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WATER CONTROL IN EGYPT's CANAL IRRIGATION

a discussion of institutional issues at different levels

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EDITORIAL INTRODUCTION

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It requires some explanation why a paper on the institutional dimensions of water control in Egypt's canal irrigation is published in a series on irrigation management in Asia. What Egypt has in common with South Asian countries like India and Pakistan, is the existence of a large irrigation bureaucracy which manages a sector that is of great importance to the national economy. Another common factor is that in all three countries a debate and policy initiatives are emerging regarding institutional reform in the irrigation sector. This not only includes the well known policy objective of the establishment of Water Users Associations at the local level, but increasingly also involves the higher levels of canal management and administration. Without wishing to draw direct parallels, the Egyptian experience in this respect, may therefore be of use in the discussion about irrigation reform in South Asia.

This collection discusses institutional issues in Egyptian irrigation at three levels. It starts with a paper by Douglas J. Merrey on the institutional characteristics of the Ministry of Public Works and Water Resources (MPWWR), which is the main government institution responsible for irrigation planning and management, and under pressure to reform. In the second paper, by Martin Hvidt, the Irrigation Improvement Project (IIP) is the subject. This paper discusses irrigation management reform at the system level. Lastly, the third paper, by Lutfi S. Radwan, looks at water management from the perspective of farmers. It discusses how they respond to the existing supply conditions.

The collection, very ambitiously, set out to make the following points.

1) That institutional issues occur at all levels of the water resources/irrigation system, from the national and policy level to the local level.
2) That water management and use is contested at all these levels, that is, that water control needs to be understood as a political process.
3) That the politics of contestation shapes and is shaped by the particular organisational form of the institutions involved.
4) That changes at all levels are necessary to attain sustainable resource use.

Below I discuss the way in which the three papers address these four points.

Institutional issues at all levels

That there are institutional issues at all levels can be demonstrated by a short summary of some of the points made in the three papers.

All three papers start with the observation that the overall context of Egyptian irrigation management is that of slowly but steadily increasing water scarcity. Merrey points out that the irrigation bureaucracy, in the face of this `creeping crisis', will have to change its behaviour as if water is plenty. It is not only the continuing expansion of irrigated area that causes scarcity, but also increasing demand for water for urban and industrial use. The orientation towards investment for

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infrastructure creation and the rather `rule of thumb' way in which agricultural demand for water is determined (see Radwan on this particularly) and water is delivered, has to make place for improved and fine-tuned management to be able to cope with scarcity. The increasing prominence of other stakeholders implies that new institutional solutions need to be developed for sectoral water allocation.

At a more specific level Merrey discusses several institutional characteristics of the MPWWR, which are problematic with regard to the necessary process of reform. He describes the MPWWR as having a fragmented organisational structure, where there is duplication of activities and overlapping of the boundaries of different units. One aspect of this is the isolated operation of foreign donor-assisted projects, for which separate institutions are created. The philosophy is to make the projects more effective in this way, but integration in the government system of their activities is actually hampered. There is highly centralised decision making in the MPWWR, meaning that little authority is located at lower levels, where it might be more effective. As a result accountability is directed upward and not to farmers. Decision making in the all important committees is oriented towards consensus and tends to avoid controversial issues. Add to this domination of civil engineers in the staff when other disciplines are increasingly required, overstaffing, low payment, and the predominance of personal relations over functional ones, and some of the problems in institutional reform can be fathomed.

Hvidt's paper discusses the issue of decentralisation of water management responsibilities to WUAs[2], and the related necessary management practices of the irrigation bureaucracy. The institutional changes involved (which also imply technical changes) are the shift from rotational supply to continuous flow, and a shift from individual lifting to collective lifting of water from *mesqas* by means of pumps. Farmers have generally responded well to these changes, but it is difficult to evaluate the value of this finding. Because the continuous flow system has been technically incompletely implemented, farmers benefit from excessive water supply. What would happen under conditions of scarcity is unclear. The main problem on the government side is, according to Hvidt, that it is under pressure from interest groups, and that there are no incentives for government officials to implement the continuous flow system. Local level engineers operate on the principle of minimising complaints rather than a technically defined operational plan like continuous flow. Complaints are voiced by local interest groups, and it is these that have to be accommodated. In this way the engineers are able to keep their superiors happy. Furthermore, continuous flow reduces the social status and additional income of canal level officials because there is less to control and regulate.

Radwan's paper looks at farmer responses to the present irrigation management conditions. He argues that the present top-down bureaucratic supply management leaves no space for users to control patterns of supply, and therefore leads to many individualist responses. In other words, the government set-up constrains the emergence of collective action and joint planning to such an extent that a `syndrome of anarchy' on the canals becomes unavoidable. Also he argues that the establishment of government institutions at local level (not only or primarily related to irrigation) has undermined part of the effectivity of local institutions (for conflict resolution for example). As a result there is an institutional vacuum at this level. Still, individuals and groups have designed coping strategies for the insecurity in water supply. These include representation to higher levels, bribing, but also forms of turn-taking around pumpsets installed to relieve scarcity. Radwan argues that these `informal' forms of organisation could be constructively integrated in the `formal' structure, and would improve the performance of the system.

2 The IIP and Hvidt's paper focus on WUAs at tertiary (mesqa) level. Interesting experiments with farmer organisation at secondary level take place in the Fayoum. On this see Mohammed Mokhtar, David Nieuwenhuis and Rens Verstappen (1996) "armers""involvement in secondary canal management. Experiences with organizational development in the Fayoum Governate, Egypt' In: ICID Proceedings sixteenth congress. Cairo. Q.46, R.2.01, pp.199-216.

Political contestation

The political dimensions of these institutional issues at the different levels are many.

At the international level the issue of scarcity has to do with allocation agreements between the Nile basin countries. At the national level it is related to the perceived role of agriculture in the national economy, and the importance given to (the degree of) self-sufficiency in food.

With regard to water resources policy, Merrey points to the political unpopularity of the introduction of irrigation service fees, or more generally, cost recovery programmes. For politicians it is difficult to be elected on cost-increase programmes, notwithstanding the other positive effects such measures might have. Merrey also points to the political context of the expansion of irrigated area, the `greening of the Sinai' policy.

Another important political factor is referred to by both Hvidt and Radwan: the importance of local elites as a support base in the Egyptian political system. This means for instance that even when policy makers officially commit themselves to a reform policy, and a project like the IIP is created to implement it, there may still be very good reasons for field level staff not to, or only partially cooperate. For the irrigation staff status and income are at stake, and these are not easily relinquished by anyone.

These examples show that institutional issues are not simply matters of knowledge, skill and organisational structure, but that they may express particular configurations of power relations and interests.

Form-dependence

It has already been suggested above that the very size of the irrigation bureaucracy is an issue in itself. It makes the bureaucracy inherently complex, and institutional change difficult. Other factors mentioned above that inhibit smooth transformation processes include the committee structure, centralisation and upward accountability, and fragmentation. The general conclusion that can be drawn from this is that not only the present structure is not ideal to cope with existing and emerging issues, but that there seem to be very few mechanisms within the bureaucratic institution that allow *internally generated* change. In other words, there are few mechanisms that facilitate institutional learning and development. This seems to be a characteristic of many large (irrigation) bureaucracies. Two concrete manifestations of this that are discussed in the papers are the nature of the incentive structure in MPWWR (Hvidt's paper) and the power vacuum at the local level as a result of the mode of state governance at this level (Radwan's paper).

On the other hand, too much pessimism, based on a structuralist view, is not warranted either. Merrey clearly indicates that there is considerable awareness and articulation of the problems by MPWWR staff at the personal level, but that the question is to find ways for collective articulation that do not put individuals on the spot. The joint MPWWR-IIMI institutional analysis seems to have provided such an opportunity at least to a certain extent. The fact that the MPWWR cooperated in this analysis shows that outsiders should be careful in their evaluations of the potential for institutional change. It is very important how that change process itself is institutionally shaped and situated.

Sustainable resource use

The need for change at all levels to achieve sustainable resource use, is an implication of the foregoing. That need derives, among other things, from the fact that localised institutional issues are often embedded in or the expression of wider processes. This should not lead to a conclusion that small things can not be changed till the larger issues are resolved. Rather it implies that the resolution of larger issues, like sustainable resource use, can start at many places.

Acknowledgements
In the composition of this collection chance played an important role. In February 1995 Prof. Tony Allan of the School of Oriental and African Studies (London) discussed his work on Egypt's water resources with a Wageningen audience in a seminar and in the Irrigation and Development course. In November 1995 Douglas J. Merrey presented the paper now included in this collection in a public lecture during his two week stay in Wageningen as a visiting researcher. Soon after that the idea to compose a collection of different papers on institutional issues at different levels was formulated. Prof. Tony Allan suggested that the work on Martin Hvidt and Lutfi Radwan would fit that objective. Both agreed to contribute a paper. In September 1996 most of the authors could meet at a conference in Cranfield College on water policy issues, where drafts were discussed, and the collection took further shape. After that the review process and other commitments of the editor caused considerable delay in publication. The editor can only apologise for the delay and thank the authors for their patience.

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GLOSSARY AND ABBREVIATIONS

behari or bahhar =	gatekeeper
EWUP =	Egypt Water Use Project
feddan =	one *feddan* is 4200 m2 or 0.42 ha
IIMI =	International Irrigation Management Institute
IIP =	Irrigation Improvement Project
IMS Project =	Irrigation Management Systems Project
marwa =	a field channel conveying water from the *mesqa* to individual fields
mesqa =	private ditches or watercourses, receiving water from branch canals for distribution either directly to the fields or into *marwas*
MOA =	Ministry of Agriculture
MPWWR =	Ministry of Public Works and Water Resources
muhandis =	district engineer
omda =	village mayor
sheikh al balad =	deputies of village mayor (*omda*)
USAID =	United States Agency for International Development

GOVERNANCE AND INSTITUTIONAL ARRANGEMENTS FOR MANAGING WATER RESOURCES IN EGYPT

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SUMMARY

The paper begins with the paradox that while all the figures show that Egypt's water resources are becoming increasingly tight, the system is managed as if there were plenty of water. Egypt faces a 'creeping crisis' in its water supply. The paper then examines whether the Ministry of Public Works and Water Resources is prepared to deal with future shortages by examining its policies, organizational structure, management processes, and human resources. Policies include investing in horizontal expansion of irrigated land, and not charging users for water services; water quality is now recognized as a very serious problem. The Ministry has been unable to make full use of, or `integrate', a set of technical and institutional investments under a 15-year USAID-supported project. This can be attributed to several factors: the highly centralized structure with little delegation of authority, in which programs and functions are fragmented, and there is considerable duplication of functions (amplified by donors' insisting on creating new units for their own projects); the large number of stakeholders and consequent lack of clear accountability for performance; difficulties in cooperation and sharing information among Ministry units; very low levels of compensation both absolutely and compared to other developing countries combined with the absence of linkages between compensation and performance; over-dependence on generalist civil engineers, discouraging both specialization among civil engineers and retention of other required specialists. The conclusion of the paper emphasizes that at present the Ministry is a 'going concern', whose performance is not bad; but that policy, institutional and human resource reforms will be needed for Egypt to solve future water problems.

1 INTRODUCTION: THE PARADOX OF PLENTY

My starting point is the paradoxical nature of Egyptian water resource management. By the usual macro-level measures, Egypt has a scarcity of water, and many authors use Egypt as a dramatic case of a country that will soon face a severe water crisis. Egypt depends on one source for its water, the Nile River. It is the furthest downstream of the 10 Nile River Basin countries. It uses about 75 % of the available Nile water, with Sudan using most of the rest. It is therefore in a very vulnerable situation in terms of its lack of control and location vis-à-vis the source of its water.

Hydrologists consider a country with 1,000-1,700 cubic meters (m^3) per person per year of water as ' water-stressed'; below 1,000 m^3 a country is considered 'water-scarce' (PAI 1993:44; see also Postel 1992:28-29). With about 1,000 m^3 per person currently available, Egypt is right at the threshold of scarcity. The available water per capita declined by 50 % from 1960 to 1990, primarily as a result of rapid population growth and a fixed water supply (and in spite of the Aswan Dam coming on-stream during this period). By the year 2025, it is estimated per capita water availability will decline to 605 cubic meters (PAI 1995 as reproduced in INBA Bulletin 1[2], 1995).

Egypt's present supply of and demand for water just balance, according to 1990 figures. In that year Egypt used 59.2 billion $m^3$of water, with agriculture absorbing 84 % of this total. For the year 2000 the agricultural sector demand is projected at 58.8 billion m^3, and the total demand at 70.0 billion m^3 (Lofgren 1995:2). Municipal and industrial demands are also increasing rapidly, as is loss of available water through various forms of pollution (Cestti 1995). Whether additional supplies to meet this rising demand can be found is questionable.

Even if present supply of and demand for water are in balance (there is evidence that at present seasonal shortages do occur), continued growth in demand will soon outstrip supply and Egypt will face a serious crisis.

But the paradox is this: Egypt currently manages its water resources as if they were unlimited -- as if it has and will continue to have plenty of water. At present, all of Egypt's agricultural land is irrigated, and cultivated very intensively, with very high yields per unit of land. In the late-1980s Egypt shifted from a policy of controlling cropping patterns to a market-driven policy in which farmers are free to grow whatever crops they wish. Egypt's irrigation authorities' management objective is to provide sufficient water to all farmers to fully meet the demand, whatever the crops grown. 'Demand' is calculated using rules of thumb and rough (but increasingly unrealistic) estimates of the likely cropping pattern at the beginning of each season; additional allocations are made when farmers "complain" about shortages and demand additional water. Achieving and continuing to pursue such a management objective presupposes the availability of sufficient water.

At the macro-level Egypt has very high average crop yields per unit of land as well as a high cropping intensity (about 200 percent). This is not surprising given the combination of a largely adequate and reliable water supply in most areas of the system, the very favorable climatic conditions for crop growth, and recent policy changes. But the very high evapotranspiration rates characteristic of this desert environment mean that crops are vulnerable to rapid moisture depletion. A reduction in the reliability and day-to-day availability of water would seriously affect crop yields. Further, a recent report by John Mellor Associates (1995: 29-30) notes that even though Egyptian yields are high compared to other country averages, they are not high compared to countries with comparable resources. In principle there are excellent opportunities to accelerate agricultural growth, especially by shifting to higher value crops. But maintaining the high cropping intensity and increasing the value of agricultural output will be impossible if water supplies are stretched too thinly, and become unreliable.

The Egyptian government continues to invest heavily in expanding the irrigated area. Between 1960 and 1990 total agricultural land increased from 2.48 million hectares (ha) to 3.02 million ha; nevertheless, as a result of population growth, per capita agricultural land fell by over 40 % during the same period, to 0.055 ha per capita . The government hopes to irrigate an additional 672,000 ha by the year 2000. Donors such as the World Bank and USAID have generally declined to finance this expansion, but Arab countries' aid and internally generated funds continue to be allocated to this ambitious expansion program. These expansion programs are based on planners' assumptions about future water savings from improved 'efficiency' in the old lands, and future additions to the Nile water supply through construction projects in southern Sudan. I return to this question of water 'savings' below.

During the peak demand season -- June to September -- the government officially attempts to control demand for water by limiting the area of rice to about 294,000 ha, much of this in the lower delta where rice is indeed the most appropriate crop, and the last opportunity to use the water before it flows into the sea. But this limit cannot be enforced: farmers want to plant rice, and about twice the area authorized is planted, much of it in areas where growing rice creates severe water shortages for adjacent areas. Although modest fines are imposed for unauthorized rice cultivation, the government continues to attempt to provide sufficient water to meet this 'unauthorized' demand.

In addition to these seemingly profligate practices, Egypt continues to provide water without charge to agricultural users: there is no irrigation service fee. Users do have some incentive to use water efficiently as most have to pump water from canals to their fields. Although there are laws to control water pollution, these are not enforced rigorously. Donors have assisted the Ministry in charge of water resources through investments in technology and human resources designed to improve water policy and water management capacities; but as we shall see below, the government has found it difficult to take full advantage of these investments. Government institutions have little incentive to management water efficiently.

Predicting when real water shortages will occur has proven to be difficult. Waterbury (1979) in a classic work predicted severe shortages by the mid-1980s, and indeed because of a multi-year drought in the upper Nile basin in the 1980s, the reservoir at Aswan reached dangerously low levels in 1987. But the rains returned, and in 1995 there were predictions the reservoir would spill for the first time ever (it did not do so because rains in the catchment areas were below normal). All the trend lines point in the same direction, to what I call a creeping crisis: the question is not if but when will Egypt begin to feel the effects of increasingly severe shortfalls of water supply compared to demand.

At present, Egyptian water resource management institutions are poorly equipped to respond to such a crisis. Some of the evidence for this lack of preparedness has already been referred to: the fact that water is a 'free good' for example. Irrigation canals are managed to maintain specific water levels; below the Nile stem and the heads of major canals, water quantities are not measured. The authorities have no information on how much water is delivered to specific areas and no capacity to measure and allocate specified amounts of water. There is therefore no clear sense of water rights (beyond a "right" to enough water to meet demand), no basis for establishing and enforcing such rights, and no clear priorities for water use.

At the international level, Egypt has an agreement with Sudan on allocation of water between the two countries. But in recent months as the relations between the two governments have deteriorated, threats have been made regarding water and their willingness to fight over it. Probably more serious than these tensions between the two major (downstream) water using countries, there is no agreement with Ethiopia (the source of 85 % of the Nile Basin water) or other watershed countries on water allocation. At present this is not a serious issue, and there are on-going efforts to develop institutional mechanisms for cooperation among the Nile Basin countries; but the Nile is often cited as one of the more likely candidates for future international conflict over water.

Clearly, trouble is brewing in the Nile Basin. The ingredients are all present for major conflicts and struggles over a most precious resource -- water. Such conflicts could occur between countries and also within the biggest user of all, Egypt. IIMI's work has focused primarily on institutional and policy issues within Egypt. Therefore, the remainder of this paper examines

Egypt's water resource policies and institutions and their capacity to address Egypt's creeping water crisis. The paper is based on data collected and observations made during an intensive 7-month program of institutional analysis and action planning.

The next section provides an overview of Egypt's policies, institutions, and the results of a major donor-assisted project. Section 3 describes the study IIMI carried out in the first half of 1995. Section 4 presents some of the key findings and implications of the institutional analysis. The last section of the paper returns to some overall conclusions and implications for both Egypt and for other countries.

2 PRESENT STATUS OF EGYPT'S WATER RESOURCES POLICIES AND INSTITUTIONS

2.1 Policies

For several decades until the mid-1980s, the Egyptian government controlled the cropping patterns, including agricultural input and output marketing. The major policy change that has occurred since that period is price liberalization and the removal of most quantitative constraints on crop areas. As a result, the area and yields of wheat and certain vegetable crops have increased dramatically, and farmers' net incomes have risen about 25 % (IIMI 1995a). An additional impact, mentioned above, has been the large increase in the area of water-intensive crops, especially rice.

Another major policy of the government since the completion of the Aswan Dam is heavy investment in expanding the irrigated area. In the mid-1980s, the government shifted from developing state-dominated farms to encouraging private investors to develop commercial farms which continue to be heavily subsidized. At present the government is constructing a large canal to carry Nile water under the Suez Canal into the Sinai to irrigate about 265,000 additional ha of mostly desert land.

