A FIELD STUDY OF THE WATER DELIVERY SYSTEM OF MIDDLE AND UPPER EGYPT

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INTRODUCTION

This report is a compendium of both interviews and personal observations conducted during a three and one half month field study of the water delivery system of Middle and Upper Egypt. This report describes:

1) the jurisdictions and governing policies of the water delivery system of Middle and Upper Egypt;

2) the perceptions of both the Ministry of Irrigation engineers and the farmers regarding the problems and needs of the water delivery system.

Our field study was financed by a grant from the Thomas J. Watson Foundation in May 1979 and by an additional grant from USAID in Egypt in March 1980. The Watson fellowship is intended to be an independent learning experience requiring the recipients not only to design their own project but to carry it out with no additional support from the Foundation other than the initial grant of money.

After six months of constant but unsuccessful attempts to make the necessary arrangements for our field study we were introduced to Dr. Abdel Hady Rady, Director of the Office of the Minister of Irrigation, who immediately began to assist us.

Dr. Rady helped us obtain a public security permit and arranged for the cooperation of the Ministry of Irrigation at the Directorate level. In particular, he provided us with letters of introduction to the Undersecretaries of Irrigation for each Directorate, requesting

their assistance in providing access to staff, their field work, transportation, and lodging.

As a result of his assistance we were able to spend three and a half months with the Irrigation and Drainage authorities in the Irrigation Directorates of Beni Suef, Minya, Assyut, Sohag, Qena, and Aswan. We spoke with the General Directors of Irrigation, the Drainage Project authorities and also with the district engineers who must decide how best to implement, on a daily basis, the irrigation and drainage policy established by the Ministry. Of equal importance were our field observations and discussions with the canal guards and farmers. They are the people whose actions and reactions determine whether or not the objectives of the irrigation and drainage policies are successful.

These meetings were supplemented by visits to farms and villages as we travelled slowly upstream in a small sailing felucca. Sleeping on our boat, stopping at whatever village we reached at sunset, we were able to observe the riparian life with a minimum of disturbance. We walked through farmlands observing farming methods and often conversing, admittedly sometimes in a rudimentary manner, with the farmers.

During the course of this trip an Egyptian journalist, Nyra Atiya, a Doctor of Social Anthropology, Dr. Andrea Rugh, and a Doctor of Political Science, Dr. William Rugh, joined us. Ms. Atiya was with us a week and traveled from Assyut to Sohag. Dr. Andrea Rugh was with us for three weeks from Assyut to El Balyana and then for an additional week and a half from Luxor to Aswan. Her husband Dr. William Rugh also joined us for that part of our journey.

All three of these guests, with their knowledge of Colloquial Arabic, acted as translators for us. However, in addition, each of these individuals shared with us their insights into what we were hearing and observing. Because of their particular interests and experiences in Egypt we often found their insights to be invaluable. They helped us greatly to understand the relationships existing between the farmer, his land, water, and the Agriculture and Irrigation Ministries personnel.

The picture this report paints of the water delivery system of Middle and Upper Egypt, and the relationships, needs, and problems which exist for the users and the regulators of this system is incomplete. Unfortunately, the nature of the interview situation and of human beings is such that problems tend to overshadow the successes.

To emphasize certain points, respondents may exaggerate or collapse the intervals of time between recurrences of a problem and therefore they may intentionally or unintentionally mislead their listeners as to the frequency or significance of a problem.

During this field study, we were first and foremost listeners. As listeners we were dependent upon the people we talked with to be as truthful as possible. When people contradicted one another we tried to find an additional source. Sometimes this was not possible and we were forced to make a subjective judgment. Whenever possible, we tried to confirm the claims of our interviewed people by our own personal observations. Limited time and the nature of many of the claims we heard made it impossible to confirm all of these claims. It is therefore impossible for us to guarantee the validity of all that we were told and in turn are now reporting. If there are inaccuracies they are due

either to our misunderstanding of what was expressed to us or the respondent's own misconceptions.

FINDINGS

The water delivery system of Middle and Upper Egypt, despite twenty years of severe financial pressures, works surprisingly well. There are times, especially in the summer, when severe water shortages in the system do occur, but the problems are fewer than might be expected. This can only be attributed to the high level of expertise within the Ministry of Irrigation which has managed to make the best of a difficult situation. Where successes are most noticeable, the reason is most often conscientious personnel. This affirms what one generally expects, that the quality of personnel is the most critical factor determining the efficiency of the system. Therefore, the primary question is how to maintain and improve upon the quality of the Ministry of Irrigation personnel.

Inadequate Salaries

The present salaries for all personnel are too low. There is difficulty in keeping high quality personnel in all areas of the Ministry, guards as well as engineers. Some of the more qualified younger personnel we spoke with are considering leaving the Ministry for less stressful, higher paying jobs abroad or in private industry. The present financial pressures upon the Ministry of Irrigation personnel increase their susceptibility to illegal outside pressures or bribes.

An increase in salary for the guards and engineers in the Ministry would help ameliorate their susceptibility to illegal outside pressures and bribes and the tendency for higher quality personnel to seek other employment.

Housing Incentives

Attempts are being made by the Ministry of Irrigation to provide their personnel with high quality low cost housing. With housing in such short supply and an apartment often a prerequisite to marriage, the access to good low cost housing would be an incentive to qualified young people to make a career in the Ministry.

As an incentive to qualified young people and to present employees, the program of providing quality low cost housing should be continued and implemented with all possible speed for all grades of personnel, especially the guards and the district managers.

Management Training

Engineers are not taught the requisite of management techniques for the operation of the water delivery system. The majority of problems facing engineers in the field are not engineering problems but management problems. The training of engineers does not provide them with the ability to recognize management problems or provide them with the management skills to correct these problems. Lack of adequate training not only decreases the efficiency of the water delivery system but also increases the stress the engineers feel in their positions. What results is an indifference on their part, a higher personnel turnover rate, and increased difficulty in recruiting personnel.

Management training seminars for engineers in the field and in-field technical assistance might help to ameliorate this problem.

Additionally, the course of study for future irrigation engineers should be revised to include increased management skills and could

perhaps be developed around the problems raised in the field engineers' management training seminars.

U.S. Training Program

In the past, programs funded by USAID in Egypt provided groups of Ministry of Irrigation engineers with a brief firsthand exposure to the current ideas, methods, and technologies presently utilized in water delivery systems of the United States. Contrasting these engineers with those who did not have this opportunity, we found the former be:

a) significantly more aware of the potentials for improvement that exist in the water delivery system;

b) significantly more committed to realizing those potentials;

c) more open to new ideas;

d) more aware of the importance of complete and thorough planning and testing of all new methods before mass implementation, and

e) more aware of the dependency of technical solutions upon an appropriate infrastructure.

The continuation of programs of this type would be advantageous. We would suggest that they be increasingly accessible to the District and Inspectorate level engineers in the Ministry of Irrigation. If these programs were to emphasize the management aspects of a water delivery system in conjunction with, but not in place of, the management training seminars previously recommended, a superb learning experience might result.

Inefficient Use of Engineers

Most engineers are utilized inefficiently. They are overqualified for many aspects of the jobs they are assigned. District engineers

spend a large part of their time performing minor clerical and accounting duties. The cost of these overqualified personnel performing minor tasks is a waste of limited financial resources. Often the difficult problems these engineers have been trained to deal with remain unsolved because of the other minor tasks they must perform. Sometimes these minor tasks are improperly done by these engineers because of boredom and frustration.

The reevaluation of the role of the engineer in the field and the development of a support system for him of qualified technical and clerical assistants would help to ameliorate the inefficient utilization of the engineer's skills.

Lack of Cooperation between Farmers and Irrigation Personnel

There is often a lack of cooperation between Ministry of Irrigation employees in the field and the farmers. Mutual cooperation is necessary if the water delivery system is to function at maximum efficiency. Farmers are often distrustful of Ministry of Irrigation employees. Many Ministry employees without farming backgrounds seem to have special difficulty in gaining the farmers' respect. The farmers tell us that this is because these Ministry personnel have difficulty understanding the agricultural system, the nature of the farmer and his problems and needs. We observed that the Ministry employees who have farming backgrounds or who have remained in one district for an extended period of time are often better able to understand and work with the farmers.

A review of this problem and the implementation of steps to correct it will result in a water delivery system of increased efficiency.

Unfortunately, no matter how much expertise is available within the Ministry of Irrigation, the lack of an efficient physical system and the means to maintain it limits the ability to most efficiently implement the expertise and optimally control the water delivery system. The following recommendations are concerned with improving the physical aspects of the water delivery system. It is important to note that the Ministry of Irrigation is aware of the problems we will mention in this section and is attempting to rectify them.

Inadequate Communication System

The communication system within the Directorate and Irrigation Districts is inadequate. Inappropriate decisions are made because of delays in receiving data. Implementation of decisions is difficult and time consuming because of delays in communicating the decision. Less qualified personnel sometimes must make important decisions because of the inability to communicate with a qualified superior. Followup of the implementation of a decision is difficult and can often only be accomplished by traveling to the site where the implementation is to occur.

As a means to improve the control of the water delivery system the Ministry of Irrigation program to improve the communication system within the Directorate and Irrigation Districts should be implemented with all possible speed.

Regulation Structures

The proper regulation of the water delivery system is impeded by the poor condition of many of the gates of the regulating structures.

Considerable leakage occurs when gates consist of ill fitting wooden beams. Measurements and estimates of the leakage of individual gates of this type range from 21 percent to 50 percent of the upstream head. Improper regulation occurs with gates of this type because two or three guards are usually required to lift the heavy wooden beams. The illegal regulation of these gates and of some metal gates is invited by the difficulty in locking them. In addition, when it is possible to lock a gate, the lack of proper locking devices may further complicate the proper regulation of the water delivery system.

The Ministry of Irrigation should attempt if possible to implement with greater speed its program to replace these wooden gates. We suggest that the actual effectiveness of the present means of locking all gates be reviewed. However, we must point out that unless the proper regulation of these gates by Ministry of Irrigation personnel can be assured it might be wiser to leave them unlocked so that if an emergency situation was to arise the gates could be regulated by non-Ministry persons.

