MATCHING IRRIGATION SUPPLY AND DEMAND IN EGYPT

Dr. Ragab Abdel Azim[1]
Eric Viala[2]

ABSTRACT

The proper assessment of water needs is a critical step towards water use efficiency. This is especially true in Egypt where the unique source for water resources is Egypt's share of the Lake Nasser reservoir, behind High Aswan Dam (HAD). Volumes of water have to be released from HAD in a timely manner in order to satisfy the needs of water users, mostly irrigating farmers.

Until the mid-1990s, irrigation demands were known with some accuracy since Egyptian farmers were organized to grow prescribed crops. Since then, the Government of Egypt has progressively freed them from any obligation, and farmers are now able to individually choose their cropping patterns. While this has resulted in significant increases in yield and farming incomes, it has also complicated the task of the Ministry of Water Resources and Irrigation (MWRI): the MWRI now would release water from Lake Nasser based on "indicative" cropping patterns and calendars. This sometimes resulted in a significant "mismatch" of supplies and demands with water volumes not being available to farmers when needed, or eventually flowing to the Mediterranean Sea without being utilized.

This has led the MWRI to design and implement a routine and systematic collection of crop information from farmers (through the Ministry of Agriculture and Land Reclamation, MALR) to the MWRI. This system is known as MISD, Matching Irrigation Supplies and Demands. It has been developed in the late 1990s with technical assistance from USAID. This paper highlights the MISD process, components, issues and suggestions for improvement.

INTRODUCTION

Egypt's water supply relies almost exclusively on the Nile through the huge reservoir behind the High Aswan Dam: Lake Nasser. Out of an annual Nile inflow of about 84 billion cubic meters, Egypt's share is set by international agreement with Sudan at 55.5 billion cubic meters. Alternative water sources are limited and

[1] Senior Director of Works, Distribution Central Directorate, Ministry of Water Resources and Irrigation, Cairo, Egypt
[2] Senior IWRM Resident Advisor, USAID-funded LIFE-IWRM Project managed by International Resources Group, Cairo, Egypt – eviala@iwrmeg.org – eviala@irgltd.com

involve erratic and meager precipitations (average annual rainfall being less than 2 inches over most of the country), fossil groundwater whose extraction is a "one-time shot", and still expensive and underdeveloped desalination technologies.

The demand for fresh water resources has, on the other hand, steadily increased over the years, along with the population growth and industrialization, thus reducing the per capita share. Egypt recently became a water scarce country (i.e. with less than 1,000 m3/capita/year). Facing the challenge of increasing water demands with limited options to increase the supply, the MWRI has taken steps towards better water management. Concepts such as water savings and water use efficiency have now become planning priorities if not yet management objectives.

The allocation of water resources at national level relies on appropriate releases from HAD. Since there is limited storage capacity all along the Nile River, the volumes released will make their way downstream and eventually reach the Mediterranean Sea after a dozen days or so. Overestimated volumes will get lost to the sea[3] while underestimated volumes cannot be augmented in any way. This means that water use efficiency relies first on a proper assessment of what the water requirements are.

Until the mid-1990s, irrigation demands were known with some accuracy since Egyptian farmers were organized through Agricultural Cooperatives and forced to grow prescribed crops. The MWRI previously released water from the HAD based on the cropping patterns planned and implemented by the MALR. In the mid 90s, a liberalization effort was carried out by the Government of Egypt in order to free farmers from centrally planned constraints (agricultural prices, mechanisms for input purchase and crop sale, and notably choice of cropping patterns).

While this has resulted in significant increases in yields and farming incomes, it complicated the task of the MWRI which now had to rely on "indicative" cropping patterns to plan the releases from HAD. MALR field agents would still assess the expected cropping patterns at the beginning of the season, but with much less accuracy. Weather conditions, market prices, and input availability (among other factors) could also lead farmers to change their plans. This resulted in a significant "mismatch" of supplies and demands with water volumes not being available to farmers when needed, or eventually flowing to the Mediterranean Sea without being utilized.

Both Ministries acknowledged the need for a routine and accurate transfer of cropping information from farmers through the MALR to the MWRI. The MISD

[3] From a purely economic or human-centered point of view, these volumes are lost. But of course volumes of fresh water from the Nile River are essential for the ecological equilibrium of the coastal areas, coastal lakes and Mediterranean Sea.

program was developed a few years ago with that specific objective: a better evaluation of real-time irrigation water demands in order to match these with actual water deliveries. The MISD program has been described as a significant step toward demand-driven irrigation management and water use efficiency.