The government's policy on cost recovery is currently under intensive review. At present, municipalities and industries withdrawing water from the Nile pay nothing, though municipalities attempt to charge individual users through a metering system. Farmers in the old lands pay nothing for water deliveries to the head of the field canals (*mesqa*). Farmers using the *mesqa* are jointly responsible for its maintenance; and farmers use their own pumps to withdraw water from the *mesqa* as it is normally below the field levels. A recent amendment to the Irrigation and Drainage Law enables recovery of capital costs for *mesqa* improvements being done under a government program, but implementation has not begun. This cost recovery provision is modeled on a system for recovering the capital costs of a field drainage program that has been underway for two decades (costs are recovered after a grace period, over 20 years, with no interest; therefore it is highly subsidized, as will be the *mesqa* improvement program). Charging for irrigation services is a very sensitive issue in Egypt. One possibility will be to begin by charging non-agricultural users for water.

The other area of increasing concern to policy makers is water quality. In a survey carried out by IIMI, this issue was ranked first by senior managers and policy makers of the Ministry in charge of water (IIMI 1995b:box 3.1). Although there are laws intended to govern water pollution, for political reasons it has been difficult to enforce these laws in a rigorous manner. One problem is that government-owned factories are among the worst polluters. Another is that the responsibility for monitoring water pollution and taking action against polluters is fragmented among a number of different ministries and agencies.

2.2 Institutions

The Ministry of Public Works and Water Resources (MPWWR) has overall responsibility for capturing, distributing, and regulating water supply and drainage in Egypt. This Ministry has a proud tradition going back nearly 200 years (for much of this period it was a 'Ministry of Irrigation'); some of the top engineers are second, third or fourth generation Ministry employees. The Ministry has an estimated full time staff of 88,000 (see table 1). About 8,000 of these are professionals -- nearly all civil engineers. It has many functions, including policy-making, water resource planning, design and construction of water-related civil works, operation and maintenance of the water distribution and drainage system from the Aswan dam to the Mediterranean (and to the head of the farmers' joint *mesqas* with residual authority to enforce maintenance of the *mesqas*); regulation of water quality and groundwater; coastal protection; and research and training. This large range of functions, some of which have been added incrementally over time, is reflected in the large number of different types of management units within the Ministry (figure 1). By far the largest of these units is the Irrigation Department, with over 38,000 employees. It is responsible for operation and maintenance of the water delivery system below the Aswan Dam. The MPWWR can be characterized as a multifunctional but single-disciplinary organization which is institutionally fragmented. We return to the implications of this below.

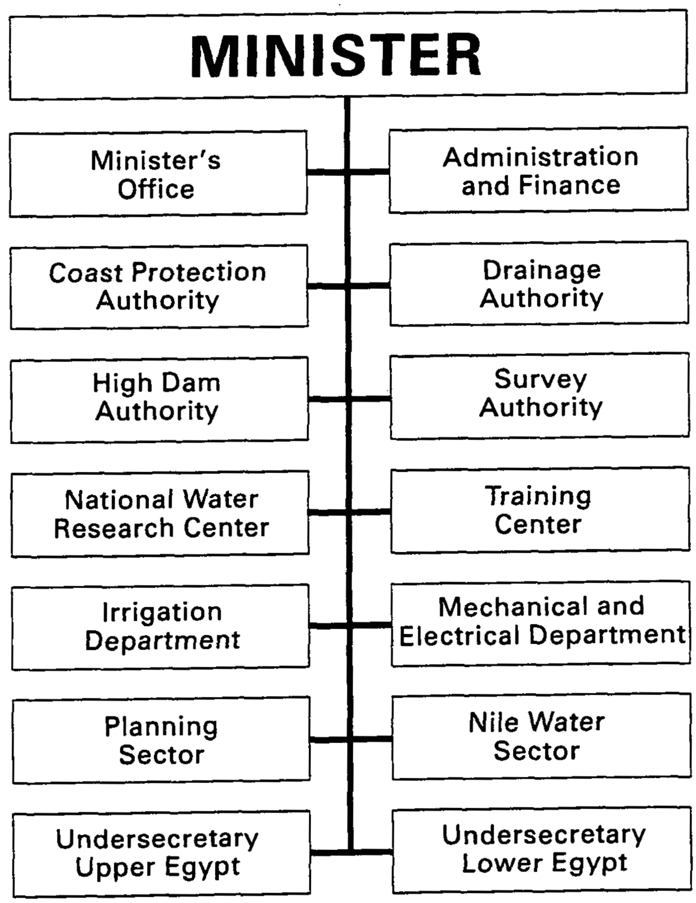
Table 1 MPWWR staffing pattern

Unit	Professional staff	Non-professional staff	Total staff	Ratio non-prof. to professional staff
Headquarters	356	1,082	1,438	3.0
Survey auth.	879	13,586	14,465	15.5
Drainage auth.	1,677	12,749	14,156	7.6
Coast protec.auth.	111	162	273	1.5
NWRC	677	2,069	2,746	3.1
Irrigation dept.	2,844	35,647	38,491	12.5
Mech. & elec.depth	1,512	15,210	16,722	10.1
Total	8,056	80,505	88,561	10.0

Source: IIMI (1995b: Table 4.2).

A number of other agencies are concerned with water resource management in Egypt. The major ones include the Ministry of Agriculture and Land Reclamation (responsible for agricultural development, policy and support); the Egyptian Environmental Affairs Agency (EEAA), which has a coordinating role in environmental protection including water resources; and the Ministries of Health, Industry, and Housing (the latter includes the agencies responsible for municipal water

Figure 1 MPWWR organization chart



supply and waste water disposal). Coordination of the large number of diverse and sometimes conflicting stakeholders for integrated water resources planning and management is a serious problem.

2.3 The Irrigation Management Systems (IMS) Project

The IMS Project is supported by the United States Agency for International Development (USAID). It began in 1981 as a 'structural replacement' project and evolved over time to include about ten components. It was recently extended – again – to September 1996, for what is supposed to be its final year. Other components have assisted the Ministry in strengthening its National Water Research Center; built a new Training Center and strengthened training capacity; strengthened the Ministry's project planning and survey and mapping departments; assisted in installing a telemetric data gathering and voice/data communications system (construction nearly completed); assisted in developing about 20 mathematical models as planning and operational tools; and supported the introduction of improved preventive channel maintenance in six of the 26 Governorates.

A major component is the Irrigation Improvement Project (IIP). Based on research results from the Egypt Water Use Project (EWUP), an applied research project funded by USAID in 1979-1984, it supports the introduction on a 'pilot' basis of an integrated program of raised *mesqas* or pipelines with single-point pumping managed by new Water Users Associations, supported by a shift from rotations to continuous flows in distributaries, and an Irrigation Advisory Service within the Ministry. Although originally planned for 165,900 ha, the current objective is to improve 29,400 ha and 1,050 *mesqas*. About half has been completed, and the World Bank is supporting an expansion of the project in the Delta. This project is potentially revolutionary in its impact, because it is an attempt to establish the possibility of a defined service to organized legally recognized farmer organizations. But IIP is facing many unresolved issues which will affect its future. These include the feasibility of shifting the entire system to continuous flow; the long-term role of water users associations and their relationship to the Ministry, the cost-effectiveness of the technology package; and whether the benefits justify a national program, versus one targeted to special areas.

This last issue relates to both the cost (an estimated $3.4 billion if implemented throughout the old lands); and the nature of the benefits. Originally justified as a 'water savings' program, it has become clear that such water savings are illusory in most parts of the system because of the return flow of excess water; the potential for 'saving' water comes toward the end of the system, in the Delta, where water not used is finally 'lost'.

This issue of the potential to save water for use elsewhere has become very controversial among Egyptian water resource policy makers. Based on findings from EWUP that field irrigation efficiencies can be raised through on-farm irrigation improvements, the IIP was designed with a specific objective of saving 5 BCM of water that could then be used elsewhere. In the 1970s-1980s, parallel to the EWUP, a comprehensive Water Master Plan was developed. A major conclusion of this exercise was that because of the large amount of re-use of water occurring in the Nile Basin, the system as 'a closed system' is actually more efficient than usually assumed, and the potential for saving water to support major expansion of the irrigated area is less than planners had believed (WMP 1984:85, 126-127). This finding was ignored, and Egypt continued to invest heavily in horizontal expansion for political reasons.

More recently, the Strategic Research Program (supported under the IMS Project) has again documented and explained far more elegantly and lucidly the original conclusion of the Water Master Plan: because water 'lost' from the fields in Upper and Middle Egypt returns to the river and is reused, 'savings' from projects like IIP in these areas are 'paper' savings. Traditional concepts of irrigation efficiency need to be supplemented by the concept of 'effective efficiency' (Keller, Keller, and El-Kady 1995). IIP has many other benefits, but the expectation that substantial water savings will occur is not realistic; and continued expansion of irrigation on the assumption that such savings will occur will lead to induced shortages in the Nile Valley.

In the recent past, both the Ministry and USAID have expressed increasing concern about the extent to which the Ministry has 'integrated', or been able to make full use of, the various IMS components. For example, the telemetry system is perceived as potentially very useful, but has not been fully accepted by Irrigation Department managers (see below). The Ministry is perceived as so far not making optimum use of its new training, research, and computer modeling capacities. And IIP has raised a large number of issues about the future management of irrigation in the Nile Valley which remain unresolved. This is the context for the Study carried out by IIMI in the first half of 1995.

3 OBJECTIVES AND METHODS OF THE MPWWR-IIMI-USAID STUDY

In 1994, IIMI was invited by USAID to submit a proposal to assist with further planning and analysis on irrigation cost recovery issues, and to carry out an institutional analysis of the Ministry's experience in implementing the IMS Project. IIMI proposed a highly intensive and participatory approach which was accepted by USAID and the Ministry; work began in January 1995 and was largely completed by the end of July 1995. The two broad objectives agreed to by all parties were:

1. To develop a long range plan that would enable the MPWWR to make effective use of IMS outputs; and

2. To make further progress towards clarifying and establishing Egypt's future policy toward cost recovery and cost sharing to ensure the sustainability and efficiency of water resource management.

At IIMI's request, the Ministry established a high-level Steering Committee to oversee the process and through which results were to be communicated and discussed at the highest levels; and a series of task forces, made up of middle-level professionals, to assist in the data collection and analysis, development of recommendations, and preparation of reports. IIMI staff and consultants and the task force members spent considerable time interviewing Ministry officials (about 120 were systematically surveyed), carrying out a survey of about 80 farmers, and analyzing a wide variety of reports, files, and documents. Much time was spent in informal discussions at field and central level staff as well; and five formal workshops were planned (of which four have been held), to discuss the results and achieve agreement on the products being produced.

Aside from the Work Plan and many supporting consultancy reports, the major products produced were: a detailed institutional analysis of the Ministry (IIMI 1995b); a detailed Action Plan for planning, testing and implementing institutional and policy changes (IIMI 1995c); and several reports dealing with cost recovery issues (IIMI 1995a; 1995d; Perry 1995; Cestti 1995; Lewis and Hilal 1995; Mohieddin 1995a). These materials, especially the institutional analysis, provide the basis for this paper.

4 FINDINGS OF THE INSTITUTIONAL ANALYSIS

The institutional analysis of the Ministry of Public Works and Water Resources (IIMI 1995b) was carried out during the first three months of the Project, and then revised based on feedback received at a workshop and additional analysis. The Ministry has not formally approved its contents (though it does reflect the views of many individuals in the Ministry). Thus the views expressed are my own and not necessarily those of the Ministry, or USAID. This presentation can only highlight a few key issues. It is organized around three concepts: structure; process; and human resources.

4.1 Structure of the Ministry of Public Works and Water Resources

4.1.1 Overall Structure

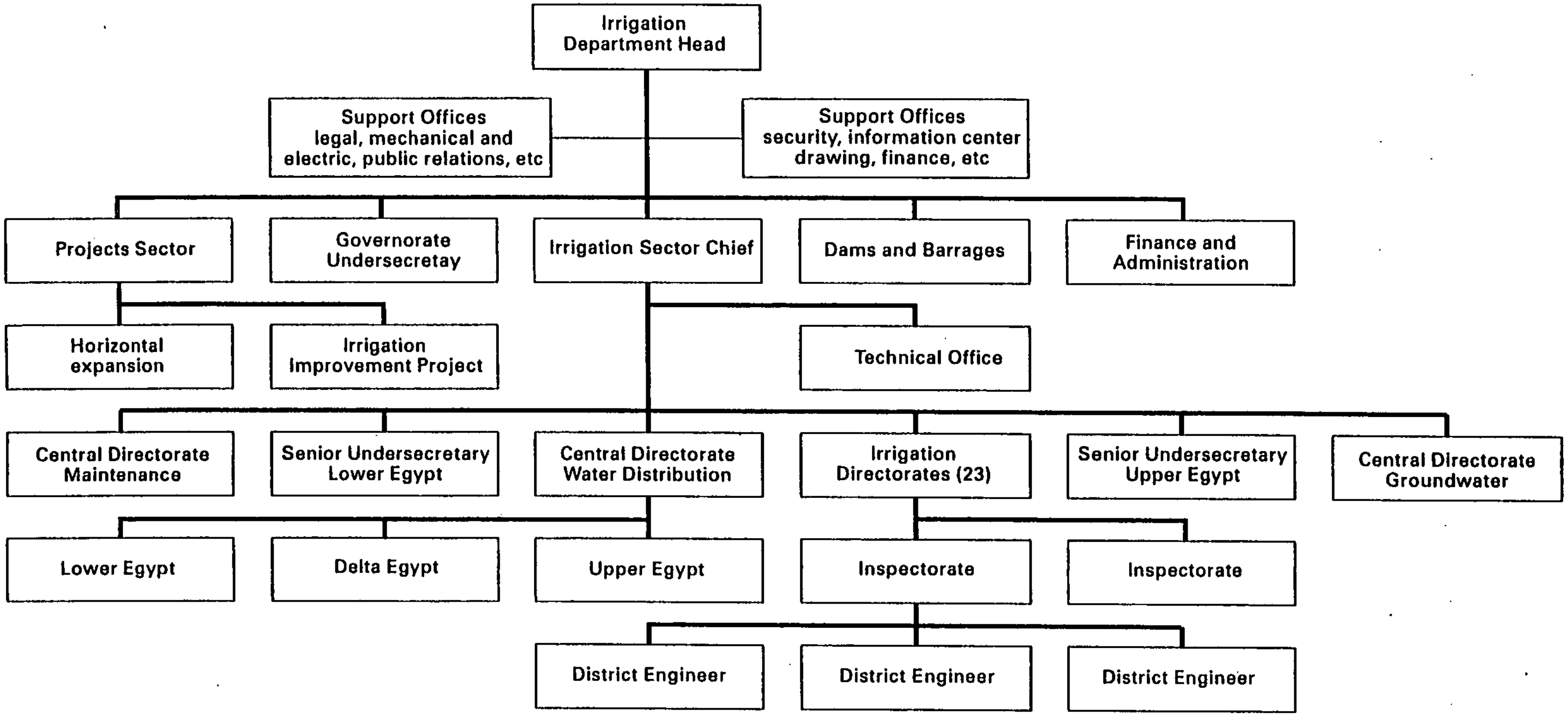
Figure 1 shows the overall structure of the Ministry at the top. There are about a dozen major units reporting to the Minister. These units vary in size and degree of autonomy; 'departments' are somewhat less autonomous than are 'authorities', though neither is truly autonomous. The National Water Research Center has recently won a fairly high status and degree of autonomy analogous to that of a university, while the Training Center has little such autonomy.

With over 38,000 employees, the Irrigation Department is the largest unit in the Ministry. It is divided into five major units including administration and finance (figure 2). The IIP and Horizontal Expansion units under the Projects Sector are fundamentally construction implementation units, though as noted above, IIP includes irrigation advisory services and formation of water users associations as well. The Projects Sector is quite separate from the Irrigation Sector, which is in charge of managing the water delivery system.

Under the Chief of the Irrigation Sector, the general directorate for central water distribution allocates water among major canals and monitors deliveries. Below this level, there are five more levels, though not all are strictly hierarchical or directly involved in water allocation and distribution. These are the regions (upper and middle Egypt, and three delta regions); 23 Irrigation Department Directorates, each of which has two to three Inspectorates, each of which is again divided into two to five Districts.

The District Engineer is the lowest level professional engineer, covering an area of 10,000 to 17,000 ha; he supervises a large number of laborers, gatekeepers (*behari*), and other support staff. There are three other directorates: one to operate the three Delta Barrages just below Cairo, and one each for supervising water distribution in Upper and Lower Egypt. The 23 field

Figure 2 Irrigation department organization



Irrigation Directorates generally do not have the same boundaries as the 26 Governorates (an important political unit), and the boundaries of the directorates of other Ministry units are also different. Decision-making is presently highly centralized: for example, the District Engineer has little formal discretion in adjusting water deliveries. He provides information and makes requests; but decisions are formally made at higher levels. In practice, there is much informal 'slippage' in terms of implementing rotations and other water management practices. The lines of communication also overlap and often bypass each other: they are not strictly hierarchical and linear.

In addition to the fragmentation of programs and functions among many Ministry units, there is considerable duplication of activities and resources, especially at field levels. For example, the Irrigation Department and Drainage Authority have entirely separate boundaries and resources below the Governorate level. Each has it own set of buildings, workshops, equipment, and each operates on its own work schedule; any cooperation that occurs is based on personal relations. Even where they maintain facilities on the same water delivery and disposal system, there is little cooperation (Vissia 1995).

4.1.2 Impact of Donor Programs

This fragmentation and duplication is amplified by the creation of special units to implement donor projects. The Irrigation Improvement Project and the telemetry system are two IMS Project examples. Donors like to have a special unit to ensure their project objectives and schedules are met. Special incentives are paid to Ministry officials working on donor projects, implying that the 'normal' incentives are inadequate for implementing time-bound programs. But this creates difficulties in terms of getting cooperation from normal Ministry entities, and in achieving the integration of programs into the 'mainstream' of the Ministry's organization and management processes. Thus, integrating the new IIP technology and institutional arrangements, as well as the Irrigation Advisory Service, into the local level Irrigation Department structure is problematic -- so much so that there is a proposal to create yet another Authority to implement IIP. This may well accelerate construction, but will worsen, not solve, the problem of integrating the new technologies and institutions into system operations.

Similarly, the telemetry system is being implemented by a unit within the Planning Sector and not the supposed user, the Irrigation Department. The telemetry system is being installed throughout the Nile Basin as an automatic telemetric data gathering system, including a voice-data communication system, flow measurement equipment, and a pilot automation program. It provides real time data on water flows every two hours. Most specialists believe it to be an excellent and much-needed system. This 'main system management' unit has successfully supervised the construction of the telemetry system and built capacity for its use and maintenance. It has made strenuous efforts through training, workshops and a variety of support services to 'sell' the system to the Irrigation Department's system managers with minimal success, in spite of strong support from the Minister himself. A few pilot Directorates where the engineer has taken a personal interest have integrated the telemetry system into their operations and monitoring programs.

But there are many problems: the Ministry has difficulty retaining staff trained in the high-technology electronic skills required to operate and maintain the system; some Directorate Engineers allege there are problems with the reliability of the system ; there is no incentive for system managers to use the system -- i.e., they see no direct benefit from a personal perspective; and because it can be used by central levels to monitor performance at lower levels, there are strong disincentives to support its use. The system has not yet even been installed in the central water distribution office -- which ought to be the unit with the greatest interest.