Bank Deterioration of Minor Canals

The efficiency of the smaller canals is severely impaired by the deterioration of the banks in or near villages. Bank deterioration is often caused by the frequent animal and human traffic crossing these canals when bridges are not available or conveniently located. Further bank deterioration is often caused by animals and humans using the canal as a drinking water source and bathing facility, and its use for the washing of clothes and dishes. Irrigation problems sometimes occur because the canal flow must be decreased to avoid overflowing the deteriorated banks. Increased regulation of the canal is thus required

to cope with the situation, yet flooding may still occur. Significant damage to private property in the villages is caused by flooding and occasionally the Ministry of Irrigation regulating structures have been destroyed by farmers desperately trying to alleviate the flooding. The proper control of the water delivery system becomes more difficult as the mutual cooperation and respect between Ministry of Irrigation employees and farmers becomes strained as a consequence of the irrigation and flooding problems.

The rebuilding of the banks of these canals and the provision of appropriately placed pitched areas for people and animals requiring access to the canals for washing and other purposes would help to ameliorate these irrigation and flooding problems.

Weeds

The present program for the removal of weeds from the canals and drains is inadequate to deal with the problem. The spread of weeds throughout the water delivery system is rapidly increasing. The growth of weeds is accelerated by current irrigation methods which result in significant amounts of fertilizer being deposited in canals and drains. Weed resistance to chemical herbicides such as magnacide is increasing. Reductions of up to 50 percent in canal carrying capacities and reverse flow situations are being caused by the weeds. The present level of agricultural production is being threatened as weed infestations of the fields increase due to the high content of weed seed in the irrigation water from the delivery system.

Efforts to solve this problem must be intensified. However, in lieu of a solution, additional weed cleaning machinery must be obtained

to affect a partial amelioration of this problem. It is important to note, however, that Egyptian experts explained to us that the technologically simpler machinery, though less efficient, is significantly more effective than state-of-the-art machinery since on-site maintenance is easier.

During the course of our study we discovered that four key assumptions, shared by many people involved in the study and control of Egypt's water delivery system.

The first assumption is that the successes, needs, and problems of the agricultural and irrigation systems vary little throughout Egypt. In believing this, many people therefore assume that by having discovered a solution to the particular problems of one small area of Egypt they have discovered a solution for all of Egypt. This is a false assumption, and patently untrue. A close look at Middle and Upper Egypt alone reveals wide variations in soil characteristics, water delivery system capabilities, drainage needs, and cultivated crops. There is no one solution.

The second assumption is that the installation of a field drainage system will solve a majority of the agricultural and water delivery problems of Egypt. A drainage system provides no final solution. It will only alleviate the symptoms of improper water management. Historically, drainage systems often increase the waste of water. This could further tax an already overburdened water delivery system and increase the leaching of essential minerals and nitrogen from the soil root zones.

The third assumption is that the farmer is not aware that overwatering will reduce his crop yields. It is true that overwatering does occur, but only in a minority of cases does this stem from sheer farmer ignorance. Many farmers we met were quick to point out that crop yields are reduced when overwatering occurs. One farmer in particular showed us his flourishing ful crop and then pointed out an adjacent field belonging to his neighbor which contained a stunted and yellowed crop of ful. His neighbor did not understand, he said, that too much water was bad for the plants. Farmers often admitted that they tended to overwater, but claimed that they did so because they could never be sure if they would have access to water when their crops needed it next. We would further suggest that overwatering occurs because fields are not level and therefore in order to cover the high spots in the field the low spots end up being overwatered.

Finally, many people assume that Middle and Upper Egypt have no water quality problems. To the contrary, the high weed seed content and the resulting weed infestation of the fields is a serious water quality problem. The growing presence of fertilizer in the water of the delivery system encourages this growth and is in itself a water quality problem. In certain areas of Middle and Upper Egypt farmers reported that the water drawn from the water delivery system "burned their crops like the fire of the sun." These farmers found that their crop yields are significantly increased when they irrigate with groundwater instead of water from the delivery system. This suggest that the quality of the water in the delivery system should be more closely examined.

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JURISDICTIONS AND GOVERNING POLICIES OF THE IRRIGATION DELIVERY SYSTEM IN MIDDLE AND UPPER EGYPT

A. Introduction

This section of the report will describe the jurisdictions and governing policies of the irrigation water delivery system in Middle and Upper Egypt. We have divided the water delivery system into three parts to facilitate a clearer description of its operation. These parts are as follows:

1) The barrages and all those canals which are not rotated; we will refer to these canals as major canals;

2) Those canals which are rotated; we will refer to these as minor canals;

3) The communal ditches which carry water from the canals to the farmers; we will refer to these as field meskas.

The jurisdictions and governing policies and the effectiveness of their implementation will be described for each of the three parts of the water delivery system. Whenever possible, discrepancies that do appear to exist will be examined to determine why they exist and whether or not they are detrimental to the functioning of the water management system.

The description of the jurisdictions and governing policies of the water delivery system of Middle and Upper Egypt is derived from interviews with engineers and other personnel of the Irrigation Directorates of Middle and Upper Egypt. The information on the working

jurisdictions in the field and the implementation of policy is derived not only from these sources but also from interviews with Ministry of Agriculture personnel and farmers, and from our own field observations.

The operation of the irrigation water delivery system in Egypt is based upon the Rational Irrigation Water Utilization Plan first introduced by the Egyptian Ministry of Irrigation in mid-1975. Under this plan Egypt's first irrigation water budget was established to reduce what was viewed as the excessive use of water in irrigation.

Today this budget is determined annually. The formulation begins with the regional Agriculture engineers establishing the authorized crop mix and area for each irrigation district according to the regional quotas set by the Ministry of Agriculture's Production Plan. Each Ministry of Irrigation district engineer then develops an irrigation water budget for his district based upon these crop mixes, evapotranspiration rates, and the conveyance losses of the delivery system in his district. We were told that experience is the only criterion by which these losses are determined.

The Inspectorate and Directorate water budgets are developed from the district water budgets. The Directorate budgets are then used by the office of the First Undersecretary of the Irrigation Sector to establish the Master Irrigation Water Budget. The daily downstream release from Sadd El Aali (the High Dam at Aswan) is programmed to meet the requirements of this water budget and the additional water needs for the production of hydroelectric power, navigation, drinking water, etc.

Throughout this process, pressure is exerted by the Ministry of of Irrigation in Cairo to decrease the difference between the expected

crop water needs and the proposed irrigation water budgets. The National Program in Irrigation and Drainage General Policies Report published in September 1978 stated that within two years after the introduction of the Rational Irrigation Water Utilization Plan, annual irrigation water consumption had been reduced by 7.50 milliard m^3. The reduction in the flow through the water delivery system fed by the Nile was approximately half of this amount with the remainder resulting from reduction in the utilization of groundwater resources. It should also be noted that we have been told that until now the Ministry of Irrigation has overlooked compliance with the weekly and monthly water budgets and enforces only the annual irrigation water budget of each Directorate.

The difficulties with the development and implementation of the water delivery system budget will be described in detail in the following sections. The two primary difficulties are:

1) The actual crop mixes and crop areas are significantly different from those authorized by the Ministry of Agriculture.

2) There are difficulties in accurately allocating the flow in the water delivery system according to each irrigation district's water budget.

B. Barrages and Major Canals

Description of Jurisdictions and Governing Policies

The Nile barrages are permanent dam-like structures which serve to raise the upstream water level so that water may be:

1) diverted by gravity flow into the major canals which have their headgates on the Nile upstream of the barrage, and

2) pumped into those canals fed by Ministry of Irrigation pumping stations.

The upstream and downstream water levels are calculated to allow a predetermined amount of water:

1) to flow through the upstream main canal headgates,

2) to be pumped into upstream irrigation canals, and

3) for the remainder to flow downstream.

The upstream diversions and the downstream flow are determined within the context of the irrigation water budget but are subject to additional constraints. The water discharge needs of the High Dam hydroelectrical station, the navigational needs of the Nile transportation system, the needs of the drinking water pumping plants, potential downstream scouring caused by excess flow, and the structural strength of the barrages themselves must all be taken into consideration.

The data base for the regulation of the barrages consists of the measurement of upstream and downstream water levels and of downstream water velocity. The water levels are measured five times per day by the barrage guards and twice per week the water velocity is measured with a current meter by an engineer and several technicians

at a downstream site. All this data is recorded by the barrage engineer and the General Director of the Irrigation Directorate and is sent to Cairo. We were told by a General Director that this data is sent directly to the office of the First Undersecretary for Barrages and Design, Ministry of Irrigation, Cairo, and that this office is responsible for analyzing the data and determining the upstream and downstream water levels. However, another source claimed that the data and jurisdiction over those levels belonged to the First Undersecretary of the Irrigation Sector.

The only person who is able to initiate a change in the upstream or downstream barrage levels is either the office of the First Undersecretary of the Irrigation Sector or the office of the First Undersecretary for Barrages and Design. However, in an emergency situation, the General Director, with the approval of the Undersecretary of Irrigation of his Directorate, may make the necessary water level adjustments in response to the situation but he is required to report this to Cairo immediately. The barrage engineer is responsible for ensuring that the ordered upstream and downstream water levels are maintained. He regulates these levels with gates in the barrage which are raised or lowered by guards under the supervision of a head guard.

Traditionally, in Egypt, the slope of the bed of the major canals is 6 cm per km, while the average slope of the land is 10 cm per km. Therefore the major canals raise the level of the water 4 cm per km with respect to the level of the land. This allows the water to be distributed throughout the rest of the water delivery system by free flow with a minimum expenditure of energy.

The quantity of water that is diverted or pumped from the Nile into each major canal is also supposed to be based upon the water budget. On a daily basis the flow should be the summation of the daily irrigation water budgets for each distribution system that the major canal feeds and any additional water requirements such as supplying drinking water for towns and villages along the water delivery system.

The quantity of water flowing into the major canals is measured not by volume, but by the water level in the canal downstream of the headgate or pumping station. This flow can be altered not only by altering the upstream barrage water level but also by:

1) raising or lowering the headgates of the canal, or

2) increasing or decreasing the number of pumps operating in the pumping station.

Taking into consideration the amount of flow suggested by the combined water budget, the General Director or Inspector, within whose Directorate or Inspectorate lies the major canal headgate or pumping station, calculates what the upstream and downstream water levels should be. This is accomplished in consultation with those additional Inspectorates or Directorates served by the canal. He then instructs the district engineer responsible for the headgate to have his guards implement and maintain the new water levels by making the appropriate gate adjustments. In the case of pumping stations, the General Director will direct the pumping station engineer to implement and maintain the new water levels.

