water delivery to farmers is on a rotational basis, with the operational constraint that a certain water level in the branch canals is to be maintained. Rotational water delivery, therefore, is used as a mechanism for limiting users' demand. Otherwise, there is no volumetric or other criteria to limit how much water farmers can take.

- Farmers can pump all the water they need from their *mesqa*, once it receives water during its rotation. Farmers at the upstream end of the branch canal often divert more water causing water shortage at the downstream end. The downstream farmers then may pump drainage water to compensate for the canal water shortage. The drainage water reuse may adversely affect the productivity depending on the water quality.

1.4 Linkages to Past Efforts

MWRI has made several important efforts aimed at improving water management. Some examples include:

- setting up a water policy advisory unit;

- initiating future planning through the National Water Resources Planning Project (1999-2003);

- water policy reform activities under the Agricultural Policy Reform Project (1995-2002); and

- irrigation system rehabilitation under the Irrigation Improvement Project (IIP, now an in-line sector in the Ministry).

Most of these efforts were aimed at irrigation water distribution and delivery issues, primarily because the crop liberalization policy and the resulting increased rice cultivation drastically changed past water use patterns. The crop pattern changes caused serious mismatch between water supply and demand, which was of immediate concern to the Ministry.

2. Primary Emphasis and Framework

Formulation of an effective policy with respect to water allocation issues is the next logical step towards the objective of better water management. To achieve an integrated water management system, the Ministry not only needs to be concerned with the supply side, but must also work with the users in managing water demand. In the past, the crop regulatory policy, in essence, provided a mechanism to limit the farmers' water requirement. Since the crop liberalization policy was adopted, there is no policy mechanism to regulate how much water a users' group can consume. With no ability to manage the demand, simple delivery and distribution of water, which is the current practice, is not sufficient.

2.1 Emphasis

In the future, therefore, a well-conceived allocation policy that considers both the aspects of water supply and demand will be necessary for an equitable distribution of water resource and its efficient use. The Ministry can do this by articulating a policy that allocates a fair share of available water resources to all users, and then delivering them their due share. That is, we need to identify possible answers to following questions:

- What criteria can be used to allocate water to various users?
- What are the options for quantifying the criteria? and
- What constraints can be expected in implementing the water allocation policy?

2.2 Framework

Policy planning to manage a certain resource would normally consider following aspects:

- Identification of policy objectives,
- Strategy and measures to achieve the objectives,
- An assessment of related constraints that are expected to occur, both physical and organizational, and
- What information and data management systems will be necessary to support effective decision-making and system management?

The overall objective of the Ministry is to improve water management so as to enhance social welfare and promote economic development of the country and its people. More specifically, a water allocation policy will enable the Ministry to distribute available water supplies among all user groups in a fair and efficient way. A fair allocation of water share to all user groups will also communicate the message that water is a scarce resource and its use needs to be limited.

Identification of an appropriate strategy to achieve the above policy objectives is the next logical step in policy formulation. The central strategic focus that has emerged after many discussions, especially with the Ministry officials and the AID Mission, is:

> *There is a critical need to define an appropriate policy criterion for water allocation, and then to use this criterion for determining allocation for various water user groups. Water delivery and distribution among the user groups will then follow the allocation decisions.*

There is a strong consensus among most professionals in the Ministry that it must adopt future policies that emphasize proper water allocation, among various sectors of the economy and especially within the irrigation sector. To avoid future conflict, simple distribution and delivery of available water supply will not be enough. And, for the water allocation policy to be effective, it must start with an allocating mechanism or criterion that is simple to understand and implement, and transparent and fair to all users.

3. Criteria for Water Allocation

As mentioned, this policy issue is of central importance. For the water allocation policy to be effective, it must start with an allocation mechanism or criterion that promotes efficiency, is simple to understand and implement, and is transparent and fair to all users. Before we settle on the most desirable criterion, in the context of Egyptian irrigated agriculture, it is important to briefly review various alternatives.

The present, Egypt allocates water on the basis of crop requirements. This practice, combined with the fact that farmers are free to choose their crops, does not promote efficiency and equity in water use that is needed in the context of impending shortages. In fact, the present practice is not based on a well-defined allocation criteria at all; rather, it just says to the users "take what you want." There is no effective mechanism to limit water users' demand and convey the message that water is a scare economic resource.

One effective alternative to limit demand is to put an economic value on water by asking agricultural water users to pay for its use. This market-based approach, widely practiced in the Western United States, for example, is probably not a valid option for Egypt, at least not for the next 20 years or so. In social settings such as Egypt and Pakistan, therefore, an effective option for creating water scarcity has been to limit physical access to water by practicing rotational water delivery. However, this water delivery practice without a policy to limit demand will likely be ineffective in promoting efficient water use in the future. Given the impending water stress, water users will look hard for all available water sources, including pumping from drains and branch and main canals. This will create serious problems with respect to social equity as well as exacerbate existing environmental issues.

3.1 Future Approach

An innovative approach for managing demand in the future would be to allocate water to various user groups based on a criterion of volumetric quotas for each group, and then schedule water deliveries to the groups based on their quotas. Volumetric quotas can be established for users in various sectors including industrial, municipal, and agricultural sectors. In the agriculture sector, since the Ministry cannot possibly deal with each and every farmer, water users' groups can be defined as those subject to the volumetric quota at the district level, at the branch canal and *mesqa* level.

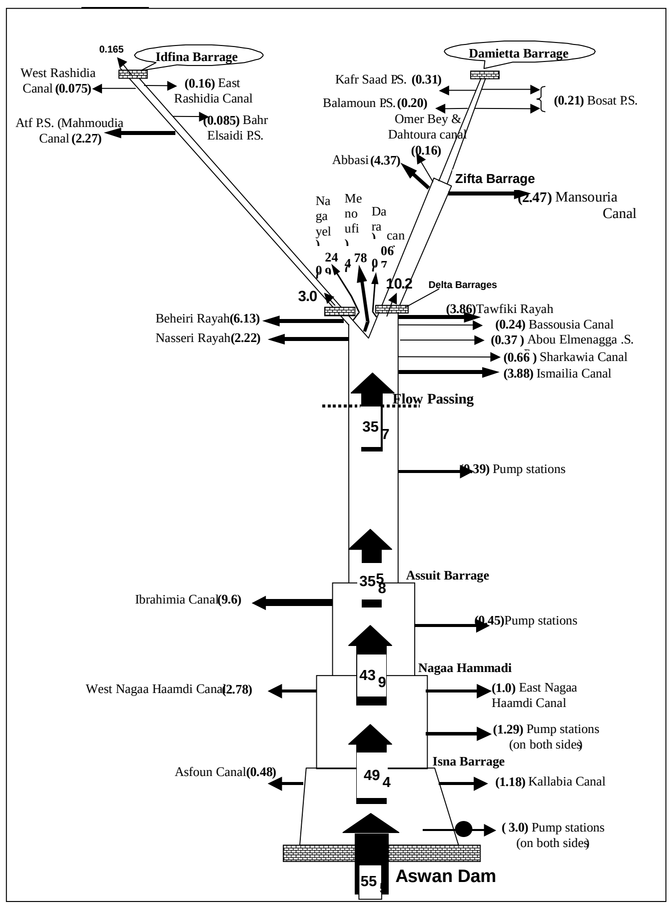
For the Ministry staff, it will certainly be convenient to deal with larger rather than smaller groups. For example, the District Engineer can easily interact with a users group representative at the district level and make sure the group is well supplied with water according to their quota. The user group can supervise further water distribution and delivery to their branch canals and associated *mesqa* service areas. Needless to say, policy implementation will critically depend on current Ministry efforts to promote institutionalization of water users' groups at the *mesqa* and branch canal levels and water boards at the district level.

The volumetric quota approach is simple to plan and implement and is not radically different from the present water distribution practice. Presently, water is supplied to all General Directors on a volumetric basis by measuring the canal flow at predetermined control points. Downstream of this level, however, water is distributed to the branch canals primarily with the consideration to maintain a certain water level so that it can flow into the farmers' *mesqas*. Also, the Ministry field staff tries to supply water relative to the farmers' demand as much as possible. But the demand is not clearly articulated in terms of volumes and neither is the supply monitored in terms of volume. Hence, it is difficult to obtain a good match between the supply and demand. The result is inefficiency and considerable water loss. The volumetric quota can form the basis for defining a common objective to be achieved by the Ministry field staff and the water users.

3.2 Planning for Volumetric Quotas

The next step is to evaluate available options for quantifying the volumetric quota; that is, how much water should be allocated to a certain users' group? In a market-based economy, such as the western United States and Spain, for example, the amount of water allocated to a group is often based on the group's ability and willingness to pay for water.   In places where water markets are still far in the future, such as Pakistan and Egypt, for reasons of equity, one can argue that the quota should be linked to some fair measure of need for water. Also, the quota should promote both efficiency and conservative use of water. Some universal measures that are used to reflect the need are: amount of land to be irrigated, regional climatic differences, soil differences, and crop types.

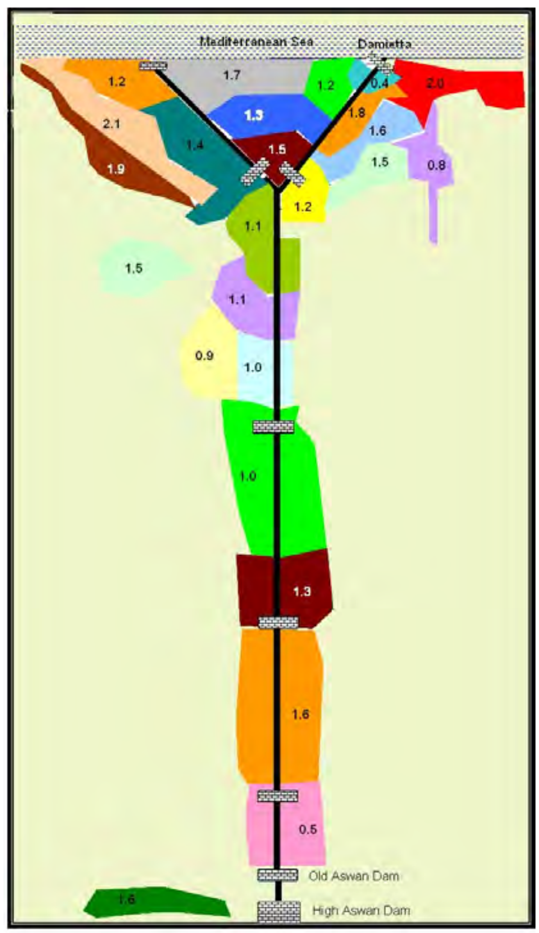
The volumetric quota for water users in agriculture can be based on land area. The land area option would provide a 'base quota'. This base can then be modified to account for additional considerations such as regional climatic differences and soil differences. Thus 'multipliers' can be developed to modify the base quota according to the additional considerations. One needs to be careful in selecting the additional considerations, because they have very important implications for equity. For example, rice cropping consumes more water compared to other summer crops such as cotton, and more and more farmers



* Figures are in BCM

want to cultivate rice. So, if we use crop types as one criterion, then the policy maker is confronted with justifying the basis for giving more water to farmers who grow rice compared to the farmers who grow cotton.

These basic water allocation concepts should not be entirely alien to the Ministry, since its staff use similar practices to distribute water. Currently, the Ministry staff uses the criterion of crop water requirements to allocate water to various regions (General Directorates). The Central Directorate determines the water quota for each directorate on a ten-day interval basis, by using a computer model called the "Nile" model. The model considers the indicative cropping pattern for each directorate, drainage reuse, groundwater use, and municipal and industrial requirements. The model can then provide information on required flow discharges in the main canals and the water releases downstream from Aswan Dam. Figure on the right shows the average annual water releases into principal canals and Nile reaches.



The same Nile model can be used to determine the base quota for various regions, and districts within regions, by using service area as the only criterion. The Figure on the right illustrates the base quotas calculated by the Nile Model for each directorate, based on the irrigation service area.

The base quota can then be modified by introducing multipliers related to additional considerations, such as regional climatic differences. Again, methods are available to do this. For example, the Ministry, in conjunction with Mott Mcdonald Consultant (1991), reviewed the existing estimates of evapo-transpiration (Eto) and showed that there is a degree of consistency in the ratio of ETo among different regions as follows:

Annual ETo	Upper/Delta	1.41
Winter ETo	Upper/Delta	1.59
Summer ETo	Upper/Delta	1.33
Annual ETo	Middle/Delta	1.17
Winter ETo	Middle /Delta	1.17
Summer ETo	Middle /Delta	1.17

These numbers show that the average crop water requirement in the Upper Egypt would be about 1.4 times that in the Delta, and in the Middle Egypt it would be about 1.17 times that in the Delta.

3.3 Operational Aspects

The field level district office will play a critical role in actual system operation. It will work with the water users groups at the district level (water boards) to make sure that the water users' groups are provided with their due seasonal or annual share. The water users can request the amount of water they want on a weekly basis. These requests from all districts can be aggregated at the General Directorate level, which can then ask the central water distribution office the necessary amount of flow in the main canal.

4. Water Delivery and Distribution

4.1 Overview

Water distribution and delivery follows from the allocation rules, in the sense that distribution is basically implementation of allocation policy. For example, when we assume that all users will have a fixed volumetric quota, then the following implications are true for water distribution and delivery.

- Water users groups will be critical, since the Ministry cannot possibly allocate quotas, and deliver the same, for each individual user.

    - In the irrigation sector, water user groups can be formed at the *mesqa* level, branch canal level, and eventually as water boards at the district level.
    - The policy will decentralize water allocation decision-making. District level decision making is critical for effective communication with water user groups, including assessment of water demand. District level decisions are also important to achieve an integrated use of all available water resources including surface water, groundwater and the reuse of drainage water.
    - The policy will promote Integration of water management functions at the district level including irrigation, drainage and groundwater. Integrated water management districts (IWMDs) will use all available water resources to meet their fixed volumetric quotas.

- The physical delivery system must be capable of regulating and measuring flow discharges so that all user groups are properly served their volumetric quotas.

    - Physical irrigation system (delivery canals and related control structures) may need rehabilitation and upgrading for distributing water based on measurement of flow rather than water level. One option towards this end is for the government to reemphasize its commitment to IIP.
    - It will be important that water user groups take water at predetermined fixed points so that water distribution among all groups can be effectively monitored to ensure equitable distribution (IIP single point pumping and related technology including the considerations of continuous vs. rotational water delivery).
    - A telemetry system can be very effectively used, both for system monitoring and control. Presently, monitoring only provides information on water levels, whereas it has the potential for providing flow discharge information if appropriate sensors are added to determine the gate opening. Telemetry can be used effectively for remote-controlled gate operations in the delivery system.

4.2 Assessment of Constraints

This section identifies constraints to policy implementation in the water delivery and distribution system and makes tentative recommendations for ways to resolve the constraints.

4.3 Measurement-based Flow Control

The primary objective of the water allocation policy is to better manage supply and demand, by allocating each user groups a volumetric quota. It is, therefore, important that the delivery system be able to monitor the amount of water delivered to various user groups. That is, the water delivery and distribution system must be managed by monitoring flow discharges rather than the current practice of monitoring water levels.

Measurement-based flow control is not an entirely new practice for the Ministry staff since it is already used in some parts of the system. The Central Directorate for Water Distribution has established a measurement-based flow control system for the principal canals, which feed different directorates. Canal flows are measured at all important control points and the information is used to deliver the required quantities of water to various irrigation directorates (please refer to Annex 3 for a detailed description of current water delivery and distribution practice). All that is needed is to extend this practice to the points where water is delivered to the district canals and, in turn, to water user groups in the district.