MISD PROCESS AND ACHIEVEMENTS

The MISD system was developed by the MWRI in the late 1990s with technical assistance from USAID. It is based on:

1. Cooperative links between the MALR and MWRI at local (district) level.
2. Agricultural data on cropping patterns and schedules being collected twice each month (at the first and middle of the month) by MALR field extension agents. This agricultural data is aggregated for each branch canal command area within the boundaries of the MWRI irrigation district and provided to the MWRI district engineer.
3. A computer program that allows the processing of the agricultural data and its translation in terms of water demands (at district level).
4. Agricultural data and water demand information being forwarded from the district through the (regional) Irrigation General Directorate to the MWRI Central Directorate for Water Distribution (CDWD) in Cairo for scheduling water releases from the HAD.
5. The water allocation schedule being prepared and communicated back to the Irrigation General Directorate, and to the MWRI district engineer.
6. Information on water availability and distribution being communicated by the district engineer to MALR agents and to farmers within the district.

Twice a month, MALR field agents determine the existing area for each major crop[4], for all other crops as one category, and for fallow land (not irrigated) in their area. At the same time they also determine crop areas expected for the next half-month period using the same categories. This cropping information is provided to the MWRI district engineer. Using a database or Excel spreadsheet, the district engineer calculates the biweekly water requirements as follows:

$$WR = (Ac \times WD) / \mu$$

where:

Ac is the cropped areas (feddans)

WD is the standard water requirement, which depends on the crop, the month, and the region (these values are standardized for Egypt, they have been calculated using climatic data and the FAO guidelines).

[4] Major crops are defined as those that occupy large areas and have significantly higher water requirements, such as rice and sugarcane. They may differ from district to district.

μ is the standard water distribution efficiency (combines canal delivery & irrigation application efficiencies). For lack of actual data, it is taken as 0.7 in Egypt, regardless of actual canal, topographic, soil, climatic conditions and irrigation practices.

These biweekly water requirements are aggregated for the entire district and sent to the MWRI's headquarters. There they are used to plan the releases from HAD, taking into consideration the proper time lags for the released volumes to timely meet the needs along the Nile valley (see map in figure 1):

1-2 day to reach Esna Barrage;
3-4 days to reach Naga Hammadi Barrage;
5-6 days to reach Asyut Barrage, and
9-10 days to reach Cairo and then the Delta.