In order to ascertain that these levels are properly maintained, the upstream and downstream water levels at the headgates, pumping stations, regulators, and escapes on the major canals are measured five

times per day by the guards. This information is given to the engineer in whose district the structure is located and is recorded in his office. The district engineer is responsible for insuring that the reported water levels correspond with the levels requested. If they do not, he is supposed to order the appropriate adjustments and report the data and any discrepancy to his General Director or Inspector. These offices also record and anlayze this data to insure that the desired flow is being carried in the major canals. It should be noted that no mention was made by any of the engineers we talked to regarding coordinating any change in the major canal flow with the office of the First Undersecretary of the Irrigation Sector. We assume that this was simply an oversight on their part when they explained how the system was supposed to be operated.

As previously stated, each Irrigation district is allocated a certain portion of the flow of the major canal which serves it. If the district is not served directly by the major canal but by a branch of the major canal then that district's portion is diverted from the major canal into the branch. In turn, if the major canal serves several Irrigation Directorates, then each Directorate is allocated that part of the flow which is equal to the sum of the allocations of the districts within it. Every district engineer is responsible for insuring that his district uses only its budgeted quantity just as his superiors, the Inspector and General Director, are in turn responsible for the Inspectorate and Directorate allocations. In order to determine whether or not he is exceeding his allocation, the district engineer relies on data collected by the guards at the regulators in the major canal or its branch. The district's allocation of water in the major canals and its

branch is distributed throughout the district by minor canals on a rotation system.

If a district engineer needs the water allocation to his district increased he must ask his Inspector or General Director to arrange such an increase. Both the Inspector and General Director have several means of increasing a district water allocation. They may reallocate the water within the Inspectorate or within all the districts of the Directorate. This could be managed by any or all of the following three ways:

1) allowing the district engineer to increase the opening of the headgates of the minor canals in his district so they may draw more water from the major canal or its branch;

2) allowing the district engineer to adjust the regulators so as to increase the water level in that part of the major canal or its branch which feeds the headgates of his minor canals, thus increasing the water level in the minor canals and therefore the flow;

3) allowing the district engineer to extend the period of time that the headgates of his minor canals are opened.

If the major canal passes through more than one Directorate then the General Director has the option of sounding out the downstream General Director for any spare water that might be reallocated to his Directorate. On the other hand, the decision might simply be made to increase the total flow of the major canal with the additional quantity of water being allocated to the district engineer who requested it.

The day to day control of the major canal regulators and the headgates of the minor canals are in the hands of the irrigation guards. They are responsible for manually opening and closing the gates at the

regulators, headgates, and escapes so that prescribed upstream or downstream water levels are maintained. The base pay for a guard is L.E. 18 per month, with the exceptional head guard receiving L.E. 35 per month. On all regulators the water level is supposed to be monitored throughout the 24 hour day. The headgates of the minor canals are supposed to be monitored throughout the day and in many cases a different water level is prescribed for day and night.

Working Jurisdictions and Policy Implementation

It is difficult for either the office of the First Undersecretary of the Irrigation Sector or the office of the First Undersecretary of Barrages and Design to correctly assess all the factors involved which determine the upstream and downstream water levels of the barrages. The authors on one occasion observed a situation where the upstream barrage water level was lowered according to Cairo's instructions. Late that evening it was discovered that the intake pumps at the local drinking water station would not operate with the water level so low. The General Director of the Directorate immediately ordered the upstream level raised. Several days later the authors were told that this situation had occurred in years past. We checked the records of the barrage and discovered that the upstream water level figures in the records did not indicate that this problem had occurred in the past, but did indicate that the barrage water levels were always as Cairo had ordered. Puzzled by the contradiction, we spoke with several engineers and were informed that in the past Cairo had not been informed of this problem, and that the records had been incorrectly written. Therefore Cairo continued

to make the same false assumptions as to how much the upstream water level could be lowered. When we asked why the problem had not been reported in the past, one engineer replied that "these things take much straightening out."

This incident would lead us to believe that certain errors have been built into the water budget as a result of incorrect data. It also suggests that discrepancies may exist between the actual downstream flow of the river and what the water budget states this flow should be.

When water shortages occur in a Directorate, the General Director or his Undersecretary may find it necessary to ask Cairo for permission to raise the upstream barrage water level. If permission is denied initially, we were told that one or both of them often ask the Mohafaz (Governor) to intercede with the Ministry of Irrigation in Cairo and often his requests are granted. This is the first of many instances we were told about in which the ability to effectively influence the control of water lies outside the sphere of the Ministry of Irrigation.

Significant difficulties have also been encountered in trying to regulate the daily flow of the major canals to correspond with the water budget of the Irrigation districts and the other water users they serve. Experience has shown all irrigation engineers that the difference between crop water needs and the quantity of water needed to deliver water to the crops is considerable.

We were told that the inefficiencies of the irrigation and agricultural systems require that whenever possible the major canals must be regulated to carry a considerably greater water load than the projected crop needs. However, some major canals such as the Asfun and Kalabia,

major East and West bank canals fed by the Esna barrage, experience such severe weed problems during the months of April through August that their flow is often cut to almost half of the water budget of the areas they serve. For example, several engineers told us that the flow of the Kalabia canal drops at times from 4.6 million m^3/day to 2.9 million m^3/day during these periods. In addition, major canals fed by pumping stations experience a further problem of water level fluctuations due to mechanical and power failures, and to the fluctuations of the level of the Nile which can affect their pumping capacity.

It was explained to us that these problems were understood by Cairo and that therefore the major concern in the past was that each Directorate stayed within the limits of its annual water budget. We were told that this was usually accomplished, but one engineer said that there have been occasions when the situation demanded that "we arrange these things among ourselves." There are indications that sometime in 1980, if not already, additional emphasis is going to be placed on trying to regulate the major canals on a daily and monthly basis according to their water budget.

The daily water flow in the major canals is actually determined by a consensus of opinion based on actual needs and experience. In the case of the major canals which serve a large part of a Directorate, if not several, the General Director in whose Directorate the headgate lies and all other General Directors whose distribution systems receive water from this canal confer regularly to determine the optimum flow for all concerned. If a district engineer feels that his district needs more water he tells his General Director who in turn telephones the General Director who has jurisdiction over the headgate and requests

an increase in flow. The system is informal and flexible and we were led to believe by some engineers that it is only when the upstream barrage level must be raised to provide the requested increase flow that Cairo is consulted. Apparently, in the case of the small canals serving only a few district distribution systems, these districts' engineers decide among themselves what the required flow should be in the major canal. As these smaller canals are usually fed by pumping stations, they simply telephone the engineer of the pumping station when they wanted the flow altered.

We were told that there are problems in properly allocating the flow of a major canal between the irrigation districts it serves. The water allocation for each district is calculated in terms of a change in the water level of the major canal as the district's allocation is diverted from that canal. This change is measured by comparing the water level of the major canal as it enters the district with its level as it leaves the district. The difference between these two measurements represents the quantity of water diverted to the district. These calculations are determined in the offices of the district's Inspector or General Director, who prescribes the water level that must be maintained in the major canal as it leaves the district. Each district engineer can utilize as much water as he wishes so long as the water level of the major canal as it leaves his district does not fall below the prescribed level. However, these calculations presume a particular velocity of flow in the major canal. And the velocity of the flow is rarely if at all measured. As the velocity of flow varies from the assumed velocity, so does the quantity of water diverted to each district. Each district's actual allocation can vary hourly and so proper allocation can only be approximated.

The difficulty of properly allocating the flow in a major canal is increased by the wide variance reported in the quality of the job performed by the irrigation guards. One of the authors accompanied a

with the head guard, the General Director ordered that the flow be increased by a certain volume. The author remarked to the General Director that he had not specified what the new downstream water level should be. The General Director replied that this particular guard had demonstrated over the past 20 years that he could regulate the volume of flow more accurately by eye than by simple staff guage. The authors encountered similar situations including one where some guards entirely reregulated the upstream and downstream water levels at a major branch canal regulator because of sudden surges in the canal flow. According to the General Director we were accompanying at the time, the guards' initiative and their actions were excellent, but he and many others felt that guards like these are the exception.

It was reported to us that some guards do not adjust their regulators periodically during the day, and especially at night, to maintain the ordered water levels. In turn, to cover this up, we were told that the guards have been known to falsify data. This makes a difficult situation a dangerous one because of the potential for flooding. The district engineer depends on this data collected, and on the implementation of his orders to effect the proper distribution of the flow both in the major and minor canals.

Yet even when the job the guards do is of the highest quality, we observed that the potential expertise of the guards can never be fully realized. Data can often not be reported to the engineer on a regular or timely basis because of the poor communication system.

The analyses of data can only be as accurate as the data itself, and the engineer is handicapped by trying to analyze a dynamic system with data which is relatively old and therefore may not apply to the

present situation. In practice, if the canal is not carrying its maximum load and the district engineer requests that his allocation be increased, the additional water is usually obtained by increasing the flow of the major canal. We were told that normally any attempt to balance an increase in the water requirements of one district with a decrease in another occurs only in situations where the canal cannot meet the additional demands placed on it. Moreover, in most areas of Middle and Upper Egypt we were left with the impression that balancing or juggling of allocations was simply impossible. Because of local farmer pressure the district engineer told us that he tries to maintain the highest possible allocation. In addition, he often feels that he does not have the ability to partially close the headgates of his minor canals to reduce the flow and therefore save water for the use of a district downstream when needed, because of pressure from the farmers in his district. Nor can he always depend on the necessary changes in the regulator heights to be made on a timely basis. Several engineers claimed that the flow in both the Asfun and Kalabia canals, in particular, fluctuated wildly.

The problems of efficiently controlling the allocation of the flow of the major canals creates three problems:

1) The overall flexibility of the water delivery system is seriously decreased.

2) During periods of water shortage in a major canal the shortage is not equally shared by all areas served by the major canal. Often those areas near the head may have excess water, further aggravating the downstream shortage.

3) The actual individual water allocations of the separate districts increasingly becomes a function of the flow in the major canal and not the regulation of the headgates of the minor canals which distribute the water throughout the district.