Some important means for monitoring canal flows already exist. The telemetry system is one example, which has been in place since the mid-1980s. It is an extensive and comprehensive water monitoring system that has gauging stations at all key control points of the irrigation delivery system. Currently, it provides information on water levels at all main and secondary canal intakes, but not the flow discharge. However, the basic structure is there, and, with minor improvements, it can also provide information on flow discharges.

There are some important constraints to implementation of the measurement-based flow control in the irrigation water delivery canals. The channel cross-sections, especially for the distributary canals, are excessively large. To obtain the desired water level in these large canals, one must introduce flow much greater than necessary to satisfy the crop water requirement. This is the main reason why water delivery and distribution system is operated based on levels rather than flow.

Another major problem with the distributary canals is that they have extremely small bed slope, with essentially no flow especially if the users are not pumping water from the canals. It is, therefore, extremely difficult to measure flow in these canals except at the control gates where water is diverted from the main canal. But, most of the control gates have deteriorated with age and are not in good working condition.

The practice of excessive mechanical dredging to remove weeds, over time, is one reason for the large sections. The large cross-sections are also good for the farmers, since the zero-slope large channels provide good storage water during the off-rotation period. A cost-effective good solution to this problem is not obvious. One immediated reaction to the problem would be to reduce the channel crossections through a rehabilitation program. But, considering the massive scale of the problem, the cost considerations will preclude this option.

4.4 Physical Condition of System Infrastructure

Most of the water control infrastructure, especially flow regulation gates, has deteriorated with age and needs to be replaced. Many control gates in the district and branch canals do not operate well and are locked in place. Addressing this issue will also provide an opportunity to introduce more modern types of control gates, since the existing ones are not easy to regulate. Again, there will be important cost considerations since the rehabilitation will be expensive.

The telemetry system—considered an essential to for good system management—is another example an area that requires system rehabilitation and modernization. The system has been used to monitor water levels at a large number of the control structures in the irrigation system. Since its installation in mid 1980s, there has been a revolution in information technology, and the system has deteriorated with age. Replacement of the water sensors, especially, is very difficult as there is not good compatibility with sensors that are available in the market. The telemetry system can be updated in the future to monitor the flow discharge, in addition to flow levels. This will make the flow measurement-based-management possible, which is a basic requirement for the water allocation policy implementation.

4.5 User Participation in System Management

Active participation of water users will be essential for allocating and delivering water based on volumetric quota, since, in practice, the quotas can only be implemented for groups of farmers. Especially in the agriculture sector, the Ministry staff are limited to the delivery of water, according to the quota, at an aggregated level such as the irrigation district. Water users associations, therefore, will be critical in the future and can embrace the following essential functions.

- User groups will participate in determining volumetric quotas.
- The user groups can receive water from the Ministry staff, e.g., the district engineer, and then the groups will manage its further distribution among all group members.
- User groups can provide important information to the Ministry staff, be involved in decision-making, and assume joint responsibility for system operation and maintenance. This will give the system managers a direct pipeline into user activity plans and thus give them better knowledge of demand. Also, it gives them better knowledge of the condition of various parts of the system.

The Ministry has considerable experience with water user associations, starting with their introduction through the Irrigation Improvement Project in mid 1980s. Since then, water user unions were introduced in the new land, Collectors Users Associations (CUA) introduced by the Drainage Authority (EPADP) to carry out routine maintenance tasks on the tile drainage system, and more recently the Water Boards for irrigation management at the district level. The Ministry also has institutionalised an Irrigation Advisory Service (IAS), which is responsible for helping farmers establish water users associations.

Initially WUAs had no legal status, but that changed with the modification of Law 12 in 1994 known as Law 213, wherein WUAs were defined as legal organizations at the *mesqa* level. The same Law 213 also introduced the Water Users Unions, which are more or less defined in the same way except that these are applicable for the old-new lands.

4.6 Decentralized Planning and Decision-making

Currently, lower level system managers, Inspectors and District Engineers, are expected to carry out plans made by the Irrigation Directorate. In the future, decentralizing planning and decision-making will be essential for effective user involvement in decision-making, since only the lower level officials have direct access to a large number of users. District Irrigation Offices, especially, will be critical in planning water allocation quotas and in actual water delivery to user groups.

The kinds and extent of decisions that can be decentralized to make overall irrigation operations more responsive to farmer needs will need to be explored. The technical innovations listed above, together with the mechanisms for user involvement in decision-making, will provide most of the data and information needed by District Engineers to make good decisions.

4.7 Integrated Water Resources Management

System managers, especially at the field level, will need to have good knowledge of how much drainage and groundwater is available for use, in addition to canal water. Consequently, managers cannot plan canal deliveries to make maximum use of these alternative water sources. Where water quality is a problem, overuse of drainage water may cause reductions in yield, a problem that might be mitigated by different patterns of canal delivery. The Ministry has recently explored ways to integrate various water management functions at the district level, through its program of Integrated Water Management Districts.

5. Data and Information Systems for Field Operations

Integrated water resources management is the way to manage water resources (River Nile water, groundwater, and drainage water-reuse) in the future. In order to carry out this dynamic process and coordinate multi-sector requirements, an integrated digital resources management approach to data systems is essential. There are currently numerous spatial and tabular database activities for different applications in private and government sectors in Egypt. The government, in the last five years, has carried out several data and systems integration studies. Recommendations have been made providing details on how to coordinate and integrate data systems nationally. Most of the recommendations are excellent and should be implemented in the future when the resources are available. More importantly, however, the "open-access" of data concept (i.e., unrestricted access of water resources data) has to be fully accepted by the government. Presently, digital resources are available in isolated cells and units with highly restricted access; data sharing does not really exist at any level in Egypt.

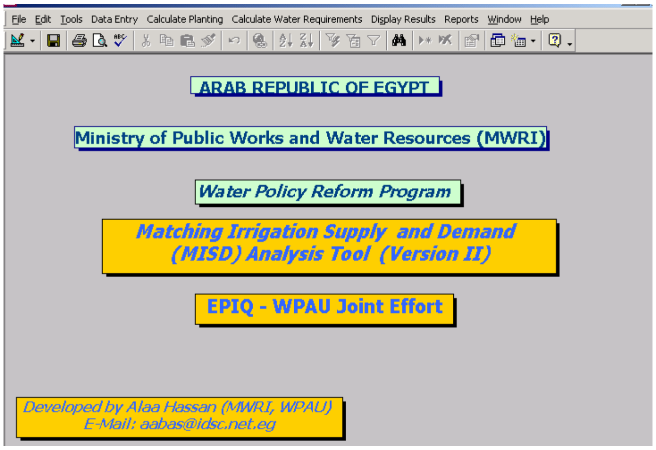
Data and information systems for water allocation and delivery within the Ministry is the main focus of the present study. The objective of this study component is to review the existing MWRI data and information systems in order to identify data and system requirements for recommended future water allocation and delivery options. As a result of the literature review, interviews with key staff at several data cells, and field visits, the Team decided to primarily focus on the data management functions at the irrigation district and the central administration. This focus should allow us to assess what will be required in order to integrate water resources data processing procedures and provide timely information to improve water management decision making at all levels. With a bottom-up data integration approach, the data management activities at the Irrigation Directorate and General Directorate levels can be simplified.

5.1 District Data Systems

The 204 District Irrigation Offices under the direction of 22 Irrigation Directorates carry out the water allocation planning and water delivery scheduling activities during each cropping season. As a part of the integrated water resources management process the government intends to require that the irrigation districts provide more precise data on water demand based on actual crops in the field by monitoring their water by discharge, and thereby tracking the quantity of water used. The District Irrigation Offices do not currently have the necessary tools and technologies to monitor the water allocation and delivery needs that will be required in the future.

In 1999, under the Matching Irrigation Supplies and Demands (MISD), APRP-Water Policy Activity, a pilot program to conserve water was initiated by the MWRI and MALR in five irrigation districts (Abou Hummus, Abou Kebir, Beba, East Isna, and Luxor). The MARL district staff provided timely cropping patterns and calendars to the irrigation district offices, and the District Engineers used the crop information to calculate the water requirements and discharges for all canals in each district every 15 days. The canal and district water needs for the current period and the next two weeks were then sent upward within the MWRI so the Irrigation Directorate could plan and allocate the required amount of water to each district. At the same time, the District Engineer sent information on canal rotations and water availability to the Agriculture Administration. In turn, the agriculture extension officers shared this information with farmers in the irrigation districts so they could manage their pumping operation at the *mesqa* level.

Two major information technology tools, Crop Information Management System and MISD Model, were developed using Microsoft Access DBMS and Excel spreadsheets under the MISD to facilitate data management, analysis, and communication requirements. Additionally, a water monitoring program at the district level was implemented in 2001, in the same five districts to ensure that each district had received the requested quantity of water every 15-day period. Results from the MISD pilot sites were very positive; the information technology tools are powerful and easy to use.



The water monitoring program is essential for the future fixed volumetric quota criteria because, in addition to matching water supply and demand, the irrigation district staff needs to know the balance of water quota minimally every 15 days. These data will allow the District Engineers to determine the overall status of irrigation so that they can make an informed decision concerning whether or not to revise the water allocation from the Irrigation Directorate to the Irrigation District and/or reschedule water delivery within the district.

In the near future, the District Engineers will also provide seasonal and/or yearly water volumetric quota and water balance information to water user groups (e.g., Water Board, WUAs, private water companies) so the groups can precisely plan, operate, and manage their fixed quantity of water accordingly. Appropriate water monitoring tools, such as current meter, canal map, and automatic water level recorders where telemetry stations do not exist, should be made available for every District Engineer. Wherever possible, data from telemetry stations from the Irrigation Directorate should be utilized.

5.2 Issues and Constraints Related to Implementation of Water Allocation and Delivery by IWM Districts

Two integrated water management districts have been established in the Delta region since 2002. However, it is too early to asses their effectiveness and how they will function. Grouping all the MWRI resources (i.e., engineers from the irrigation, groundwater, and drainage departments) within the district under one roof should strengthen technical capabilities, allow financial resources to be shared, and create a “one-stop-shop” for the farmers and/or water user groups. The district is responsible for all water management activities, such as water allocation, groundwater development, and drainage water-reuse for all sectors.

Currently, data and information are typically recorded in a register at the district level. Only 69 out of the 204 districts have PC computers and they are mainly used for administrative and financial activities. As a part of the decentralized decision-making effort, the Ministry intends to provide computer training, hardware, software, and special data management and analysis tools at all administrative levels, especially at the district-level in the near future.

With the anticipated tasks and responsibilities under the integrated water management approach, the MISD Model should be modified with additional database tables to store and manage the groundwater (government and private) and drainage water-reuse data. These new tables should to be properly coded and linked to the district canal data. The water demand calculations for each 15-day period can be modified accordingly to clearly identify the different water supply sources and amounts for each canal and the district.

For the district water monitoring program, additional MISD database tables can be developed and linked to the canal table to store and manage the water level and discharge data. A data management interface is needed to facilitate the data transfer from the telemetry DMS system to the MISD Model. With the flow data, the model can easily be used to prepare a report to compare crop water needs and water delivered on a district-wide basis.

The Water Management Research Institute, National Water Research Center is currently developing a new Nile Model for the Ministry. The Study Team visited the group and learned that the new model is virtually the same as the MISD Model. Unfortunately, the Institute staff was not aware of the MISD Model so they are building the new model instead of modifying the MISD model.

5.3 Data Management and Communication System Options

To improve data management and communication within the Ministry in the future, several possible options were identified by this study. One data management option is to store and manage: (1) all detailed data (i.e., cropping patterns and calendars, canal scheduling, flow levels, discharges, etc.) at the district level; (2) district water demand and supply summary information at the directorate level; (3) directorate water summary information at the general directorate for water distribution level; and (4) general directorate water summary data at the central level, namely, the Information Center in Cairo. In this case, the district detailed data are only available at each District Irrigation Office. This is a decentralized, distributed database management approach, and it will require good data communications among all the irrigation offices.

Another option is to archive the detailed district data at the central level as well so it can be directly shared and used by everyone within the Ministry. Under this option, it is important for the Information Center to receive the detailed data from each district every 15 days.

There are many ways to upload and download data and information to and from one computer to another. Remote Access System (connect two computers via modem connection), XML protocol, disk file transfer, wide area network, FTP and Internet to name a few. The existing VDCS (Voice and Data Communication System) and MB (Meteor Burst) under the telemetry system may very well be the best option because most of the irrigation districts have one or more RTUs (Remote Terminal Unit), all Irrigation Directorates have access to the VDCS and/or MB, and the main server for the telemetry system at the Ministry is already connected to the Information Center. The VDCS and MB communication system should be further evaluated in terms of costs to compare with other options, especially FTP and the Internet.

5.4 Recommendations

The Team has concluded from its brief review that the MISD data management and analysis tools could be extremely useful for supporting the new water allocation policy in the future. Several recommendations are made for increasing the utility of the data and information management technologies in the field.

5.4.1 DBMS-based Nile Model

The Water Management Research Institute should build the new Nile model by refining the Crop Information Management System and improving and adding three new modules to the MISD Model as discussed below.

The database design and structure of the Crop Information Management System, MALR, should be improved to meet database design standards by reviewing and modifying the data items in each table, if necessary (e.g., Hood - code, district, canal, area), and reconstructing the relationships between tables. The coding systems for irrigation network and irrigation districts should be the same as the codes used by the Information Center. As for the crop code, the MALR coding standards should be used. With consistency in the coding systems, relationships between tables can be easily established. Therefore, queries, forms, and reports can be constructed to display information from several tables at once. At the same time, data aggregation via standard queries can be built for each administrative level. A data export interface should be constructed to facilitate transfer of data from Crop IMS to the MISD Model.

Similar shortfalls exist in the MISD Model, MWRI. The suggested modifications outlined above (data items, tables, relationships, coding systems, and export interface) should be carried out here as well. As indicated in earlier sections of this report additional tables and relationships will be required to accommodate data from the water monitoring and integrated water management district activities. A data management interface is needed to facilitate the data transfer from the telemetry DMS system to the MISD Model. The fixed input data for the model such as Kc, Eto, and effective rainfall, should be updated with the new information from the Water Management Research Institute. These modifications can be done within 3-4 months. It is really unnecessary to build another “Nile” model for the irrigation districts.

For the irrigation directorate, general directorate for water distribution, and central levels, the database technologies should be carried over from the MISD model so water and crop information from the districts can be easily aggregated at each of the administration levels and properly managed at the Information Center using its robust database management systems.

For the three new modules, the Water Management Research Institute needs to focus on the specific functions below.

With respect to the directorate module (run by the Directorate Engineer), tasks include:

1. Import district summary information exported by the MISD district model. The summary information includes 4-5 figures for each district, such as canal water needs forecast for the current and next periods, quantity of water received last period, and balance of water quota at the end of the last period.
2. Calculate canal discharge rates and scheduling for this and next periods.
3. Export the directorate summary data (i.e., canal water needs forecast for this and next periods, quantity of water received during the last period and balance of water quota at the end of last period) to a file and send to the General Directorate for Water Distribution.

Regarding the general directorate module (run by the Directorate for Water Distribution Engineer), tasks are:

1. Import the summary information from the directorate module.

2. Calculate canal discharges and scheduling.
3. Export the directorate summary information to a file and send to the Central Directorate for Water Distribution.