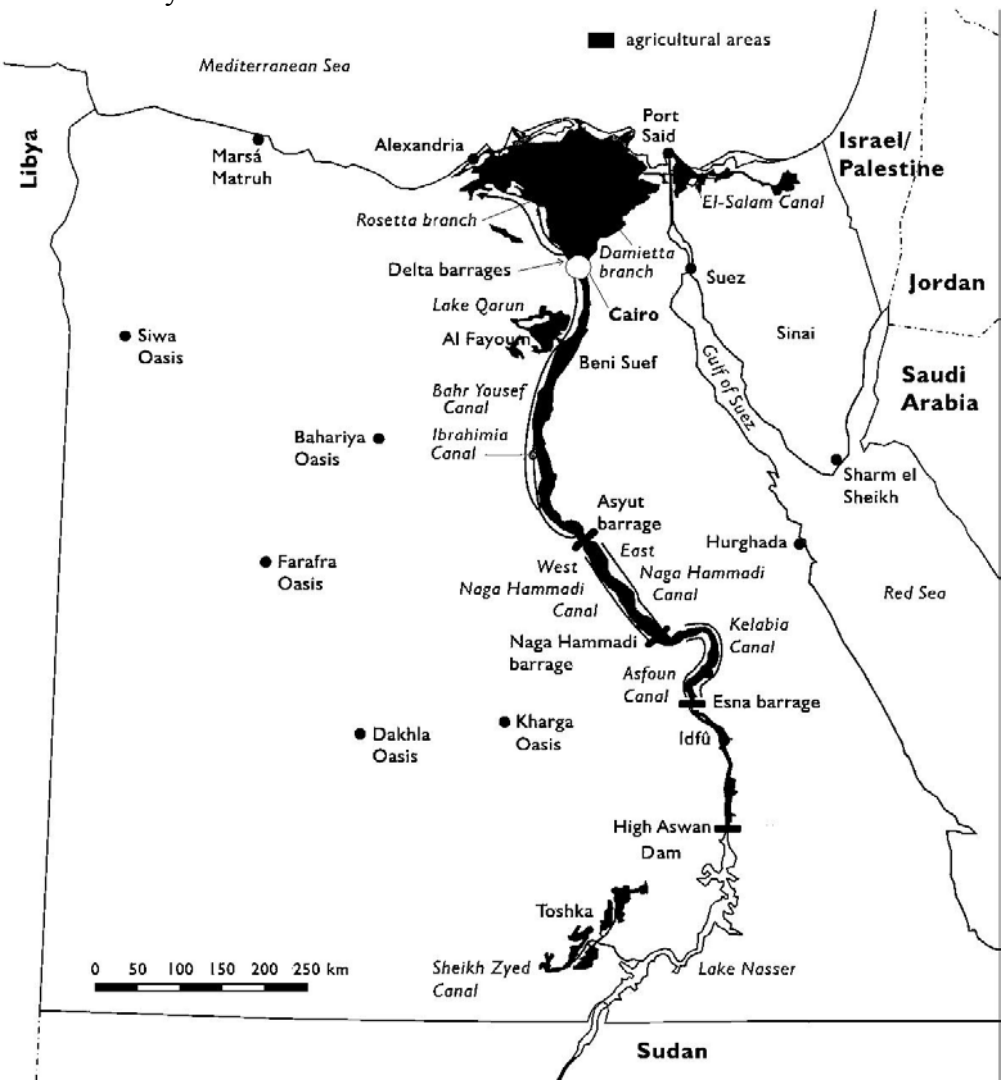

Figure 1. Map of the Nile Valley.

The LIFE-IWRM[5] Project (hereafter defined as the Project) has been supporting the implementation and strengthening of the MISD program in all 27 Integrated Water Management Districts (IWMDs) established by the project (covering 15% of the irrigated area of Egypt). Significant project achievements to date include:

- Excellent collaboration between MALR and MWRI;
- The data collection effort being carried out on a routine and systematic manner in all IWMDs;
- IWMD managers being able to translate the crop information into biweekly water requirements and thus know their district water needs; and
- Biweekly water requirements being communicated to the CDWD in Cairo every two weeks.

The main success of the MISD program is the fact that at national level, about half of the districts (one hundred or so) routinely evaluate and send their water needs to the CDWD. This major data collection effort is essential and significantly contributes to plan the proper releases from HAD. Another significant impact is that through the MISD process, IWMD managers and engineers have been sensitized to the demand side of water management. They also became aware of the limited amount of water resources available in Egypt, and the need to use them efficiently.

MISD ISSUES AND POTENTIAL IMPROVEMENTS

The MISD process, as designed but most importantly, as implemented, suffers from several issues:

- Inaccuracy of the cropping pattern information;
- Inaccuracy of the cropping area information;
- Inaccuracy of the calculation of water needs;
- Limited understanding of the actual routing of the released volumes and their matching with water needs (and thus limited capacity to optimize the releases);
- Lack of information to local (district) MWRI managers on the supply to be expected, in order for them to plan and optimize the distribution; and
- General lack of feedback and monitoring for the process to improve over time.

Adequacy of crop information

The accuracy of the crop information depends on the MALR field agent's ability to adequately identify the current cropping pattern and forecast the cropping pattern expected two weeks in the future based upon existing crops, knowledge of the farmer's practices, and direct contact with farmers. This data collection effort

[5] LIFE (Livelihood Incomes from the Environment) is a USAID-funded program in Egypt which includes other projects besides the Integrated Water Management Project.

is not necessarily the most important task assigned to the MALR field agent. Even though cooperation is usually good at field level, the usual (political) antagonism between agriculture and irrigation agencies also undermines the effort.

It is foreseen that in the future, the Branch Canal Water User Associations (BCWUAs) being now established by the project will be tasked to carry out this data collection effort, with technical support from MALR and MWRI. The crop information would be of better quality since farmers have a vested interest in seeing their water needs properly addressed.

Accuracy of cropping areas

Cropping areas are rarely known with accuracy, and often over-estimated for the following reasons:

- The cadastral maps (scale 1/2,500) are more than 20 years old and thus outdated, especially considering the development of urban areas all along the Nile;
- Both MALR field agents and MWRI are afraid to be held responsible by farmers for water shortages and thus tend to over-estimate cropped areas;
- Farmers recognize queries regarding their landholding as being related to the collection of the land tax; they are understandably vague or misleading in the information they provide.