These examples illustrate another important point: while some units of the Ministry have benefited from a variety of donor investments, the Irrigation Sector -- the operational arm of the Irrigation Department -- has been starved. Special units are created parallel to the Irrigation Sector, for example IIP and 'Preventive Maintenance' (an IMS Project component designed to improve management of structure maintenance using modern management tools), but very little investment has been made to upgrade the Irrigation Sector itself -- rather surprising given its central function. In our field visits, we found that district engineers' resources are generally very inadequate given his responsibilities, and few of them have had opportunities to improve their skills.

4.1.3 Centralization of Decision-Making

Another key characteristic of the Ministry is the high degree of centralization of decision-making authority, and the separation of tasks and authority. Decisions are routinely sent to higher levels of the system, and many seemingly small decisions go to the head of an Authority or Department or even higher. One reason is that the law on delegation of procurement and financial authority is very restrictive. Another is that in job descriptions, while tasks are well-defined, the authority to make decisions is not clearly specified. But even when it is, officials are reluctant to make decisions, preferring to let their superiors decide. Although the telemetry system is sometimes justified as a management tool intended for middle and lower level system operators, it lends itself to further centralization of monitoring and control of water supplies.

A few senior people -- about 14 -- hold most of the authority for making decisions. Their span of control -- the number of people reporting to them -- is very large. The Minister and the Senior Undersecretary of the Ministry who is also the Head of the Planning Sector were identified by IIMI has having too many different units under their direct control -- an observation not accepted by the concerned officials. Senior officials spend a great deal of time sitting in committees and dealing with issues that could, in principle, be addressed by their subordinates; this leaves them very little time for strategic planning and broad policy-making.

Uphoff (1991:38-42)) has suggested that in addition to the number of levels in an organizational hierarchy, the shape of the organizational pyramid has important consequences for its operation. An organizational structure can be relatively tall and narrow -- i.e., be steeply sloped -- or it can be shorter and broader, with a flatter gradient. The height of the organizational pyramid will be greater in large systems because there will be more levels. But the gradient reflects the extent, ease, and directions of coordination and cooperation, and the locus of authority. A flatter gradient results when: a) the flow of decisions and information are fully two-directional; b) authority is delegated and subordinates participate in decision-making; and c) there is accountability to lower levels and ultimately to users.

The MPWWR organizational structure reflects the opposite, or steeper gradient: decisions and information flow more downward than upward; authority is held mostly at higher levels and there is little participation of lower levels in decision-making; and there is little accountability of higher to lower levels, or the organization to its customers. The greater distance implied by this structure can be amplified by differences in educational qualifications between the higher and lower levels and by the prevailing style of communication -- whether it is open and free-flowing or not (Uphoff

1991:37-42). 'Sluggishness' of management processes characterizes organizations with steep gradients compared to the more rapid and timely flow of decisions and information in those with flatter gradients.

4.1.4 Accountability

Accountability is an especially difficult issue in any large public service agency with many different stakeholders. Primary accountability of officials in the Ministry is upward, to higher level officials and to the Minister. There are many stakeholders in Egypt's large multi-purpose water system, and it is very difficult for politicians and senior officials to understand and represent all these local interests. An accountability system based on hierarchical control alone will not serve the interests of the most relevant stakeholders (Paul 1991). Egypt's Ministry of Public Works and Water Resources presently has no effective mechanisms of accountability to the large number of customers with diverse interests.

We carried out a survey of 40 farmers in each of two areas, in middle Egypt and the delta (Mohieddin 1995b). In both places farmers ranked 'absolute water shortage' as their first problem. Larger landlords said they have very few problems -- but poor farmers reported serious problems. In the middle Egypt site, farmers respond to shortages by pumping groundwater, while the delta farmers pump (often low quality) drainage water onto their fields. Mohieddin (1995b:5-6) reports that the high degree of uncertainty and variability in water supply 'leads to an irrigation frenzy' when water is available, with too many people pumping simultaneously, depleting the supply and causing frustration and conflict. The middle Egypt farmers were more favorably inclined toward IIP as a sway of solving their problems than were the delta farmers, and were also more likely to seek the district engineer's assistance to solve problems. Overall, it appears that those with connections and wealth get their water supply, and those who do not have these advantages are more likely to face serious problems.

It is important to note these problems are not unique to this Ministry: they are characteristic of Egypt's bureaucracy (and indeed to many countries' public services). Palmer *et al.* (1988), based on a systematic study of Egypt's bureaucracy carried out by an Egyptian institution, come to similar conclusions. Senior officials are reluctant to delegate authority; subordinates are reluctant to assume the responsibility that is delegated; and there is no accountability to the public -- indeed there is a wide 'rapport gap' between the Egyptian public and the bureaucracy.

4.2 Decision-Making and Information Processes in the Ministry

The highly centralized yet fragmented organizational structure has important consequences for the decision-making and information processes in the Ministry, as noted in the previous section. The Ministry uses two primary organizational forms of decision-making: hierarchy, in which a manager makes decisions for his subordinates; and committee, in which a group makes (or recommends) decisions.

Hierarchical decision-making is effective when decisions are made at the appropriate level; but we have already noted that delegation of authority is limited, and decisions are made at higher levels than necessary. To give an extreme but revealing example, decisions on daily adjustments in water allocations among and along main canals throughout the country are normally made by the General Director for Water Distribution in Cairo. However, during peak demand periods, the Minister himself makes these decisions. An underlying reason for this highly centralized and rather *ad hoc* decision-making process is the lack of clear guidelines and operational rules, and the high degree of politicization of water deliveries.

Committees play a very important role in Ministry decision-making. There are at least 14 permanent high-level Ministry committees; there are committees for all special projects (and sometimes for components of projects); and authorities (but not departments) have boards of directors which are really committees. Many committees are officially advisory -- they advise the Minister, who takes the official decision (of 15 decrees establishing committees examined, only one indicated the committee has authority to make decisions.)

Further, most senior officials sit on a large number of committees; and a small number of senior officials dominate all the high level committees. For example the Head of the Planning Sector is a member of 13 committees of which he chairs seven. Of the 45 positions on the various IMS Project committees, 14 officials fill all but the ten or so project manager positions (IIMI 1995b: table 4.1). Decision-making by committee may be a way of sharing -- or avoiding -- responsibility, and may lead to 'safe' rather than innovative decisions. This is because committees make decisions or recommendations by consensus; this leads to a tendency to avoid controversial decisions, limiting innovativeness. The style of committee functioning in the Ministry does not encourage brainstorming to generate and debate ideas.

To recapitulate: the number of decision-makers is small, there is very little delegation of authority and thus the few senior officials are saddled with very high levels of details in their workloads, and committees lead to 'safe' but not necessarily optimal decisions.

A complaint heard very frequently from Ministry officials is that inter-unit cooperation and especially sharing of information is problematic. We were told that data are often hoarded, not shared; access to information is often possible only through personal contacts; and the process for gaining access to what should be public data is often highly formalized and lengthy . Some officials said cooperation and communication among units at the higher levels is not as bad as is communication between headquarters and field even within the same unit. As noted above with reference to management of maintenance at field levels, there is almost no cooperation among overlapping units of different departments even on the same water delivery and disposal system.

Finally, IIMI examined the budgeting and accounting systems from a management perspective (Lewis and Hilal 1995). We found that while these systems are adequate for tracking 'total expenditures' at highly aggregated levels, it is difficult to disaggregate costs of particular activities and evaluate their cost-effectiveness. Further, neither the planning and budgeting systems nor the accounting systems are organized on a functional basis. This reflects the current 'administrative' style of the Ministry, but will inhibit a more active approach to management for achieving objectives cost effectively. Ironically, accounting and budgeting are relatively decentralized, leading to reporting systems unique to different units. This complicates comparative analysis of data. In sum, the present system could be revised (and computerized) to make it an effective management tool.

4.3 Human Resources of the Ministry

4.3.1 Specialization and Training

Nearly all the professional staff of the Ministry are civil engineers. We found that even accountants are engineers with some training in accounting. The Planning Sector, responsible for annual programming, long term water resource planning and policy-making, does not contain any economists or other disciplines. Because of the dominance of civil engineers, and the fact that promotions to top positions are only available to them, the mechanical engineers and increasing numbers of specialists in electronics (to manage the telemetry system) feel little loyalty to the Ministry. In our interviews, many of these other professionals complained strongly about their lack of career prospects, lack of influence and prestige, and were bitter about not being invited to the large number of workshops held under donor-funded projects. The functions of the Ministry are broad, and becoming increasingly specialized, but it is difficult for the Ministry to accommodate new disciplines and skills.

A related feature of the Ministry's personnel policies is its emphasis on generalists, rather than encouraging specialists. Engineers are expected to be competent in all fields of irrigation engineering, and are therefore subject to transfer to any department in the Ministry. The Ministry is forced to use consultants for much specialized work, and there is often a mismatch between an engineer's real strengths and job assignment.

An important component of the IMS Project was the establishment of a major Training Center in the Ministry. A large facility was created in Six October City, outside Cairo; and there are satellite training centers as well as training programs run by various special projects (including IIP). The Director of the Training Center reports to the Minister, suggesting it is perceived as important. About 106 courses, mostly of less than two week duration, are being offered in 1995; most are technical in nature but there are two general courses on 'management'. There is demand for the courses, but it is not clear what the impact of training has been on job performance in the absence of specific studies. There are also questions about the future budgetary support for the Training Center, and about its ability to innovate and continue offering courses that meet real needs (Rao 1995). Under donor-funded projects, large numbers of Ministry personnel have gone out for both short-term and long-term foreign training.

The Ministry does not have a career development program for its officials. Receiving training in special skills is no guarantee one will be able to make use of these. Palmer *et al.* (1988: 126-129) examined the impact of education level and special training on officials' performance in the Egyptian civil service. They found that educational level per se had a greater impact on productivity, innovation and flexibility than either foreign or local training programs; when education was held constant, training programs were found to contribute only modestly to the productivity of less-educated officials, and not at all to those who are better educated. This would suggest that investments in training need to be evaluated rigorously in future; and that training will not be a panacea for improving performance.

4.3.2 Staffing Pattern

An issue we did not address directly is whether the Ministry is over-staffed. Table 1 provides data on the overall staffing pattern of the Ministry. There are about 10 non-professional staff members for every professional, but this ratio varies among units from 1.5 to 15.5. Based on interviews with managers, there are clearly too many lower level staff, including technicians and administrative support staff. On the other hand, there are reported shortages of good engineers in some donor-funded projects.

Table 2 Staffing patterns in Egypt and Pakistan compared

Country	Staff-professional	Staff-other	Staff-total	Area in million ha	Ha per professional	Ha per overall staff
Pakistan						
Punjab	3,092	47,185	50,277	8.32	2,691	165
Sind	1,240	22,466	23,706	5.10	4,113	215
NWFP	301	4,731	5,032	0.45	1,495	88
Baluch.	255	2,859	3,114	0.38	1,490	123
Total	4,888	77,241	82,129	14.25	2,915	173
Egypt						
Irrig.dept.	2,844	35,647	38,491	3.02	1,062	78
MPWWR	8,056	80,505	88,561	3.02	375	34

Source: Wolf (1986: Tables 1 and 4); IIMI (1995b: Table 4.2).

Table 2 compares Egyptian staffing levels with those in Pakistan and each of its four provinces. Pakistan, with 14.25 million ha, has 4,888 engineers; it has only 60 percent as many engineers as Egypt, but nearly five times as much irrigated area. For every professional staff member (nearly all civil engineers in both countries), Pakistan has 2,915 ha versus only 375 for the Egyptian Ministry (or 1,062 for the Irrigation Department); if we look at ha per total staff (including non-professional), the comparable figures are 173 ha per person in Pakistan, but only 34 in Egypt. The differences in system design – Egypt's requires a more intensive management – would probably not account entirely for this difference in staffing patterns.

4.3.3 Compensation and Individual Performance

As is true for the entire Egyptian government, the Ministry faces serious problems in its compensation policies. Salaries are extremely low, except for a few top officials and researchers at the NWRC. Most engineers can expect to take home between US$59 to $147 (LE 200-500) per month in base salary, allowances, and incentives or bonuses. Even compared to countries whose per capita income is significantly lower than Egypt's, compensation is low (table 3). Further, we found quite a few inequities -- staff getting the same pay who are doing unequal jobs for example. Officials working on donor-funded special projects get incentives; to balance this, other staff get annual 'bonuses' intended to equalize compensation. Officials are driven by their desire to maximize per diems through field trips, attending workshops, and getting overseas trips. There are even special payments for sitting on committees! We estimate that more than half of the Ministry's staff hold other jobs outside the Ministry to supplement their incomes.

Table 3 Compensation of engineers in MPWWR, and GNP per capita in Egypt and selected countries (percent of Egyptian)

Country	Entry level %	Upper level %	GNP/Capita %
Pakistan	486	383	66
India	470	260	54
Sri Lanka	293	194	82
Bangladesh	230	198	36
Egypt	100	100	100

Sources: IIMI surveys for compensation. For GNP per capita, figures as of 1991 are taken from World Bank (1993: 238, Table 1).

Aside from the obvious impact this system of compensation may have on performance, there is no link between compensation and performance; and very little relationship between performance and promotions. The annual performance evaluations are not done objectively or effectively; and promotions are based primarily on seniority. Those government entities viewed as revenue-generating, for example the Suez Canal Authority, are able to provide attractive compensation packages; but the MPWWR, which provides water to the nation, is seen as revenue-consuming, and therefore does not have the authority to pay its staff adequately.

Palmer *et al.* (1988: table 3.4; 57) found that low salary was by far the most important source of job dissatisfaction among their sample of government employees. However, they found that when their sample was asked to rank the incentive values of a set of motivational mechanisms, a high salary ranked second, and was substantially below prestige, the highest-ranked item; salary was ranked only marginally higher than 'location' and 'security' (Palmer *et al.* 1988:64-71). The extremely low salaries paid to Egyptian government employees force them to find supplementary sources of income, diverting their attention and energy and thus reducing performance; raising salaries would enable the government to demand, and expect, higher performance. But as Palmer *et al.* (1988) emphasize, this change by itself is unlikely to lead to major improvements.

4.3.4 Social and Cultural Variables

Given the low levels of compensation, it is not surprising that there are serious problems with performance. What is remarkable is that in spite of the litany of problems described here, the Ministry does have a large number of loyal and hardworking staff, who take pride in their work, and do their best under difficult conditions. The two hundred year tradition of service is an important value.

In their study of Egyptian bureaucracy, Palmer *et al.* (1988:156-158) place a great deal of emphasis on the effects of social and cultural variables as 'a major determinant of bureaucratic behavior'. They suggest that many of the deficiencies they document 'find their roots in the broader configuration of Egyptian political and social life'. Our study did not assess this dimension. But we noted several features of Ministry culture that seem to an outsider to have an impact on performance. One is that officials often expect payment for any special activity or additional task beyond their normal work. Thus attendance at workshops and training sessions is accompanied by payment of per diems -- if no per diem is to be paid, even if all actual expenses are covered, attendance may be minimal. Similarly, the task force members who worked with us requested, and received, additional payments for work that seemed to substitute for, not add to, their normal duties.

The second cultural factor that significantly affected performance is that everything in Egypt is done based on establishing and using personal relationships. Egyptians constantly exchange greetings and inquire after each other's health and family well-being, every time they meet. These rituals are very important and valuable to maintain relationships We were told many times that much of the Ministry's work is also done through established personal relationships. This may underline the apparent lack of emphasis on formal rules for water allocation, and the need for high level officials to involve themselves in water distribution decisions.

4.4 Implications of the Institutional Analysis

The major conclusion emerging from the institutional analysis can be stated as follows (IIMI 1995b:90):

> effective use of past and future technological investments will require improving the overall management processes and institutional framework for water resource management, especially within the MPWWR, as well as continued improvement in the human resources of the Ministry.

The Ministry is obviously a 'going concern'; it is managing Egypt's water resources and implementing improvements. As noted in the Introduction, the overall performance of Egypt's irrigated agriculture, measured in terms of crop yields, is not bad. Compared to the sample of Egyptian bureaucrats studied by Palmer *et al.* (1988), the performance of the Ministry of Public Works and Water Resources is also not bad. Further, the Ministry has changed over time, as circumstances have changed. Before the construction of the High Aswan Dam, the then Ministry of Irrigation was apparently highly disciplined and powerful, as it had to be to manage flood and drought crises. After the construction of the Dam, the Ministry was basically distributing a water surplus in most years, leading to changes in the values, roles and authority of irrigation engineers -- a deterioration in discipline from the perspective of senior officials with experience during the pre-High Aswan days.

The 1990s are a transition period, in which Egypt is moving from a water surplus situation to a likely water scarcity situation. Like all organizations, the Ministry needs to continue adapting and changing to solve new problems. To make best use of currently available new technologies, and more important, to face future water resource challenges, the Ministry must make major changes in its structure, policies, functions, processes, and human resources. The lack of 'integration' of IMS outputs, the starting point of this exercise, can be attributed to -- and is indicative of -- deeper institutional problems. To date, the Ministry has relied on lectures, commands, and training to achieve more effective use of its technologies, but the results are not satisfactory. At an individual as well as institutional level, accountability and incentives for good performance are not adequate.

More important, as currently structured, the Ministry does not have either the capacity (in terms of human resources and management processes) or the institutional incentives to manage a water-stressed system effectively, or to take on new responsibilities such as regulating water quality. While the Ministry can undoubtedly mobilize to handle a crisis – for example season of water shortage, as it did in 1987 – there is no institutional capacity to manage the system when it becomes permanently water-short.

5 CONCLUSIONS AND IMPLICATIONS

It is important to recognize the Ministry is not an ossified Goliath, unchanged in its 200 year history. The Ministry has evolved and adapted over time, both changing the water regime in the country and adapting itself to manage new technologies. There are many outstanding, dedicated and well-trained engineers in the Ministry. The first workshop of the MPWWR-IIMI Study was devoted to developing a positive 'vision' of Nile water resource management for the year 2010 (IIMI 1995e). That vision, which emphasizes doing more with less water, and includes recognition of the need for institutional change, shows that Ministry officials are able to respond to changes creatively and positively.

But even under the best of circumstances it is difficult to recognize and respond to a 'creeping crisis', i.e., a crisis that one knows is coming in the future but whose exact time of arrival is difficult to predict. In the case of Egypt's water resources, preparing for this eventuality is made especially difficult by several factors. First, the imperative for the horizontal expansion of irrigation is politically powerful. High level politicians see this as one way of relieving the unemployment generated by the combination of slow industrial growth and rapid expansion of the population. The 'Greening of the Sinai' is a strong political imperative, understandable in the light of recent history. Arab donors are prepared to fund this expansion, so it is financially painless. Some of the engineers in the Ministry recognize the problem and dangers, but speaking out on such issues is not easy for civil servants to do. Further, while these engineers recognize the technical dimensions of the problem, understanding and responding to the institutional issues faced by the Ministry is more difficult.

But the nature of the changes ultimately required are more radical than most officials have so far recognized. 'Accountability', 'incentives', and 'financial sustainability' are some key words for what is required. The Ministry needs to be re-organized, to separate its policy-making and planning functions, and its regulatory functions, from its construction and operational functions. The operational functions need to be separated in terms of the 'wholesale' and 'retail' delivery of water supplies; and water delivery, drainage, and groundwater management need to be integrated at local levels. This would suggest the need for defining water rights and services to be provided at various levels, and creating appropriate organizations for management. An autonomous regulated financially self-sustaining public utility could be imagined for managing the Nile River and the major canals. Smaller public utilities or water user-owned entities can be imagined for water management at directorate and district levels. Indeed a few Ministry officials speak privately about such arrangements already.