For the central module (run by Irrigation Sector Engineer), tasks include:

1. Import the general directorate information from the general directorate module.
2. Calculate the main canal water demands, flow discharge rates, and Aswan Dam releases for the next 15-day period.
3. Share the water allocation information with all administrative levels via a data communication (i.e., the MWRI Website, Intranet, and/or VDCS).

5.4.2 Hardware and Software

As indicated earlier, 69 out of the 204 District Irrigation Offices have PC computers. Only five out of the 69 have used the MISD Model with the crop data from MALR. To improve water allocation and delivery and implement the district volumetric quota, each district office will need at least two PC computers with the improved MISD Model, Microsoft Office Suite, one laser printer, and two UPS'. One computer should have an Internet dial-up connection and/or be linked to the VDCS/MB telemetry station for direct data communication.

5.4.3 Training

Most of the engineers at the district level have limited experience with computers. In fact, only 2% of the population in Egypt (1 out of 42 people) has a computer. Training on general computer and information technologies, database management, and the MISD Model will be required to improve job performance leading to better water management. Training programs should address real issues of concern to those responsible for data management and communication in the districts. With the new tools and capabilities, the district staff would be able to streamline work processes, improving management and communication, and providing support for better decisions. The trained staff with the new tools will enable the Ministry to decentralize decision-making and delegate more responsibility to the districts in the future.

6. Data and Information Systems for Central Planning

The study team carried out an inventory of databases that support managers and planners in the Ministry. These are considered essential under an integrated water resources management paradigm. At the same time, data management issues were identified with a focus on decentralized water management while maintaining the national water delivery and allocation objectives.

A total of 8 information and data cells in MWRI and MALR were visited. These included the systems in the Information Center, the Planning Sector, the Irrigation Sector, the Central Directorate of Telemetry, the Egyptian Public Authority for Drainage Project, the Water Management Research Institute, the Drainage Research Institute, and the Nile Research Institute (See Appendix D for more details).

6.1 Data Management Issues and Constraints

Many MWRI departments and research institutes in Cairo have well-established digital resources management capabilities. Most of the data/information cells interviewed in Cairo are well equipped with several trained staff members. Almost all of the cells are focusing on a small numbers of applications. The status of database development and applications being carried out, and outputs being produced, are generally limited by a number of constraints, as follows:

- Many cells in the Ministry collect data for a specific application and project. The data is stored in files with limited flexibility for use by others.

- Some of the data sets are not properly coded, stored, and managed in RDBMS.

- No formal/official data sharing and exchange policy, data standards, coding systems, documenting and reporting procedures, coordination, and collaboration within the Ministry exists.

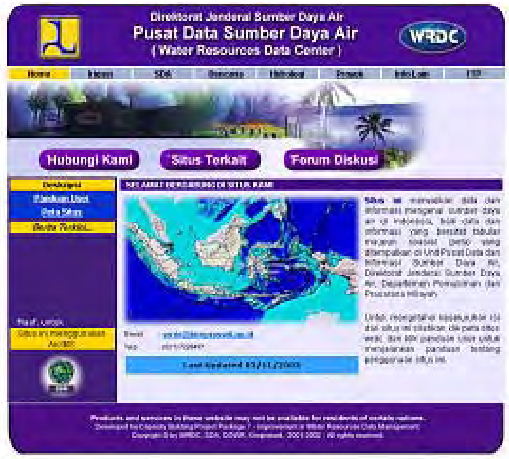
- No overview of the kind of information and data that is available and the means by which others can access this information within the Ministry exists.

6.2 Data and System Integration for Water Allocation and Delivery

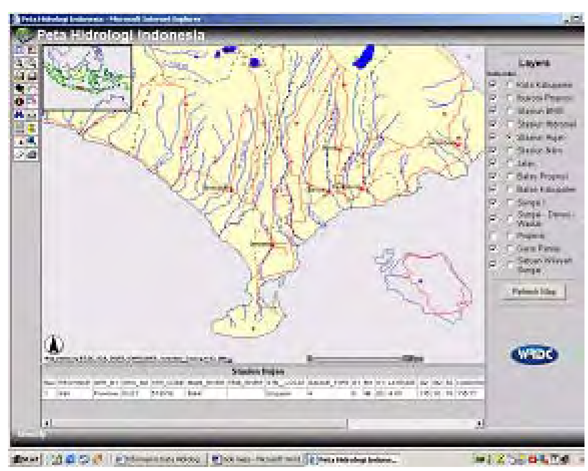
Digital resources are safeguarded by the individual cells in the Ministry. Accessibility of these data is nonexistent. Integration and consolidation of these data are required in the near future to better serve the integrated water resources planning and management process. Without the ability to access data and information for irrigation, groundwater, drainage water reuse, water quality, agriculture, municipal and industrial water uses, navigation, etc. from one integrated data system, it would be extremely difficult, if not impossible to properly plan, allocate, and deliver water to meet the increasing demands of all water user groups in the future. Timely data/information for supporting decision-making is one of the key ingredients to improve water allocation and delivery.

6.3 Options and Recommendations

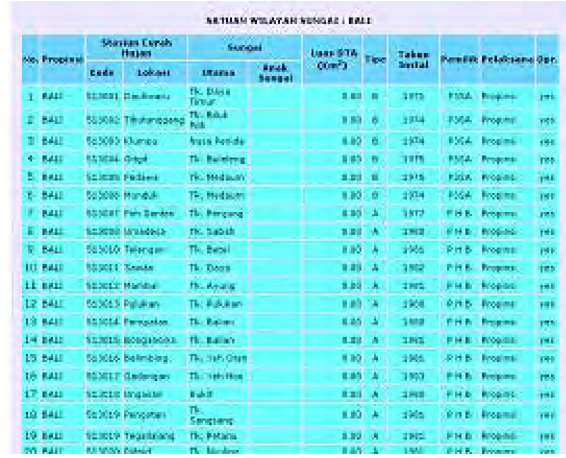
To overcome these data and information problems in the future, a data warehouse should be developed to establish a national water resources data clearinghouse to integrate all the water data within the Ministry. For more information on data warehousing, visit the Water Resources Data Center Website for the Directorate General of Water Resources, Indonesia (http://sda.kimpraswil.go.id/cbpweb) as shown on the right.



The MWRI Information Center is a good place to house such a data system because it already has the hardware (high speed network system), software (Oracle, ArcSDE, ArcIMS, ArcGIS), and trained staff to develop and deploy the data warehouse. With the advanced software packages currently owned, the Information Center has the right tools to convert and load a wide variety of types of data into the data warehouse to create a fully integrated water resources "geodatabase." The geodatabase will not just integrate water and crop data from the 204 irrigation districts, but also map (vector and raster) and tabular data in a standard relational database management system such as Oracle. This approach will allow multiple, simultaneous edits from different departments to mange a geodatabase (of unlimited size) that has a continuous and seamless spatial database and is not titled. In addition, the spatial data can be managed with standard database management tools such as backup and recovery. The data warehouse is a "data-centered" approach so it can support many applications in the Ministry. The benefits of accurate maps of irrigation and drainage systems created by the Information Center will ripple through all departments and field offices. For example, the multi-layer spatial information (i.e., water quality map and administrative boundaries) could allow the Ministry to warn local governments to protect communities against contaminated water supplies.



ArcIMS software can be used to create a map service on the Intranet and Internet to share all the available data and information with more than 30 layers (i.e., roads, irrigation networks, water quality monitoring data, groundwater wells, administrative boundaries, hydrological boundaries, drainage networks, railways, cities, cropping patterns, etc.) as a part of the national water resources data clearinghouse. This will allow decision-makers, managers, and field staff to access the available data and information to perform technical analyses and support planning and operation at all levels. For example, the district engineer can directly download a copy of the district map to his computer to verify the service area of each canal, and resolve any disagreement with the local agriculture administration office. The example on the right illustrates that a geodatabase can provide specific tabular data and information by simply selecting an object, such as a rainfall station, on the map. In reverse, an ad-hoc database query can be performed to find tabular data for a specific rainfall station and simultaneously locate the station on the map.



SATUAN WILAYAH SUNGAI : BALI

No.	Propinsi	Stasiun Curah Hujan		Sungai		Luas DTA (Km²)	Tipe	Tahun Instal	Pemilik	Pelaksana	Opr.
		Kode	Lokasi	Utama	Anak Sungai						
1	BALI	523001	[illegible]	Tk. Daya Timur		0.00	B	[illegible]	[illegible]	Propinsi	yes
2	BALI	523002	[illegible]	Tk. [illegible]		0.00	B	1974	[illegible]	Propinsi	yes
3	BALI	523003	Klumpu	[illegible]		0.00	B	1974	[illegible]	Propinsi	yes
4	BALI	523004	[illegible]	Tk. [illegible]		0.00	B	1975	[illegible]	Propinsi	yes
5	BALI	523005	[illegible]	Tk. [illegible]		0.00	B	[illegible]	[illegible]	Propinsi	yes
6	BALI	523006	[illegible]	Tk. [illegible]		0.00	B	1974	[illegible]	Propinsi	yes
7	BALI	523007	[illegible]	Tk. [illegible]		0.00	A	1977	P H B	Propinsi	yes
8	BALI	[illegible]	[illegible]	Tk. [illegible]		0.00	A	[illegible]	P H B	Propinsi	yes
9	BALI	523010	[illegible]	Tk. [illegible]		0.00	A	[illegible]	P H B	Propinsi	yes
10	BALI	523011	[illegible]	Tk. [illegible]		0.00	A	[illegible]	P H B	Propinsi	yes
11	BALI	523012	[illegible]	Tk. [illegible]		0.00	A	[illegible]	P H B	Propinsi	yes
12	BALI	523013	Pulukan	Tk. Pulukan		0.00	A	[illegible]	P H B	Propinsi	yes
13	BALI	523014	[illegible]	Tk. [illegible]		0.00	A	[illegible]	P H B	Propinsi	yes
14	BALI	523015	[illegible]	Tk. [illegible]		0.00	A	[illegible]	P H B	Propinsi	yes
15	BALI	523016	Belimbing	Tk. [illegible]		0.00	A	[illegible]	P H B	Propinsi	yes
16	BALI	523017	[illegible]	Tk. [illegible]		0.00	A	[illegible]	P H B	Propinsi	yes
17	BALI	523018	[illegible]	[illegible]		0.00	A	[illegible]	P H B	Propinsi	yes
18	BALI	523019	[illegible]	Tk. [illegible]		0.00	A	[illegible]	P H B	Propinsi	yes
19	BALI	523019	[illegible]	Tk. [illegible]		0.00	A	[illegible]	P H B	Propinsi	yes
20	BALI	[illegible]	[illegible]	Tk. [illegible]		[illegible]	A	[illegible]	P H B	[illegible]	yes

To start, the team recommends a Ministry-wide data management taskforce be established and the following issues get resolved immediately:

- Data sharing and exchange policy,
- Data standards,
- Coding systems,
- Documenting and reporting procedures, and
- Coordinating and collaborating on database development.

7. Summary Recommendations

1. Develop policies and practices for volume-based water management at the district level.

    - Set up pilot programs in selected districts to demonstrate flow measurement in district and branch canals;

    - Demonstrate the practice of allocating volumetric quotas for branch canal service areas in pilot districts; and

    - Set up water monitoring programs at the district level for water delivery based on volumetric quotas.

2. Strengthen the current policy and practice for Integrated Water Management Districts.

    - Evaluate current experience and determine future needs; and

    - Strengthen capability at the district level, by providing appropriate hardware and training to the engineers on issues related to integrated water management.

3. Strengthen and implement policy and practice for water users' associations (at the district, branch canal and *mesqa* level).

4. Plan and design appropriate physical rehabilitation and upgrading of irrigation system infrastructure.

    - Conduct a comprehensive review of the on-going IIP program and formulate a plan to strengthen the program;

    - Study and evaluate how to rehabilitate and update the telemetry network, so that it can be more effectively used for the volume-based irrigation system management; and

    - Study and formulate a program to rehabilitate and upgrade control gates in the main and branch canals.

5. Establish Ministry-wide data management and use policy.

    - Appoint a task force to formulate policy on system of coding, standards and ownership; and

    - Build metadata intranet site.

6. Integrate MWRI digital resources via data warehousing.

   - Integrate existing databases;
   - Develop recommendations for building future database; and
   - Improve data communication systems.

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Annex 1: Available Water Resources and Demand in Egypt

1. Available Water Resources

Egypt depends on the Nile River as the main source of water. Egypt's share from Nile River is 55.5 BCM/year, which is governed by the 1959 agreement with Sudan. Additional projects for the augmentation of the Nile flows are jointly planned by Egypt and Sudan, but their future is uncertain and cannot be relied upon for country planning (NWRP, 2000).

Rainfall is scarce and very limited except for the northern parts close to the Mediterranean Sea. The deep groundwater in Sinai and western Desert represents another water resource in Egypt, but it is non-renewable and expensive to exploit. Therefore, its utilization is very limited and the future expansion of its use will not exceed small fraction of Egypt's share of the Nile water.

For more efficient and intensive use of the Nile water, ambitious programs were developed to reuse the agricultural drainage water and the shallow groundwater in the Nile Delta region. The current groundwater use is estimated at 4.5 BCM/year in the delta and and its fringes, which is planned to increases to reach 7.5 BCM/y in the future (Attia, 1996). However this estimate may be affected by the future water conservation programs to meet the increasing water demand. Both farmers and the government pumps use groundwater to supplement canal water for irrigation. Farmers located at the downstream ends of branch canals suffer from water shortage, and tend to use groundwater.

Drainage water reuse is practiced at locations along the canal network where the good quality of drainage water is available to be mixed with canal water. Drainage water in Upper and Middle Egypt returns to the Nile system at about 4.0 BCM/year. In Delta region there are 23 locations for reuse, of which 5 locations discharge drainage water directly to Rosetta and Damietta branches of the Nile River. Other locations discharge drainage water to the main canals. The total drainage reuse is estimated at about 4.0 BCM/year in Delta region including the two Nile branches with an average salinity of about 1000 ppm. In the recent past, however, the quality of drainage water has rapidly deteriorated, especially because most rural population discharge their sewage in the agricultural drains. The pollution of agricultural drains will drastically reduce the reuse of water for irrigation purposes.

2. Water Use

The High Aswan Dam, completed in 1968, provided a high degree of water control to satisfy diverse use in agriculture, municipal/industry, navigation, hydropower generation, and fisheries sectors. Agriculture sector is by far the most water-consuming sector as it uses about 85% of the Nile water. Sectors such as navigation and hydropower generation are non-consumptive sectors but water releases are needed to maintain their operating water levels. Recently, water demand for municipal and industrial sectors has increased with the increasing population.

2.1 Irrigated Agriculture Sector

The agricultural sector currently accounts for over 40% of the total employment in Egypt and about 17% of the gross domestic produce (Oad and Azim, 2002). The current cultivated area is about 8.0 million feddans, where two crops are grown through the year. In some cases, farmers tend to cultivate a third crop (Nili crop) during the period between the summer and winter crops. Until 1992, the government exercised control on how much area was planted with main crops such as cotton, rice, sugarcane and wheat. Presently, farmers are free to choose the crop they want to grow on their lands. However, rice was excluded from this crop liberalization policy, and government can still exercise control on how much area can be planted to rice since it consumes much more water compared to other food crops.