For example, one General Director we met deliberately forced water conservation measures on his entire Directorate by lowering the level of the main major canal by 50 cm. While acknowledging that this method created additional problems, he felt that this was the only way to solve the water overuse problems given the inability to effectively regulate the minor canals by their headgates. It should be pointed out here that his concern was with trying to cope with the drainage problem and not water conservation per se.

The lack of flexibility in the allocations of the flow of the major canals did not allow this General Director to provide specific solutions to the specific drainage problems of the area served by each minor canal. We would suggest that this very same lack of flexibility initially contributed to the drainage problems that some of these areas are facing. In short, the net impact of being unable to effectively control the allocation of the flow in a major canal is that the potential agricultural yield will not be realized.

C. Minor Canals

Description of Jurisdictions and Governing Policies

The minor canals are those canals under rotation which are fed by major canals, the branches of major canals, or floating and permanent pumping stations. These canals distribute water to the field meskas which carry water to the farmer. The minor canals vary in length from several kilometers to 40 km in extreme cases such as Terra Gebel which runs from just upstream of the Nag Hamadi Barrage along the eastern fringe of the Nile Valley to a point just across the river from Girga. They range from 2 to 4 meters wide and are primarily below field level. In Middle and Upper Egypt, drains and tailgates on the tail of the minor canals are the exception rather than the rule. These canals are operated on a rotation system: 5 days on, 10 days off, or 7 days on, 7 days off, varying with the seasons and crops.

The demand for water in the minor canals varies greatly, being highest in the daylight and during the beginning and end of the on rotation period. At night the demand decreases as many farmers stop irrigating, especially during the winter. The situation of fluctuating demand is aggravated by a lack of rotation on the minor canal by the field meska it serves, i.e., when the on period of rotation begins all the field meskas served by a given minor canal try to draw off water at the same time instead of taking turns in order to maintain a sufficient head of water.

The minor canals are presumed to be operated on a water budget system where crop distribution and individual crop water requirements are determined by the Ministry of Agriculture's local agricultural

engineers. This information is then used by the district engineer to calculate the water budget for the minor canals and for his district as a whole.

When the minor canals were built, the expected water needs of the farms served by these canals were determined and then the appropriate dimensions of the canals and the size of their head intake gates were selected. The system was designed under the assumption that a constant head would be maintained on the minor canal and in turn, that only a certain number of farmers would be irrigating on a particular day. As an example, if the on rotation period is 7 days, then 1/7 of the farm area should be irrigated in each day.

Both Egyptian and American engineers have told us that when the system was built, great allowances were made and often the system would have actually supported the irrigation of 1/3 of the total farming area on the same day. However, it is important to note that an irrigation day was considered to be a 24-hour cycle, rather than 12 hours of irrigation followed by 12 hours of no irrigation.

The guards are responsible for reporting the water levels at the head, tail, and at any other regulatory structures along the minor canals from 2 to 5 times daily. In addition, they are responsible for reporting illegal weirs or dams in the minor canals, illegal regulation of the head and tail gates, and any disputes that arise between the farmers over water.

The district engineer is responsible for recording all data collected by his guards. He is supposed to analyze this data to determine if the correct volume of water is flowing into each meska, if the

tail is receiving too little or too much water, and if a danger of flooding exists. In addition, he is responsible for insuring that disputes between farmers are settled so as not to disrupt the general water supply and for investigating cases where the minor canals are illegally regulated.

The district engineer is empowered to initiate the following actions concerning the regulation of the minor canals:

1) order both headgates and tailgates to be opened or closed at his discretion;

2) order any regulators on the minor canal to be adjusted at his discretion;

3) increase the water supply to one minor canal by decreasing the supply to another;

4) grant a particular farmer or group of farmers an extra rotation period if he can do so without exceeding his water budget;

5) appeal to his Inspector or General Director for permission to increase his allocated water supply by increasing the water level of a major canal;

6) hire and fire his guards;

7) transfer his guards from one control point to another.

Working Jurisdictions and Policy Implementation

The water budget for the minor canal is supposedly determined on the basis of theoretical crop mixes according to the Master Agricultural Production Plan for that area. The actual crop mixes rarely comply with the Production Plan and therefore the actual water needs vary from

those projected in the water budget. No quantifiable means exist to determine exactly how much water is actually diverted from the major canals or their branches into the minor canals on a daily basis. Nor can these minor canals be completely regulated, and therefore the water budget becomes meaningless.

In most areas of Middle and Upper Egypt during the winter season, there are few water shortage problems in the delivery system. Even so, we observed farmers irrigating at night. This surprised us because it contradicted what many engineers had told us. We questioned farmers and found that in particular, those located on the latter half of a minor canal would irrigate at night when necessary. They said that normally during the summer it is always necessary and made two claims of particular interest.

First, that there was considerable feuding and as a result, during a feud, night irrigation stopped due to the danger of being mistaken and possibly shot. We observed a farmer with a handgun in a holster belted to his waist. He told us that he wore a gun because of "some small problems." When feuds break out, the actual irrigation day becomes only 12 hours long with little irrigation occurring at night. Consequently, a system which could potentially supply 1/3 of the total crop needs during that entire rotation in a 24 hour irrigation day can only supply 1/6 of the total crop needs in the actual 12 hour irrigation day. Water shortages therefore occur both in the minor canals and field meskas, particularly near the tails, as farmer demand exceeds the design capacity.

The second claim was that when shortages occur during the summer, they are not shared equally. The farmers at the head of the minor canals

still have as much water as they want and tend to waste it, thereby aggravating the shortage for those farmers toward the tail.

In some areas it was reported to us that the district engineers are unable to maintain continuous control of the regulation of the minor canals. Part of the problem is the scope of the district engineer's job. The extreme size of the irrigation districts--25,000 to 50,000 feddans--the time consuming administrative duties, and the poor communications system make it difficult for the district engineer to maintain an effective presence in the field. In addition, we found that some district engineers were not interested in going out into the field for a variety of reasons ranging from the physical discomfort of traveling in the heat and dust, the necessity of walking to some areas, and perhaps a sense that such a close relationship with the farmers and agricultural life was demeaning. Some engineers expressed a real lack of interest in their work and conversations with many of them revealed misconceptions and fears about their jobs because their training as engineers did not prepare them for the primarily management orientation of their jobs. In one area we visited, the farmers claimed that they had not seen a district engineer in ten years. A few district engineers also consider the small farmers to be their adversaries and have little appreciation of their skills.

One engineer reported that his life had been threatened and that he was shot at on one occasion by a group of farmers. District engineers seem consciously to be trying to do th best they can with the difficult situation. There are district engineers who seem capable of managing their districts with exceptional skill. They tend to understand

and emphasize the importance of their presence in the field, and in general they come from farming backgrounds and/or have been the engineer of a particular district for eight years or longer.

Because it is so difficult for the district engineer to maintain an effective presence in the field, the opportunities for the illegal regulation of the water management system increase. We are told that both the guards and the farmers are involved in this illegal regulation. It is rarely reported to the district engineer, either because the guard is responsible for the illegal regulation in collusion with the farmers who are regulating the system illegally, because the guard is afraid of the farmers, or because the guard is away working on another minor canal. Illegal inlet pipes which take additional water from the minor canals are never reported as they are accepted as a necessity by all concerned. Another difficulty reported to us is that the data is sometimes either not collected or is falsified by the guards to cover up the following:

1) illegal regulation of the gates;

2) lack of regulation due to apathy or physical difficulty in regulating the headgates, tailgates, and regulator gates;

3) their inability or unwillingness to travel to the regulatory structures because of distance, farmer hostility, or lack of transportation.

The farmers will report illegal regulations of water shortages when it affects them directly. No data of this kind is completely accurate, however, as all the people involved are interested parties with something to be gained by manipulation of the data.

The district engineer, in fact, does try to analyze the data to insure that the water levels he wants in the various minor canals are maintained or at least approximated. Many told us that they recognize the inaccuracy of the data and therefore were careful not to place too much trust in it. Often they end making decisions based on personal estimates or on intuition rather than on hard facts. On those occasions when we had a chance to follow up on their intuitions they proved most often to be correct.

Farmers and engineers have reported that some guards can and do try to seize control of the minor canal for their own gains. Many groups of farmers, especially the tenant farmers, are powerless against the guards. They have neither the political power nor the influence necessary to threaten him, and the larger farmers will generally protect the guard if he represents their interests. In exchange for money, the guard may ignore weirs built in the canals to raise the upstream water level so farmers can irrigate by free flow. He can manipulate regulators on the minor canal in favor of the upstream or downstream farmers. Canals that have both low and high spots are potentially exploitable by the guard because the different water needs of these farmers necessarily breaks them into two conflicting groups. By altering the flow he can either supply water to the high farmers while flooding the low ones, or provide adequate water for the low farmers causing the high farmers to have to lift their water and those at the tail to have little or no water.

Many farmers also attempt to control the guard and therefore the minor canal. If the guard is a family relative then the obligations one has to one's family are emphasized by the farmer. If the farmer or

a member of his extended family is a local leader or involved in the politics of the Markaz (District) or Mohafza (Governorate) then threats are made to create problems for the guard, causing him to be harassed or transferred if he does not comply with the farmer's wishes. If a farmer or a member of his extended family works for the Ministry of Irrigation or Agriculture or is the local police representative, the same situation occurs. The guard and his family may be threatened or bribed as a means to gain or maintain farmer control of the water supply. It should be noted that farmers not only attempt to influence the guards but also all levels of the Ministry of Irrigation and Ministry of Agriculture. We observed a farmer apply to his nephew, who is an employee of the General Director of Agriculture and also owns some of the land that his uncle farms, to arrange with the Ministry of Irrigation for an extra rotation.

The district engineer can be subject to the control of those people with political power and influence. Time and again we heard from certain farmers about their difficulty in obtaining extra rotations when they had received an inadequate supply of water on the previous on rotation, or when agricultural or pumping problems had prevented them from taking advantage of the previous rotation. When we asked if all of them had this problem they replied affirmatively, but added that the larger and more influential farmers could get water whenever they wanted it. We asked many engineers about this and the majority told us that when the Mohafaz (Governor), the appointed Director or the Chairman of the Maglis al Markazi (District Council), the Leader of the Maglis al Mahali (Village Council), or the 'Umda (Mayor) calls on them to request an extra rotation on behalf of a farmer, they cannot

refuse. Furthermore, we have been present when large (80-100 feddans) farmers have taken their requests directly to the Inspector or General Director who appeared to automatically grant their requests and order the district engineer to carry them out. It would therefore appear to us that the district engineer, with regard to the management of his district, is subject to those people with political power and influence. This also suggests that effectively, there are different water policies for different classes of farmers. Both the powerful and the poor farmers attested to this inequality.

