

DECENTRALIZED FLOW MONITORING IN EGYPT

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ABSTRACT

The equitable and accountable allocation of water resources is a critical step towards water use efficiency. This is especially true in Egypt where multiple and growing demands are competing for a limited water supply (Egypt's share of the Lake Nasser reservoir, behind the High Aswan Dam). The Egyptian per capita annual water share has in recent years decreased below the 1000 m³ threshold.

Water distribution in Egypt strives to maintain optimal water levels in the main canals, high enough to ensure gravity supply of secondary and tertiary canals, while preventing bank overflow. The monitoring of flows is limited to main canals and critical locations at the national level to optimize water distribution.

The MWRI has recently taken steps to simplify its structure by establishing Integrated Water Management Districts (IWMDs). These IWMDs are empowered with most water management responsibilities, notably monitoring water resources. The USAID-funded LIFE-IWRM Project has supported this effort through the procurement of equipment and the training of IWMD staff.

Each of the newly established 27 IWMDs has now defined a flow monitoring network which includes the locations of main inflow and outflow structures. Discharge measurements are being carried out twice a month in each of these locations, while water levels and gate openings are recorded daily. All of these inflow and outflow structures have recently been calibrated, thus allowing IWMD managers to know the daily volumes of water being supplied to their district.

This process of decentralized flow monitoring is a first step on the road from water distribution to water management. Reliable information on actual supplied volumes is essential and can then be compared to actual demands to improve water use efficiency.

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 inflow of

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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 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 distribution of water resources remains a centralized process, first based on proper releases from the High Aswan Dam (HAD). Released volumes are then monitored at some key locations in the Nile River while they flow downstream. After being diverted or pumped from the Nile River, water resources transit through carrier and main canals which supply branch canals. These, in turn, gravity-feed meskas (tertiary canals).

Along the Nile Valley, water distribution relies solely on gravity (apart from some initial pumping out of the Nile, or pumping into desert lands on the outskirts of the valley). In the Delta, both branch canals and meskas have over the years been lowered below field level, due to repeated excavation for desilting, and to increase the capacity of these canals. Nowadays, farmers use diesel pumps along meskas and branch canals to supply their marwas (field ditches) and plots.

Until the mid-1990s, irrigation demands were known with some accuracy since Egyptian farmers were organized through Agricultural Cooperatives and required to follow prescribed cropping patterns and calendars. In the mid 1990s, a liberalization effort was carried out by the Government of Egypt to free farmers from centrally set constraints (agricultural prices, mechanisms and entities for input purchase and crop sale, and notable crop choices). This has resulted in insignificant increases in yields and farm incomes. But water demands vary now much more from year to year, with farmers choosing their cropping patterns based on market prices, weather conditions, and input availability, among other factors.

The chief concern of regional and local MWRI managers was and still remains to ensure that water reaches the tail ends of branch canals, and that water levels are high enough to feed meskas. To that end, they operate the gates of regulators according to set or ad-hoc rotations schedules. Water levels are thus the key information upon which these managers rely for their decision-taking. In practice, the key references are the water levels recorded at the same period during the

previous year(s). Past water levels are the targets, with marginal adjustments made when farmers complain about shortages or if over-supplies are observed.

This 'status-quo' type of management has been somewhat successful in the past, when cropping patterns and calendars were centrally planned with limited variations from year to year. Today, this management practices fail to adjust to rapid changes in the water demands. But for lack of better monitoring tools, local MWRI still rely on water levels.

In each district (on average 50,000 acres), water levels at 30-50 sites are read and reported daily (more often at the main structures or during critical periods). This massive and repetitive amount of data is then used by the MWRI managers to operate their structures and control the water distribution.

But relying on water levels means that:

- Water resources are not yet managed but simply distributed; and
- Water use efficiency is unknown (and presumably rather low, with significant over-supply in winter³ and during night time).

PROCESS AND RESULTS SO FAR

The MWRI has recently taken steps to simplify its structure by establishing Integrated Water Management Districts (IWMDs). These IWMDs are empowered with most water management responsibilities, particularly in terms of monitoring water resources.

The USAID-funded LIFE-IWRM Project has supported this institutional reform effort. Regarding water flow monitoring, the first objectives were to train IWMD staff to:

- Become proficient in the use of equipment for regular flow measurement;
- Correlate measured flows with recorded water levels and establish calibration formulas; and
- Use these calibration formulas to translate water levels into discharges.