Rice and sugarcane are the two main crops with high consumptive use. The area of sugar cane is about 265,000 feddans, which is concentrated in upper Egypt where the weather is hot. Rice cultivation is currently very popular among farmers and its area has increase to about 2 million feddans. The original design allocation was 0.8 million feddans, and the current operational number is reported to vary from 1 to 1.5 million feddans. Some of the rice cultivation, such as in the northern Delta, is necessary to prevent sea-groundwater salt intrusion, but the Ministry would like to limit this to the minimum necessary. Water requirement for rice is estimated to range from 7000 to 8800 m3/feddan, that for sugar cane about 12000 to 15000 per feddan, and for wheat (APRP, 1998).

2.2 Municipal and Industrial Sector

Water demand for municipal and industrial sectors has started to seriously compete with the agriculture sector requirements as the population increases. Municipal and industrial water uses have the first and second priorities followed by agriculture water use. Fortunately, these requirements are small relative to agriculture water use, and a large part of water supplied to cities and industries returns back and is available for reuse. The current water delivery to this sector, reached about 8.8 BCM/y; 4.2 BCM/y for municipal and 4.6 BCM/y for industry (NWRP, 2000). There is no available estimate of return flow from the sector.

3. Water Balance

Table A1 shows a mass balance of water supply and demand for present (1997 numbers) and the future situation (2017). The current cultivated area is about 8.0 million feddans with total annual diversion per feddan 6988 m^3. As the cultivated area increases, as well as municipal and industrial demand, the diversion per feddan is expected to decrease. Future water requirements for municipal and industries are quite difficult to be determined. These requirements may be affected by improvement of distribution system efficiency, per capita consumption and population growth. Three alternatives were considered in such concern). The MWRI Planning Sector has estimated the municipal water requirements by year 2025 to be about 4.7 BCM/year considering the most realistic development scenarios (Planning Sector, MPWWR, 1995).

The National Water Resource Planning Project (NWRP, 2002) estimates the present total water use for agriculture to be about 55 BCM/year, of which about 37.5 BCM/year is consumptive use. By year 2017, due to expansion of cultivated area by 3.4 million feddans, the Planning Project forecasts the crop consumptive use will need to decrease to about 33.5 BCM/year. The implication is that the per-feddan water use will be reduced from the current 4,510 m^3/year to 3,269 m^3/year, which will impose a serious strain on the agriculture sector (refer Table A1).

NWRP recommends that for future water allocation options, the basic water quota be considered as 3,700 cubic meters per year, assuming all strategy improvements are implemented. This basic quota is an average number for the whole country and does not account for regional differences in climate, soils and other considerations that influence farmers' crop selection decisions.

Ta ble 1.1. Mass Balance of Water Supply and Demand—All Sectors

Item	Present 1997	Future (2017) No improvements	Future (2017) With improvements
Inflow			(billion cubic meters/year)
Releases Lake Nasser	55.8	55.5	55.5
Rain	1.3	1.3	1.3
			Outflow to sinks in the Desert
Expansion Areas	0	1.4	1.1
Fayoum	0.7	0.5	0.5
New Cities	0	1.2	0.7
			a. Outflow to the sea
Nile branches	0.2	0.2	0.2
Drains	14.5	13.3	10.8
Fishponds	0.9	0.4	0.4
			b. Evaporative Losses
Evaporation (Eo)	2.4	2.5	2.5
Fallow	0.7	0.9	0.9
Fish Ponds	0.4	0.2	0.2
M & I	1.6	2.5	2.5
ET agriculture	35.7	33.5	37.0
			Crop Consumptive Use (m^3/fed/y)
Area (million feddan)	7.915	10.263	9.978
ET per feddan (m3/y)	4510	3269	3703

Source: *National Water Resources Planning Project (2002).*

Table 1.2. Water Supply and Demand in the Agriculture Sector

Water Balance for Nile system, Bm^3/year

	Current (1998)	Future (2017)
1. Inflow	**57.1**	**56.8**
Nile	55.8	55.5
Rainfall	1.3	1.3
2. Outflow	**16.3**	**17**
To sea & Lakes	16.3	14.4
Expansion Areas	0	2.6
3. Other Depletion*	**5.1**	**6.1**
Evaporation	3.5	3.6
M&I	1.6	2.5
4. ET (Agriculture)	**35.7**	**33.7**
Area (million feddan)	7.9	10.3
per feddan (m3year)	4,510	3,272

** non-agriculture depletion*

Annex 2: Current Water Allocation Policy

1. Current Policy

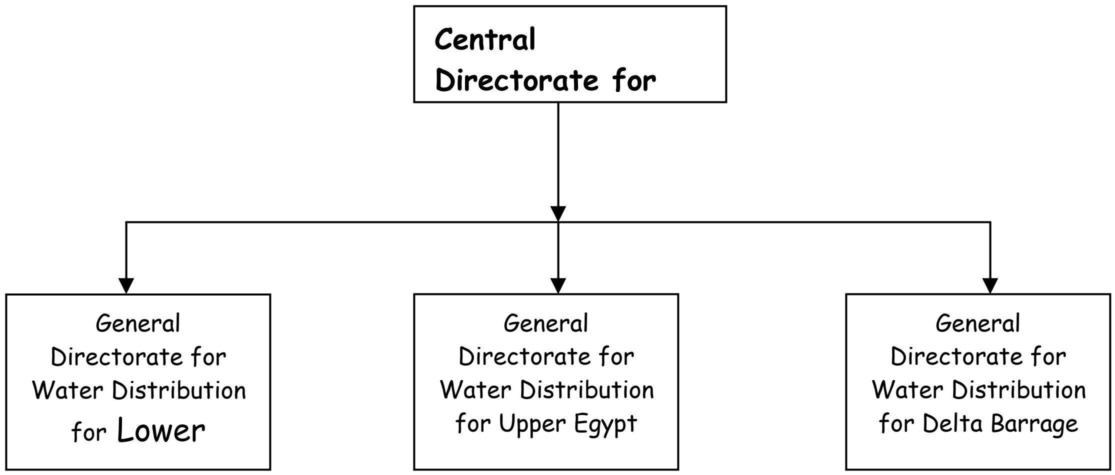
The current practice is largely focused on actual water distribution and delivery, and a large amount of information is available on these topics, both written and verbal. However, no information is available on the underlying policy for water allocation. For example, in response to the question "what criteria is used to allocate water to users in various sectors and within agriculture sector?", the most frequent answer is that there is a priority scale, whereby city and industrial water use has the first priority. Responses related to water allocation policy and practice can be summarized as following.

- Municipal and industrial water requirements are met first.
- The remaining water is allocated to agriculture based on information about the anticipated cropping pattern provided by the Ministry of Agriculture.
- Adjustments to water allocation are made in response to requests from users. That is, "allocation" in reality is used to refer to actual day-to-day operation of the delivery system
- Water allocation and adjustment decisions are made at the central level of the Ministry.
- Water Allocation is volume-based at the main system where each directorate can get its water quota. Further down, water is allocated to agricultural users on a full demand basis.
- Water delivery to farmers is on a rotational basis, with the constraint of maintaining certain water levels in the branch canals. Rotational water delivery, therefore, is used as a mechanism for limiting users' demand. Otherwise, there is no volumetric or other criteria to limit how much water farmers can take.
- Farmers can pump all water they need from their mesqa, once it receives water during its turn.
- Farmers at the upstream end of the branch canal can divert more water causing water shortage at the downstream end. The downstream farmers then may pump drainage water to compensate for the canal water shortage. The drainage water reuse may adversely affect the productivity depending on the water quality.

2. Water Distribution and Delivery

The Central Directorate of Water Distribution at the Ministry is primarily responsible for water allocation and distribution, with three General Directorates in the field (Tanta, Assuit and) (Figure B1). These offices distribute and deliver water to main canals and irrigation directorates. Further down, the irrigation directorate is responsible for allocating water to Inspectorates, which in turns allocate water to irrigation district. The District engineer delivers water to farmers through a rotational water delivery table. The rotation is either two-turn or three-turn according to crop type and physical conditions of the delivery network.

Figure 2.1: Organizational structure for water allocation and distribution



The Nile water released from the Aswan Dam is distributed among regions through barrages and canals, to meet their water requirements. Any unused excess will pass onto the sea through Damietta and Rosetta branches. The canal hierarchy includes principle canals (Rayah), main canals, branch canal and distributary canals. This canal system is called public canals where the government is responsible for its operation and maintenance. The public canal system delivers water to private farmers' channels called mesqas, which serve an area ranging from 50 to 200 feddans each.

MWRI has developed a standard for crop water requirements in different regions on a ten-day interval basis. These water requirements are used to allocate water to these regions or General Directorates. Evaluation of the crop water requirements was conducted by the MWRI in conjunction with Mott Mcdonald Consultant (1991). The study reviewed the existing estimates of evapotranspiration, ETo, and showed that there is a degree of consistency in the ratio of ETo among different regions as follows:

Annual ETo	Upper/Delta	1.41
Winter ETo	Upper/Delta	1.59
Summer ETo	Upper/Delta	1.33
Annual ETo	Middle/Delta	1.17
Winter ETo	Middle /Delta	1.17
Summer ETo	Middle /Delta	1.17

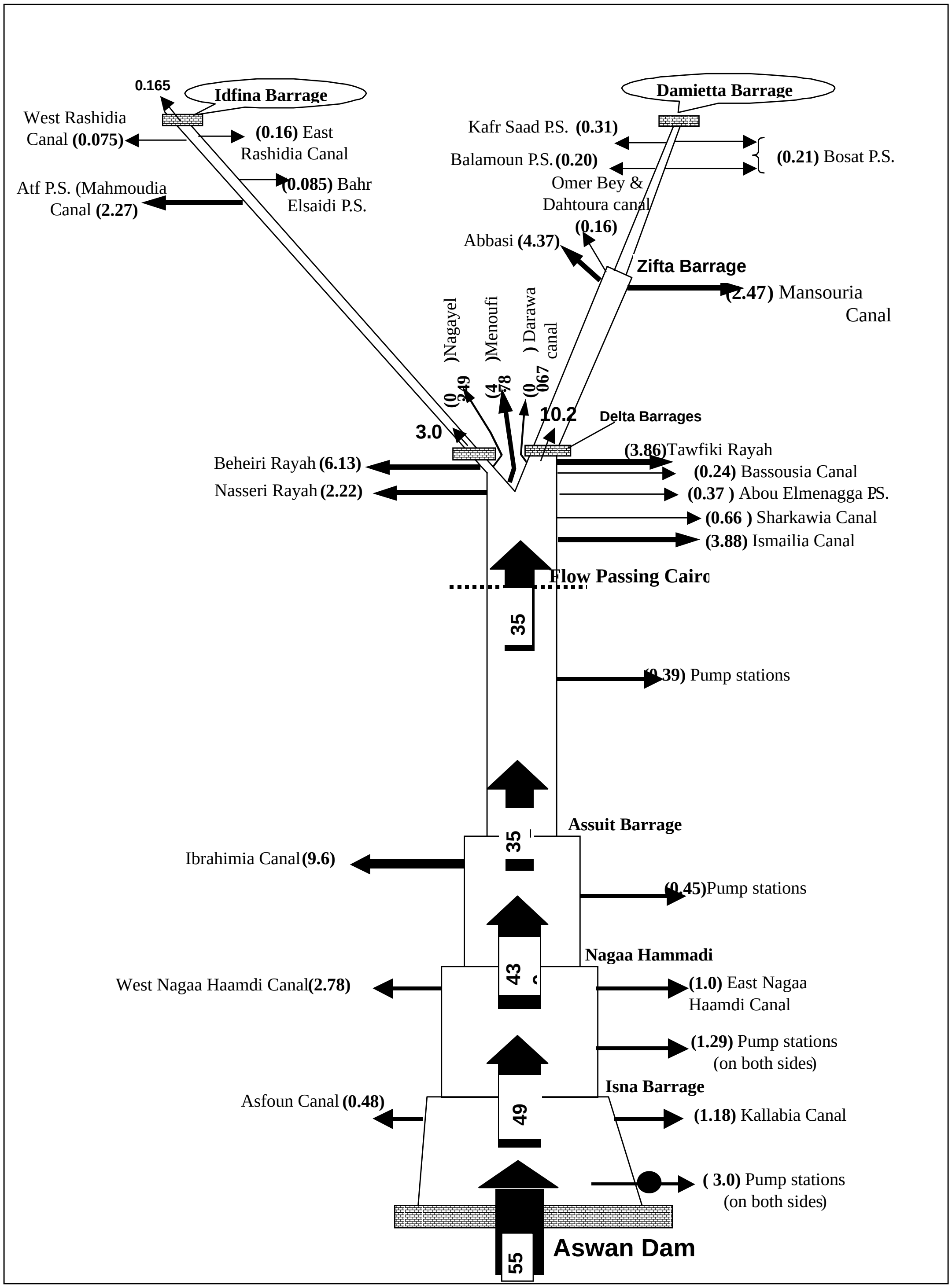
The Central Directorate determines the water quota for each directorate on a ten-day interval basis, by using a computer model called the "Nile" model. The model considers the indicative cropping pattern for each directorate, drainage reuse, groundwater use, and municipal and industrial requirements. The following formula is used as follows:

WR (for a 10 day period) $= \sum_{1}^{2} A_i \times CWR_i$ + (M&I - Reuse – Groundwater)

Where Ai is the area of crop i, CWR_i is the crop water requirement for crop i, M&I is municipal and industrial requirements, Reuse is drainage water reuse, and groundwater is the amount of groundwater to be used at the directorate. WR is the water quota for a certain directorate.

The model can calculate water requirements over the year on 10-day basis. The model can also compile the data on the level of the principal canal that serves more then one directorate. It produces also the proportional distribution among the directorates.

Aswan Releases: The model is used for routing water releases along the river to determine the water releases downstream Aswan Dam and main barrages considering lag time and gain and loss of water through Nile reaches. Figure B2 shows the average annual releases and quota for principal canals and Nile reaches.



** Figures are in BCM/y*

Figure 2.2. Average Volumetric Quotas for Regions.

3. Water Management Issues and Need for a Water Allocation Policy

3.1 Lack of Knowledge About Farmers' Water Requirements

The government previously regulated the amount of land planted to principal crops, mainly cotton and basic food grains. After 1985, farmers were free to choose the crops they wanted to cultivate. While socially desirable, this posed a management problem for the Ministry. The Ministry now must have a reasonably accurate knowledge of farmers' cropping pattern, as a function of time, so that it can match its water deliveries to the crop water requirements. This is a very difficult, if not impossible, job for a government agency because of the very dynamic nature of farmers' cropping decisions and large regional variations.

As a consequence, there has frequently been a large mismatch between water delivery and its use by the farmers, resulting in substantial water losses to the sea. There is very little storage capacity throughout the Nile river system between the Aswan dam and the sea. Any water released from the Aswan Dam must either be used or it will outflow to the sea. It is therefore important to obtain a good match between water supply and demand.

3.2 Absence of a Mechanism to Regulate Demand for Water

The old crop regulation policy provided a mechanism to limit farmers' demand for water. In the absence of this option, there is a need to develop another mechanism to manage demand. Farmers, in essence, can plant any crop and then expect to receive water to satisfy the crop water requirement. One policy option would be to assign a volumetric quota for each group of farmers and then help them decide how best to use their seasonal or yearly allocation.

Irrigation water is presently distributed to each regional directorate on volumetric basis. However, further downstream the system, water is allocated to branch canals and users to satisfy the existing crop water requirement. That is, there is no volumetric quota or limit to how much water can be used in a branch canal or district service area.