Remote sensing is the generally suggested solution to provide information regarding cropped areas. It has however a significant cost, chiefly for the purchase and processing of adequate satellite images. While the project is supporting some pilot activities in that direction, a simpler decentralized assessment has also been promoted. The measurement of actual cropped areas is done by MWRI field staff:

1. Using the old cadastral maps as initial mapping support;
2. Recording, in the field, with GPS devices, the boundaries of cropped areas; and
3. Calculating cropped areas with a simple digital mapping software such as AutoCAD.

Evaluation of water needs

The third issue is the translation of cropped areas and cropping patterns into water requirements. The standard water requirements are reasonably valid since they are based on regional climatic data and are tailored to the type of crops and the month of the year. They could however be improved through actual field measurements. The most significant source of inaccuracy is the use of the same standard irrigation efficiency everywhere, regardless of actual canal, topographic, soil, climatic conditions and different irrigation practices.

A first step for tailoring this efficiency factor would be to identify different regional values through the consideration of canal, soil and climate characteristics along with irrigation management and application techniques. A second step would be again to conduct field measurements to better define regional or local efficiency values. For the time, this is being beyond the scope of the project although local flow measurements are being carried out at district-level and could be used to that end (see hereafter).

Operational optimization

The fourth issue relates to the actual routing or downstream propagation of the releases. The MWRI collects real-time water level information on more than a hundred sites along the Nile. The CDWD should use this information to:

- First better understand when and how the released volumes reach different points along the valley (the magnitude of the releases, the contribution of return flows and drains, and the levels of the Nile River are all factors that impact the routing); the aggregation of all individual (district) water needs into a water requirement schedule and the planning of the releases would become more accurate;
- Second optimize the operation of the several barrages along the Nile to somewhat augment or delay the flow[6]; this can simply be done through monitoring and experience; and
- Third possibly develop a DSS model to manage HAD and the other barrages along the Nile River.

These activities are beyond the scope of the project but could be implemented by the MWRI, given central level commitment and the allocation of resources (and possibly external technical assistance in the case of a DSS model).

Distribution information

The fifth issue is the fact that little information is provided back to regional and local MWRI managers as to how much water they will receive for distribution. This is actually an issue with the way the MISD program is implemented. There is limited intent to convey information back to the local level for several reasons:

- From the perspective of central MWRI managers, the data provided by each district is not considered as an allocation request; the MISD program is simply seen as a bottom-up data collection effort to plan the water releases from HAD;

[6] Currently the operation principles are the following:

- In summer, the barrages are kept at their maximum water level, so as to allow some augmentation of the flow if needed to prevent shortages;
- In winter, the barrages are kept at their minimal water level, so as to allow some reduction of the flow if needed to prevent flooding.

- There is limited flow monitoring, only on critical locations along the Nile and main canals, and thus limited understanding of when and how the released volumes will eventually reach different points along the valley; and
- Centralization still prevails, with limited delegation to lower levels; providing distribution information downward is not yet an innate inclination.

The Project is not only training district engineers to prepare and submit biweekly water requests, but has also been supporting a flow monitoring effort that allows the calibration of water structures and thus a regular translation of water levels into actual discharges. MISD requested volume and actually received supply can thus easily be compared to each other at district level.

Lack of monitoring

A critical design flaw is the absence of monitoring activities within the MISD program: the process as currently implemented actually stops with the planning of the releases. The actual matching of supplies and needs is somewhat measured at central level, but not at regional or local level. The accuracy of the data provided is not cross-checked either..

But without feedback, the MISD program cannot learn from experience, and cannot develop from a conceptual exercise to an actually ground-truthed management process. A typical example is the system constraints, such as insufficient canal capacity: even if the proper volumes are released, they cannot be conveyed on time to address the needs.

As mentioned earlier, the Project has been supporting a flow monitoring effort that allows the calibration of water structures and thus a regular translation of water levels into actual discharges. Water needs and actual deliveries can thus be compared. In parallel, several monitoring activities have been developed and are being implemented at district-level:

- Recording and follow-up of complaints registered by water users;
- Recording and follow-up of violations committed by water users and residents; and
- Annual farmer satisfaction survey (about 200 farmers are asked through a short questionnaire to grade the water delivery service they receive).