To achieve this, the project has:

- Provided current-meters and other flow-monitoring equipment such as boats (see Figure 1 next page);
- Prepared simple water measurement guidelines;
- Trained IWMD staff on how to operate and maintain current-meters;
- Assisted in the identification of the measurement locations for main inflow and outflow sites in each IWMD, both on canals and drains;

³ In winter, water needs are limited, but water levels have to be kept high to gravity feed all canals. The lack of control means that as a consequence significant volumes flow directly from the tail end of canals into the drains.

- Prepared calibration guidelines, and trained IWMD staff to apply these (see Figure 2).



Figure 1. Flow measurement staff

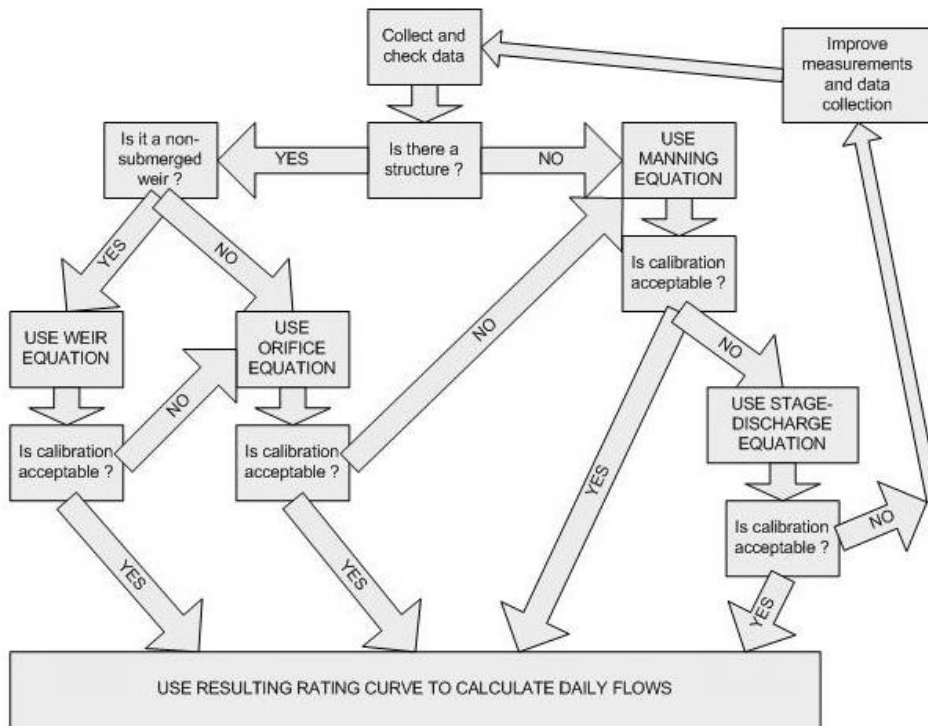


Figure 2. Decision tree for calibration of water monitoring sites

After only one year, each of the newly established 27 IWMDs (covering a total of about 1 million acres) has defined a flow monitoring network which includes the main inflow and outflow locations (from two to eight sites per district, see figure 3 below). Discharge measurements are being carried out twice a month in each of these locations, while water levels and gate openings are recorded daily.