3.3 Issues Related to Municipal and Industrial Sector

Although the municipal and industrial sector has the highest priority, there are serious issues related to water use in this sector. For example, the Egyptian Gazette newspaper dated March 6,03 claimed the Cairo city to be the largest user of water per capita, in the world! The main reasons for such large quantities of water use cited were:

- Inefficient water use (e.g. the practice of cleaning houses, streets with water rather than brooming)
- Increased leakage from the supply network
- Insufficient public awareness for water use conservation

4. Future Water Allocation Policy Criterion

Volumetric quotas is a fair and feasible criterion that can be used to allocate water to various sectors, and various groups of farmers within the agricultural sector.

The following tables and figures illustrates calculation of volumetric quotas, for various directorates, based on irrigated land areas.

Table 4.1 Base Quotas for Directorates

Region		Directorate	Area	Basic Quota	Quota based on a multiplier	
				3270	*Multiplier*	Quota
Eastern Delta	1	Qalyobia	372,424	1.2	0.920	1.1
	2	Sharkia	499,394	1.6		1.5
	3	Ismailia	247,000	0.8		0.7
	4	East Dakahlia	558,626	1.8		1.7
	5	Salhia	476,068	1.6		1.4
	6	Damietta	122,401	0.4		0.4
	7	Elsalam	600,000	2.0		1.8
		Total	**2,875,913**	**9.4**		**8.7**
	8	Menoufia	458,700	1.5		1.4
	9	Gharbia	423,340	1.4		1.3
	10	Kafr Elsheikh	546,436	1.8		1.6
	11	West Dakahlia	377,963	1.2		1.1
		Total	**1,806,439**	**5.9**		**5.4**
	12	West Beheira	417,256	1.4		1.3
	13	Beheira	355,499	1.2		1.1
	14	Nobaria*	653,960	2.1		2.0
	15	Nasr	567,619	1.9		1.7
		Total	**1,994,334**	**6.5**		**6.0**
Middle Egypt	16	Giza	335,375	1.1	1.075	1.2
	17	Beni Suef	330,020	1.1		1.2
	18	East Menya	305,310	1.0		1.1
	19	West Menya	290,142	0.9		1.0
	20	Fayoum	457,379	1.5		1.6
		Total	**1,718,226**	**5.6**		**6.0**
Upper Egypt	21	Assuit	308,455	1.0	1.222	1.2
	22	Sohag	387,405	1.3		1.5
	23	Qena	495,075	1.6		2.0
	24	Aswan	166,898	0.5		0.7
		Total	**1,357,833**	**4.4**		**5.4**
	25	**Toshka**	**500,000**	**1.6**		**2.0**
Grand Total			**10,252,745**	**33.5**		**33.5**

* including area of 100,000 feddan irrigated by sewage of Alex

Annex 3: Existing Practices of Water Delivery and Distribution in Egypt[2]

1. Irrigation Organization

1.1 Field Level Organization

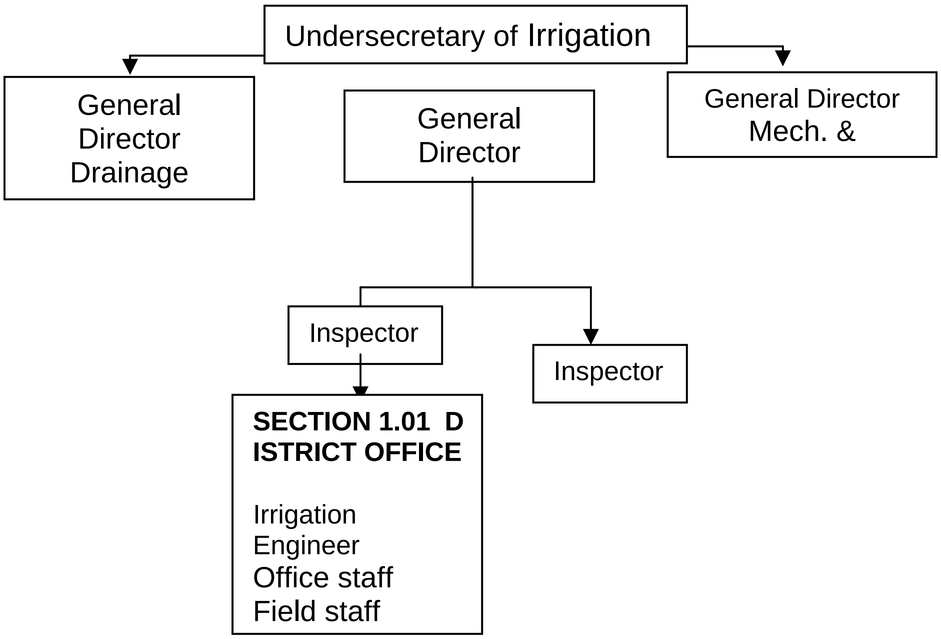
Irrigation Districts are fundamental units of the Ministry since the field offices maintain and operate the irrigation system, and provide water to the farmers. The district is headed by an irrigation engineer with assistance from technical and administrative staff. The district office serves, on the average, an agricultural area of 50,000 feddans. Inspectors, who in turn report to the General Director, supervise the district officers. The General Director, on the average, supervises eight district offices with a total service area of 400,000 to 500,000 feddans. The regional directorates of irrigation, drainage and mechanical and electrical operations are coordinated through the office of the Regional Undersecretary of Irrigation, who represents the Minister (Fig. C1. Field level organization of MWRI).

1.2 Central Organization

The Ministry of Water Resources and Irrigation has three technical departments that manage water to support irrigated agriculture in the country. The Irrigation Department is responsible for managing the irrigation infrastructure and for delivering water to the water users, the Drainage Authority is responsible for maintaining the drains and the Mechanical and Electrical Department is responsible for operating and maintaining all mechanical facilities including pumps for drainage reuse and groundwater utilization. All three departments have separate lines of accountability to the Minister, with separate budgets. At the district operational level, however, work of these departments must be well coordinated since all their activities affect water delivery to the farmers.

[2] The information enclosed herein was taken from a report prepared by Ramchand Oad (2001) ,“ Water Monitoring Program for Integrated Water Management District” EPIQ.

Figure 3.1: Field Level Organization for Irrigation

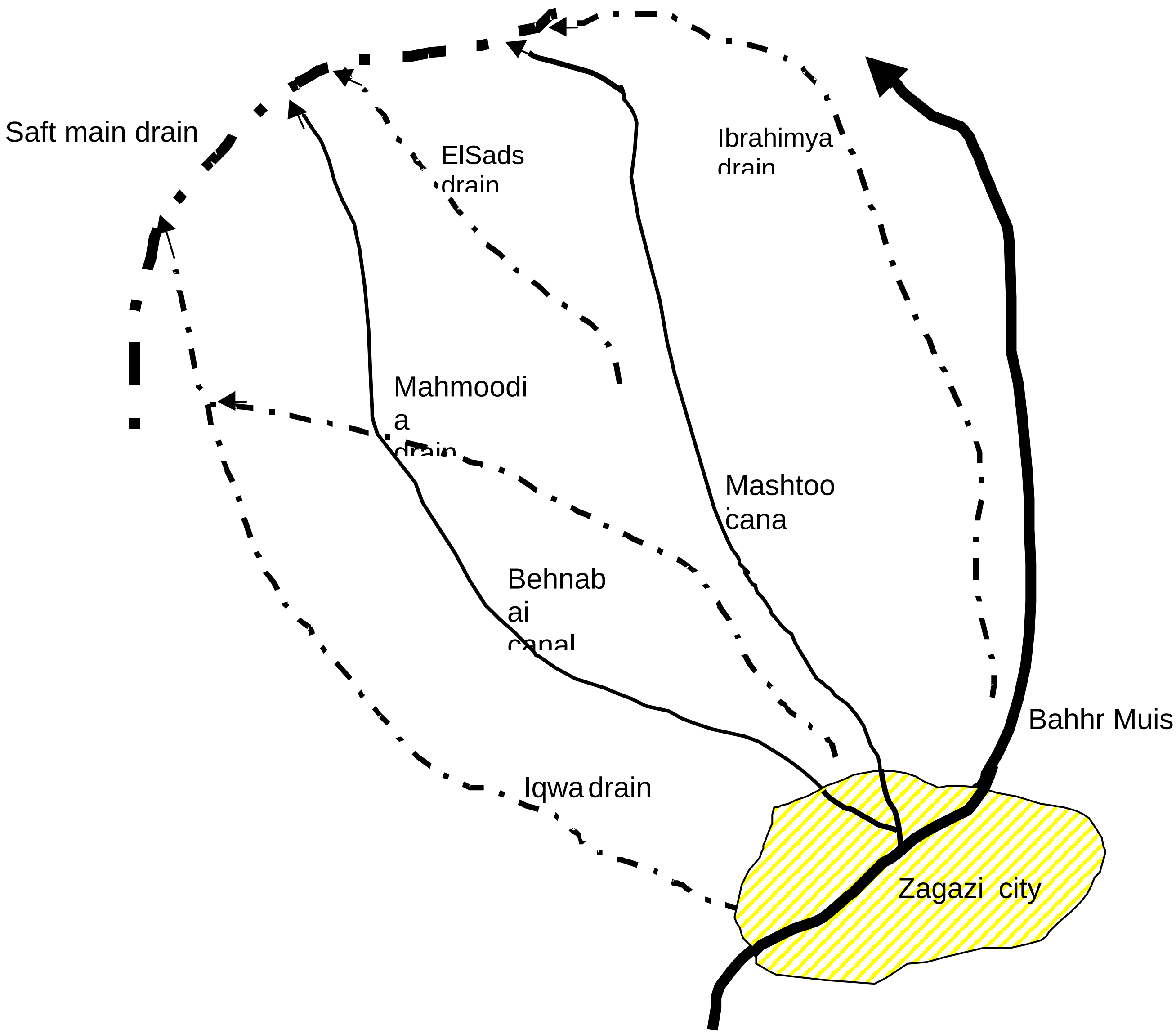


1.3 System Operation for Water Distribution

1.3.1 Field Operations

The district engineer has a large responsibility that includes an efficient and equitable water distribution among all water users. The district receives water through two or three main district canals, each of which feeds several branch canals. The branch canals in turn supply water to the field channels (mesqas), where farmers pump from to irrigate their lands (Fig. C2). The district field staff must maintain sufficient water amount and head in the district canals so that water can flow by gravity into branch canals and their mesqas. Since most canal sections are enlarged, the district staff often puts unnecessary large quantities of water into the canals to obtain the required water surface level (hydraulic head). Water surface levels, therefore, become the controlling parameter for canal operations rather than the flow discharge. This limitation explains why the field staff monitor water levels rather than flow discharge in their canals.

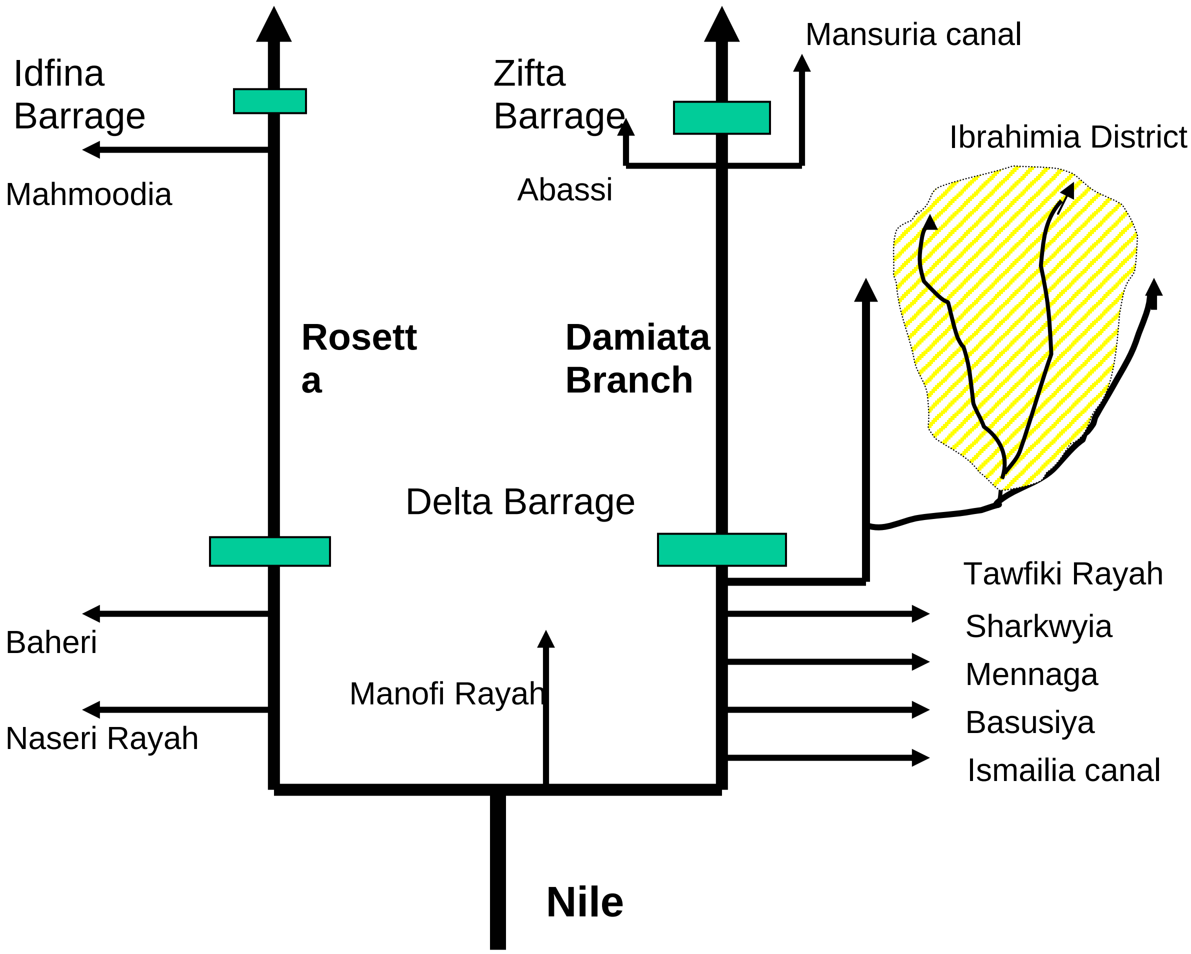
Figure 3.2. A Typical District Service Area—Ibrahimya District



1.3.2 Main Canals

Water diversions at the Delta Barrage, and smaller diversions at the Idfina and Zifta barrages, are the primary source of irrigation water for the delta region (Fig. C3). A network of main canals then conveys water to service areas of various directorates and eventually to the districts. The Ministry has a Central Directorate of Water Distribution CDWD in Cairo with two regional offices, one for the Upper Egypt and the other for the Lower Egypt. This directorate decides how much water is released in main canals at various diversion points on the Nile, and then how that water is allocated for use among various directorates. The main canals are operated by delivering measured discharges and volumes of water at specific point for each directorate. The common practice is to assess the actual water delivery based on the manual readings of the marble gauges upstream and/or downstream control structures then use a suitable formula or chart to calculate the discharge. The readings are usually taken once a day at "6:00 AM". However, in some locations the readings are taken three or four times a day to get better picture of the actual flow. The discharges associated with the levels are not known accurately because of changed canal parameters. The rest of the system is operated by maintaining water levels at key points throughout the system. The proper levels are known from experience rather than from calculation.