Illegal turnouts aggravate the overall problem of controlling the allocation of the canal flow and often result in the wasteful use of the water in the delivery system. Yet very few of the engineers we met considered this a serious problem. To our questions about illegal turnouts they often replied, "perhaps they are necessary." They would point out that these turnouts are a simple solution to problems with the delivery system, helping to alleviate the problems of overburdened minor canals and the excessively long ditches which are needed in some areas to bring the water from the minor canals to the farmers' fields.

We were told that some of what appear to be illegal turnouts are actually legal, having been approved by the local Ministry of Irrigation officials. Several engineers told us, however, that it would be extremely difficult to distinguish the legal turnouts from the illegal ones. We felt that they were implying that accurate records of the authorized turnouts were not easily obtained.

We observed what appeared to be quite a few illegal turnouts including a considerable number of pumps and permanent pumping

platforms, in one instance counting 5 platforms along a one-kilometer stretch of a major canal. Some of the illegal turnouts we have seen are ingenious, involving aquaducts spanning drains, the reversal of the gradient of tails of minor canals, and pipes buried 3 meters under the canal banks. We saw areas where the farmer's only effective source of water was an illegal turnout. On the other hand, we also saw situations where the turnout had been installed not because of lack of water, but because it allowed the farmer to irrigate without having to lift the water to his field.

Perhaps most importantly, many of the illegal turnouts we saw were not regulated and would continue to flow after the farmers had stopped irrigating. We believe that the long term effects of these outlets are detrimental to the water delivery system. They waste water when not in use, and can tempt the farmer to overwater, increasing water wastage and drainage problems. They also create a factor of uncertainty in the determination of canal flow allocations, because they represent unaccountable water losses from the canals and unaccountable water gains to the districts in which they lie.

D. Water Delivery System Maintenance

The physical state of the water delivery system affects the formulation and implementation of a regulatory policy. A description of the water delivery system would be incomplete without a description of the jurisdictions and policies governing the maintenance of the major and minor canals.

In Middle and Upper Egypt there is a general consensus that the major maintenance problems are:

1) the infestation of weeds in the canals and drains;

2) the deterioration of canal banks and regulatory structures;

3) the deposition of silt in the canals.

Weeds

Throughout the water delivery system of Middle and Upper Egypt, a wide variety of weeks growing in the canals are reducing the velocity of flow. Some varieties grow under the surface of the water while others break the surface and grow up to a height of approximately two meters.

The engineers we spoke with believed that the infestation of weeds occurred because the rays of the sun could penetrate further into the water with the decreased silt content that followed the construction of Sadd el Aali (the High Dam). The engineers are as yet unable to explain why the amount of weed growth varies significantly along the same canal. Many believe that the infestation increases each year and

that some varieties are developing strains resistant to magnicide, the primary herbicide used to combat these weeds. All engineers agreed that it was impossible to cut or pull these weeds by hand and that heavy machinery such as draglines and backhoes are a necessity in the cleaning of canals. One engineer suggested that to clear the most severely weed-infested major canals, a backhoe is needed for every 15 km section. Other engineers were of the opinion that the only way to reduce or eliminate the weed infestation was by deepening the beds of all the major canals to allow a constant water depth of 4 meters. They claimed that experiments by the Research Institute for Weed Control and Maintenance of Waterways had demonstrated the successfulness of this approach.

The authors observed significant weed growth along the banks of the Nile and in the canals. Farmers living in these places verified that this growth had appeared since the annual floods stopped.

During winter closure, the authors observed that the entire bed of the Asfun and Kalabia canals were covered with underwater weed growth. While most weed growth occurs in late March, April, and May, we observed in late February that a passageway had to be cut through the weeds in several minor canals to increase their flow. Even then, the flow was greatly restricted. We also observed that there were few weeds in the Ibrahimiya canal which, we were told, operates with a normal water depth of 3.8 to 4.0 meters.

Banks and Regulatory Structures Deterioration

The deterioration of canal banks and regulating structures has led to severe water losses, flooding, and the reduction of the carrying

capacity of many canals. While these problems occur throughout Middle and Upper Egypt they are perhaps most serious in those areas where the delivery system was constructed while the High Dam was being built. Several engineers told us that a large number of these systems were erected temporarily and were to have been rebuilt or replaced.

The opinion of engineers regarding the existence of scouring in some of the canals varied, but generally the higher officials felt that there was a significant scouring problem. Many engineers told us that some of the regulatory structures in their districts needed to be replaced and all engineers with wooden gates in their districts complained of leakage and their desire to replace them with metal gates. These wooden gates are ill fitting, often rotten, wooden beams which are dropped horizontally one on top of the other into the vertical slots of a brick masonry structure on either side of the intake opening.

Throughout our trip we were constantly aware of the large number of heavy trucks and construction equipment traveling on the roads which lie along the canals. Several times, low lying areas near a canal would be flooded with no obvious source of water in sight. We believe we were seeing the effects of horizontal seepage from the deteriorated canal banks.

During winter closure we observed that along the Ibrahimiya canal degradation had begun approximately 20 to 30 meters downstream of each of the spurs built out into the canal to control scouring. Again, during closure, we saw severe degradation in the Nag Hamadi East and the Kalabia canals, particularly in the curves of these canals.

Twice we saw an approximately 30-meter stretch of a major canal bank which appeared to have fallen away leaving a two meter deep indentation in the bank. One of the places this occurred was just downstream from a bridge crossing the canal.

Twice we observed major canal banks which had been cut away and the soil from these banks partially blocked the entrance to a branch canal farther downstream. Often during winter closure, on the major canals, we observed severe deterioration at the headgate structures for the minor canals. The pitching had been washed away, some of the headgate structures had been seriously undermined, and often the canal bank on the upstream side of these structures had suffered considerable erosion.

The worst cases we saw of bank deterioration occurred on the minor canals as they passed near or through villages. As the banks are worn down, the water of the minor canal will often spread out to become a shallow pool in these spots and often severe flooding of the village results. We have observed animals and humans crossing these canals when they are dry instead of using a bridge. These canals are frequently used for bathing and as a water source for both animals and the villagers. This activity breaks down the banks and reduces the carrying capacity of the canals.

We observed countless wooden gates and found that often sections of minor canals were filled with water when their headgates were closed, because of leakage. Last December, when the Ibrahimiya canal was 50 to 60 cm below its summer level, the leakage of one of these gates was measured with a flow meter. The flow through this closed gate was found to be 21 percent of the flow into the canal when the gate was fully open. The authors and a Ministry of Irrigation official examined the gate and compared it with many others throughout that Directorate. We concluded that this gate was in far better condition than over 50 percent of the

others we inspected. The Ministry of Irrigation official estimated that some of the other gates were leaking at 40 to 50 percent of their flow when opened. This offical also remarked that the present wooden gates require three people and much effort to adjust them. He suggested that the metal gates might be adjusted more frequently because one man could do the job with ease. Furthermore, they could be locked more easily to prevent tampering but if left unlocked they could be illegally regulated more easily also.

Siltation

Siltation of the canals decreases their carrying capacity and if severe can lead to a situation where the bed of the canal will begin to develop reverse gradient. We were told that the amount of silt removed from the canals today is equal to the amount removed before the High Dam was built. In canals infested with weeds the accumulation of silt is even greater. Several engineers told us that the most severe problems occur in the smaller canals where the silt accumulation can be greater than 25 cm per year.

With both the shortage and rising cost of laborers in Middle and Upper Egypt, we were told that the Ministry of Irrigation is often unable to find enough men to clean the canals. Moreover, they claim that although men are much less efficient than steam shovels or backhoes, they have few machines of this type and consequently few canals can be properly cleaned. To complicate this situation further, the period of winter closure, when all the canals are emptied of water for maintenance, has been shortened. We were told that winter closure was shortened at the instigation of the Ministry of Agriculture in the hope that the wheat crop yield would improve.

It was thought that this would decrease the stress on the crop which occurs when it must go for a long period without water.

We observed that as one proceeds upstream the waters of the Nile become increasingly clear. In Cairo last November, we had difficulty seeing an object submerged inches below the surface of the water. In Aswan late in February, we could see an object submerged almost three times as deep. We infer from this that the silt accumulating in the canals must be eroded from the banks of the Nile, from the canals themselves, or from the fields due to improper irrigation methods or the wind. We cannot judge if the silt is deposited evenly in the canals, but we did observe severe siltation in the smaller canals. It was difficult to tell how much silt had accumulated in the larger canals. We observed only one major canal being cleaned during winter closure, and this was being accomplished by hand. After the bottom had been broken up with a fas (hoe) the men would scoop the mud up by hand and fling it up the side of the canal. Often half of the mud would slide back down into the bed of the canal. The other half would cling precariously to the side of the canal. We suspect that during the course of the next year much of that silt will be washed off the sides of the canal and settle back into the canal bed downstream.

We were told that the guards are responsible for reporting the occurrence and severity of the maintenance problems to the district engineer. In addition, on occasion, the condition of some of the major canals are monitored by Ministry of Irrigation officials as they travel on the roads which parallel these canals. Large farmers and local government officials such as the 'Umda (Mayor) and members of the Maglis al

Mahali (Village Council) are also quick to inform the district engineer or his superiors of any problems which they feel adversely affect themselves or their constituencies, e.g., flooding caused by horizontal seepage from a canal.

The district engineer is supposed to inspect and assess the problems brought to his attention. He can assign his guards to handle small problems such as unblocking tail-gates or removing obstructions placed in the canals by farmers which serve as weirs. However, larger problems must be reported to the Inspector. Because of limited funds, the Inspector is not able to authorize action on all the maintenance problems brought to his attention. Instead, in consultation with the General Director, the priority of each maintenance problem is established. The ability of the General Director and Inspector to initiate maintenance measures is effectively controlled by the Ministry of Irrigation in Cairo, which oversees the disbursement of the limited machinery, supplies, and funds necessary for the maintenance operations.