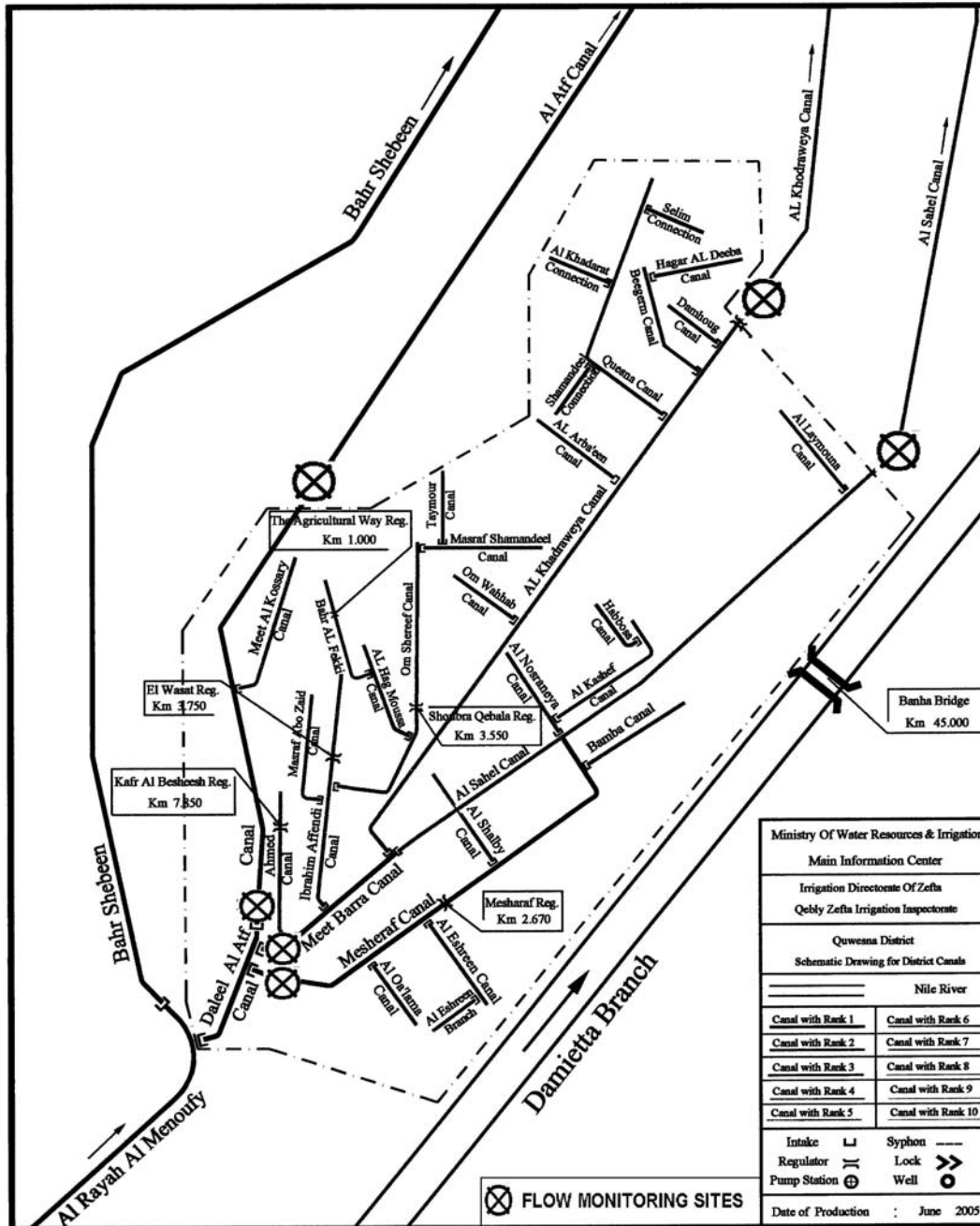


Figure 3. Flow monitoring network for Quesna District (three inflow sites and three outflow sites)

Calibration formulas (see example in figure 4 below) have been established in all of the 86 canal sites, thus allowing IWMD managers to know every day the volumes of water that have been supplied to their district.