Figure 3.3. Irrigation System in the Delta



2. Current Canal Water Monitoring Practices at the District Level

2.1 Water Monitoring

Canals that irrigate the district service area are normally second or third order canals, meaning that water has already passed through a network of main canals since its diversion from the Nile River. At the main canal control points, flow discharge and volumes are monitored to ensure that all irrigation directorates receive their fair share. But, water discharge and amounts are not measured in the district canal and its distribution system (branch canals and mesqas). Presently, the management level of General Director, rather than the District, appears to be pivotal for ensuring an equitable water allocation and its efficient use. In the future, however, the efficiency considerations will require monitoring of water volumes at the district level also, so that the water supplies can be better matched to the allocated volumetric quota.

The Ibrahimya District, for example, receives irrigation water from two canals: Mashtool and Behnabai that take water from the main canal Muis, which receives water from the Tawfiqi Rayah originating at the Delta Barrage (Fig. C3). Canal water level and flow are monitored at the intakes of Tawfiqi Rayah and Bahhr Muis canals, but not for the district canals Mashtool and Behnabai. The South Zifta District receives irrigation water from three canals: El-Atf, El-Khadrawiya, and El-Sahel that take water from the Manofi Rayah, which originates at the Delta Barrage.

2.2 Service Area

Average service area of most irrigation districts in the Delta is reported to be 50,000 feddans. The service area of the Ibrahimya district is about 59,000 feddans, and that of S.Zifta is 42,360 feddans. Farmers within the service area of a given district canal receive water on a turn basis, which in summer for non-rice crops is normally 5 days on followed by 10 days off. For rice service areas, the water rotation is 5 days on and 5 days off. For example, the Behnabai canal in Ibrahimya district is operated on a three-turn rotation:

- Intake to km 8: 5 days on followed by 10 days off
- Km 8 to end: 5 days on followed by 10 days off
- In the third five-day period: water is shutoff in the whole canal.

On Mashtool canal, there is two-turn rotation:

- Intake to middle: 5 days on followed by 5 days off
- Middle to end of district 5 days on followed by 5 days off.

The Mashtool farmers receive more water since they cultivate more rice. The farmers in the South Zifta District receive water on a turn basis also, which in summer is 5 days on followed by 10 days off.

2.3 System Operation

The district canals have flow regulation gates at the intake, where water levels upstream and downstream of the gates are read through the telemetry system. In case where two districts share the same canal, their boundary is defined at a check regulator where water level can be controlled and measured. The water level is used to monitor a district's share, and not necessarily the flow discharge or water volume. That is, the Inspector delivers water to the District Engineers at a certain level, measured at the canal intake or at the boundary regulator. Flow discharge and water volume supplied to the districts are not monitored and measured.

The district canals are further provided with check regulators along their length, which are used to divide the total length into two or three rotational reaches. During the turn of a particular reaches, the field staff maintains a certain level at the downstream regulator so that water can flow into all upstream branch canal turnouts. Again, no flow discharge and volume measurements are made for the branch canal service areas.

3. Current Monitoring Practice at the District Level

3.1 Monitor Water Levels.

At the district level, the present water monitoring system for the irrigation canals essentially measures water levels at key water delivery points. The idea is to maintain a certain water head at various delivery points so that water flows, by gravity, form main to branch canals and eventually to mesqas. Water level, therefore, is the critical information field staff needs to "operate" the system, not necessarily flow discharge and amounts. The practice, however, does not encourage efficient water use, which is possible when the system managers know how much water is supplied compared to crop water requirements.

3.2 Difficulties in Measuring Flow Discharge.

There is another important reason why the engineers don't measure flow in the branch and mesqa canals. It is simply very difficult to measure flow in the zero-bed slope, low-level canals. The canals are essentially "long, narrow reservoirs" with very little flow that can be measured with reasonable accuracy. In general, the intake to the district and branch canals is the only place where flow can be measured, by using the orifice equation for the intake gates.

4. Current Canal Water Monitoring Practices at the Directorate Level

4.1 Water Allocation at Source.

Each General Director, who heads a Directorate, supervises an average of eight districts (some 400,000 feddans service area). The General Directors are allocated their water share by the General Directorate for Water Distribution[3] on volumetric basis and that is how they receive it and manage it. The Water Management Section in each General Director's office is responsible for checking

[3] For the Delta Region, the Regional Directorate for Water Distribution is located in Tanta. It is further supervised by the Central Directorate for Water Distribution, which is located in the Ministry Office in Cairo.

whether the Directorate is indeed receiving its share, by measuring flow discharge at specified locations. The Regional Directorates for Water Distribution resolves any disputes among directorates.

The Ibrahimiya irrigation district, for example, is under the West Sharkia General Director, who shares water with the East Sharkia Directorate on Bahhr Muis Canal (E.Sharkia 55% and W.Sharkia 45% of the flow). The flow measurement for the allocation occurs at the measuring station located at km 24, where the intake for Abu Alghadar canal for E.Sharkia is also located (Fig. C4). The intakes for Behnabai and Mashtool canals are located downstream at km 36. The General Director reported that his staff regularly measures the flow discharge, especially in summer. Often, the staffs from the two directorates and the Regional Directorate for Water Distribution jointly measure the flow discharge to avoid any allocation disputes.

4.2 Distribution within Directorates

From the main canal, the General Director and the Inspectors then allocate water to the district canals; Mushtool and Behnabai for Ibrahimiya district, for example. The General Directors use information on crop water requirements, supplied by the Ministry of Agriculture, to estimate flow discharge for each canal. Gate settings are then calculated to deliver the required flow discharge in various district canals, based on orifice equation calibrations. The General Director then instructs the Inspectors and field staff to set the canal intake gates to deliver the required flow.

4.3 Operational Constraints

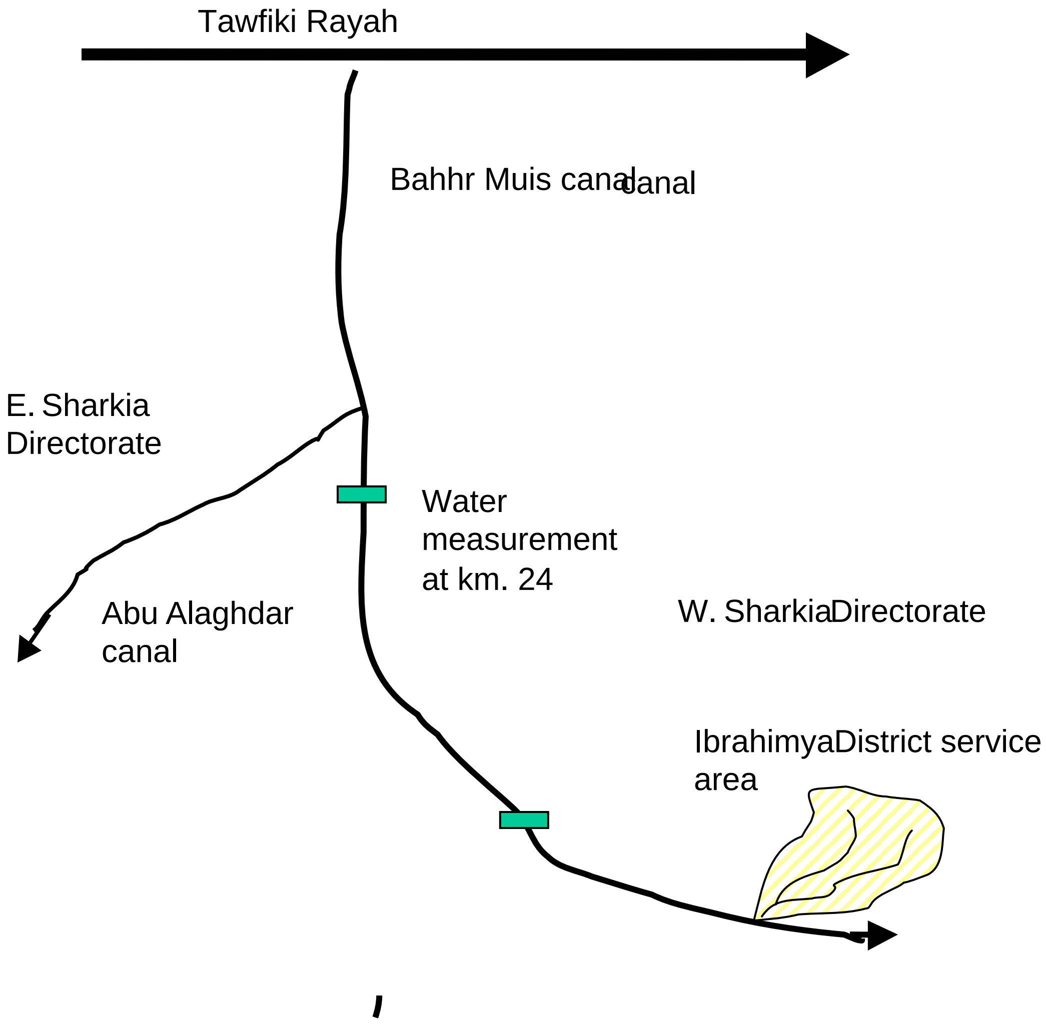
In practice, however, there is an operational problem. Most canal sections are enlareged, and the flow discharge, based on crop water requirements, may not produce the water surface level that is necessary to feed the branch canals. The field engineers said that since the canal sections are large, they probably put more water compared to what is needed to satisfy the crop water requirements. And, this is one reason why they monitor water levels rather than the flow discharge, since they cannot operate the system with flow discharges alone[4]. The water managers, therefore, may tell what ought to be the flow discharge in the district canals; not what actually is the flow discharge

4.4 Strengths and Weaknesses

In summary, water allocation and delivery in the main canals is on volumetric basis and flow discharge is monitored and measured to ensure equity and efficiency. However, past the main canal into the district canals, water is monitored for its surface level only. This is a universal response of operational engineers who must maintain appropriate energy head at key delivery points – form distributary to branch canals and from branch to mesqas. It does, however, seriously reduce their ability to properly “manage” water, in terms of efficiently matching irrigation water deliveries to crop water requirements.

[4] This is not entirely correct since the district canals are provided with check structures that are used to control the water level.

Figure 3.4. Water Allocation and Monitoring Among Directorates



Annex 4: Inventory of Data/Information Systems and Computer Models

1. MWRI Information Center (MIC)

1.1. Irrigation network

Hardware=PC, Operating System=LINUX, Database=ORACLE
Contact Info: Dr. Mohamed Ramy, Tel 025449481

The database contains the following entities:
Directorates, Inspectorates, Districts, Channels, Reaches, Structures

The attributes describing these entities are as follows:

- Directorates
  Directorate code, Arabic name, English name, Photo pictures.
- Inspectorates
  Directorate code, Inspectorate code, Arabic name, English name,
  Photo pictures.
- Districts
  Directorate code, Inspectorate code, District code, Arabic name, English name, District area (Fadden), Length of cannels (Km), Total wetted surface (m2), Photo pictures.
- Channels
  Channel code, Arabic name, English name, Rank, Location on parent, Intake side (right/left/Extended), Parent channel code, Parent reach code, Length (Km), Intake type (Gated over shot/Gated under shot/Open over shot/Open under shot/pump station/Regulator/pipe), Total area (Fadden), End structure type (Regulator/weir/End of channel/Bridge/Pipe/Siphon/ Aqueduct/Calvert/Tail escaper/Intake regulator/Pump station/Feeding end/Gate/Open end/Pipe bridge/Concrete bridge/Mesqa/Hiar/Railway bridge/Lock/Sola/Not exist), Photo pictures.
- Reaches
  Channel code, Reach code, Start at (Km), End at (Km), Bed width (m), Side slop (1:1/2:1/3:2), Reach type (opened/Covered), Reach end structure (Regulator/weir/End of channel/Bridge/Pipe/Siphon/ Aqueduct/Calvert/Tail escaper/ Intake regulator/Pump station/Feeding end/Gate/Open end/Pipe bridge/Concrete bridge/Mesqa/Hiar/Railway bridge/Lock/Sola/Not exist), Start bed level (m), End bed level (m), Start maximum water level (m), End maximum water level (m), Start minimum water level (m), End minimum water level (m), Discharge (m^3 per s), Total area (Fadden), Direct area (Fadden), Number of right vents, Number of left vents, Number of right mesqa, Number of left mesqa, Road type right (Paved/Not paved/Railway/Aggregate soil), Road type left (Paved/Not paved/Railway/Aggregate soil), Equipment movement right (Yes/No), Equipment movement left (Yes/No), Directorate code, Inspectorate code, District code, Photo pictures.
- Structures
  Structure code, Arabic name, English name, Channel code, Reach code, Structure type (Bridge, Barrage,….etc), Year of construction, Location (Km), Structure order in the reach, Description, Photo pictures.

- Govornorates : code, Arabic name English name. More than 7,000 channels and 11,000 reaches has been entered.

1.2 Water Distribution Data
Hardware=PC, Operating System=LINUX, Database=ORACLE
Contact Info: Dr. Mohamed Ramy, Tel 025449481

From the data requirements point of view the monitoring points are classified into the following class:

High Aswan Dam, Aswan Reservoir, Barrages, Nile measuring points, Channels, Sea terminated channels, Channel reservoirs, Passing by Cairo, Pump stations .

The data attributes for each type are as follows:

- High Aswan Dam
  Date, Up stream level (m), Down stream level (m), Reservoir (10^9 m^3), Natural river (10^6 m^3 per day)
- Aswan Reservoir
  Date, Up stream level (m), Down stream level (m), Discharge (10^6 m^3 per day), Discharge (m^3 per s), Average discharge (10^6 m^3 per day)
- Barrages
  Date, Up stream level (m), Down stream level (m), Discharge (10^6 m^3 per day)
- Nile measuring points
  Date, Level (m)
- Weirs
  Date, Down stream level (m)
- Channels
  Date, Up stream level (m), Down stream level (m), Discharge (10^6 m^3 per day)
- Sea terminated channels
  Date, Up stream level (m), Down stream level (m), Discharge (10^6 m^3 per day)
- Channel reservoirs
  Date, Up stream level (m), Down stream level (m), Discharge (10^6 m^3 per day)
- Passing by Cairo
  Date, Discharge (10^6 m^3 per day)
- Pump stations
  Date, suction level (m), Delivery level (m), No. of operating units, No. of working hours, Discharge (10^6 m^3 per day)

The data are measured on daily bases. These data has been entered in computer from year 1986 to year 2002 for 67 measuring points classified as follows:

- High Aswan Dam (1)
- Aswan Reservoir (1)
- Barrages (7)
- Nile measuring points (20)
- Weirs (1)
- Channels (29)
- Sea terminated channels (2)

- Channel reservoirs (5)
- Passing by Cairo (1)

The number of measuring points to be stored in the computer system is increased to 235. The data for the new points in the same period are being entered now.

1.3 Nile Basin Database
Hardware=PC, Operating System=LINUX, Database=ORACLE
Contact Info: Dr. Mohamed Ramy, Tel 025449481

This database contains two types of data; discharge and levels. The data for discharge has been entered for years 1890 –1882 while the data for levels has been entered for years 1900-1992. The monitoring points cover the hall Nile basin up stream and down stream High Aswan Dam. The time frame for the discharge measurements is 10 days – mean monthly – total monthly while the time frame for level measurements is 10 days and mean average.