The institutional constraints discussed in this paper are not unique to Egypt. Other countries also have highly centralized single-disciplinary technocratic water resource policy and management organizations. Such organizations do not have the incentives and accountability systems required to respond to the increasingly alarming water resource trends and the needs of users. The lack of linkage between financial flows and accountability of the organization is also a common characteristic. Examples include Pakistan's provincial irrigation departments, most state irrigation departments in India, the Bangladesh Water Development Board, and the irrigation departments in Nepal and Sri Lanka. Pakistan and some states in India face water resource challenges every bit as serious as Egypt's.

Changing these old, large organizations, with their long traditions, large numbers and political power of their vested interests, and their critical important to the economy will not be an easy job, and will not be accomplished in a short period. But if even one of these large organizations can be convinced and assisted to initiate and carry through a program for institutional reform, it can be a source of lessons and inspiration for other countries.

The major output of the IIMI-Ministry study is an Action Plan for Strengthening Water Resource Management in Egypt (IIMI 1995c). This Plan includes a package of management training, activities for reviewing water resource policies, re-examining and reforming the role and organizational structure of the Ministry, implementation of cost sharing with its customers, and pilot testing technical and institutional changes in irrigation management. Thus, Egypt's success can have important implications for many other countries. Although donors are shifting their attention to 'policy reform' and attempting to use broad benchmarks to evaluate progress in this area, I argue that the kind of institutional reform reflected in the Action Plan is essential if such policy reform is to succeed. But such reforms require time, patience, a high level of commitment from politicians and senior officials, and professional assistance.

The next few years will be difficult and challenging ones for the Ministry as it carries out the Action Plan. But if it is carried out successfully, Egypt will be well on its way to developing the institutional capacity for managing its increasingly scarce water resource; and it will be an example for other countries to emulate.

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IMPLEMENTING NEW IRRIGATION TECHNOLOGY IN UPPER EGYPT: POLITICAL AND BUREAUCRATIC CONSIDERATIONS

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1 INTRODUCTION

Irrigation has a history of nearly 7,000 years in Egypt. Since the mid-18th century, new practices and technologies have gradually been implemented on a wider scale. As the last major attempt to harness the Nile flows for productive use, the Aswan High Dam was erected. This provided over-season and over-year storage and flood control which supplied agriculture with a steady, year-round and, until recently, plentiful source of irrigation water. Thus, the Aswan High Dam offered the possibility of a substantial rise in the productivity of the country's irrigated agriculture.

Twenty-five years have elapsed since the High Dam was inaugurated (1971). During this period substantial technical improvements have been made in the irrigation system, *i.e.* in the main conveyance system and the drainage system. Until recently, however, *no* attempts have been undertaken to improve the farm level systems, including the way the farmers allocate and use water in their fields.

This paper analyzes current efforts by the Egyptian government to increase irrigation system performance in Upper Egypt. It focuses on the prototype Irrigation Improvement Project (IIP) financed by USAID and the Egyptian Ministry of Public Works and Water Resources (MPWWR).

The IIP set out to field test and further develop a package of improvements suitable for implementation in what is known as the old lands[1]. Mid-1996 these were adopted as the model for improvements to be undertaken nationwide through the so-called National Irrigation Improvement Program (NIIP). The IIP is a state-of-the-art project, especially in terms of the approach followed to involve the end users - the farmers - through Water User Associations (WUAs) in the design, implementation and maintenance of the physical structures and the allocation and distribution of water by WUAs themselves. The WUAs are viewed as instrumental for a future policy of turnover and self-management of the irrigation system below the main canals. The IIP is to be seen as the first step to bring the Egyptian irrigation system in line with the functional demands it will be facing by the turn of the 21st century.

The focus of this paper are the institutional and political aspects of this development effort. It seeks to answer the following questions:

1) What is the IIP effort ?

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1 Egypt has 7.5 million feddans (about 3.0 million ha) of agricultural land. 5.4 million feddans are located in the Nile basin and delta are termed the 'old lands', 1.9 million feddans are "new" lands, reclaimed since 1952, and 200.000 feddans located elsewhere, that is in oases (World Bank, 1993:6).

2) Did the combined technical and institutional interventions of IIP succeed in improving water control ?

3) What are the conditions for successful implementation of the IIP package ?

2 WHAT IS THE IIP EFFORT ?

The overall goal of IIP is to increase production and productivity in agriculture. In this effort it addresses problems related to increasing scarcity of water, and related to the accommodation of the effects of Egypt's economic liberalization policy.[2]

The means applied by IIP to achieve these goals are twofold. Firstly, to strengthen the planning, the operations and the analytical capacity of MPWWR, and secondly, to field test a technological package which includes distinct technical and social changes in water allocation and application at field level. In short the aims of IIP are the following.

1) Strengthening the institutional capacity of MPWWR in managerial and administrative skills, and in operational policies and procedures.
2) Development of a rational interdisciplinary approach in planning, designing and implementing the renovation of specific canal commands.
3) Establishment of policies and procedures for the recovery of an appropriate portion of operation and maintenance costs, and 100 percent of the nominal costs of *mesqas* and on-farm improvements.
4) Organization of operational WUAs in all IIP areas whose tasks include: scheduling of water delivery on *mesqas*, perform maintenance and resolve disputes, increase communication links between farmers and government officials.
5) Development of an Irrigation Advisory Service (IAS) to transfer water management technical information and technical assistance to WUAs (Devres Inc., 1993:xiv).

This paper primarily deals with the implementation of the project at field level. At field level, the project includes a shift from rotation to continuous flow at the branch canal level, new water application technologies at the *mesqa* level, and the formation of WUAs[3].

At the field level the basic aim of the IIP effort is to increase farmers' control over the water. This essentially means the provision of an adequate, reliable and fair water distribution which allows the farmers the flexibility to grow diversified and high yielding crops. For this purpose, a technological package has been developed over a period of 19 years[4]. It includes the following elements.

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2 For an overview of these efforts, see World Bank (1993).

3 The IIP was expected to cover an area of 38.600 hectares, representing a cross section of Egyptian environments, and the total funding requirement was budgeted at $ 63 million for the period 1988 to September 1995. The aim was to create 1.200 WUAs (Devres Inc., 1993: xiv and xviii). These figures have later been revised to 29.400 ha and 1.050 WUAs.

4 The IIP technological package as it looks now has been developed through three projects. First The Egypt Water Use and Management Project (1976-1985), then by the Regional Irrigation Improvement Project (1985-1989), and finally through the implementation of the IIP project (1989-1996).

Physical changes:
- continuous flow
- physical rebuilding of existing *mesqas*
- replacement of individual pumping by collective pumping

Organizational changes:
- establishment of Water Users Associations (WUAs)
- creation of an Irrigation Advisory Service (IAS).

Physical changes

In order to provide flexibility in water delivery, the IIP effort implements continuous flow in the branch and distributary canals. Previously only principal and main canals ran continuously, while branch and distributary canals operated on a rotational basis, for example with 5 days `on' and 10 days `off'[5]. This rotational system is by nature rigid, and places severe limitations on the type of crops which can be grown. And due to deficient operation of the system, water was inadequate, unreliable and unevenly distributed throughout the system[6]. The implementation of continuous flow holds the promise to redirect the system from one of `supply' management to `demand' management, which places the farmers in a position where they can irrigate according to the water needs of the crops.

It is important to point out, that the areas in which IIP was implemented, all suffered from water shortages, especially during the summer months (IIP, 1990a:3; IIP, 1990c:9; IIP, 1991b:2/12; IIP, 1991c:2/12).

In order to improve water management and get the maximum benefit from implementing continuous flow, IIP has found it necessary to redesign the field level systems: replace the old earthened *mesqas* with new concrete lined *mesqas* or buried PVC pipes and replace the individually owned pumps with a single collectively owned pump[7]. Note that as a policy of the MPWWR all irrigation water is delivered (75 cm) below field level, in order to force farmers to lift the water, and thus, use it efficiently. With the exception of few areas in Egypt, pumps are needed in order to irrigate. Thus, the physical improvements included under the IIP technological package changes irrigation from an individual tasks into a collective one. This implies, that the farmers along each *mesqa* must necessarily organize in order to acquire and operate the improved *mesqa* systems.

Organizational changes

The organizations of farmers are termed Water Users Associations (WUAs). A WUA is defined as:

> "a private organization owned, controlled and operated by member users for their benefits in improving water delivery, water use and other organizational efforts related to water for increasing their production possibilities" (IIP, 1990b:3).

5 From a technical point of view, continuous flow is facilitated by the installation of different types of flow control gates. Ultimately it necessitates a downsizing of all hydraulic structures to provide for good system operation. For an in depth explanation of the rotational system (see Hvidt, 1997: Chapter 1).

6 Several research projects and studies document how the operation and physical conditions of the delivery system places a significant constraint on farm water management (Abu-Zeid and Rady, 1992: 96; EWUP, 1984: 11-26; IIP, 1990c: 9; Replogle, 1986: 119; World Bank, 1993: 26).

7 For an in depth description of the technical properties of the IIP technological package see IIP (1991a).

WUAs are a completely new undertaking in the Egyptian countryside. They are permanent organizations contrary to the different types of *ad hoc* cooperative arrangement which have always existed around water distribution (for example to share pumps and cleaning *mesqas*). They are private organizations, which distinguish them from the different types of state controlled agrarian cooperatives present in the rural areas[8].

Utmost care has be taken within IIP to design the WUAs in accordance with the traditional forms of farmer participation and conflict resolution which exist fully or partly today. These encompass the former systems of leadership and water allocation at *mesqa* level, the Saqia ring for collective pumping of water, the traditional Islamic legal system for maintaining peace and resolving conflict, and finally contemporary law which designates water as a public good but the *mesqa* system as private property belonging to the water users (Aziz, 1994:1-3; Mehanna *et al.*, 1984:18-66, 92-133). Establishing the WUAs on these traditional forms of participation is thought to increase the farmers' acceptance of the improvements, and for building and maintaining strong farmer participation in the irrigation systems over time (Aziz, 1994:3).

More specifically, the WUAs are responsible for the operation and maintenance of the improved *mesqas*, the operation of the collectively owned pumps, scheduling irrigations among water users, collection of pumping charges, hiring pump operators, maintaining the *mesqa* and pumps and handling conflict among the users. At medium term, the WUAs are expected to merge into branch canal federations and acquire the responsibility for the above mentioned functions for the entire canal, maybe encompassing several hundreds of *mesqas*, and thousands of farmers[9].

At the ministerial level the Irrigation Advisory Service (IAS) has been established. It is a new service under the MPWWR, which supports the irrigation system and WUAs by providing the water users with services and technical assistance in relation to water delivery, water use and the process of WUA organization. IAS applies a strong participatory approach and emphasizes actual farmer involvement in design, operation and maintenance of the field level systems. As such, IAS can be seen as an effort to provide an organization responsive to the needs and wishes of the farmers within the MPWWR.

The participatory approach applied by IAS represents a radical change over former practices. Previously, the MPWWR was a top-down, supply organization, without formal interaction with farmers. The MPWWR engineers alone decided on the water allocation, and in general viewed farmers as ignorant and always complaining over water allocations with the underlying intent of getting more water[10].

<u>A comparison of the traditional and the IIP technological package</u>

As mentioned, the IIP effort can be conceived as a technological package. Using the comprehensive and holistic definition of technology developed by researchers at The Aalborg School of International Technology Studies, Denmark, technology is defined as encompassing four interrelated elements, those of: technique, knowledge, organization and product (Müller, 1980:19ff; Müller, 1990:27ff). Figure 1 below provides a comparison between the traditional irrigation technology and the IIP technology organized according to these elements of technology.

8 See e.g. Holmén (1991) for a description of the structure and functioning of rural cooperatives in Egypt.

9 By fall 1996 the first branch canal federation was established in the Beni Ibeid canal command (Personal discussion Dr. Ramchand Oad, 26 November 1996)

10 As told by Assistant director, MPWWR, Minya Eng. Adel Zaky (21 October 1992) and Inspector, MPWWR, Minya Eng. Samir Faheem (11 November 1992).

Table 1 Characteristics of the two types of Irrigation technology

	Traditional irrigation technology	The IIP technological package
Technique	Rotation system Private pumps Earthen low-level mesqas	Continuous flow in branch canals Collectively owned pumps Improved mesqas: - raised lined - buried pipes Single point lifting
Knowledge	Pump operation Traditional farming knowledge	Pump O & M Mesqa O & M Accounting practices Irrigation Scheduling Organization building Scientific knowledge of agricultural practices On-farm water management
Organization	Ad hoc cooperation Shared ownership of e.g. pumps Shared mesqa cleaning	Permanent organizations Delegation of responsibility Dissemination of knowledge
Product	Low yielding crops	High yielding crop varieties Change in cropping pattern

As shown in table 1 the IIP project seeks to implement changes simultaneously in all four elements defining a technology. Significant changes are envisaged, both in the technical and management aspects of canal operation, in farmers' organizations and in the knowledge component, which is associated both with these organizations and the technical tasks they are to undertake. Finally, there are potential changes in the outcome of the process, the product, and thus, in the productivity of agriculture.

As seen, IIP emphasizes a broad and multifaceted development effort which seeks to establish a radical new setting for agricultural production. Besides aiming to increase flexibility and reliability in water deliveries, it stimulates that each *mesqa* is operated as one agricultural unit, thus counteracting the adverse effects of extremely fragmented land holdings[11]. Through the WUAs it establishes a way of disseminating information and knowledge to the farmers, and finally it allows for an increased degree of specialization of tasks and functions within agriculture. The final point is worth noticing. Prior to the IIP effort the individual farmer was required to undertake a broad set of functions related to water delivery, for example, hiring pumps or owning one, transporting pumps back and forth to the fields, to operate and maintain it, monitoring water levels etc. Following the IIP improvements, the individual farmer can rely on the WUA (and its hired personnel) to operate and maintain the pump, do the accounting and organize the water schedules and solve conflicts.

11 The average farm size in Egypt is around 2 feddans, while nearly 50 percent of the farms are less than one feddan (World Bank, 1993:8). Small and fragmented ownership of land is seen to have limited the establishment of efficient irrigation methods (Abu-Zeid and Rady, 1992:96).

3 DID THE IIP EFFORT LEAD TO IMPROVED WATER CONTROL ?

As mentioned the basic aim of the IIP effort is to increase farmers control over the water. Water control is defined as

> "..the capacity to apply the proper quantity and quality of water at the optimum time to the crop root zone to meet crop consumptive needs and soil leaching requirements" (Freeman *et al.*, 1989:10).

In other words, the term means the relative control over quantity and timing of supplies. As pointed out by Freeman and Lowdermilk (1991:117) "water control at the levels of the command area and the farm is the most basic yardstick against which to measure the effectiveness of irrigation: it relates to the particular needs of the crop at a particular moment". Water control is important because it directly affects productivity. "If water comes too soon, too late, in amounts too great or too small, the productivity of that water is sharply reduced." (Freeman *et al.*, 1989:12)[12]. It is furthermore critical to farmers' decisions concerning which crops to grow, when to grow them, and whether or not to adopt new agro-technologies such as fertilizers, pesticides, and high-yielding crop varieties (Wade, 1990:175)[13]. Finally, water control has an environmental impact. If farmers lack water control they tend to counteract this by applying too much water (Clemmens, 1987:60; Wade, 1990).

Water control is both a technical and a social/political endeavor. Technical because the main and micro delivery systems must be physically capable of exercising this control[14]. Social/political because water control is an outcome of proper management at all levels of the irrigation system. Ultimately "water control is a function of collective actions and can be enhanced only through disciplined organizations" (Freeman and Lowdermilk, 1991:122).

In this paper, water control is analyzed as a multifaceted variable encompassing three dimensions: adequacy, reliability and fairness. Each of these dimension have been operationalized using one or more indicators[15]. The results of the survey is presented in table 2 below.

12 This is especially the case in arid areas like Egypt.

13 Studies from Pakistan and India show that improved water control results in higher cropping intensities, larger inputs of fertilizers, higher yields, and greater income per hectare (Lowdermilk, 1990:156).

14 For an in depth discussion of this point see for example Burt (1987).

15 The primary data reported in this paper was collected during October and November 1992 in three Canal Commands in Upper Egypt (south of Cairo); Herz-Numaniya and Beni Ibeid located close to the city of Minya, and Qiman Arus, adjacent to the city of Beni Suef. Data was collected through structured interviews undertaken by local interviewers. A total of 137 WUA council members were interviewed each located on different field turnouts (marwas). All the selected mesqas were improved by IIP and had been in operation between 2 and 48 months. The farmer interviews were supplemented by interviews with key informants in the areas, and review of the WUAs' financial status.

Table 2 Summary of findings: IIP impact on water control

Indicators analyzed	Findings
Adequacy	
Adequacy of water supply	74 % of respondents rate the situation as improved
Number of days with critical water shortage	85 % reduction
Number of irrigations done at night	89 % reduction
Source of irrigation water	Use of drainage water is eradicated
Reliability	
Water level maintained in branch canals?	Only in Herz-Numaniya, the oldest improvement
Deviations from planned irrigations	86 % of respondents rate the situation as improved
Fairness	
Head-Tail differences along mesqa	Less Head-Tail differences

Note: Percentage figures are calculated for summer season

The data in table 2 provides evidence that the IIP technological package with its combination of technical and social changes has led to significant improvements in water control. Even though the *mesqa* systems, at the time of the survey were not fully developed, approximately 80 % of the farmers rated the water supply to be adequate in the post-project situation compared to 13 % before. The estimated number of days with critical water shortage and the number of irrigations done at night has decreased significantly[16]. Furthermore no farmers were using drain water to satisfy their irrigation needs after the improvements[17].

Reliability in water supply has increased too. Water is available when the farmer expects it to be there. And finally, fairness of water distribution along the *mesqa* has improved. Prior to the project the tail end of the *mesqas* often suffered from severe water shortage. Because of the renovation of the *mesqas* the seepage losses have been reduced, which in combination with the WUAs' effort to schedule the water flows, the tail end farmers receive the same amount of water as the head section[18].

Further analysis of the data showed, that the presence of a well functioning continuous flow regime in the branch canals was the single most important factor contributing to security of water control at farm level. This finding is both understandable and in compliance with the investigator's expectations, since prior to the IIP efforts water supply in the surveyed areas was erratic and less than adequate specially during the summer months.

At the outset one could think that the success of the technology is primarily due to the fact that more water has been made available to the farmers. This is true, but it is not a sufficient explanation. Continuous flow as pointed out is only one of many components of the IIP package. Other findings of this study point out, that the micro-system improvements, both with and without continuous flow, contribute to increased water control (Hvidt, 1996:271ff). There are strong

16 Because of the inconvenience of irrigation at night, it is primarily done when daytime water supply is not adequate.

17 6.6 percent (N=9) of the sample farmers reported using drainage water to satisfy irrigation needs before the IIP. No one reported doing this after the implementation of the project.

18 For a detailed account for these findings see Hvidt (1997:chapter 6).

indications, that the adoption of the technical, organizational and knowledge-related aspects of the IIP technological package has put the farmers in a far better situation to mitigate the effects of an unstable water supply, than they were before. So even with some instability in the continuous flow regime, there will be positive effects on the farmers water control, resulting from the development effort.