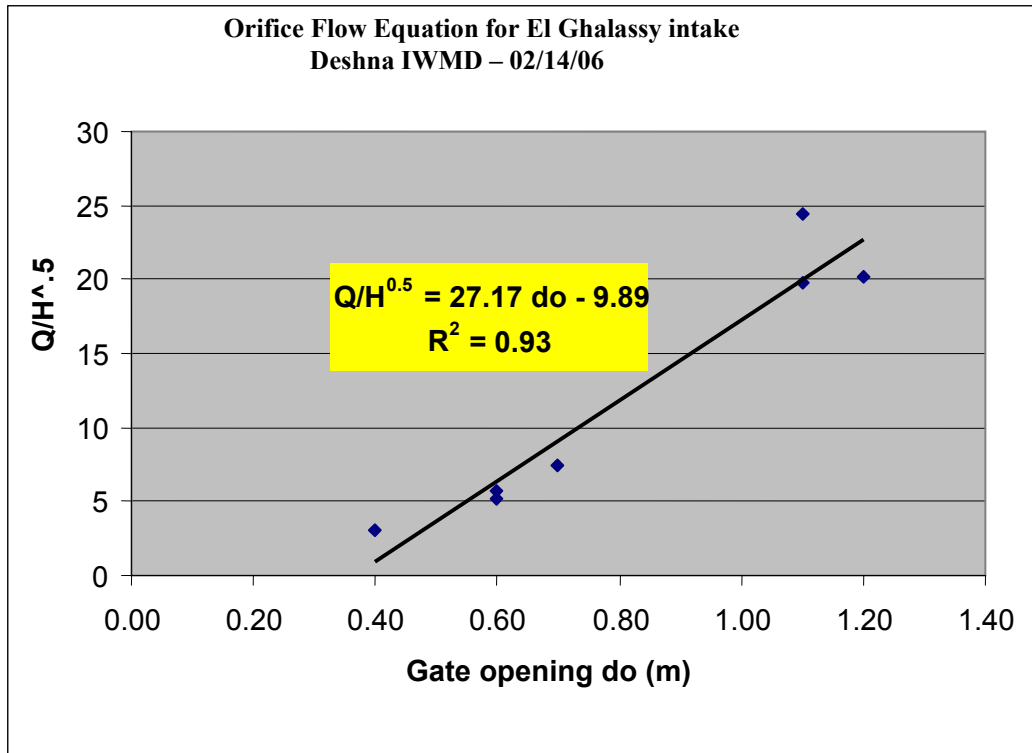


Figure 4. Example of structure calibration

The initial results of flow monitoring provided IWMD managers with the ability to compare the volumes actually received by their district with the target allocations, and thus to optimize distribution and provide feedback to the regional level. Comparing actual supplies between districts is also possible (on an area basis). But much remains to be done to ensure decentralized flow monitoring as a sustainable practice in Egypt.

REMAINING ISSUES AND NEXT STEPS

The correlation of some of the calibration formulas is poor or very poor (correlation coefficient lower than 0.85). This poor correlation is due to inaccurate data or improper recording. Collecting and recording water levels is a well established practice in Egypt, but recording gate openings is not, while essential for the proper calibration of control structures (most of the measurement sites are cross-regulators). Since the calculation of calibration formulas has demonstrated to IWMD staff how essential gate opening data is, the correlation of calibration formulas is expected to improve.

Another issue that impacts directly all data activities in Egypt is the lack of awareness of technical staff regarding the magnitude to be expected from measurements and calculations. IWMD staff and even engineers and managers sometimes submit and sign off figures whose magnitude is obviously incompatible with the relevant physical conditions. While water levels matter to both water users and managers, other water data such as discharges do not yet have much significance. Awareness raising is being provided for engineers to check the validity of their results before submission, through constant follow-up of the results.

But the best way to improve data quality is to ensure that it is being actually used for water management and decision making. This calls for both technical assistance and behavioral change⁴. The most critical objective is to lead MWRI staff to evaluate water demands, and assess water use efficiency by comparing actual supplies with the demands.

In parallel to flow measurement activities, the project is thus supporting the implementation of the Matching Irrigation Supply and Demand (MISD) program whereby crop data is being collected and used to evaluate biweekly water demands in each district. These demands are then aggregated at regional and national levels to plan the releases from the High Aswan Dam and the distribution of water resources along the Nile Valley.

While the MISD program is chiefly a national data collection effort, the project is promoting its use at district-level. The objective is to have IWMD managers compare on a biweekly basis these demands with the actual supplies they receive in their district. First results for five of the districts are shown on figure 5 below. Data accuracy needs to be seriously improved before these results can support actual decision making.

From figure 5, some observations can however be made:

- The supply-demand adequacy is reasonably good during the summer for most districts (ratios from 0.5 to 1.5); early summer sees some adjustment as the planting periods may not match the managers' expectations;
- The winter (January) closure of canals for maintenance purpose appears clearly in several districts (ratios decreasing to 0);
- The general over-supply seen during the winter period is due to the fact that water levels need to be maintained high enough in the branch canals for meskas (tertiary canals) to be supplied, while the water demands are

⁴ A significant behavioral change is needed because there is currently some reluctance within MWRI to produce accurate demand and supply data (the same is true for the dissemination of water quality data). This lack of transparency and accountability is well-known in many if not all countries around the world.

comparatively low; because of limited control at the tail of the branch canals, this implies that significant volumes of water are lost to the drains⁵.