CONCLUSION

The MISD program is intended to address what the MWRI has identified as specific situations that give rise to mismatching. These can be grouped into three general categories:

1. *Under- or over-estimating crop water demands under free cropping choices*, including cropping patterns and calendars.
2. *System constraints*, such as canal capacity, system storage capacity, and lag time between water releases from HAD to the farm.
3. *External factors*, such as precipitations, unseasonable temperatures and unanticipated drainage water reuse.

The MISD program as implemented only addresses:

- The first issue to some extent, but with serious accuracy concerns (notably regarding actual cropping areas and irrigation efficiency);
- The system constraints inadequately without regular monitoring and feedback; and
- The external factors incompletely without proper operational procedures being defined and used.

The Project attempts to address some of the technical issues identified with the MISD program, notably by decentralizing the process: the evaluated water requirements can now be compared at district-level to the actual supplies and thus used by the MWRI district engineer to manage and allocate the water resources being received.

But the concept and the implementation process of the MISD program need also to be reviewed. From the perspective of MWRI managers, the MISD Program was designed as a tool for central planning, with a bottom-up data collection effort feeding into the decision-making regarding releases from HAD. As usual with such approaches:

- Local level data collectors have limited incentive to improve the accuracy of the data they collect and transmit since they are not necessarily aware of the objectives of the exercise, and do not get much feedback (nor praise) for their efforts; and
- Central level managers cannot assess or improve the quality and accuracy of the data they receive.

Such concerns cannot be tackled through technical fixes. The MWRI should promote accountability and decentralization by (see also Figure 2 next page):

1) Requesting central managers to:
    a. Communicate the release plans they decide on and implement;
    b. Monitor how the releases actually match the needs;
    c. Collect and use feedback from the field to improve their decision-making process;

2) Improving the awareness of district managers and field staff regarding:
    a. The need to be more efficient in its water use;
    b. The concept of balancing demand and supply;
    c. The MISD process and the need for accurate data; and
    d. The need for measuring and comparing demands and actual deliveries.

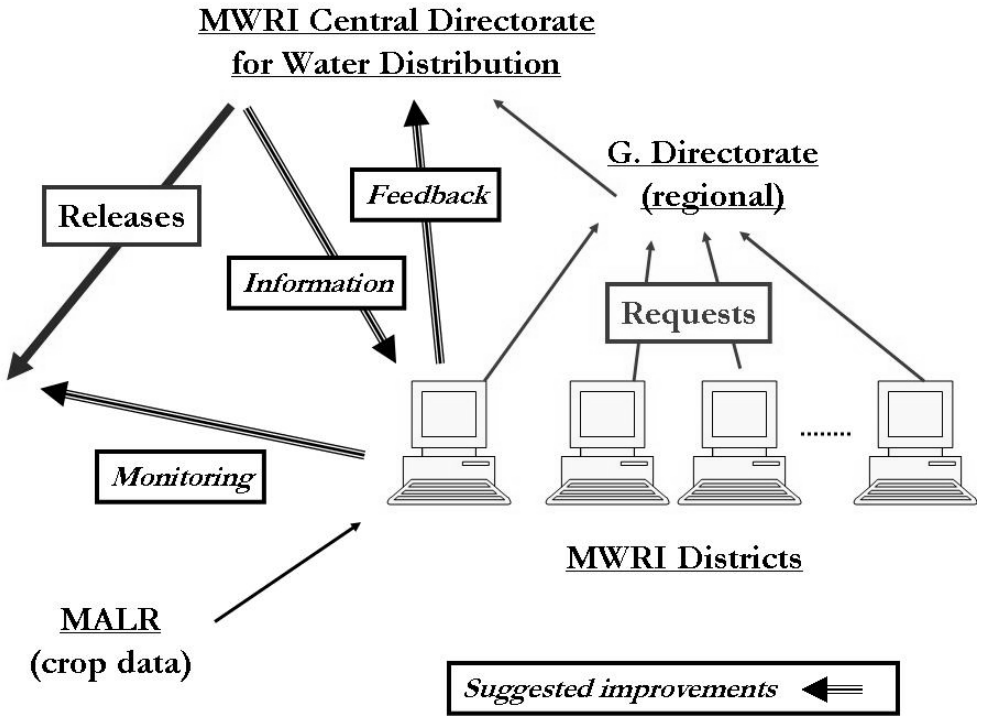

Figure 2. Improved decentralized MISD process

It is only through this kind of institutional/behavioral change that the MISD program can effectively contribute to better water use efficiency and become an important step toward an efficient, demand-driven irrigation system.

REFERENCES

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