Nevertheless, the operation of continuous flow remains an essential issue to the success of the IIP improvements in the future. It is too early to assess the potential impact of a severe water scarcity situation on the improved areas. But it could mean state-implemented sanctions on crops or on water, or maybe water allocation based on farmers willingness to pay for water.

In summary, it was found, that the IIP effort significantly increases farmer water control. This indicates, that the technical and social components included in the IIP technological package do have an impact.

4 WHAT ARE THE PRECONDITIONS FOR THE SUCCESSFUL IMPROVEMENT IN WATER CONTROL ?

> "Which is more important for better management of irrigation water: organizational improvements in water users' organizations ..., or improvements in water conveyance structures? This question may be equivalent to asking a person whether his left or right leg is more important" (Gisselquist, in Jones, 1995:120).

This part of the paper discusses the conditions of possibility for improved water control. A vast number of factors is influencing the outcome of such a development effort due to the variegated and site-specific nature of irrigation projects[19].

In this specific project two factors seem to be especially important for the success of the IIP technological package. Firstly, whether the farmers experience visible and felt benefits through the adoption of the IIP technological package. Secondly, whether or not the MPWWR has succeeded in establishing an operational continuous flow in the branch canals. A third factor of importance is the nature of the technology transfer process, especially whether or not the formation of WUAs are adequately supported by the IAS. The latter issue however, shall not be dealt with here. It is sufficient to note, that the IAS effort has been adequate (see Hvidt, 1996:250ff).

Visible and felt benefits
In line with numerous studies of technology transfer, it is assumed that the main condition for a successful adoption of a given technology is that it has `visible' economic returns for the farmers (Lele, 1984:180). Later writings, for example by Ostrom (1992:25), point out that in addition,

19 As stated by Jones (1995:36) "Irrigation is the most variegated and site-specific subsector of agriculture, which is itself the most variegated and site-specific sector of Bank lending."

non-economic returns (which is a far broader set of incentives) play an important role in the farmers decision either to adopt or reject a given technology[20].

It is important to note, that to establish, maintain and develop local organizations such as WUAs are susceptible to the same logic of returns. As the concept of transaction costs implies, to engage in organizations takes time, which could be used for other purposes and thus has a cost (Ostrom, 1992:30ff; Tang, 1992:14ff)[21]. Freeman (1991:59) for example reports that farmers are willing to engage in organization if and only if they gain in economic or non-economic terms by doing so.
Within the IIP project, the farmers at each individual *mesqa* are free to choose either to accept or reject the improvements. The farmers (through the voluntarily formed WUA) are the legal owners of the *mesqa*, the pump, and the land on which it is placed, and they sign a bank loan for the repayment of the physical improvements over a 30 year period. This means, that the farmers can not be forced into accepting the improvements against their will.

Was the condition of benefits fulfilled in the IIP project ? The experiences from the first two years with the improved system suggest that there are substantial gains to the farmers both monetary and non-monetary. The survey showed that for both farmers who owned pumps and those who did not, stood to gain. For non-pump owners there was an increase of approximately 40 % of net farm income, and for pump owners this was between 30 and 50 %, depending on the extent to which they rented out pump services prior to the shift to IIP technology. In general, the farmers worst off in the pre-project situation stood to gain most from the improvements. But both categories of farmers are in a situation where they win by implementing the IIP technology (Hvidt, 1997:chapter 8). In addition to the above analysis, the farmers report a number of less tangible factors which are perceived as major benefits resulting from the improvements: flexibility in irrigation, savings in time to irrigate, less hassle in irrigating, and no night irrigation.

So, an adequate level of benefits - perceived or real - resulting from the IIP technology has been present. And the outcome, from this, and other factors that might influence farmers decision making has been that the farmers readily accept and adopt the IIP improvements[22].

A further and strong indicator of acceptance of the improvements is that the powerful or status-conscious farmers involve themselves in the WUAs - often as leaders[23]. These farmers

20 This presupposes a certain level of economic rationality among the Egyptian farmers. A number of studies point out that the farmers are highly integrated in the market mechanism, and are acting in a somewhat rational fashion, that is, are responsive to changes in price signals for their choice of farm machinery, crop varieties and pumping costs (Esfahani, 1987; IIP, 1990c:9; Richards and Waterbury, 1991:159; World Bank, 1993:9).

21 See Lowdermilk and Barakat (1994) for a quantification of the transaction costs involved in maintaining and developing WUAs under IIP.

22 Resistance to change was present in the first period, but after the first demonstration mesqas had been operational in Herz-Numaniya for some time, which had allowed potential adopters of the technology to see the improved systems and through discussions with the farmers at these mesqas had learned about benefits and shortcomings, the process of establishing WUAs has generally not met with resistance. See Hvidt (1996:250ff) for key elements of the WUA formation process.

23 The term status is used here in a common sense meaning. Based on field experience and general experience with Middle Eastern societies, status seems to be closely linked to a person's abilities to assist other persons in solving their problems. Examples of this are lending money to persons in need, or providing useful advice when someone has a problem. A very important indicator of status is to whom a person turns in time of need. In Beni Ibeid for example powerful farmers were generally selected as WUA leaders. This means that the selection process of WUA leaders made it possible for the rural elite to attain these positions if they found it attractive to do so. Thus, creation of WUAs does not challenge the existing power structure in the countryside. There is no evidence that involvement of the rural elite in the leadership of the WUAs has negative effects on the functioning of the WUAs. In fact, some of the best operated WUAs were headed by powerful farmers, who employed their management

generally have less to gain from the improvements than the not-so-well-off farmers, because they are in a position where they to some extent can counteract water supply problems by means of investment in pumps, which both provides greater assurance of water and which can yield a sizable income from renting. So the fact that this group of farmers have involved themselves in the WUAs is an indication that the package, as stated above, provides substantial benefits.

In summary, a precondition for the successful adoption of the IIP technological package, both technically and socially, is that it provides visible and felt benefits to the farmers. It was highlighted that this condition has basically been met by the IIP effort.

Continuous flow as a condition

As argued by Lusk and Parlin (1991:33) farmer participation is less a problem for project success than is the participation of bureaucrats. While farmers are the ultimate project beneficiaries, the bureaucrats "have little or no incentive to implement policies which have no bearing on their own welfare". This finding seems to capture the dynamics of establishing continuous flow under IIP.

As argued above, continuous flow is the single most important factor in achieving improved water control. And as such, it is a precondition for obtaining the visible and felt benefits of the IIP technological package, that makes it worthwhile for the farmers to invest their money and energy in the improvements.

The discussion below will revolve around the question, why implementation of continuous flow has lagged far behind the implementation of the farm level systems. It is hypothesized that both the technical and the political/bureaucratic nature of continuous flow impedes its timely implementation. It is argued that there are several sound reasons why implementation of continuous flow has not been - and probably in the foreseeable future will not be - adequately supported by MPWWR staff. These reasons are discussed under the following three headings:

1) Preferential water allocation to the IIP canal commands.
2) The MPWWR is susceptible to pressures from interest groups.
3) Lack of incentive structures for local level agency staff to implement continuous flow.

Preferential water allocation

In volumetric terms, the amount of water supplied under continuous flow is designed to be identical to that of the canals operating under rotation. [24] But, preferential water allocation to the improved canal commands is a necessity in the initial phases of the IIP implementation. This is due to technical and behavioral reasons.

Concerning the technical reasons, the implementation of continuous flow with on-demand water delivery entails that canals are physically capable of operating under this regime. This presupposes at a minimum, that the canals must be equipped with automatic downstream control

capacity and power to make the new technology function. There furthermore is no evidence of substantial power struggles between rural elite and smaller farmers over the issue of water allocation. This may be due to the fact, that there is no correlation between farmers location on the mesqa and the size of land holdings. In other words, farmers with large landholdings are evenly spread out along the full length of the mesqas (IIP, 1990c:chapter IV). The implication is that the farmers, large and small, have a mutual interest in getting the mesqa systems to function in the best possible way. This does not mean, that there are no struggles between the two types of farmers, but merely that such a power struggle seems to be played out in other spheres than that associated with water. Based on field observations, it seems that the main type of power struggle concerned with the water issue is between `the farmers' as a group and the government supply organization, the MPWWR.

24 Meaning that the identical volumes of water are allocated to a canal during a given period, both before and after the shift to continuous flow.

gates. To operate fully under on-demand continuous flow, however, most canals must be redug and downsized, improvements in earthwork must be undertaken and all new *mesqa* intakes must be reconstructed and aligned on a standard level. The point is that establishing continuous flow is expensive (however in this case the cost is carried by a donor agency) and if optimal operational efficiency is to be achieved, it implies substantial physical changes of the current branch canals. In the surveyed canal commands, continuous flow was established only by installing the automatic gates, while the branch canals were used as they were (or with minor modifications). This does not represent an optimal operational solution, but the situation was counteracted by running larger volumes of water in the canals, than would be necessary when and if the canals were fully redesigned. This calls for preferential water allocations to the improved branch canals until the situation is rectified.

Concerning the behavioral reasons, it takes time for farmers to adjust their traditional irrigation behavior to the new water regime. As argued by for example Clemmens (1987:60) and Wade (1990) there is an inherent tendency for farmers to apply too much water when water is available in order to counteract possibly future shortcomings. This `water hoarding behavior' however, will decrease gradually as knowledge of how much water to apply, and when to apply it, becomes accepted.

IIP anticipates that by providing adequate, reliable and fair water supplies in combination with a strong on-farm water management program, it promises to decrease water use per *feddan* in the long run (IIP, 1994:36). IIP measurements show that the water deliveries to selected improved *mesqas* exceeded the crop water requirements (and conveyance and other losses) by approximately 60 percent during the summer months of 1993 (IIP, 1994:36)[25]. If the on-farm water management program succeeds in bringing the farmers irrigation behavior and practices in compliance with the new technology, there would be scope for a substantial decrease in the water needs on a per *feddan* basis. It is through this mechanism that IIP is trying to tackle the problems of increased scarcity of water.

The issue of preferential water allocation to the IIP areas should be viewed in the context of water scarcity. Farmers, especially large and influential farmers, are very outspoken when it comes to obtaining their allocated share - and if possible a larger share - of the available water. During water scarcity, especially in the summer months when the water demand by the crops is at its peak, no farmer, large or small, rich or poor, can be indifferent whether he gets his allocated share of water or not[26].

In practical terms, this means that farmers place substantial pressure on the lower echelons of the MPWWR bureaucracy, the district engineers and gate keepers, in order to acquire water. This dynamic factor is important in understanding the change process associated with the implementation of continuous flow. If the district engineer allocates more water to one branch canal in his command area, this evidently means that other canals are suffering - unless supplementary water allocations are provided by the MPWWR to the district. This has, however

25 Excess irrigation also existed prior to the shift to IIP technology. IIP (1993:table 2) reports a figure of approximately 27 percent for July 1993. The excess application of water by farmers is, however, to some extent caused by technical deficiencies in the system.

26 In a number of cases the investigator has witnessed how farmers as individuals or groups approached the assistant director of irrigation in Minya to complain loudly about lack of water.

not been the case[27]. Thus, if the district engineer decides to allocate the amount of water needed to operate continuous flow in the improved canals, the number of complaints from farmers at other non-improved canals will pile up on his desk[28]. This is strongly detrimental to his future advancement in the MPWWR[29]. So, in order to keep his good standing in the MPWWR, the rational behavior of the district engineer is to allocate the water so that it yields the fewest possible complaints. This means that he most likely will not satisfy the extra water demands necessitated by implementing continuous flow. This suggests an institutional bias against the implementation of continuous flow.

The MPWWR is susceptible to pressures from interest groups

As pointed out by Uphoff *et al.* (1991) there are at least three sets of actors involved in irrigation: the government, the water users and the staff of the irrigation agency. Their objectives may not be compatible.

> "The staff of the irrigation agency constitute a critical third set of actors who can tilt one way or the other - or operate somewhat independently of both. This latter possibility may not be desirable or tenable, but no one should assume that the bureaucracy will invariably be working to further others' goals." (Uphoff, Ramamurthy and Steiner, 1991:21).

The Egyptian state bureaucracy is well known for its inefficiency, resulting from overstaffing, low salaries, lack of incentives etc. (Ansari, 1986; Commander, 1987; Palmer *et al.*, 1988; Sadowski, 1991; Springborg, 1989; Waterbury, 1983; Zohny, 1988). An in-depth survey of institutional issues in the MPWWR confirms that this mode of operation applies to this Ministry as well (IIMI, 1995).

The Egyptian bureaucracy seems to resemble what Gunnar Myrdal called `the soft state'. The term refers to a state in which the bureaucracy cannot implement its rules and regulations independently of the interests of groups or individuals in society[30]. In his excellent book, Adams analyzes the power structures in the Egyptian countryside. He finds that state intervention has never eradicated the dominance of rich farmers in the political decision processes. He points out that

> "(...) in the absence of concerted government efforts to exclude rural elite, rich peasants will tend to dominate all important political structures established by the national government at the local level." (Adams, 1986:154).

And in the concluding chapter he writes:

> "The rich-peasant domination occurs with the tacit approval of the state. Since 1952, the Egyptian state has come to rely upon the rich peasantry as the overseers for much of what it undertakes in the countryside.... "Rule through the wealthy" ....The members of the rich peasantry, ... exercise decisive control,

27 Interview with District Engineer, Magdy Maghmoud, Minya (11 November 1992). This has often led to discontinuing continuous flow especially during the summer months (IIP, 1993:59-60). Note that the canals selected for IIP improvement all suffered from severe lack of water during especially the summer months.

28 Satisfaction of complaints from water users and experience of the operational personnel are the normal means by which water deliveries are based (IIMI, 1995:35).

29 Discussion with Head of IAS, and former district engineer, Engineer Essam Barakat (8 August 1992).

30 The term `soft state' is understood to comprise "all the various types of social indiscipline which manifest themselves by deficiencies in legislation and in particular law observance and enforcement, a widespread disobedience by public officials on various levels to rules and directives handed down to them, and often their collusion with powerful persons and groups of persons whose conduct they should regulate. Within the concept of the soft state belongs also corruption ... These several patterns of behaviour are interrelated in the sense that they permit or even provoke each other in circular causation having cumulative effects" (Myrdal, 1970:208). See also Sadowski (1991:90ff).

> over the human and material resources within their own particular local domains. ... *The consequence of this type of socio-political organization is that the state possesses a sharply delimited type of power in the countryside.*" (Adams, 1986:191; emphasis added)[31].

This explains why a bureaucracy with such characteristics has difficulties in transferring or implementing decisions made at the top bureaucratic level. In this case, these characteristics provide an understanding why the decision by the MPWWR to implement continuous flow in the areas designated for IIP improvement was not fully followed up at field level.

Lack of incentive structures for local level agency staff to implement continuous flow
A closer look at the incentive structure at regional and local levels in the MPWWR provides a further indication of why implementation of continuous flow has not been adequately supported by the MPWWR. It is hypothesized that the implementation of continuous flow will result in loss of status and income for the district engineers and gate keepers.

Under the rotational system, the district engineers were viewed as important persons in the rural community. Provided with a certain volume of water, their task was to allocate/distribute this water among the different canal commands within their domain. Thus the district engineer was the person the farmers would approach in order to get more water. Similarly, the gate keeper who carries out the actual water allocation by raising and lowering the gates, is by nature of his work at the key physical point where the division of water takes place. Due to lack of strict monitoring of the water allocations, the gate keeper has some degree of freedom to decide how much water flows where and when. Specially for the gate keepers, substantial amounts of "extra legal" income can be obtained through this process[32].

Table 3 below depicts the quantity and quality of contacts between the respondents and institutions related to irrigation, as estimated by the farmers themselves. The argument is that a decrease in the level of contacts and/or the usefulness of the contacts indicates loss of status in the eyes of the farmers.

31 See also Richards (1982: 178ff) for further discussion of rich farmers' influence on local politics.

32 This statement is by nature impossible to quantify. Field experience however, points out that extralegal payments take place. As stated by Sadowski (1991:122) "In any soft state, where officials are underpaid, poorly trained, and loosely supervised, corruption tends to be a problem".

Table 3 Estimated quantity and quality of contacts between categories of field staff, before and after IPP improvement

N=137

	Average number of contacts per month		Usefulness of contacts (scale 0 <-> 5)	
	Before*	After	Before*	After
MOA Extension worker	3.71	3.71	3.60	3.64
District Engineer	1.69	1.15	1.56	1.38
Gate Keeper**	3.99	2.23	3.43	1.82
IAS Field Agent	1.40	4.52	1.47	4.53
IAS Engineer	1.08	4.04	1.22	4.08
IPP Design Engineer	0.72	1.44	0.67	1.57
IIP Construction Engineer	1.04	2.04	1.04	2.12

Note: A contact is defined as a situation in which a water user and an official meet face to face to discuss issues and exchange information.
* "Before" refers to the period before the mesqa + pump started operation, but after UWAs were formed.
** In the implementation period of the new technology, the Gate Keepers were still present in the areas.

Table 3 shows that the average number of contacts between both the district engineer and the gate keepers and the respondents is reduced after the shift to the IIP package. It is most dramatic for the gate keepers, where the number of contacts were reduced by half after the shift to the IIP package. Furthermore, the perceived usefulness of the contacts is also reduced. This supports the argument that these two categories of irrigation department staff are losing status in relationship to farmers, where the IIP package is implemented. At the same time, IAS staff's, the field agents' and the IIP engineers', status seem to have increased.

Based on discussions with district engineers and gate keepers, I conclude that the loss of functions and status are an issue of great concern. This is especially the case for the gate keepers, because implementation of automated downstream control gates threatens to completely eradicate their job function. But it is also of concern to the district engineers, especially the younger ones who need to occupy this position for a number of years before they can be promoted to higher positions in the MPWWR. In other words, the field staff responsible for operating continuous flow have little or no incentives to forcefully implement the continuous flow system.

It has been argued, that the combination of the preferential water allocation, the susceptibility of the MPWWR to pressures from interest groups, and the lack of incentive structures for local level agency staff, substantially hampers the MPWWR's ability to adequately support a stable continuous flow regime in the branch canals. While it could be argued that these findings are closely related to the fact that the field study was conducted on only the first canal commands improved, it is thought that the problems are of a more general nature, as indicated by the literature on the Egyptian bureaucracy. Furthermore, it is safe to assume that the bureaucratic structures, and thus the incentive structures, change very slowly in a society such as the Egyptian. Therefore, it is expected that the above mentioned problems will continue to impede the timely implementation of continuous flow in all areas designated for NIIP improvements.

WUAs and continuous flow
In a more optimistic mode, the IIP hopes that the WUAs in the future can attain the strength to play a decisive role in pressuring the bureaucracy to provide the needed continuous flow. When the farmers have made the substantial investment of both time and money in the physical systems and in the establishment of functional WUAs, they have gained a vested interest in continuous flow. As a result they can be expected to closely monitor the flow, and either directly, or through the IAS, exert pressure on the district engineers or his superior, to re-establish the flow if it is discontinued or when the water level drops below the agreed level. Already at the time of the survey the investigator experienced a number of incidents where the WUAs did exactly this. It is hoped and expected, as the strength of the WUAs grows over time, the WUAs move from being primarily technical organizations with limited scope to become political stakeholders which will try to hold the MPWWR accountable for delivering the services they are supposed to.

And when the WUAs, as emphasized both within IIP and NIIP, merge into branch canal federations, they are likely to acquire a more powerful status, being a broadly defined interest organization of the farmers.