1.4 Digital Maps
Hardware=PC, Operating System=LINUX, GIS=ArcGIS, ArcSDE and ArcIMS
Contact Info: Dr. Mohamed Ramy, Tel 025449481

Recently MIC bought 102 paper maps with scal1 1:50,000 which cover Nile valley and Delta. Each of these maps has more than 30 spatial layers. Each layer contains information about channels, drains, roads, or railways,…etc. The center staff digitized each map and stored each spatial layer as a separate theme in ArcGIS software.

2. Planning Sector

2.1 Integrated Management Information System
Hardware=PC, Operating System=Windows 2000, Database=ORACLE
Contact Info: Eng. Tarek Elsaied, Tel 025449463

Recently Planning sector has developed an integrated management information system which can be used as a data source to the sector mathematical models as well as to other departments in the MWRI. The system covers many application areas e.g. irrigation, drainage, ground water, Environments, etc. The following list summarizes these application areas and the basic entities included in each area. More details about the attributes of these entities can be found in the user manual of this application.

b)

Irrigation

- Irrigation Controlling Structure, Irrigation Pump Station, Hydropower, Station, Telemetry Station, Water Supply Data – Stretch/Canal/Sub Data, Telemetry Data, Navigation Data, Hydropower Generation Data.

Groundwater

- Groundwater Well, Aquifer, Groundwater Data.

Reuse /Waste/ Desalination

- Drainage Reuse Plant, Wastewater Treatment Plant, Desalination Plant
  Drainage Reuse Data, Wastewater Treatment Data, Desalination Data.

Drainage

- Drainage Controlling Structure, Drain /Sub- Drain Characteristics, Drainage Pumping Station, Drain / Sub Drain Flow.

Municipal and Industrial

- Industry Code, Industrial, Municipal Data, Industrial Data.

Agriculture

- Crop, Livestock, Fish, Fertilizer, Pesticide, Agriculture Land, Reclamation, Land, Horizontal Expansion, Agriculture Land Water Demand, Reclamation, Land Water Demand, Livestock Data, Fish Farming Data, Fertilizer and pesticide consumption

Environment

- Lake, Quality Standard, Meteorology, Flash Flood, Rain Fed Supply, Environmental Demand, Meteorological Data, Flash Flood Data, Rainfed Supply Data, Water Supply Data-Lake Data, Environmental Demand Data, Reach / Canal / Sub Canal, Drain / Sub Drain, Groundwater, Municipal, Industrial and Drainage Reuse, Wastewater Treatment, Desalination, Environmental Data-Lake Data, Stakeholder, Legal And Constitutional.

Economic

- Demography, Agro-Economic Data, Socioeconomic Data, Health Data, Gender Data

Upper Nile

- Upper Nile Flow Station
- Upper Nile Meteorological Station
- Upper Nile Controlling Structure
- Upper Nile Satellite Image
- Upper Nile Project
- Upper Nile Flow Data
- Upper Nile Meteorological Data
- Upper Nile Project Data

c)

The system is planned to feed the required data to the water supplies models, water demand models and water quality models. However, the system was not feed with real data up till now.

2.2 Computer Models
Contact Info: Eng. Tarek Elsaied, Tel 025449462

During the last decade planning sector has developed many mathematical models. The following list summarizes these models:

MODEL GROUP	MODEL
Water Supply Model	Operational Planning Distribution
Water Demand Model	Regression Forecasting Models Short-term Forecasting Long-term Forecasting Coefficient Forecasting Models Municipal, Industrial, Agriculture Livestock, Fish Farming Water Demand Effect Municipal, Industrial, Agriculture Livestock, Fish Farming

3. Irrigation Sector

Hardware=PC, Operating System=Microsoft Windows, Software=Microsoft Excel Contact Info: Eng. Sanaa Abd Elrashied, Tel 025449559

The information hosted by the irrigations sector is not stored in digital databases. This information is stored on paper and some of it stored in Excel sheets. The data required to operate the models is stored in digital files that limits the usability of this data with other applications. The following are the available information in the sector:

3.1 Water Distribution

The water distribution data is the levels and discharges values at different locations in the irrigation network. The water level and opening area readings are measured manually (daily at 6 am and some time at 12 am and/or 4 pm and/or 10 pm) by *BAHARY* who send it to the district using Admin. Tel. Line if available. In many cases the line is not working, so he either uses the Telemetry wireless set if available or use the public tel. Using the discharge calibrated curves the district engineer calculate the discharge for specific locations. The data is stored in specific books in the district (books for 6 am measurements and another books for the rest of the data). The data at the district boundaries is send through tel. to the directorate where it is stored in specific books. The data at the directorate boundaries is send through tel. to the central office at MWRI., where it is again stored in specific books. Part of this data is entered in the database in MIC as explained before. The structure of this data is explained in the MIC section. However, some other channel/structure basic information is stored within the water distribution books mainly flood levels, levels of maximum requirements, levels of minimum requirements, maximum volumes, locations and command areas.

3.2 Nile Basin Database

The data for levels and discharges at specific locations upstream Aswan Dam is measured daily at 6 am by River Nile Water Authority. This data is send to the central office by Tel. 3 or 4 days later where it is stored in specific books. For barrages the data is upstream levels, downstream levels and discharge while for general points the data is the levels.

3.3 Pump Stations

The water levels for pump station are measured daily at 6 am. The data is send from directorate to the head quarter where it is stored in specific books. These data includes the following fields:
Directorate name, Station name, Design suction water level, Design delivery water level, Date, Actual suction water level, Actual delivery water level, No. of working units, Reuse(Yes/No).

3.4 Cropping Patters

There are two types of cropping pattern; the planned and the actual. The source of this data is ministry of agriculture. The data for the planned cropping pattern is represents with reference to govornorate, while the actual cropping pattern is represents with reference to the reach of the channel within the district. The data elements for the actual cropping pattern as follows:
Directorate name, District name, Channel name, Command area {# Date, Crop name, Actual planted area, Expected area to be planted next 15 days, Area not to be irrigated #)

3.5 Industrial and Municipal Water Requirements

For each directorate the following data is stored:
Station name, Location (Km), Discharge (m^3/sec).

3.6 Complains

The number of complains are stored in specific books for each directorate on daily basis.

Manual Channel Maintenance Program (MCMP)
Hardware=PC, Operating System=LINUX & Windows98, Database=ORACLE
Contact Info: Dr. Tarek Kotb, Tel 025449489

The database contains the following entities:

- Maintenance items
- Contractors
- Contracts (Updated Yearly)
- Planning (updated Yearly)
- Follow up (Updated monthly)

The attributes describing these entities are as follows:

- Maintenance items
  Maintenance item code, Arabic description, English description, Unit (m/m^2/m^3/Km/Hectar/Ton/Barrel/10 Trees/Number/Day/Km per month)
- Contractors

- Directorate code, Contractor code, Arabic name, English name, Contract type, Address, Tel, Fax, Class, Previous experience.
- Contracts
  Directorate code, Financial year, Contract code, Contractor code, Starting month
  {# Serial no, Inspectorate code, District code, Channel code, From (Km), To (Km) #}
- Planning
  Directorate code, Financial year, Contract code, Serial no, Maintenance item code, Unit price
  {# Month, Planned quantity #}
- Follow up
  Directorate code, Financial year, Contract code, Serial no, Maintenance item code
  {# Month, Executed quantity, Quality, Payment #}

The data for three Directorates for year 2001-2002 has been entered.

3.7 Computer Models
Contact Info: Dr. Ragab Abd Elazim, Tel 025449559

3.7.1 The Nile Model (FORTRAN)

This model is used to calculate the required water volume on 10 days basis on the level of Directorate/channel. The model also aggregates these data on higher levels. The calculation is done based the actual planted area and the area prepared for planting during the next 15 days including information about crops to be planted. The model was developed at 1986 and used until 1993. The model has some limitations and problems which terminate its operation. The data used to operate the model is not stored in database but in normal files which limits its usability. New model will be developed by Water Management Research Institute.

The input data to this model is classified as follow:

Water Duty: Egypt is partitioned into four sectors two in upper Egypt and two in delta. For each sector the required water for each crop per Fadden per 10 days is specified.

Water Requirements: For each directorate the command area for each channel serving the directorate is specified. The actual cropping pattern (cropped and planed to be cropped in the next 15 days in old and new lands) is received from ministry of agriculture. Also the winter drought period and network efficiency are entered to the model. The monthly requirements for navigation, industrial and municipal are also inputted.

Water Availability: The availability of other water resources on monthly basis (ground water and drainage reuse) are also entered to the model.

Transition Period: The required period for the water to travel from Aswan Dam to the end of the channels for different channel discharge are specified.

The outputs of the model are:

The required 10 days amount of water on the level of sector, directorate, sector/channel, directorate/channel and barrage are calculated. The 10 days amount of gain and loss water along the river Nile reaches are also estimated.

4. Telemetry

Hardware=VAX and PC, Operating System=Windows Database=Microsoft Access
Contact Info: Eng. Alin Adib, Tel 025449464

The Telemetry system is installed at 1990. The system is designed to deliver real time data about water level, discharge and water quality as well as to automatically and remotely control the operation of the gates of the structures. However, the water quality monitoring system is installed only in pilot area in Fayoum and is not working now. The gate opening area sensors are also not installed, so the calculation of the discharge is not possible. However, for some specific locations in Minia the control system is installed. This system controls the opening area of the gates, thus the area is known. For these controlled sites, the discharge can be calculated automatically. However the control facility is not used.

The Telemetry system consists of the following components:

- Measuring and control system
- Communication system
- Data manipulations system

4.1 Measuring and control system

Two different kinds of level measurements sensors are used; floating (mechanical) and pressure (solid state). The control system consists of electric motor and relay contacts. The sensors and the relay contacts are connected to the Remote Terminal Unit (RTU). The RTU consists of two parts RTU Data Station and RTU Radio with voice channel option. The input (sensors) and output channels (relay contacts) are connected to the data station while the antenna is connected to the radio. The RTU is equipped with chargeable battery and solar panel.

4.2 Communication system

Two different types of communication systems are used; the Voice and Data Communication System VDCS, and the Meteor Burst MB system. The function of both systems is the same; to send the data from the RTU antenna to the data manipulation equipments in the directorate and MWRI Telemetry centre. However the VDCS system is used for controlling the gates by sending the control signal in the reverse direction and it is also used for wireless voice communication. The data is sent from stations to the repeaters and then to the directorate station and to Qanater VHF node. The data is then sent from Qanater to the main centre in MWRI. The carrier frequency is in the VHF range near 155MHZ.

For MB the data is sent from stations to one of the main MB nodes in Aswan or Qanater and then from Aswan to Qanater. The data is then sent from Qanater to the main centre in MWRI as well as to the directorates through repeaters.

The total numbers of stations working with VDCS and MB are 516 and 200 respectively. However few stations are working with the two types simultaneously. To operate a station with one specific communication system special board shall be installed in the RTU as well as installing the corresponding antenna.

In MB system the data is measured and sent every 2 hours. In the VDCS the data is pulled every 40 seconds. If the water level is changed by 1 cm or more than the previous value the data will be sent. Also the data can be pulled manually.

4.3 Data manipulations systems

The data manipulation system differs from one communication system to another. For the MB system the data is stored in text files. Later on, these data will be imported to access database where it is saved, manipulated and backed up. The application doing this job is an Arabic application developed by Telemetry staff. This application also imports the data from the VDCS system and manipulates it. The application is called DMS.

For VDCS system the data is received by two VAX machines one of them works as stand by which automatically takes over when the primary one has problem. The data is stored in text files where it can be presented and manipulated at different levels. The first level is done using the VAX machine that presents the data on two different screens connected to each VAX where the output is displayed graphically. The data can be also printed or exported to the DMS application or special management reporting system running on the PC. The VAX computer can also set up and calibrate the RTU. The control system can either remotely adjusts gate-opening area or pre-set the water level to specific value.

The Telemetry station in the directorate is equipped with 10 KVA 8 hours UPS to supply the communication and data manipulation equipments with power in case of main failure. Although the system was installed from many years ago, the system was not utilised as it was expected. Many reasons affect the usability of the system e.g.

- The system does not deliver more data types (e.g. discharge) than the manual system.
- Most of the staff trained to use the system left the work, and the new staffs were not trained.
- Nearly no development or improvement was done to the system e.g. monitoring new parameters.
- Spare parts are not available or expensive.
- The communication system suffers from noise and reliability.

In order to operate the system with the available budget the stations have been classified as following:

- First priority which includes stations on the Nile and between directorates (107 station)
- Second priority which are used by directorates to distribute the water between its districts.
- Third priority which are specified according to directorate’s needs.

Whenever there is problem that needs spare parts, one can take the required parts from low priority station until the budget is available.

4.4 Data/Information Management Systems

Hardware=PC, Operating System=Windows 2000, Database=Microsoft Access Contact Info: Eng. Amr Hafth, Tel 025449466

The data records sent from stations to the data manipulation equipments consists of the following attributes: Site ID, Measuring date, Measuring time, Date of arrival to the directorate, The reading, Battery condition, Sensor type, Battery voltage.

These data are stored in the DMS database along with some definitions e.g. site location. The manual data was also entered in the database (started from about 6 months) for comparison with the Telemetry data. The structure of the manual data table is similar to the structure used in MIC database. It is noticed that the manual data is close to that of the Telemetry data unless the sensor is not working where the Telemetry data is out of range.

5. Egyptian Public Authority for Drainage Projects (EPADP)

5.1 Drainage Database (DRDB)

Hardware=PC, Operating System=Windows 2000, Database=ORACLE
Contact Info: Eng. Samia Samy, Tel 025709838

The database contains the following entities:

- Govornorate
- Drainage Sectors
- Drainage Directorate General
- Drainage Centers
- Drainage Sub Centers
- Drainage Sinks
- Drains
- Control Structures
- Water Treatment Stations

The data has been entered for more than 3750 drains, however about 60% of the detailed information has not been entered yet.

5.2 Water Levels Database

EPADP collects daily data about water levels at start and end points of drains as well as at suction and delivery points of the pump stations. These data are collected on paper while part of it is stored in excel sheets. The structure of the data is as follows:

- For Drains: The database contains the following attributes:
  Sector name, Drain name, Date, Design water level at start point, Critical

water level at start point, Actual water level at start point, Design water level at end point, Critical water level at end point, Actual water level at end point.

- For Pump Stations: The database contains the following attributes:
  Sector name, Directorate name, Station name, Date, Design suction water level, Critical suction water level, Actual suction water level, Design delivery water level, Critical delivery water level, Actual delivery water level.

The data entered into excel sheets represents only the pump stations suction points where the critical levels are replaced by the regular levels. These data are available from may 2001. The number of pump stations in the database is 87 classified as follows:

- West delta has 22 stations.
- East delta has 19 stations.
- Middle delta has 23 stations.
- Middle Egypt has 14 stations.
- Upper Egypt has 9 stations.

6. Drainage Research Institute (DRI)

Hardware=PC, Operating System=Windows, Database=Microsoft Access
Contact Info: Eng. Rasha El Kholy, Tel 022189841

The technical data that the DRI staff collected from the field , analyzed in laboratories and publish can be classified into:

- Water quantity and quality data (collected by open drainage department)
- Sub-surface drainage system characteristics and performance data (collected from pilot areas by drainage technology department).
- Application of drainage water in irrigation (collected by special research unit).
- Publications and technical production of DRI staff.

Analysis of the available Technical data within DRI can be summarized in Table 6.1.