We do not know precisely how a maintenance project is implemented. We believe that most projects involving the reconstruction of regulators or headgates, or the manual cleaning of canals, are put out to bid by the office of the Inspector or General Director. Each project is supervised by a Ministry of Irrigation engineer and sometimes, where heavy equipment is needed, the General Director will arrange for the use of Ministry equipment.

Some engineers suggested that the amount of recorded data on the maintenance of the canals is less than what might be expected. Apparently, the inability to respond to these problems over the last twenty years, due

to financial limitations, had resulted in a situation where many of the Ministry of Irrigation personnel feel that any attempts on their part to improve the maintenance problems are futile. Farmers and engineers have reported that the guards will demand payment before they will report maintenance problems on minor canals.

It was also reported to us that the priority of each maintenance project is often determined not only on the basis of need but also according to political pressure or financial inducements. Many farmers told us that the minor canals of certain farmers were cleaned on a regular basis, while the majority of the minor canals are cleaned only once in five years. Other farmers said that they would have to pay money to get their canals cleaned. Several times we observed startling differences in the conditions of adjacent minor canals. We also observed several minor canals where a cleaning operation had been abandoned with only the first half of the canal cleaned.

Several times we were told that General Directors will ask the Muhafaz (Governor) to put pressure on the Ministry of Irrigation to increase the allocation of maintenance equipment and funds to their Directorates. Apparently, on occasion this method is successful. At other times, projects are funded jointly by the Ministry of Irrigation and the Muhafza (Governorate). We observed one project where a road along a canal bank was being rebuilt and the bank was being pitched at the same time, reportedly saving money for both the Directorate and the Governorate.

E. Field Meskas

Description of Jurisdictions and Governing Policies

Field meskas are ditches, fed by minor canals, which distribute water directly to the farmer. The field meskas range up to 1 km in length, and their width, a function of the water load they are supposed to carry, is usually 25 to 100 cm. The depth varies depending on the land elevation, and the field meskas can be either above or below the level of the field. However, there is presently a concerted effort to place all field meskas below the level of the land. This is thought to be a solution to the extensive drainage problems supposedly caused by crop overwatering. It is thought that if the farmer has to lift water to the field he will be less inclined to waste it. In Middle and Upper Egypt, the vast majority of field meskas do not have drains or tailgates. While these meskas were initially built by the Ministry of Irrigation, they belong communally to the farms which they serve.

When each field meska was built, the expected water needs of the farms served by that meska were determined and then the appropriate dimensions of the field meska itself and the inlet pipe size were chosen. Because these pipes are ungated, whenever the minor canal is on rotation, all field meskas theoretically should also have water in them. This meska system was designed on the assumption that a given constant head would be maintained on the minor canal. In other words, the system assumed that only a certain percentage of the total area on each field meska would be irrigated on a particular day. As an example: if the on

rotation period is 7 days then 1/7 of the farming area on each meska should be irrigated on each day.

Both Egyptian and American engineers have told us that when the system was built, great allowances were made, and that often the system would actually have supported 1/3 of the farming area on each meska being irrigated on the same day. However, it is important to note that an irrigation day was considered to be 24 hours, rather than 12 hours, as was discussed in the section on minor canals.

Some of the field meskas in Middle and Upper Egypt have been built above the field level and the inlet pipe has been replaced with a pump which supplies the entire meska. All the farmers on these meskas can then irrigate their fields by gravity flow from the meska. When these pumps are installed on a minor canal to feed an entire field meska, we assume that they are supposed to operate within the constraints governing the system, but we do not know who is responsible for insuring that this happens or whether anyone has considered the problem. Thus, the flow into each field meska is a function of two factors:

1) the head of water in the minor canal, and

2) either the size of the inlet pipe or the capacity of the pump which pumps water into the field meska.

The daily operation and maintenance of the field meskas is the collective responsibility of the farmers served by each meska. However, certain powers of review have been established to insure that the farmers accept their responsibilities. At the moment there is some confusion about whether these powers and the responsibility for exercising them belongs to the Ministry of Irrigation or Ministry of Agriculture.

In Cairo we were told that this jurisdiction over the field meskas belonged to the district engineers in the Ministry of Irrigation. In the Beni Suef and Minya Directorates the district engineers we talked with confirmed this. However, further South, more and more engineers we met claimed that this jurisdiction belonged to the agricultural extension engineers of the Ministry of Agriculture. The Ministry of Agriculture officials flatly denied this, but we were unable to resolve exactly who was responsible. No one disagreed with the nature of the responsibilities, just with who was responsible for carrying them out. In the following discussion, we have continued to assume that the district engineers of the Ministry of Irrigation are actually responsible.

The guards are responsible for inspecting the field meskas on their minor canals to insure that 1) they are all receiving water, 2) are kept clean, and 3) where they exist, that drains and tailgates are cleaned and properly regulated. They are supposed to try to settle any disputes between farmers on a field meska over access to water. If they cannot get the farmers to settle these disputes among themselves then the guard is supposed to inform the district engineer.

The district engineer is responsible for investigating the following field meska problems as they are brought to his attention:

1) incorrect water flow in the meska due to incorrect inlet size or the lack of the proper head in the minor canal;

2) insufficient water flow in the meska due to improper cleaning (the engineer only has jurisdiction over this problem when the meska serves two or more farms and one of the farmers lodges a complaint);

3) inability of the farmers on a meska to agree on a rotation system so that all have access to water;

4) the improper regulation or cleaning of the drains.

The district engineer can initiate action to increase the flow into the field meska by:

1) increasing the flow into the minor canal;

2) installing a larger inlet pipe in those cases where a long term water shortage has occurred on a particular field meska.

When field meskas or their drains are not kept clean the district engineer has the authority to order the offending farmers to clean them. If they refuse he can order his guards to clean them and seize the offending farmers' property as compensation for the required labor. Furthermore, the district engineer can enforce a specific rotation schedule on all farmers on a given field meska if they cannot come to an agreement among themselves about their access to water. However, the district engineers told us that they had no authority to force the field meskas on a minor canal to rotate.

The farmers are responsible for carrying out all maintenance of the field meskas themselves. This includes cleaning, changing the inlet pipe if so instructed by the district engineer, and keeping the tailgates clean. The guards are responsible for insuring that this is done. In case of seizure of property as compensation, the police are responsible for implementing the district engineer's order.

Working Jurisdictions and Policy Implementation

We were told that changing crop mix patterns and land reclamation have often altered the crop water requirements without a corresponding change being made in the carrying capacity of the field meskas. Consequently, the field meskas are often unable to cope with the needs of an area and water shortages occur. The problem here is similar to the problems throughout the water delivery system except for one significant difference. On the field meskas, the farmers are able to take the intiative to combat the following problems:

1) overextension of the water delivery system;

2) reduced water supply;

3) lack of proper regulation, and

4) the consequent lowered head on the minor canals.

In our opinion, the impact of the farmers' initiatives is substantial. We have observed that almost without exception the farmers have increased the size of the field meska inlet pipes and often have widened their field meskas. We have been told that consequently, field meskas at the head of minor canals can often supply more than 1/6 of their farms' crop water requirements in 12 hours of irrigation. This can lead to wastage of water and shortages in the meskas close to the tail of minor canals. The defense of the farmers at the head of minor canals who enlarge their inlet pipes and meskas is that when there is a decrease in the flow of water into the minor canal due to a general shortage in the water delivery system, an unmodified meska would not provide them with their usual share of water. Often they are correct, but the

consequence is that many meskas near the tail of the minor canal receive almost no water at times. The farmers farther downstream on the minor canal in turn must alter their meskas, which further increases the problem. We suspect that if shortages were equally shared by all, the Egyptian agricultural production would benefit. This is certainly a question well worth investigating.

We have been told by farmers that the same problems occur with the use of mechanical pumps which pump water from a minor canal to an entire meska. Farmers have begun to install bigger pumps that, in the words of one farmer, "swallow up the canal." As was mentioned earlier, we have observed other farmers' initiatives in the construction of illegal turnouts on nearby major or minor canals. These turnouts will transport water from the canals to the tail of field meskas or minor canals. We have seen cases where these turnouts are necessary but again, we suspect that their use increases the overall problems of the delivery system.

We have been told that when the guards do report information about the field meska to the district engineer, it is usually at a request of the farmers and it almost inevitably concerns a lack of water in the field meska due to insufficient flow in the minor canal. The district engineers have told us that they have little time for investigating field meska problems. Most engineers we talked to said that they avoid getting involved in disputes between farmers over access to water on a field meska. No engineer we asked had been involved in more than two disputes in the past year. They said that it is an exception when one of these disputes is really about the access to water, as it usually has its origins in other matters. Most guards and farmers we talked to confirmed this.

Most turn a blind eye to the illegal field meska inlet pipes or turnouts built by the farmers to route additional water from a nearby canal into the tail of their field meska or minor canal.

The district engineer also rarely initiates action regarding maintenance of the field meskas. No district engineer that we talked with had ever ordered a farmer's property seized as compensation for having his guards clean a meska. Perhaps once a year in his entire district, the district engineer has his employees clean a dirty section of a particular meska at the request of the rest of the farmers on that meska.

In Sohag Governorate, however, in the past the maintenance of the field meskas of entire irrigation districts was assumed by the Ministry of Irrigation. The farmers in these districts were charged a cleaning fee of LE 2 per feddan and the district engineer determined the amount and priority of the cleaning that needed to be done from data furnished by the guards and farmers. In the last year the responsibility for running this program was supposed to be shifted from the Ministry of Irrigation to the Ministry of Agriculture.

There appears to be some confusion, however, between these two Ministries in Sohag as to what the responsibilities of each are at the present. It would be interesting to investigate the effects of this program on the water use and drainage in the area.

Some of the district engineers told us that all of the problems of water shortages in the delivery system were the result of farmers' laziness in irrigation practices or in the cleaning of field meskas. The majority disagreed with this but all felt that an organized 24 hour

rotation system of all the field meskas on a minor canal would ease the water shortage problems significantly.

We observed that with regard to rotation on the field meska itself and keeping meskas clean, the farmers generally work these things out among themselves fairly well. While the field meskas are not as clean as they might be and consequently do lead to inefficiencies in the delivery system, they are certainly in much better condition than many of the major and minor canals in the delivery system.

The one exception involves any field meskas which go through or near a village. These are always open public sewers and rubbish heaps, and three times while we were in the field with a district engineer, farmers approached the district engineer and asked to have these cleaned. These requests were always immediately, and we were told properly, refused.