5 CONCLUSION

In this paper, the content of the IIP improvement effort was described and its effort to improve water control was analyzed. It was found, that the implemented combination of technical and social changes, led to significant improvements in farmer water control. Both the technical aspect, notably establishment of continuous flow and the social aspect, the creation of viable WUAs, were important elements to achieve this goal.

The second part of the paper analyzed the conditions for such positive change. It was highlighted, that the attractiveness of the package in both economic and non-economic terms was the key element in the farmers motivation to invest the time and money, necessary in order to adopt the IIP improvements at field level.

The establishment of continuous flow was found to be a key factor in determining the attractiveness of the package. Recognizing substantial delays in the provision of continuous flow to the improved areas, the reasons behind the MPWWR's lack of support for continuous flow were scrutinized. This discussion revolved around the technical, bureaucratic and political factors which determine the bureaucratic characteristics of the MPWWR and the incentive structures within the MPWWR to supply continuous flow. It was argued, that continuous flow is a radical departure from previous practices and that few, if any, incentives for regional and field level staff existed to adequately support its successful implementation. The implication is, that as a primary condition for the anticipated spread of the IIP technological package throughout Egypt (now through NIIP), the MPWWR must secure the participation of its own staff, through the provision of clear cut directives and substantial changes in the incentive structures for regional and field level staff.

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FARMER RESPONSES TO INEFFICIENCIES IN THE SUPPLY AND DISTRIBUTION OF IRRIGATION WATER REQUIREMENTS IN DELTA EGYPT

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ABSTRACT

Many countries within arid and semi-arid regions are facing increasing constraints on the availability of water, leading to gradual shifts in policy which de-emphasize the importance of agriculture. Whilst such adjustments will be inevitable in the long term, it is also true that water use efficiency within the irrigated sector is generally low and significant savings could be achieved through more careful management of water resources. This paper argues that part of the problem lies in the nature of bureaucratic administration governing large scale irrigation systems in Egypt. The inability of state institutions to effectively manage local level operations has led to a large degree of inefficiency and manipulation of the system by low level bureaucrats. This is contrasted with the more efficient use of water observed where farmers have established their own groundwater pump and a high level of informal cooperation and coordination exists.

1 INTRODUCTION

Moving into the 21st century Egypt faces important decisions regarding the efficient allocation and use of increasingly scarce water resources. Indeed many commentators feel that water is the ultimate constraint on development which will need to be adequately addressed by almost all of the countries of the Middle East and North Africa region in the near future (Ohlsson 1995). Some authors argue that competition over scarce water will increasingly lead to conflicts of varying degrees over the control and allocation of precious shared water resources, resulting in the increased incidence of 'water wars' (Bulloch and Darwish 1993). More optimistic analyses suggest that water may indeed be a factor promoting the peaceable negotiation of solutions to shared development problems (Shuval 1993).

Egypt is almost completely dependent upon a single water resource, the Nile and currently utilizes its full quota of 55.5 bn m^3 as granted under the terms of the 1959 Nile waters agreement. Indeed due to limited utilization by the Sudan of its share, Egypt has hitherto been able to make use of an additional 5 bn m^3 per year. However it is increasingly likely that this additional availability will be curtailed as the Sudan moves to expand its irrigated area, furthermore recent climatic conditions suggest a reduction in total flows or at least greater variability than originally foreseen (Folland *et al.* 1986; Allen and Howell 1994). As a result there is little optimism that Egypt can obtain increased flows. At the same time the combination of population growth and increased food consumption mean that the food deficit gap is growing. In the recent past the standard policy response to a growing food gap has been to concentrate on land reclamation schemes to extend the available irrigated acreage. However given the above water constraints coupled with increased competing sectoral demands (industrial and municipal) such a response is less attractive and a reassessment of the countries agricultural potential will need to be made.

Allen (1994) indicates that in reality some decisions have already been taken, albeit unconsciously, in that Egypt currently imports over half of its food requirements and is therefore dependent on 'virtual water', that is water implicit in the production of imported food. Thus it is argued that countries such as Egypt must instead turn to consider the most efficient sectoral allocations of scarce water resources and where necessary take the decision to divert water from sectors where it receives a low unit price, such as agriculture, to sectors such as industrial and municipal uses where it commands a much higher price (Allen 1994). This can be viewed as a shift from supply management to demand management. The concept of demand management implies that any increase in a specific sectoral demand must be met through an equivalent reduction in other sectors.

However although in the long term there is little doubt that attention needs to be focused on demand management strategies there is sufficient evidence to indicate that significant savings can be made by improvements in the control and management of existing irrigation supplies. Egyptian agriculture, whilst suffering from water constraints at the national level, also suffers from serious problems associated with rising water tables within the delta, suggesting an over-application of water. Indeed numerous studies have shown that wastage and inefficiencies within the system are high and that savings of the order of 30 % could be achieved if a fundamental restructuring of the mechanisms of allocation and management were to be introduced (Radwan 1994; Ruff and Metawie 1987).

Part of the problem lies with the nature of the system of bureaucratic control governing agricultural activities. Internal opposition to measures to reform the state bodies governing rural production have ensured that previous attempts at supply management have concentrated upon technical modification and rehabilitation of the control structures (Macdonalds 1988). However little attention has been paid to the social mechanisms and institutions governing the control and distribution of irrigation requirements. As a result the technical modifications have often failed to translate into greatly improved irrigation efficiencies (Mehanna *et al.* 1981).

Below it will be illustrated how a combination of erroneous assumptions and inadequate mechanisms for the calculation and control of irrigation supplies have led to a general pattern of oversupply. One result of the current top-down, bureaucratic approach to managing the irrigation supply system has been that farmers have been divested of any meaningful control over the patterns of supply, with the result that cooperation, a characteristic of communities with control over a shared resource, has been replaced to a large degree by individualism, as farmers limit their attention to there own specific needs in a local context of (paradoxical) surplus.

This paper argues that whilst, given the realities of regional water availability and the existing mechanisms for the control and allocation of irrigation supplies, attention must undoubtedly be turned to issues of demand management, the longer term sustainability of rural production systems will depend upon the ability of the Egyptian government to restructure the nature of organization of both the ministries of agriculture and irrigation (MOA and MPWWR) such that they incorporate a far greater degree of farmer involvement in all aspects of the irrigation system. The paper is broadly divided into two sections. The first seeks to illustrate the degree of surplus observed along the majority of canals in the study region and indicates how this is related to the assumptions and mechanisms governing the operation of the irrigation supply system. This pattern of supply will be contrasted with the actual patterns of farmer demand to demonstrate the degree of wastage within the system. The latter part of the paper will concentrate upon the smaller number of canals experiencing an overall water deficit, to illustrate not only the problems faced by farmers along such canals but also to illustrate the complexity of cooperative social arrangements to overcome such constraints. It will therefore be argued that given the current patterns of oversupply along the majority of canals there exist very real possibilities for major savings in water use and that for these to be realized serious attention needs to be paid to modifications which incorporate irrigation communities more closely into all aspects of design allocation and control of water resources. The complex and coordinated forms of cooperation witnessed along water deficit canals in the study region can be argued to offer examples of successful informal social arrangements which if integrated into the formal system of control and management could lead to improved sustainability of local operations and result in increased water use efficiency.

2 LOCATION

The data for the analysis of irrigation supply and demand patterns are derived from the study of the main distrubutary canals and a number of their off-takes (*mesqa*) in the village of Yaqut in the Egyptian Delta. The village of Yaqut is located 80 Km north-west of Cairo, in the district (*markaz*) of al-Bagoor, in the fertile agricultural province of Minoufia. The area represents in many respects a typical agricultural region with a mixed cropping pattern common over much of the Delta. The principal crops in Yaqut, as for most of the Delta, are wheat and *berseem* in the winter and maize in the summer, with significant areas of vegetables and orchards (Adams 1984). Similarly the size of land holdings in the Governate of Minoufia reflect the national averages for the Delta with more than 80 % of all holdings of 3 *feddan* or less (Harik 1979 and MOA census 1975)[1]. Two specific *mesqa* were selected for closer study, the first Um Aisha, was representative of the majority of canals experiencing a water surplus and the second, Sibiliya *mesqa*, was representative of a smaller number of canals experiencing a water deficit (figures 1 and 2). For these *mesqa*, patterns of daily discharges and farmer use patterns were noted providing a record of daily, monthly and seasonal patterns of supply and demand.

1 Other studies of water use efficiency have produced corroborative findings indicating that many of the problems discussed here are common to other regions of the Delta, most notably the quantitative data gathered by Ruff and Metawie (1987) as part of the Egyptian water use project (EWUP), based on studies in Kafr al-Sheikh and the qualitative analysis of Mehanna et al. (1984) and Hopkins (1987) as well as the numerous studies dealing with the problems of inefficiency and corruption within the Egyptian bureaucracy (Naguib and Leyton, 1982; Sadowski, 1991; Mehanna et al., 1981; Mayfield, 1971).

Figure 1 Um Aisha Mesqa, Yaqut

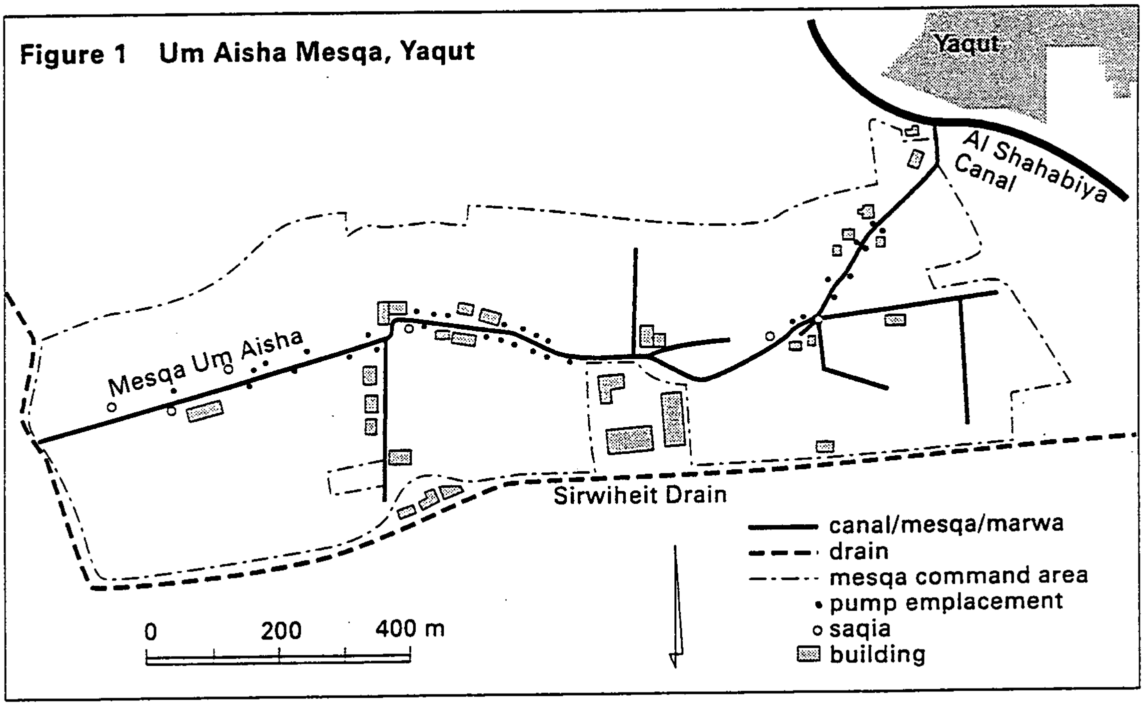
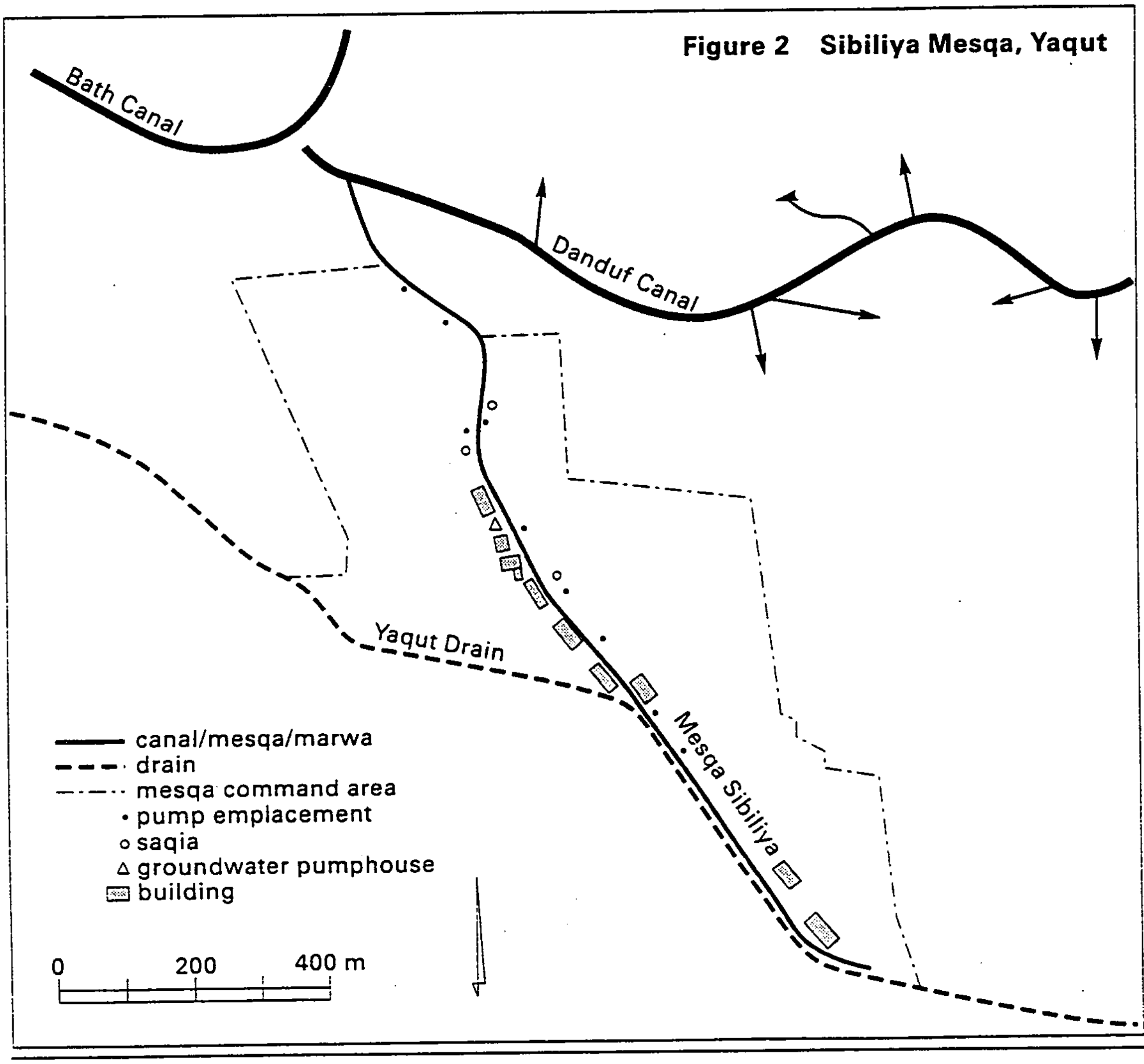


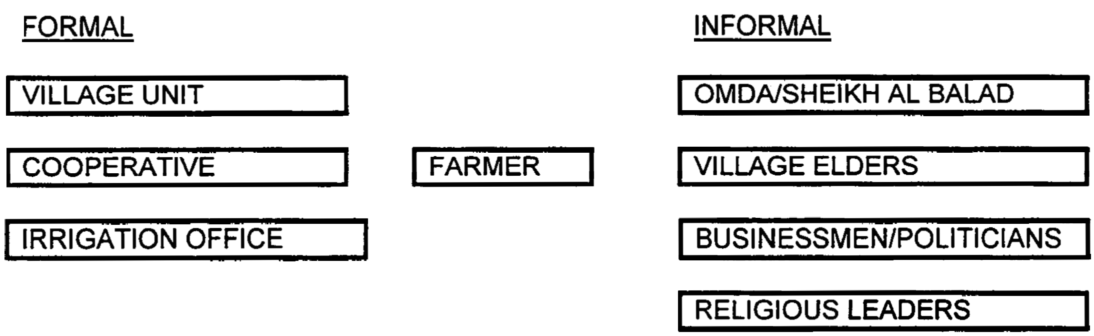
Figure 2 Sibiliya Mesqa, Yaqut



3 FORMAL AND INFORMAL INSTITUTIONS IN RURAL EGYPT

In order to achieve an assessment of the operation of the local irrigation system in Delta Egypt, one must take full account of the institutional setting within which it operates as well as the cultural context within which the farmers live and work, that is the formal and informal power structures which govern social behaviour. In reality these two systems interact to create the functioning village power structures. It is the nature of this interaction which is most relevant, and specifically the tensions and contradictions to which it gives rise. It is therefore first necessary to outline the modern formal institutions operating in the rural environment and consider how far they have embedded themselves in the village structure and the nature of their articulation with the older traditional and now informal village structures (figure 3).

Figure 3 Principal institutions in the village environment



3.1 Formal institutions

The principal formal institutions operating in the rural environment are the village council, the agricultural cooperative and the district irrigation office. Of these only the last two play a significant role in irrigation organization.

The agricultural cooperative in Yaqut has existed since the early sixties and from its inception has served as the principal tool of the Ministry of Agriculture (MOA) for enforcing its agricultural policies. The village cooperative is theoretically open to local control through an elected committee (*maglis al-idara*) (Mayfield 1971). However in practice the role of the committee is limited and real power resides with the *mudir* (director) of the cooperative, Abdul Gawad. Indeed few farmers interviewed in Yaqut were aware that the cooperative was required to hold elections.

With the progressive removal of quotas and price controls in recent years the actual role of the cooperative has declined. This is however welcomed by most farmers, who expended a great deal of energy in avoiding such obligatory quotas. During the past three years crop quotas on wheat and maize have been phased out, at the same time, price controls have been removed and farm-gate prices have risen (Hvidt 1995). The only crops still grown to enforced quotas and subject to price control are cotton and sugar, of which only cotton was an important crop in the study region.

The Irrigation office

Responsibility for the operation of the irrigation system lies with the department of irrigation of the Ministry of Public Works and Water Resources (MPWWR). This is achieved on the basis of continuous flow down to the command area level (120,-160,000 *feddan*) below which supply is exercised on a rotational basis, either between whole command areas or between different parts of the larger command areas. Below the point where rotation begins it is unusual to find any control or measurement structures except where dictated by particular local circumstances (Metawie 1989). Flows along the lower levels of the irrigation system are controlled by the maintenance of levels rather than a precise measure of discharge (Metawie 1989). Thus water released into the distributary canal system is largely unregulated and any surplus or unused water flows through the canal tail escape structures and enters the drainage network. Such a system involves a large degree of waste and nationally a large proportion of the 15 billion cubic meters which are annually discharged into the Mediterranean, is first pumped from drainage canals in the Delta[2].