Table 6.1 Test groups taken by different Departments in DRI

	Pilot Areas and Experimental Fields (A)			Open Drainage System (B)
Test groups	Soil A1	Water Table A2	Crop A3	
Chemical (1)	(A1,1)	(A2,1)		(B,1)
Physical (2)	(A1,2)			(B,2)
Hydrological (3)	(A1,3)	(A2,3)		(B,3)
Yield (4)			(A3,4)	
Metrological (5)	(A1,5)			

Where:
" A ": Denotes that the tests are performed on the drainage pilot areas and experimental fields in the Nile delta.
" B " : Denotes that the tests are performed on the Water Quality Monitoring Networks in the Nile delta and Fayuom (about 140 monitoring locations.).

7. Research Institute for Ground Water (RIGW)

Hardware=PC, Operating System=Windows, Database=SQL server
Contact Info: Dr. Madiha Mostafa, Tel 022184283

The groundwater monitoring system consists of different types of observation points that have different characteristics (time independent information) and measuring entities (time dependent information). The observation points can be classified as surface points, vertical electrical sounding points and wells. The wells can be classified either as wells without screens and wells with screens. The wells with screens can be classified as observation wells and production wells. The latter can be classified either as simple production well or as collection of wells treated as one well (well inventory). There are two main departments in (RIGW), Nile and Delta department and desert department.

7.1 Nile and Delta department

Table 7.1 shows the available Nile map sheets and total number of observation points for each type.

Table 7.1: Available Nile Map Sheets and Number of Observation Points.

Info. Book no.	Map sheet no.	Map sheet name	Number of observation points

Info. Book no.	Map sheet no.	Map sheet name	Number of observation points						
			Total	**O**	**P**	**W**	**V**	**B**	**S**
1	NH36M1	Damanhur	45	45					
2	NH36M2	Kafr el Shikh	74	28		46			
3	NH36M3	El Mansura	32	31	1				
4	NH36N1	Damitta	253	253					
5	NH36N2	Port Said	8	8					
6	NH35L5	Hamam	8	8					
7	NH36I4	Abu el Matamir	146	80	6	60			
8	NH36I5	West Tanta	65	61		4			
9	NH36I6	East Tanta	49	49					
10	NH36J4	Zagazig	97	97					
11	NH36J5	Ismaliya	49	49					
12	NH36I1	Wadi Natrun	430	9	5	416			
13	NH36I2	Minufiya	495	44	8	443			
14	NH36I3	Cairo	115	101	14				
15	NH36J1	Bilbeis	27	27					
16	NH36J2	Fayed	4	4					
17	NH36E6	Helwan	29	27	2				
18	NH36E3	Beni Suef	38	38	6				
19	NH36A5	Maghagha	136	136					
20	NH36A2	Minya	85	85					
21	NG36M5	Malawy	334	334					
22	NG36M2	Menfalut	19	19					
23	NG36M3	Asyut	20	20					
24	NG36I6	Tahta	19	19					
25	NG36J4	Sohag	19	19					
26	NG36I2	Aqbit el Ramleia	3	3					
27	NG36J1	Girga	14	14					
28	NG36J2	Naga Hamadi	46	46					
29	NG36J3	Qena	8	8					
30	NG36F5	El Rozikat	7	7					
31	NG36F6	Luxor	39	39					
32	NG36F2	Naga Steeh	19	19					
33	NG36F3	Esna	24	24					
34	NG36A5	Baris	46	5	41				
35	NG36B6	Edfu	27	27					
36	NG36B3	Aswan	19	19					
37	NF35P6	West Gabel SharShar	2	2					
38	NF36N6	High Dam	1	1					
39	NF35P1		2	2					
40	NF36M3	West Donql	6	6					
41	NF36N2	West el Aleqee	1	1					

Info. Book no.	Map sheet no.	Map sheet name	Number of observation points						
42	NF36N3	El Aleqee	8	8					
43	NF35K6		1	1					
44	NF35L4		4	4					
45	NF36J5	Kirsko	2	2					
46	NF36J6	Seala	1	1					
Total obs. Pts.			2876	1824	83	969			

Abbreviations

O = observation, B = borehole,
P = production well, W = inventory,
V = VES, S = surface water

7.2 Available Data Analysis

There are two types of available measurements for the groundwater monitoring system, water level and chemical tests.

7.3 Available Maps

Hardware=PC, Operating System=Windows, Software=ArcView
Contact Info: Dr. Yahia Edrise, Tel 022182117

Available base and hydro-geological maps in RIGW are summarized in table (10). Base maps include main roads, canals and drains.

Table 7.3 Available base and hydro-geological maps in RIGW.

No of maps	Scale
1	1:2000000
1	1:500000
7	1:250000
24	1:100000

The 1:500000 map cover the delta region with latitudes from 30:00 to 32:00 and longitudes from 29:30 to 33:00. vailable (1:250000) hydro-geological maps and water resources maps that include : Base map - Land Use - Aquifer - Water Type - Extraction units - Well Locations - Potential – Vulnerability – Pollution Risk.

7.4 Desert department

The groundwater monitoring system for this department covers twelve regions and consists of observation wells and production wells. Measurements that are available at each monitoring location include water level and water quality for observation wells and discharges for production wells. There are (1:500000) water resources maps available for each location that include: Base map, Land Use, Aquifer, Water Type, Extraction units, Well Locations, Potential, Vulnerability and Pollution Risk.

8. Nile Research Institute (NRI)

Contact Info: Dr. Ahmed Fahmy, Tel 022189791

There are two available data types in Nile Research Institute, water level measurements and water quality measurements. Daily measurements of water level are available at several monitoring locations. Water level measurements are available from 1958. Station names and the distance of the site from Aswan are shown in tables. Water quality measurements are available for bi-annual records. Tables are available that shows the available monitoring parameters, the monitoring sites for the river Nile, the monitoring sites on irrigation system, and the monitoring sites on drainage system (Upper Egypt and Fayoum).

9. Summary of Meetings

Date	Place	Participants	Comments
3-12-2002 14-12-2002	MWRI 9th Floor Irrigation Sector	Dr. Ragab Abd Elazim Eng. Sanaa Abd Elrashied Dr. Mostafa Ghith Dr. Hatem Fahim	Discussion of: *Water distribution *Nile model *Matching water distribution with demand
14-12-2002	MWRI Ground Floor Telemetry	Dr. Ragab Abd Elazim Eng. Alin Adib Eng. Amr Hafth Dr. Mostafa Ghith Dr. Hatem Fahim	Discussion of: *Telemetry system *Data elements provided by the system *Problems and limitations
15-12-2002 11-1-2003	EPADP	Eng. Wedad Kalaf Dr. Hatem Fahim	Discussion of: *DRDB database *Drainage water levels
18-12-2002	Monofay Directorate	Dr. Ragab Abd Elazim Eng. Aly Elawamry Eng. Raof Nashed Dr. Mostafa Ghith Dr. Hatem Fahim	Discussion of: *Water distribution *Calibration of Discharge Equations *Discharge calculation *Telemetry system
18-12-2002	Shebeen District	Dr. Ragab Abd Elazim Eng. Raof Nashed Dr. Mostafa Ghith Dr. Hatem Fahim	Discussion of: *Water distribution

Date	Place	Participants	Comments
22-12-2002	MWRI 6 Floor Information Center Center	Dr. Mohamed Ramy Eng. Ebtsam Dr. Hatem Fahim	Discussion of the following databases: *Irrigation network *MCMP *Water distribution * Nile basin
29-12-2002	MWRI 10 Floor DRI	Dr. M. Abd Elkalaa Dr. Hatem Fahim	Discussion of: *Reuse and yearbook database.
1-1-2003 5-1-2003	MWRI 6 Floor Planning Sector	Eng. Tarek Elsaied Dr. Hassan Dorra Dr. Hatem Fahim	Discussion of: *Integrated management information system *Water allocation and distribution models.
8-1-2003 9-1-2003	West Minia Directorate	Dr. Ragab Abd Elazim Eng. Hany Glal Sadk Eng. Atef Habib Eng. Omar Darwish Eng. Ahmed Saleh Eng. Hala Shahin Eng. Nader Samir Eng. Mohamed Ashref Eng. Mohamed Abd Elhamid Eng. Welim Zaki Eng. Refat Sedik Eng. Adel Eng. Nagy Eng. Manal Eng. Sahar Dr. Mostafa Ghith Dr. Hatem Fahim	Discussion of: *Telemetry operation *Automated system *Water Allocation *Water Distribution *User association groups *Continues irrigation system *Control structure design issues *Mesqa feeding mechanisms
8-2-2003	Irrigation Department	Eng. Hussin Elwan Dr. Ragab Abd Elazim Dr. Hatem Fahim	General discussion of the project policy.
19-2-2003	MWRI 9 th floor	Eng. Thrwat Dr. Ragab Abd Elazim Dr. Mostafa Ghith Dr. Hatem Fahim	Studying work progress
2-3-2003	Water Management Research Institute	Dr. Mohamed Lotfy Eng. Mahmod Khedr Eng. Shreef Saad Dr. Tom Sheng Dr. Hatem Fahim	Discussing the new mismatch model
5-3-2003	Ministry of Agriculture	Dr. Ragab Abd Elazim Eng. Ebrahim Labib Dr. Tom Sheng Dr. Hatem Fahim	Discussing the software used to gather the real cropping pattern and transfer this data to the irrigation district engineer

Annex 5: Field Notes

6.1 General Directorate for Irrigation in Monofia[5]

The General Directorate of irrigation in Monofia is located in the Middle Delta, North of Cairo, in the Monofia Governorate. Offices of the relevant Inspector and General Director are located in the main Irrigation Ministry building in Shebeen Elkom . It has to two Inspectorates, North "*Bahhary*" Monofia and South "*Kebly*" Monofia. Bahhary Monofia Inspectorate has four Districts with total service area of 177,780 feddan distributed as follows:

Shebeen Elkom District	46,130 feddan
Elshohada District	44,590 feddan
Tala District	46,600 feddan
Kebly Kafr Elzayat	40460 feddan

Kebly Monofia Inspectorate has four District with total service area of 146,670 feddan distributed as follows:

East Ashmoon District	39,980 feddan
West Ashmoon District	35,860 feddan
Menoof district	36,600 feddan
Elbagoor District	34,230 feddan

6.2 Existing Irrigation Water Monitoring Practices at the Directorate Level

Water allocation at source: Monofia Directorate, takes its water from Monofi Rayah and Bahhr Shbeen. It shares water with the Gharbeia Directorate (Monofia 40% and Gharbeia 60% of the flow). The flow measurement for the allocation occurs at the measuring station located just down stream of Delta Barrages on Monofi Rayah and at Melig Regulator where the water goes to Gharbeia Directorate. Each directorte, therefore, is allocated its water share on volumetric basis and that is how they receive and manage it.

The Water Management Section in the General Director's office periodically (twice a week on Monofi Rayah) checks the discharges by using current meter measurements. The General Directorate for Water Distribution (in Tanta) overseas the allocation among all directorates and resolves any disputes by periodic flow measurements. However, when water flows further into the district service areas, system operation is by water levels and not water amount.

Distribution within directorate: From the main canal, the General Director then allocates water to the Inspectorates then to the district canals. The information on crop water requirements is used as a basis for the water allocation, which is supplied by the Ministry of Agriculture. The General Director then instructs the inspectors and field staff to set the district canal intake gates to deliver

[5] This report is based on information gathered during a field trip to the Monofia Directorate on Dec, 18,2002.

the required flow. The incoming flow in the canal then results in a water surface level, which is then tracked by the inspector and district engineers to operate rest of the system described above.

6.3 Existing Irrigation Water Monitoring Practices at the District Level

Canal water: The district canals have flow regulation gates at the intake, where both upstream and downstream water levels are read through marble gauge and the telemetry program for 21 location (13 using Voice and Data Communication system (VDCS) and 8 using Meteor Burst (MB)) . However, the flow discharge is not measured and monitored at this level, which could be easily done if the control gate opening was regularly monitored. The telemetry software and hardware is designed to permit this addition. The districts receive their quota or share of water at these control points, which are important locations for future flow monitoring and measurement program.

Water delivery to farmer: Water delivery to the farmers on some canals based on three-turn rotation: 5 days on followed by 10 days off. On some other canals, there is two-turn rotation 7 days on followed by 7days off

In each District, the District Engineer and his staff monitor water levels at the check regulators in the main canal for assessing water sufficiency They maintain a certain level at the regulators so that water can flow into all upstream branch canal turnouts. No flow discharge measurements are made in any of the district irrigation/ drainage canals.

Monitoring practice: The present water monitoring system, therefore, essentially measures water levels at key water delivery points (usually 6:00 AM is the main reading at all the intakes). The practice is quite logical since by maintaining a certain water head at various delivery points, the operational staff make certain that water flows, by gravity, form main to branch canals and eventually to mesqas. Water level in the branch canals and mesqas is normally lower than the land, and farmers must pump it to their land. Water level, therefore, is the critical information field staff needs to "operate" the system, not necessarily flow discharge.

Annex 6: List of Persons Interviewed

MINISTRY OF WATER RESOURCES AND IRRIGATION

1.	Eng. Hesin Elwan	Head of Drainage Authority, Former Head of Irrigation Sector, Cairo
2.	Dr. Tarek Sadek	Director of NWRP
3.	Eng. Eleen	Head of Central Directorate for Telemetry
4.	Eng. Amr Hafez	Inspector, Telemetry
5.	Eng Tahany Mostaf Sleet	Engineer, Telemetry
6.	Eng. Sanaa Abdelrashied	Assistant Director of Works, CDWD
7.	Eng. Aly	General Director for Irrigation, Monofia
8.	Eng. Raoof Nashed	Head of Water Section, Monofia
9.	Eng. Ashraf Elhefnawy	District Engineer for Irrigation, Shibeen Elkom
10.	Eng. Hanye Gala Sadek	General Director for Irrigation, West Menia
11.	Eng. Refat Sedeek	Deputy Director, West Menia
12.	Eng. Nagy Sabrah	General Director of IIP, Menia
13.	Eng. Atef Habeeb	General Director of IAS, Menia
14.	Eng. Adel Zaki	Irrigation Inspector, East Elyousefy Inspectorate, East Menia
15.	Eng. Omer Darwish	Technical Office, West Menia
16.	Eng. Halah Shaheen	Technical Office, West Menia
17.	Eng. Ahmed Saleh Mohamed	Head of Telemetry , West Menia
18.	Eng. Nader Sameer	Technical Office, IAS, West Menia
19.	Eng. Mohamed Ahraf	IAS, Bni Ebeid, West Menia
20.	Eng. Mohamed Abdelhameed	IIP, Bni Ebeid, West Menia
21.	Eng. Weliam Zaki	Head of Design Section, IIP, Menia
22.	Eng. Sahar	Engineer, Telemetry, Menia
23.	Eng. Manal	Engineer, Telemetry, Menia
24.	Eng. Enas	Engineer, Telemetry, Menia
25.	Ehaab	Bahhaary, Shibeen Elkom District, Monofia
26.	Foad Amer	Senior Bahhaary, Qaraneen Regulator

MINISTRY OF AGRICULTURAL AND LAND RECLAMATION

27.	Eng. Mohamed Omer Raslan	Head of Agricultural Services Sector

WATER POLICY ADVISORY UNIT

28. Eng. Gameel Elsaied
29. Eng. Sarwat Fahmy
30. Eng. Moemen
31. Eng. Alla

USAID Cairo: Dr. Ross Hagan and Dr. Wadie Fahim.