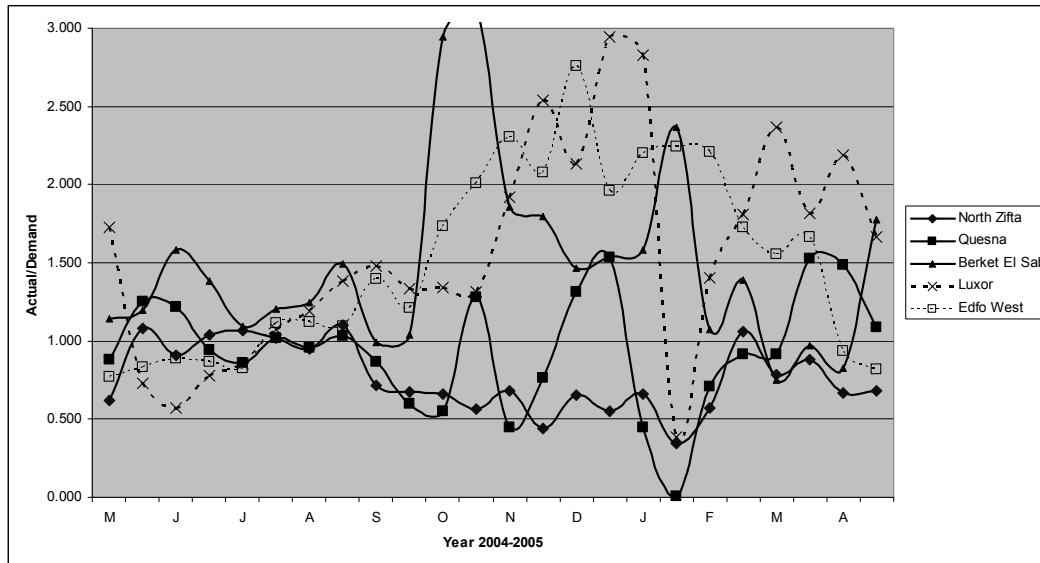


Figure 5. Biweekly actual supplies versus water demands in five districts (first three districts in the delta, last two in Upper Egypt)

A related activity is the establishment of water budgets in each IWMD (see table 1 below). The objective is again to encourage IWMD managers and their staff to think about the availability and quality of the water resources they use, and the magnitude and types of water needs present in the district. This would contribute to better water use efficiency by:

- Assessing how efficiently water is used in the district; and
- Evaluating how equally water is distributed among the districts.

This water budget would also be the basis for a proper district-level water balance (including drain flows) and most importantly for developing a district-level water management plan, where current and future demands would be compared to current and future availability of water resources.

The common thread in all these activities is to decentralize water management by training and empowering IWMD managers and staff.

⁵ It is a known fact, notably in the Delta, that the water quality in drains is significantly better in winter than in summer. This observation has led to the design and implementation of the Irrigation Improvement Project, which promotes the use of automatic downstream-control gates.

Table 1: Water budget of an Integrated Water Management District

Directorate.....
IWMD

SEASONAL WATER BUDGET
(Summer Season, May 1st - September 30th, or
Winter Season, October 1st - April 30th)

Water Demand (Mm3)		Water Supply (Mm3)	
1. Agriculture		1- Canal	
1-1 Area Served (f)		2- Rainfall	
1-2 Rice Area (f)		3. Drainage Reuse	
1-3 Sugar Cane Area (f)		3-1 Official	
1-3 Water Req (MISD data)		3-2 unofficial	
2. Municipal		4. Groundwater	
3. Industry		4-1 Governmental	
4. Other		4-2 Individual	
		Total Non-conventional Water (3+4)	
Total Water Demand		Total Water Supply	

Note: While some of the data above is measured or calculated, the remainder are guesstimated (e.g., unmonitored private groundwater withdrawal or drainage reuse).

The difference between demand and supply are discussed with IWMD managers and used first to improve demand assessment and supply measurement, and second to match supply and demand.

The following indicators will also be calculated and analyzed:

<i>Indicators</i>	
¹ Water Surplus/deficit (m.m3/y)	
² Water Use index	
³ % of non-Conventional Water	
⁴ Per feddan water delivery (m3/y)	

1 water Surplus/deficit = Total water supply – total water requirement
+ for surplus
- for deficit

2. Water Use Index = Water Supply/Water Demand

3. % of non-Conventional Water = Total non-conventional / Total supply

4. Per feddan Water Delivery = Water Supply for Ag./Cultivated Area

CONCLUSION

The objective of decentralized flow monitoring is to provide local IWMD managers with tools to better allocate the water resources they receive and also provide intelligent feedback to their hierarchy. Decentralization is also meant to counter the heavy centralization which has always been the main characteristic of water management in Egypt⁶.

The first achievements are the ability of IWMD staff to conduct regular flow measurement and to calibrate the main inflow and outflow sites of their district. IWMD managers can now compare the volumes actually received with the target allocations, and thus optimize distribution and provide feedback to the regional directors.

To maximize the use of the flow data produced, and improve water management, the project is also supporting the evaluation of water demands at district-level (MISD program) and the comparison of these with the actual supplies. A related activity is the establishment of water budgets in each IWMD, to encourage IWMD to think about the availability and quality of the water resources they use, the magnitude and types of water needs present in their district. This would contribute to better water use efficiency by:

- Assessing how efficiently water is used in the district; and
- Evaluating how equally water is distributed among the districts.

But much remains to be done to ensure decentralized flow monitoring and decentralized water management are sustainable practices in Egypt.

⁶ This centralization is not only due to the ages-old weight of the Egyptian bureaucracy and to the socialist type of management developed during the Nasser period, but also to the fact that there is only one river or one watershed to manage in Egypt. Moreover the sole water supply is Lake Nasser behind High Aswan Dam, so planning adequate releases requires centralized data collection and decision taking.