Control over discharges, below the main canal, falls to the *muhandis* (district engineer) who is responsible for maintaining the prescribed rotations and discharges in the branch canals and *mesqa*[3]. The district office serving Yaqut is situated in al-Bagoor and there is no office or other point of contact located at the village level. The *muhandis* is in charge of a small workforce of eight, comprising three clerks and five water guards or *bahhar* who each have responsibility for a specific set of canals and *mesqa*. The *bahhar* is responsible for opening and closing the canals according to the rotations and noting the upstream and downstream water levels, to ensure that water is reaching the tail-enders. In theory he is required to visit all sections of the canals on a daily basis and should serve as the direct point of contact between farmers and the MPWWR. In reality it was observed that the *bahhar* rarely visited the tail-ends of canals and measurement of levels were not carried out on a regular basis. Farmers on the Um Aisha *mesqa* had no idea of the identity of the *bahhar* responsible for their section: however as water supplies were above requirements they did not regard this as a problem. Along the Sibiliya *mesqa* the situation was very different. *Mesqa* supply has been less than demand for a number of years and farmers have sought by various means (legal and illegal) to obtain an increase. As a result, when farmers do come into contact with the district engineer it is usually as a result of an infringement of ministry regulations, such as the illegal replacement of a pipe inlet or unauthorized opening or closing of a canal inlet or outlet gate[4]. In such a case a summons (*mahdar*) to the local court will be threatened by the *muhandis*. Thus the perceived role of the irrigation office is more punitive than supportive. Enforcement of the ministries regulations however rarely takes the form of a legal suit. It is in fact far more common that farmers will pay an unofficial 'fee' to the *bahhar* or *muhandis* to overlook the pipe at least until it is 'officially' discovered.

3.2 Traditional (informal) institutions

2 Unlike the upper and middle reaches of the Nile where surplus flows into drains result in downstream gains, little re-use is possible of surplus flows in the Delta.

3 Farmer responsibility is limited to the maintenance of field ditches or marwa into which they must lift water from the mesqa.

4 The EWUP Technical report 6 (1980) estimated that up to 72 % of all turnouts at the mesqa level are of a larger than legal size. These illegal pipe inlets have all been placed by the farmers, who insist that the legal inlets are inadequate. This view has been confirmed by studies conducted by the MPWWR research department (Metawie 1989 and Sallam et al. 1982).

In contrast to the state sponsored institutions there are a number of traditional or informal institutions with a specific role in the organization of irrigation activities at the local level. Foremost amongst these are the Mayor (*omda*) and his deputies (*sheikh al-balad*) as well as leading figures along individual canals.

The village mayor (*omda*)

Prior to the establishment of the village councils in 1960 the leading government representative in the village was the *omda*. His role included the collection of taxes, the maintenance of law and order and the organization of corvee labour for the control and maintenance of the irrigation supply. As such he represented the chief focal point for interactions between villagers and the state (Baer 1961). In recent times this traditional role has been eroded and many of his former functions have been absorbed into the various ministries with responsibilities in the rural environment. Even his authority in the maintenance of law and order has been limited by the presence of a state police force represented by the chief of police in the district office at al-Bagoor.

The ability of the *omda* to mediate between individuals, and on behalf of the community, is therefore severely reduced by the increased presence of representatives of the central government's institutions in the village setting. In relation to agriculture and irrigation, responsibility for dealing with various disputes has passed to the MOA and the MPWWR. For example, responsibility for land and land-use disputes has been assumed by the MOA and the *omda*'s traditional role in organizing and directing corvee labour for the digging and maintenance of irrigation canals has been assumed by the MPWWR (primarily through mechanized maintenance). As a result there are few cases of the *omda* being involved directly to deal with conflicts relating to irrigation and agricultural disputes between farmers and outside institutions. The *omda* did however have some influence over the agricultural cooperative, due to its partial integration into the village social order and was occasionally involved in disputes concerning land use, particularly in relation to the payment of fines for non-compliance with compulsory quotas. In relation to irrigation affairs the *omda* only played an important role in the settlement of inter-farmer disputes. He was rarely called upon to intervene directly on behalf of farmers in disputes with the irrigation office. However this is not to say that he played no role, as he generally kept informed by his *sheikh al-balad* of any moves by the farmers to organize coordinated actions such as sending a delegation to al-Bagoor or sending telegrams to Cairo requesting additional water[5].

5 Depending upon the size of the village the omda will be served by a number of local deputies (Sheikh al-balad) selected by the omda with reference to the informal consensus of the districts they represent In Yagut there were five Sheikh al-balad, each responsible for a region of the village which contains eight or so family groups. Along the two study canals there were two separate Sheikh al-balad, al-naadi Ahmed Abbas along the Um Aisha and Ashraf Kamal along the Sibiliya.

4 PROBLEMS IN THE CONTROL AND DISTRIBUTION OF IRRIGATION SUPPLIES

Problems associated with the patterns of supply can be divided into two categories. Firstly the fundamental assumptions upon which delta water distribution systems are based and secondly the failings in the allocative mechanisms governing supply.

4.1 System assumptions

The basis from which irrigation demands are calculated is the national cropping pattern, collected by the MOA through the village based cooperatives. For the village of Yaqut it was found that the officially submitted cropping patterns bore only a general relationship to the actual cropping patterns of farmers. Land area was overestimated by around 5 % along most canals. This was due to inadequate updating of land records either through negligence or, as was observed, due to corrupt practices governing the transferal of agricultural land to residential land[6]. If such inaccuracies were transferred to the national level and there is no reason to suppose they would not be, indeed greater overestimates closer to the major urban centers are likely, then there would be a national overestimate of the agricultural land base of the order of some 250,000 *feddans*.

In addition to the overestimate of available land there was observed to be only a general recording of farmers cropping patterns, consisting of the principal crops (maize, wheat, *berseem*, cotton). Minor vegetable crops were not recorded, nor the short season *darawa* fodder crop grown from October to December. This appears to have developed as a result of the cooperatives desire to demonstrate that it was adequately enforcing the cropping patterns formerly required by the MOA for a wide range of crops. Although almost all of the restrictions on cropping patterns have now been removed, the cooperative appears to still only submit land use patterns for a narrow range of principal crops either as a result of inaccurate data supplied by suspicious farmers or due to inadequate record keeping. Such inaccuracies give rise to important variations in seasonal requirements between the actual and officially calculated crop water requirements.

An additional problem related to the use of regional cropping patterns as a basis for deciding water requirements is that this ignores the canal/mesqa level variations in requirements. Cooperative districts, which form the basis of MOA data, contain a number of canals and *mesqa* and in collecting crop data no effort is made to note the location of crops along specific canals. Thus a canal with a majority of its area devoted to a water demanding crop and a canal dominated by a crop with a lower water requirement may receive equal inflow, if they fall within the same cooperative district. Finally it was noted that the optimal planting and harvesting dates were assumed to be valid for the various regions, yet observations in the field indicated that actual planting and harvesting dates would often be delayed or put forward by anything up to one month as a result of various localized factors, such as climatic considerations, delay in the arrival

6 As much of the agricultural land along the study sites was within the village green belt, residential developments were restricted. A common practice to evade such regulations was for a bribe to be paid to the cooperative to overlook building infringements for a number of years, after which wime the owner would be liable for a fixed fine but would be allowed to retain the property.

of seed or other inputs or social behaviour such as delay due to a particular festival or celebration (e.g. Ramadan).

A further error in the assumptions made at the national level concerning water requirements was in the delivery efficiencies of the system. A canal conveyance efficiency of 80 % is assumed by the MPWWR for the delta region, although my own observations of efficiencies along the main and distrubutary canals serving the study sites suggest a figure of 65 % is more realistic. On the other hand the poor farm-to-field efficiencies suggested by the MPWWR (75 %) were not observed in the field and detailed measurements of farm-field efficiencies in the study sites revealed an average efficiency of 82 %. Although these different efficiencies resulted in broadly similar overall system efficiencies and therefore would not greatly affect the calculation of requirements, they are important indicators of where the MPWWR places blame for conveyance losses and where it should be truly located.

From the above one can see that any assumptions made concerning the water requirements of crops in rural Egypt will bear only a general relevance to the actual patterns. To give a true representation of requirements they must be supplemented by accurate data of actual cropping patterns, delivery efficiencies and farmers practices for a particular season. Such data can only be gathered with the willing cooperation and participation of farmers. Under the present system, where this is a duty of the MOA, there are no efforts to involve farmers. The cooperative system is largely seen as an alien structure imposed upon rural society to effect control over agricultural production. Its principal activities are seen as extractive, in that it has hitherto been responsible for ensuring the production of crops required by the state, according to national priorities and objectives. As a result farmers are wary of supplying state representatives with accurate data concerning land area and cropping patterns. More importantly, as the cooperative system is not integrated within the traditional village structures, it is in no way responsible to farmers and they exert no control over its employees. Similarly the MOA at the national level has no direct knowledge of agricultural organization at the village level and is therefore unable to determine the accuracy of data supplied. In such a situation it is commonplace for the cooperative employees, free from effective control, to abuse their positions and through a combination of neglect and corruption supply data which is incorrect.

Mechanisms governing the distribution of irrigation water requirements

The data collected in the above manner are used by the MOA for national projections of cropped areas and patterns and by the MPWWR for calculating total crop water requirements and as such appears in published figures of national estimates. However at the same time officials at the MPWWR are aware that whilst in general terms such data might give an adequate picture of national water requirements, they accept that such figures mask a high degree of error. As a result the MPWWR has a policy of committing releases into main canals well in excess of the requirements which would be calculated from the available data. In effect the ministry, admitting that it has little reliable knowledge of water requirements at the local level, relies instead upon the maintenance of releases based upon canal levels, ensuring that during any particular on-rotation water is available to a predetermined height. Thus whilst the ministry is aware in general terms of the water released into the main canals it has no knowledge of particular releases into lower level canals and no measurements are made of how accurately water is divided between minor distributary canals nor of the quantity of through-flow passing from the system to the drains.

Operation of the irrigation system at the lower level is in the hands of the district *muhandis* and his small staff of water guards (*bahhar*). It was therefore necessary to observe the actual operation of the supply system at this level to determine how accurately this met the pattern of required discharges. What was found was that releases in general to the principal distrubutary canals in the region, far exceeded the water requirements and that as a result subsequent diversions into *mesqas* generally provided more than adequate supply. In order to observe the degree of oversupply and patterns of farmer use one *mesqa*, Um Aisha, was selected for closer study and its patterns of supply and demand recorded. Firstly the overall patterns of discharge were compared to calculations of total water requirements, based upon local data of cropping patterns, planting and harvesting dates and climatic factors. On this basis the region was observed to have an annual discharge which was 64 % in excess of the requirements (taking into account distribution requirements and canal storage capacity). More importantly the canal provided a discharge of twice the crop requirements for six months in the year and slightly below requirements for three months (during the *darawa* fodder season). If this pattern were reflected in patterns of excess demands by farmers then the additional releases could be justified as necessary to ensure that all farmers, specifically those at the tail end and farmers using traditional water lift technology (water wheels), obtained access to sufficient supply. However what was found was that farmer use patterns reflected closely the calculated water requirements, suggesting little wastage on their behalf (figure 4).

The greatest discrepancies occurred as a result of diurnal variations in farmer use patterns with a marked preference for irrigations from 7 a.m. until 12 a.m.[7] The inflexibility of the supply system to reflect such variations often resulted in high rates of night time discharge into drains from tail end gates (figure 5). Furthermore, during the period of peak demand a number of farmers were prevented from irrigating due to the form of lift technology employed or their location along the canal and were forced to postpone irrigations to a later time. Even where they are able to irrigate, all farmers will pay a greater price at peak periods due to the greater head lift required. Farmers at the tail end in particular must pay a greater price in both time and money invested in irrigation.

7 Farmers were observed to have a clear preference for day-time irrigations, citing the lack of adequate lighting and health hazards as the principal contraints upon night-time irrigations.

Figure 4 Total water requirements, farmer use and canal inflow, 1991

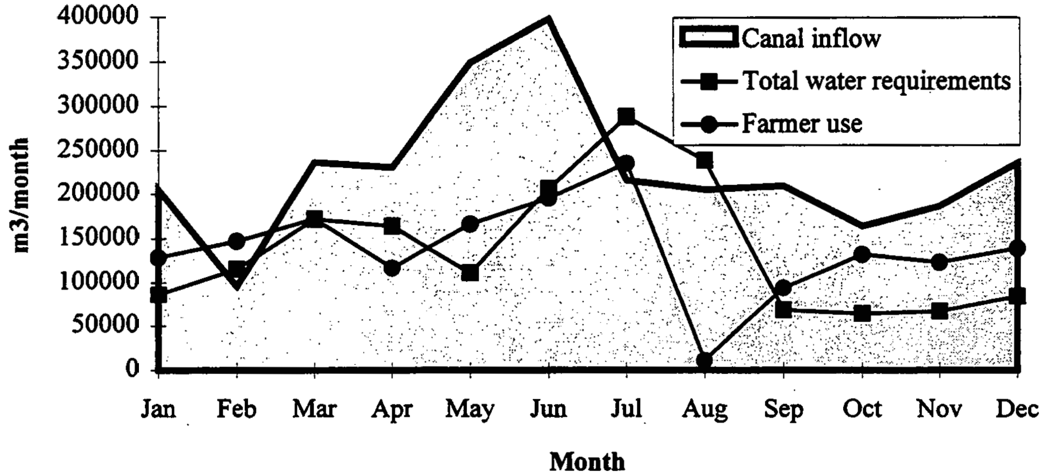
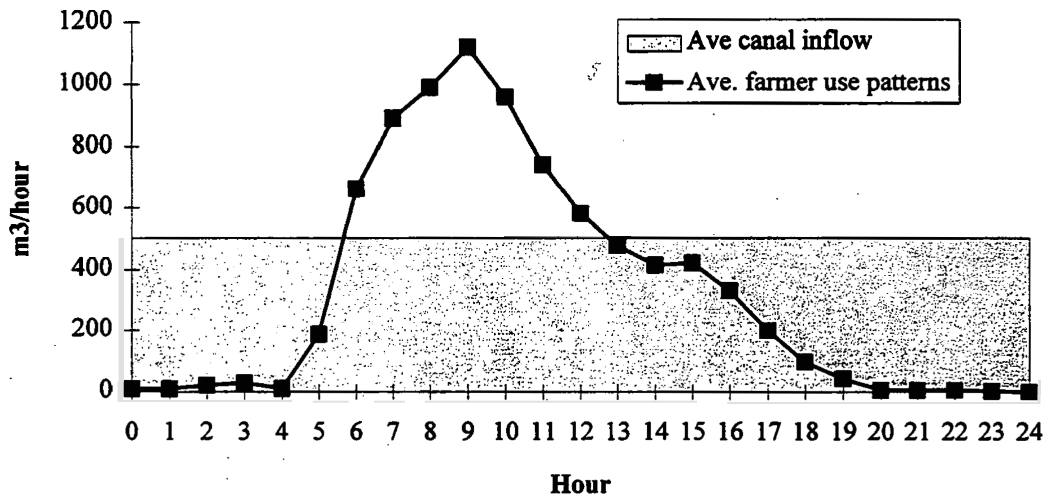


Figure 5 Average diurnal demand and supply patterns 1990-91



Significant losses were also observed as a result of seasonal discrepancies. These resulted from the above noted problems of variations in actual and recorded cropping patterns and planting and harvesting dates. The most notable discrepancies occurred in April to June when excess discharges were released into all canals in the region for the cotton crop and in August, when most farmers preferred to leave their maize crop for an extended period without irrigation prior to

harvest. In the first case it was observed that despite the additional water releases, cotton was not planted anywhere in the region[8]. In the latter case the reduced farmer demand meant that over an 18 day period in late August only 7 % of the available water was utilized (figure 4).

In addition to the above there are a multitude of collective and individual circumstances which could alter the normal patterns of irrigations, these could include local celebrations/anniversaries, market days and of course climatic factors such as increased rainfall or excessive heat. Thus patterns of irrigation along any specific canal will vary depending upon the particular physical and social circumstances of the community of irrigators. It can therefore be argued that the principal cause of wastage within the system is the variable nature of farmer use patterns. Indeed the standard response of many employees within the MPWWR when questioned on problems of oversupply and wastage within the system is to attribute this to unpredictable and excessive farmer use patterns. However the above analysis of patterns of demand has revealed that patterns of farmer use, although variable, were extremely close to the optimal water requirements and that they achieved high levels of efficiency in raising water from the *mesqa* to the field. The losses observed in the system were due to the lack of coordination between the supply and demand patterns for irrigation water. Losses were seen to occur as a result of seasonal factors, due to the lack of congruence between actual and official cropping patterns and planting and harvesting dates and due to the mis-match between the rotational and daily supply and demand patterns.

5 WATER DEFICIT AND FARMER COPING MECHANISMS

From the above one can see that the assumptions and mechanisms governing irrigation supply have led to a situation of general oversupply with periodic shortages due to specific factors. The principal causes of this were the inflexibility of supply patterns and the lack of farmer involvement in the determination and control of releases into their canals. For the majority of canals experiencing a situation of relative water surplus, such as Um Aisha, the negative impacts upon farmers were limited as they were generally able to obtain sufficient water on demand. There were however a number of *mesqa* in the region which received discharges below the observed crop water requirements. For the study region these were all associated with the Danduf distrubutary canal which was observed to receive an insufficient discharge for the area it serves. This appeared to be due to the mechanized dredging of the canal which had resulted in an uneven gradient along its course. Thus farmers along the Sibiliya *mesqa*, located at the tail end of the Danduf, were observed to receive only 41 % of their requirements from canal inflow. As a result of the long term problems in supply observed along this canal it was decided to observe patterns of farmer use to illustrate the problems associated with the poor coordination of supply patterns between the state and farmers and secondly to illustrate the degree of cooperation between farmers to overcome shared problems of water shortage.

The relative severity of problems faced by farmers, as a result of inappropriate patterns of supply, will therefore vary depending upon whether they are facing constraints as the result of surplus or shortage. Problems of oversupply are often less serious for individual farmers,

8 A small area towards the tail end of the Shahabiya mesqa was required to grow cotton under the compulsory cropping regulations. However, all farmers within this area had chosen not to grow cotton and instead were prepared to pay the fine, on the assumption that it would be covered by the income generated from growing alternative (vegetable) crops.

although they have important consequences at the national level, whereas problems of shortage can result, in extreme cases in total crop failure. The procedures for redress, open to farmers in such cases, range from sanctioned to un-sanctioned channels (formal/informal) by which farmers can obtain their needs. The un-sanctioned forms are generally referred to in the literature as coping mechanisms. What is meant by this is extra legal or often illegal activities through which farmers may be able to ensure an adequate and timely supply of water for irrigation. The need for such mechanisms is indicative of the failings of the present control structures, whereas the presence of these mechanisms is indicative of the persistence of an alternative social structure which still exerts some force over the control of resources in the rural setting. The most important of these coping mechanisms will be considered below with reference to Sibiliya canal.

5.1 Formal coping strategies; recourse to institutions

When a shortage occurs, either through delayed or insufficient supply, farmers have two options; to seek increased discharges by requesting additional water, or to utilize other sources of water which may be available. Requests for increased discharges can be raised to the district *muhandis* directly or through the cooperative. In many cases the *muhandis* will simply refuse the farmers' demands on the assumption that their requests are unjustified, often acting on the advice of his *bahhar*, or simply out of inertia and an unwillingness to involve himself in extra work. It is also true that he has little authority to increase discharges and therefore is unwilling to involve himself in a process which may bring him into confrontation with his superiors. In the case of the Sibiliya the *muhandis* substantiated his inaction by arguing that the problems of the *mesqa* were chiefly as a result of inadequate farmer maintenance of the channel. This would be true if the recorded discharges were actually observed along the Danduf distrubutary canal, though it is difficult to believe that the *muhandis* is completely ignorant of the likelihood that the water levels submitted by the *bahhar* are fictitious.