APPENDIX 1

PERCEPTION OF PROBLEMS: MINISTRY OF IRRIGATION PERSONNEL

Ministry of Irrigation engineers usually begin any discussion of the problems that they face or the needs that they have with a shopping list of equipment. Their inclination is to look to mechanization and higher technology for the solution to their problems. It is interesting to note that much of the equipment and the uses they envisage for it would decrease their reliance on the human factor in implementing the operational and maintenance policies of the water delivery system.

Their requests vary depending upon the nature of the local problems facing them and the extent of their exposure to higher technology products through advertisements sent by equipment manufacturers, through observation, or firsthand experience. The few engineers who had even a limited experience with these products were always the most perceptive about their limitations and applicability in Egypt. The engineers' requests ranged from spray and drip irrigation equipment to remote controlled regulator gates, and invariably included heavy equipment such as draglines, steam shovels, and weed cutting equipment.

Once we got past the requests for technology in our discussions, many of the engineers were willing to discuss what they felt were some of the underlying problems within their own organization, the water delivery system, and Egyptian agriculture in general.

Most of the problems the engineers identified within their own organization can be categorized as management problems. However, only once during our many discussions did an engineer actually classify them this way. Many engineers talked about never being certain that their orders were followed. Some talked about corruption and one in particular claimed that he thought that 50 percent of the district engineers in a Governorate he worked in were corrupt. Others talked about the amount of time they spent involved in essentially clerical duties. Some pointed out that they were not interested in nor had they chosen their jobs, and that the training they received had not prepared them for the jobs they were performing.

Two general directors and several other engineers also expressed concern about the attitudes of many of the engineers towards the farmers. They felt that some of the engineers had a social bias against the farmer and his life of manual labor. This resulted in the development of an antagonistic relationship between the two and an unwillingness on the part of the farmer to accept the advice of or to cooperate with the irrigation authorities.

The second major problem many engineers discussed was the lack of trained personnel within their organization. They claimed that at present they are understaffed by 50 percent in engineers and as a result much of their work in the field has to be abandoned. The district engineers, however, did not want more engineers, but rather a cadre of technicians and clerical staff to ease their workload and allow them to spend more time with the actual delivery system.

Two problems with the water delivery system often mentioned by the Ministry of Irrigation engineers were "water loss" and drainage

problems. "Water loss" was defined as the difference between the quantity of water which entered the delivery system from the Nile and the quantity of water which the crops actually received. Whether or not all of this difference is actually a "loss" is debatable, since a large part of the water not used in irrigation of the crops would find its way through drains and escapes back to the Nile to be diverted into another part of the delivery system further downstream. Nevertheless, whatever the term, many engineers felt that this was one of their greatest problems and that presently they were experiencing a 50 percent "water loss." The engineers blamed this problem on the farmers because of their excessive water use in irrigation and their refusal to irrigate at night. They also maintained that this exacerbated an equally serious problem, which was the lack of proper drainage in most of Middle and Upper Egypt. They generally felt that drains were the only way to rectify what they saw as the overuse of water by the farmers.

The lack of funding for equipment for maintaining the drains and canals was always mentioned. We were asked countless times to inform "the American Embassy" that draglines, steam shovels, and weed cutting machines were needed. Even the problems of weeds and silt in some of the smaller canals has been so severe that the Ministry of Irrigation engineers seem to have abandoned attempts to clean many of these canals and drains by hand. The deterioration and design of the wooden minor canal gates was also a serious concern. They felt that these gates leaked excessively and were unnecessarily difficult to regulate, resulting in the guards' reluctance to regulate them.

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Two general directors mentioned that the lack of a communication system which would allow them and their district engineers to be in touch with guards at the important regulators and minor canal gates was a serious problem which had to be solved before any accurate regulation of the delivery system could be instituted.

The engineers discussed the problems they were having with the farmers that resulted in shortfalls in the water delivery system. The engineers generally tended to place the blame on the unwillingness of the farmers to organize themselves into rotations, rather than to recognize the possibility of problems in the physical system itself. In addition, engineers complained that the water problems of the farmers in the tails of the field meskas were due to improper cleaning by the farmers along these field meskas.

There was a general consensus among the engineers that the method of irrigation presently employed by the farmer leads to excess water use and therefore taxes the water delivery system. Presently, the farmer divides his field into small basins, perhaps 2 to 3 meters wide by 4 to 5 meters long. He irrigates his field, basin by basin, until the field has been covered. Almost without exception, the Ministry of Irrigation engineers felt that this method was inefficient, resulting in far more water being applied to the field than the crops required, taxing the delivery system beyond its capacity and increasing the surface and root zone soil salinity.

Time and again, the engineers complained about what they termed the "stubborness" of the farmers. Often they were perplexed about how to solve this problem and identified it as one of the major causes of agricultural problems in Egypt. The term "stubborness" was used to

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describe the farmers' resistance to changes in farming practices proposed or implemented by Ministry of Irrigation and Agriculture engineers. The term also was used in reference to the resistance of farmers to organizing their water use and cropping patterns. Many engineers attributed this stubborness to a lack of intelligence on the part of the farmer. One engineer summed up these feelings when he said, "the farmers are not equivalent to us."

Many engineers felt that the land reform acts under President Nasser were perhaps the greatest disaster that has befallen Egyptian agriculture. They all felt that Egypt's potential for agricultural production was permanently crippled by this "so-called reform." They felt that nothing could replace the economic advantages inherent in large scale agricultural operations, and that under the present land ownership system and pricing policies, large scale agricultural operations would never be possible in Egypt. This was also a common consensus of the Ministry of Agriculture engineers we talked with.

All engineers felt that the most important problem facing Egyptian agriculture was the decrease in crop yields due to the increasing salinity of the soil which in turn they blamed on farmers' overuse of water.

APPENDIX 2

PERCEPTIONS OF PROBLEMS: FARMERS

During the course of our conversations with farmers we tried to discover what they felt their problems and needs were. A frequent complaint was the lack of order in the agricultural and water delivery systems. Each farmer had a slightly different story to tell about different aspects of the agricultural system, but invariably they were commenting about the unnecessary uncertainties that they face in what by nature is an uncertain business.

Almost all of the farmers mentioned that they never knew when rotation schedules would be changed, or when winter closure would actually begin and end. On January 31, 1980, both a farmer and a Ministry of Agriculture official reported that there was still no water in Kalabia canal 30 km from its tail, even though they thought that winter closure was supposed to have ended on January 27. On February 8, we observed that the Kalabia was less than one-third full, yet our understanding was that Ministry of Irrigation policy is to provide maximum flow in the delivery system two weeks preceeding and following winter closure. It appears that for the Kalabia canal, winter closure lasted 27 days this year.

Farmers mentioned that the budgeting of water during the year was not properly regulated and that shortages were occurring in many areas not only during the summer but also during the spring cotton planting in March and the winter crop planting in October. After October, an excess of water occurred which occasionally led to flooding.

Farmers at all points along minor canals whose water supply was provided by Ministry pumping stations, the East and West Nag Hamadi canals, and the Asfun and Kalabia canals, reported that they could never be sure from one rotation to another how much water would be diverted into their minor canals.

Farmers at the tails of minor canals maintained that from one rotation to another, they could never depend on a consistant irrigation schedule or water quantity usage by the upstream farmers. The irregularity of the total water flow into the minor canals combined with the irregularity of upstream irrigation schedules and water use result in a constantly changing situation in the tails with regard to both quantity and scheduling of irrigation.

Another problem pointed out by all concerned, farmers, Irrigation and Agricultural officials, is that inconsistencies in the supply of seed, fertilizer, and labor for growing crops, and transportation, processing, and storage facilities for harvesting crops often place the farmer in situations where he cannot match water rotation scheduling and available water quantities to his farming needs. This has led to situations where district engineers may grant as many as 50 additional rotations per year.

It was always possible to find situations where a particular field meska or the tail of a minor canal had water problems in the summer. However, as we traveled upstream towards Aswan these situations increased to the point where farmers in the middle of minor canals reported experiencing severe summer shortages. In particular, one farmer near Dishna said that the entire last half of the minor canal which feeds his field meska was without water for an entire on rotation period and

as a result he lost 1/3 of his corn crop. A Ministry of Irrigation engineer mentioned that the flow of the Kalabia canal, which is designed to carry approximately 5 million m^3/day, actually carries 4.6 million m^3/day, and drops to 2.9 million m^3/day during the summer due to severe weed infestations. This tends to verify the Dishna farmer's report.

Water quality was also an issue frequently raised by the farmers. There is a dissatisfaction in Upper Egypt with the quality of water for three reasons:

1) Farmers with access to both groundwater and water from the delivery system claim that they experience sharp declines in their crop yields when they switch from groundwater to delivery system water, and several farmers talked about the delivery system water "burning" their crops.

2) Farmers are also concerned about the weed seed content in the delivery system water. Almost all farmers mentioned this problem. Every time they irrigate they must then reweed the fields. Some weeds, such as bermuda grass, are almost impossible to eradicate once they have infested a field.

3) The final aspect of water quality is that of health. Many farmers and engineers have told us that the canal water is undrinkable. While most General Directors maintained that there was little or no bilharzia, one district engineer and some of the farmers we asked asserted that there was. In general, however, we found a great ignorance on the part of farmers as to the causes and symptoms of bilharzia.

Even when there is water in the minor canals, several farmers and a police officer we talked with claimed that access to this water was sometimes difficult, for the following reasons:

1) Those farmers dependent upon another farmer's pump sometimes found themselves without the use of the pump because the pump owner had changed his own irrigation schedule or because a delay in fixing a broken pump meant that only the pump owner could irrigate at the end of a rotation period. Often, spare parts are available only in Cairo.

2) A much more serious access problem involves the limitation of access to water as a means to force farmers to sell their land or to force tenants to give up their leases which under the current law remain in force in perpetuity, even if the owner of the land changes. We heard reports of field meskas being blocked or having their access limited in attempts to deny a farmer or group of farmers water so that they would be forced to give up their land.

3) During our entire trip we never met a farmer who did not complain about the present lack of silt that used to cover their lands after the floods. They are adamant that their crop yields have decreased since the High Dam was constructed and the annual floods stopped.