Alternatively the *muhandis* can agree to the farmers' demands and either raise their request to the governate level, or release extra water without obtaining authorization (generally after payment of a 'fee'). In the first case it is unlikely that there will be any response from the governate level unless the *muhandis* personally follows up his request. In the second case the solution is likely to only be temporary, as generally after a short time the situation returns to the previous condition[9].

Due to the lack of sanctioned authority at the district level, farmers may seek to by-pass local institutions and often they will jointly send a telegram direct to the minister, who has established an office for this purpose with the under secretary. Such action is only likely to occur in cases where there is a recurring deficiency, as the governmental response is unlikely to be swift (Sadowski 1991). Farmers along the Sibiliya indicated that they had on two occasions sent such telegrams but had seen no response.

In view of the above it would appear that the most effective channel for obtaining additional water supplies from government appointees is through bribery. This practice is prevalent in all spheres of Egyptian public life to the degree that it has assumed a level of acceptability (Sadowski 1991).

9 During the study period I observed such a delegation visiting the muhandis (much to the displeasure of the bahhar) and by the time they returned to Yaqut the mesqa had received extra water. This was however short-lived, as it only continued for three days and furthermore the promptness of his action was possibly influenced by his knowledge of my presence in the region.

However the farmers along the Sibiliya have had a long history of water shortages and their problems finally led them to install their own ground water pump. In 1982 they concluded an additional agreement with the *bahhar* that he would ensure their water supply for a determined fee. However, this agreement broke down a number of years ago when some farmers refused to pay, arguing that the water supply was still too variable, therefore he no longer guarantees their supply. In reality this means that he does not take measurements at the tail-end, and although he may be aware of their shortages, he reports an adequate supply and is ready to blame any lack of water on the inadequate maintenance of the Sibiliya by the farmers.

The degree to which the *muhandis* is aware of the activities of his *bahhar* is unclear though it is more than likely that he is not only aware but is also open to bribery[10]. It is certainly not uncommon for a *muhandis* to be accused of accepting bribes, indeed such practices have been a feature of centralized and bureaucratic control since the rule of Muhammad Ali, as a result of the dual problems of ineffective penetration of outside institutions and the diminished influence of local institutions. The farmers along the Sibiliya seem to have preferred not to involve themselves in such arrangements, not only out of a sense of moral indignation, but more importantly as a realization of two issues. Firstly, that the problems require the intervention of individuals with greater authority than the *bahhar* and the *muhandis* (i.e. authorization of the restructuring of the entire canal) and secondly that, as small and middle sized farm-holders, they have little influence as compared to neighbours along competing canals[11].

5.2 Informal individual solutions

As a result of the farmers inability to influence the formal institutions governing the water allocations they will often seek to find a solution individually without conferring and cooperating with their neighbours. The most common of these are discussed below.

The initial reaction to a shortage is to seek to exploit what dead storage is available before it becomes depleted. This is a limited option and certain farmers are placed at a clear disadvantage in this respect. Farmers at the tail-end or those without access to pumps will generally be unable to take advantage of such limited supplies. And even those willing to rent a pump may find that pump owners are unwilling to hire out their pump after the water falls to a certain level due to the high silt content of the residual water and the danger of damage to the pump.

One alternative, to avoid the need to irrigate from dead storage, is that farmers will often water ahead of requirements on those occasions when there is sufficient inflow to the Sibiliya. This may mean a farmer will irrigate up to a week early. However they are not likely to over irrigate and instead may only apply a lighter precautionary irrigation and need to repeat the process earlier than otherwise necessary. Although this makes a greater demand on the farmers' time and labour, it is a rational reaction to the unreliable supply patterns.

10 During the period of the field study extra releases into the Shahabiya distributory canal were noted at the time of the winter closure and farmers claimed this was in response to a request and payment from themselves to the muhandis.

11 Most farmers along the Sibiliya cited the case of the neighbouring Batha canal which served the area containing Ezba Jamal (the remnant of a pre-reform estate). They asseerted that this canal received more than adequate discharges due to payments made by the landowners. As the canal and estate fell outside the study area it was not possible to verify these assertions.

Related to the above practice of precautionary irrigations is the technique of damming, used by some of the farmers along the head-end of the Sibiliya *mesqa*. When there is a small inflow to the Sibiliya, which is barely sufficient to reach the tail-end, some farmers will seek to raise the water level, especially if they intend to lift the water to the *marwa* (field ditches) by *saqia* (water wheel). This they achieve by blocking the *mesqa* immediately downstream of their *marwa* inlet. The result is that water supplies to the tail-end are completely cut off. If the tail-end farmers have recently irrigated they will allow such practices to pass unopposed. However if they feel that their crops are endangered, or if there is already some bad feeling between them and the upstream user, they will travel upstream and remove the blockage, this inevitably causes arguments and as a limited number of families are involved, feuds can develop. Here one can identify the instances of conflict as occurring as a direct result of the inadequacy of the water supplies. A large number of farmers are attempting to irrigate at roughly the same time with only a small quantity of water available. It is therefore almost impossible to establish a rota system to which the farmers can stick and individual attempts to obtain their necessary water supplies serve to bring farmers into conflict with one another. This conflict of interest extends to maintenance responsibilities, as the head-end farmers were found to be less willing to cooperate in maintenance activities than the tail-enders due to the fact that a poorly maintained canal will trap available inflow and retain it at the head-end.

Another method for coping with shortages is to pump water directly from the drain (*masraf*). This is an individual reaction, open only to those farmers located along the tail-end which runs parallel to the Yaqut drain. However this is the most strongly disliked alternative as the quality of the water is poor[12]. The farmers are aware of the deleterious consequences of regular use of such water and strongly believe that it results in reduced yields. This belief was confirmed by measurements of yields taken in the field indicating significantly lower yields along the Sibiliya when compared to those along Um Aisha (table 1).

Table 1 Average yields for study *mesqa* (1990-91) and national averages (1984). kg/*feddan*

Crop	Um Aisha	Sibiliya	Egypt
Wheat	1,800	1,440	1,300
Maize	1,750	1,605	1,980
Potatoes	12,000	10,600	N/A

Source: National figures from Economist intelligence report 1986

5.3 Informal collective solutions

If the supply entering the Sibiliya was sufficient to meet at least all the needs of the head-end farmers, and the supplies in the drain less polluted so that they could meet the needs of the tail-

12 Water samples taken from the Yaqut drain revealed significantly higher levels of salinity and certain micro-elements and pollutants than observed in canal water which would present moderate to severe problems idf used regularly. Furthermore, the disturbingly high levels of bacteria observed present an additional health risk (Radwan 1994).

enders, then one could expect such individualistic solutions to dominate and a high degree of localized and informal conflict to prevail. However the occasions upon which the Sibiliya supplies sufficient water to meet even the needs of the head-end users are rare, and the water in the Yaqut drain is now so polluted that farmers avoid its use except on the rarest of occasions. Thus the farmers, both head and tail-end, have no option other than to employ alternative solutions which can ensure their irrigation needs are met. These have tended to be collective solutions and the shared hardships have encouraged a high degree of cooperation and mutual interdependence.

One collective mechanism to obtain increased discharge is to replace the pipe inlet, either to the distributary canal or to the *mesqa*. In measurements taken by the Water Research Centre (WRC) in Kafr al-Sheikh governate it was found that 72 % of the turnouts were larger than the legal size (Hanson *et al.* 1983). This solution was long ago adopted along the Sibiliya but has failed to alleviate their problems, as there is rarely sufficient water in the Danduf distrubutary canal. Thus farmers have been forced to adopt other solutions.

In the case of the Sibiliya *mesqa* the shortage of water has been long-term with varying degrees of severity. Occasional dredging of the Danduf distrubutary canal partially alleviates the problem for a while, though as a fundamental redesign of the dimensions appears to be necessary, this is only a temporary alleviation and in fact in the long run contributes to the problem as dredging widens the canal and encourages collapse of the canal embankments, reducing the canal depth. As a result the farmers along the Sibiliya have sought to gain access to increased water supplies by almost all of the formal and informal mechanisms which are at their disposal. However they were eventually forced to seek a solution which would remove them from a dependency upon the *mesqa* discharge and the inefficiencies of the MPWWR.

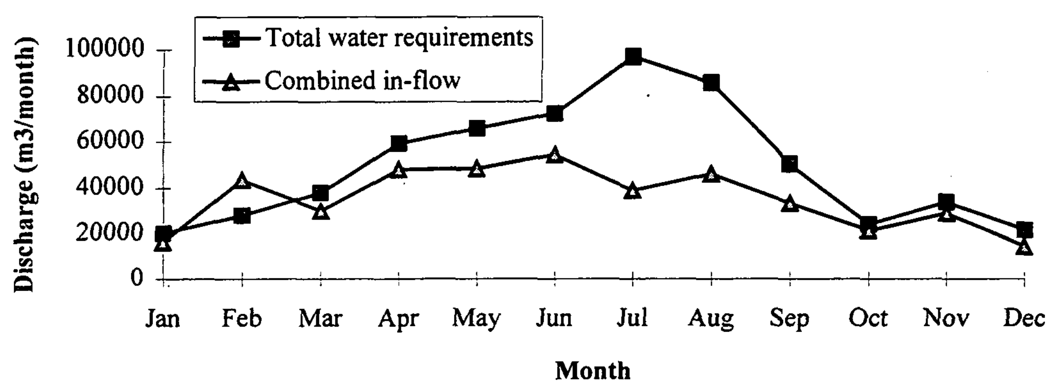
Fifteen years ago the leading landholders of the Isa and Maarik clans invested in a diesel powered ground-water pump which they installed at a point one third of the way down the Sibiliya *mesqa*. They then sold shares in it to all farmers who in return were permitted to irrigate at a lower charge (currently 1 LE per hour, which covers fuel and other recurring costs, plus 20-30 LE maintenance costs per year). Farmers who do not hold shares in the pump pay a fee of 2 LE per hour. In addition all farmers need to raise water into their *marwas* from the *mesqa*, except for a small number at the tail-end of the *mesqa*, where it becomes little more than a *marwa* and is at a level whereby irrigation by gravity is possible. This development led to a high degree of cooperation and coordination of practices amongst the farmers and a feeling of solidarity which is un-equaled along *mesqas* with a regular surplus such as the Um Aisha.

The pump is located on a small piece of land donated by the Isa clan which presently lies on the land of al-hag Abdul Hamid Isa who is the head of the clan. As head of one of the principal clans in the region he held a position of traditional authority and his role in coordinating the use of the pump serves to reinforce this traditional leadership role. He appears to enjoy this position of influence, though at the same time he is easily accessible and always prepared to respond to farmers' needs. Any farmer wishing to irrigate will need to make a request that he or his son operate the pump. Generally they will do this at least 24 hours before they wish to irrigate. Often a group of farmers will come together to make a request, as one will generally talk to his neighbours before talking to Abdul Hamid. It will then become known to the other farmers that the pump will soon be operated and this encourages those who need to irrigate to come forward and state their needs. In this manner a rota will evolve and when the pump is turned on, any other farmers who may not have been previously aware and are interested in irrigating will ask for their

names to be added to the rota. During periods of high demand this can result in the pump being left on almost continuously for a number of days.
Due to the informal nature of interactions to establish the rota, water is supplied on a first come first served basis. When a large number of farmers require water this may mean that some farmers will be forced to wait one or two days for their water and tail-enders will particularly suffer as upstream users often ignore the informal rota and help themselves to earlier irrigations. Furthermore tail-end farmers face higher costs than upstream users, as the water takes almost four hours to arrive to the end of the *mesqa*. For this reason most tail-end farmers prefer not to object when allocations are based upon location along the *mesqa* as this reduces the cost of bringing the water to their land. However as Abdul Hamid Isa will rarely operate the pump before the morning prayer (*Fajr*), which represents the start of the working day, a farmer at the tail-end cannot irrigate before 9 or 10 a.m. As some farmers along the tail-end have holdings of up to 3 *feddans* (requiring approximately 12 hours) they will on occasion need to irrigate well into the night. However it is rare for a farmer to irrigate such a large area during one rotation.

The existence of the pump has clearly reduced the problem of shortage faced by farmers. However there are occasions during which the pump is in-operational and requirements must be met from alternative sources. It has been indicated above that the available inflow along the Sibiliya canal was sufficient to meet approximately 41 % of farmer requirements. It was observed that the total quantity of water raised from the ground water pump provided a further 30 % of requirements. Thus the combined availability from these two sources was approximately 71 % of total water requirements. As a result farmers were still forced to exploit the other sources of available water at specific times to make up a deficit of around 29 % (figure 6).

Figure 6 Total water requirements and combined in-flow from pump and canal. Sibiliya canal, Yaqut, 1991



On those occasions when the groundwater pump is in-operative farmers are forced to rely on the alternative coping measures indicated above. However on occasions when there is a convergence of factors such as a lack of water in the Danduf, high levels of pollution in the drains and an in-operative ground water pump, an even more complex system of irrigating arises. Several farmers will coordinate activities to hire three pumps and share the cost among themselves. The first will be placed into the neighbouring Batha canal to draw water into the

Danduf, from there the water will again be raised into the Sibiliya. The flow in the Sibiliya will then eventually reach the individual farm outlets and water will be drawn off by the farmers using the third pump according to a strictly observed rota.

This is probably the most complex and unusual form of irrigation organization observed and technically is water theft as it draws water from the budget of a neighbouring canal. It is interesting that it also encourages the highest degree of coordination and cooperation and it is unusual for any farmer involved to attempt to irrigate out of sequence or avoid his financial responsibilities. Again such a solution is more onerous upon the tail-enders as a result of the extra hours taken for the water to reach the end (although as indicated some tail-enders can irrigate from the *mesqa* by gravity flow). For this reason many tail-enders will prefer to risk irrigating from the drain, often with disastrous consequences, in terms of yield reductions. However such instances are rare and on most occasions the pump is working and able to meet the needs of the farmers. During an average year it is likely to be out of service on three or four occasions, although each such occasion is likely to last for a number of days. During the study year the pump was inoperative for a total of 48 days and on one occasion, during the critical month of July, it was out of operation for 12 consecutive days (July 7-19).

6 SUMMARY OF PROBLEMS

The inadequacies of the present irrigation system arise from the inappropriateness of the mechanisms governing the determination and control of supply patterns as well as the physical state of the technical system and the lack of correspondence of both of these with the actual demand patterns of use. Both facets of this problem, the failure of the technical system and the administrative system governing its operation, arise from the inability of the central government to maintain sufficient control over operations at the local level and the lack of any alternative institutions with formal authority to exercise such control. The result is that a power vacuum exists within which, whether as a result of neglect or corruption, the farmers interests are ignored to the detriment of the operation of the irrigation system.

For the farmers such a situation can present a number of problems some of which have been outlined above. Most important are those related to reductions in crop yields or in extreme cases the total failure of a crop. These can occur as a result of prolonged water shortages, as in the case of the Sibiliya, or from cases of severe surplus such as are occasionally experienced along Um Aisha or the Shahabiya. However one must also be aware that farmers along canals, which suffer prolonged shortages, are likely to be forced to pay a relatively higher price for water in both financial terms and in terms of the labour input required to obtain water. Similarly both shortages and surpluses of water force farmers to adopt remedial measures to protect their crops which can lead to increased incidence of conflict whether that be between farmers or between farmers and government representatives.

7 CONCLUSION

The principal aims of this paper have been twofold. Firstly to outline the nature of the assumptions and mechanisms governing the allocation of irrigation requirements and demonstrate how this has resulted in a general pattern of over-supply. Secondly, to examine the nature of informal arrangements along a particular water deficit canal to highlight the level of cooperative behaviour possible where farmers assume a direct role in the control and allocation of irrigation requirements.

The inflexibility of state controlled irrigation systems is not a failing peculiar to Egypt indeed there is a large body of evidence indicating similar problems within many large scale irrigated schemes[13]. As indicated above, a large part of the problem arises from the nature of assumptions made at the national level. For a national water distribution system to be established, a degree of standardization of mechanisms of control is required. However it is this very process which serves to underplay regional and localized variations and can lead to problems of shortage or surplus at the micro-level.

In addition to the miscalculation of requirements, due to the lack of detailed local knowledge and the use of averaged national figures, a further problem of centralized control is the problem of demarcating authority and of policing its exercise. The inability of national institutions to effectively exercise authority at the local level and the lack of empowerment of local institutions to coordinate such activities leads to what Hart has termed the 'anarchy syndrome' (Hart 1978). Under such conditions, cultivators are increasingly apathetic towards the operation of an irrigation system over which they have no direct control and seek to exploit localized solutions to obtain more reliable water supplies. In many cases this results in infringements of the ministries regulations. Similarly the irrigation field staff, who are often aware of the shortcomings but do not have the authority, resources or the incentive to effect the required changes, often become complacent and seek to exploit any opportunities for their own benefit. Such manipulation of the bureaucratic systems of control (or rent seeking) is not a feature restricted only to the ministry of irrigation, nor for that matter to Egypt, indeed it is a common feature of public administration systems in much of the Third World (Mbaku 1993). With regards to irrigation such exploitation of authority for the advancement of self interest leads those in control of the distribution of water to ensure the perpetuation of a random and dependent water supply to ensure a position of control over the community of irrigators.

Whilst the manifestations of such inefficiencies in state controlled systems are measurable in terms of levels of wastage and access to water, the roots of these problems lie in the nature of the institutional structures which manage irrigation and particularly in the conflict between formal state sponsored institutions and traditional and less formal patterns of association persisting in the rural environment. It is possible therefore to view, in part, the problem as a result of an underlying conflict between traditional forms of social organization and modern forms introduced through the principal state institutions. In this respect it is imperative that we do not consider irrigation activity in isolation but rather regard it within the wider context of rural social and economic development.

With regards to Egyptian agriculture the government has sought to control and direct change through the concentration of power within the centralized state controlled institutions of the MOA and the MPWWR. This has resulted in a decline in the official role for traditional institutions, such as the *omda* and village notables, in areas such as conflict resolution and the regulation and maintenance of the irrigation system. This study has sought to demonstrate some of the shortcomings of these top down state controlled institutions and highlight the continued importance of informal mechanisms, articulated through traditional kinship and authority structures, in governing irrigation activities at the local level. It has however also been indicated

13 See for example Bottral 1985.

that such informal patterns of social organization and the traditional institutions that formerly regulated them, have been seriously undermined by their lack of legality at the national level. This was most notable with regards to the examples of communal responses to failings in the irrigation system.

At the same time the state sponsored institutions have failed to create the necessary ideological and cultural environment for the adoption of their underlying value systems and as a result the democratic structures envisaged for both the village councils and the cooperative systems have failed to embed themselves in rural society. With respect to the control of irrigation supply the MPWWR has in practice become heavily bureaucratized, to the extent that the state has been unable to maintain control at the center and is often unaware of what is happening at the district level. In practice such state institutions, at least at the village level, have become modified to incorporate a degree of traditional hierarchism in which the benefits of these institutions have been channeled through a series of patron client relations, similar in many respects to the traditional systems they were required to replace. However as this development has been contrary to the desired structure (often illegal) and furthermore, as the state appointed representatives were drawn from outside the traditional village social hierarchy, they have in many respects remained reliant upon the state for their position and are not regarded by villagers with the due respect and loyalty accorded to a traditional patron (Sadowski 1991). Thus their position fails to derive sufficient authority from either their formal state affiliation or their partial integration into the traditional village structures, with the result that inefficiency, corruption and evasion have become integral features of the operation of the irrigation system.

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