Recently, research into the use of trace elements such as zinc, boron, and manganese has revealed the importance of these elements for high crop yields, and has also revealed their presence in the silt of the Nile. Farmers suggested, and this suggestion was seconded by an Assistant General Director, that the silt removed from the canals be

made available to them free of charge instead of selling it for 25 piasters per cubic meter, which only the brick makers can afford.

The farmers, for all their mention of corruption, never seemed to be upset by it. On farmer said, "The guards? all they want is money," not in a hostile but a matter of fact tone. In the opinion of many farmers, the corruption does not stop with the guards but continues up through the ranks of the Ministry of Irrigation and of Agriculture. Yet the farmer displays little resentment over this situation.

Almost all the farmers reported that their minor canals were in need of major maintenance and in Upper Egypt they were often weed choked.

Drainage is still a localized issue. The farmers in areas already experiencing serious declines in crop yields because of high water tables and salts in the root zone view it as one of their most, if not the most, pressing problem. However, until the farmers actually see their yields decline dramatically and the ground covered with salt stains, they do not recognize it as a serious problem. Presently, farmer perception with regard to the problem of drainage seems to be after the fact.

APPENDIX 3

FARMER WILLINGNESS TO PAY FOR SYSTEM IMPROVEMENT

One of the questions we tried to answer was whether farmers were willing to pay for the maintenance and improvements in the water delivery system. A very good case can be made that presently the farmers are paying for maintenance and improvements of their water delivery system. This argument goes beyond the fact of indirect taxation of the farmer when he sells his crops at fixed prices to the agricultural cooperatives. The farmers are already paying for water delivery in the following four ways:

1) On their own initiative they are constructing aquaducts, conduits, small canals, inlet pipes, drainage systems, and pumping platforms.

2) Whenever the construction of these structures is considered illegal, the farmers often have to pay bribes in order not to be reported or fined.

3) The farmers pay bribes to guards, or obtain influence with the district engineer or local political powers, in order to have their minor canals cleaned and maintained.

4) The farmers are having to pay the men hired to perform the maintenance work so that the job is done properly and so their crops are not damaged in the process.

From the farmer's perspective, he is already paying for the maintenance and improvement of the delivery system and his costs are significant.

We were unable to form a definitive answer to the question of whether the farmers would pay for an organized program of improvement and maintenance of the water delivery system or under what circumstances this would occur. Some farmers claimed that they would distrust any governmental program. We would suggest, however, that if three critical conditions were met, such a program might prove successful:

1) There must be a recognized, immediate and personal need for the improvements;

2) The improvements must be directed and supervised by the farmers;

3) The regulation of any system improvments must be in the hands of the farmers or they must be assured that it will be regulated properly.

We saw many farmer-initiated and farmer-implemented improvement projects which were operating successfully. A few examples are discussed below.

A 50 meter meska and aquaduct were built across a drain to carry water from an inlet pipe near the head of one minor canal to the tail of another. This system was constructed by a group of tenant farmers who were from the tail of the second minor canal which was frequently short of water. The cost of the total project was about LE 100 plus a rental fee of LE 20 per year to the farmer whose field the newly built meska runs through. We were impressed with both the design and workmanship of this project.

In a second example, private pumps at the head of field meskas were used to raise the water from the lower minor canal to a field meska

which lay above the level of the land, permitting free flow irrigation of the farmers' land without additional pumping or lifting. Often these pumps are owned by several farmers who sell the water to others.

A third example we saw was what may have been an illegal turnout on a major canal. This turnout was tunneled 8 feet under the bank of the canal, crossed a small drain, and continued on to a small field meska. Again, we were impressed with the ingenuity and design of this turnout.

Another example is a project involving the drainage of the old Sohagiyya canal near Johina in the Governorate of Sohag. This project required cooperation between the appointed director of the Maglis al Markazi (District Council), the elected members of the council, the Ministry of Irrigation, and most importantly, a group of farmers along the banks of the old Sohagiyya canal. The project required draining the canal and establishing a fish farm. Draining the canal lowered the surrounding high water table and eased the area's drainage problems, allowing land which had been flooded to be reclaimed. While the exact details of the financing of this project were not made available to us, we understood that it had been financed by 100 farmers who in return for a LE 50 subscription obtained the first right to rent approximately 3 feddans each of the reclaimed land at a nominal fee. We believe that the USAID-funded joint Indiana University/Cairo University training program in local government administration was indirectly involved in this project. We suggest that an in-depth study of the initiation and implementation of this project might lead to the development of an

effective methodology for the initiation and implementation of additional projects of this sort.

The final example is the only one we are familiar with that involved farmers of different socioeconomic status. A wealthy farmer received permission to reclaim desert land on the periphery of the Nile Valley adjacent to his village, with the understanding that he would pay rent of LE 5 per feddan per year for any reclaimed land. He enlisted the help of 13 farmers from his village whose land holdings averaged 1/2 to 1 feddan each. The wealthy farmer agreed to put up the capital for the reclamation if the farmers would provide the labor. They began by digging a 45-meter well and installing a 35-hp pump. In the first year they reclaimed 8 feddans, the second year 16 feddans, and by the third year when we visited the project, 30 feddans had been successfully reclaimed at an average cost of LE 500 per feddan. These farmers received no input or advice from agricultural or irrigation engineers, but were experimenting themselves to determine which crops grew best in the sandy soil.

In conclusion, we would like to emphasize the farmers' distrust when the question of paying for governmental system improvements is raised. The farmers do, however, demonstrate a willingness to act when they can see that a direct economic benefit will result. As the tenant farmers in the first example told us as we were leaving, "If you see our district engineer please tell him that all we want is for him to pay the annual LE 20 rental fee for our meska."

APPENDIX 4

FARMER OPERATED PUMPS

Trying to gather accurate data about farmer operation irrigation pumps is difficult for two reasons. First, the Maglis al Markazi (District Council) has established an annual tax of LE 2 per horsepower per pump. Second the Ministry of Irrigation has established fixed rates for the selling of pumped water. Most farmers attempt to avoid at least part of the tax money and none obey the fixed prices. The farmers actually pay approximately LE 3 per feddan for irrigation, which is almost twice the usual official price. The farmers are suspicious of questions about their pumps and twice, angry pump owners thought we were tax collection informants. Because our information is incomplete (see Pump Data table at end of this Appendix), it is not warranted that we draw any firm conclusions from the data alone.

However, during the course of our conversations with Irrigation and Agricultural engineers and farmers we were able to establish that during the last five years there has been a great increase in the number of farmers utilizing irrigation pumps. Ministry of Agriculture officials in Qena suggested that almost 100 percent of the farmers in their governorate used pumps, but that only 5 percent owned them and sold water to the remainder. Certainly, the conversations we had with farmers and the number of new pumping platforms for portable pumps we saw would support the contention that there has been a great increase

in the number of farmers using pumps. However, we felt that the 100 percent figure was exaggerated and that the 5 percent figure was quite low. We would estimate that perhaps as many as 20 percent of the farmers own pumps and that even small farmers with as few as 3 feddans are buying pumps.

Farmers are using pumps in increasing numbers for two reasons. First, in Upper Egypt there is a labor shortage with farm labor receiving on the average LE 1.50 per day. This labor shortage is a result of increased immigration to other Arab states for higher wages, an increased interest of the farmer in sending his children to school, and the custom of generally limiting field work to men in Upper Egypt, contrary to practices in the Delta.

The second reason for an increase in the use of pumps by farmers is that the time during which they have access to water is generally limited. With a mechanical pump they can maximize their use of this water during the limited time that it is available.

Additional evidence of increased pump use is seen in the number of private pumps on the Nile and what appears to be a significant increase in the installation of these pumps. On two separate occasions we talked with farmers installing these pumps and both indicated that they knew of other farmers in their own areas who were also buying pumps.

In the one case, two farmers representing 4 feddans and in the other 5 or 6 farmers representing 10 feddans were buying the pumps. When asked why they bought pumps, the farmers in the first case said that they had other land that they farmed and so had a limited amount of time which they could spend irrigating the land. They also wanted to increase the amount of water they could apply and in turn increase

their yields. They felt that the economics of rising labor costs and decreasing real return from the land forced them to buy a pump. The second group was installing a pump because the old canal which connected them to the Ministry of Irrigation water delivery system had been destroyed by the main course of the Nile's eroding the earth from under the bank and causing it to collapse into the river.

We believe that trying to accurately determine the number of pumps brought into operation in the last 5 years and their actual horsepower cannot presently be accomplished through a field survey of the farmers. Nor do we think that the irrigaiton or agriculture authorities have any more than a general idea of the situation. We would suggest that a survey and examination of the invoices of local pump dealers might be one way of obtaining the needed data.

APPENDIX 4. PUMP DATA SHEET

GOVERNORATE	SOHAG 1.	2.	3.	4.	5.	QENA 1.	2.	ASSYUT 1.	2.	3.	4.	5.	6.	7.
Pump horsepower		7.5	6	11	60	35				9		18		
Pump age (years)		?	3	5	40	30				20?	25?	40	12	
Stationary/Portable	P	P	P	P	S,elec.	S		P	P	S	S	S		
Water availability	exc.	?		exc.	exc.									
Water source	minor canal	minor canal		minor canal	minor canal	ground		minor canal	minor canal	Nile	Nile	ground	ground &m.canal	
Farm location	field meska	middle											head	
Farm size, feddans	1	8			12	30	35	10	12	10	1.5	0.5	1.5	
Years irrigating by pump	?	?	1	5	40	3		5	1	new	1 mo.	40	16	
Own pump/buy water	Buy	Own			family owns	Own		Own	Own	Own	Own	Buy	Own	
Cost of water/ feddan/day	LE 3						LE 3					LE 3 + gas	LE 3?	LE 2
Pump owners: all farmer(s)	1	1		1	's	's	1	1	7	3	2	10	2	1
Feddans owned by pump owner	3	8			12	30						35	22	
Pump owner's feddans served by pump	3	8			12	30		10	12	10	4	35	22	
Total fed. irrigated by pump	30	20		30?	120	30				10	4	50	92	60
Do adjacent farmers to pump owner buy water fr. him	all					6								
Winter Pump hrs./day		8	?											
Feddans irrigated per day	3	3	3											
Summer Pump hrs/day		12	21	10	16							24		24
Feddans irrigated per day	3	3	3	4	6				3			3		5

APPENDIX 5

POLITICAL FACTORS

Time and again, throughout the control points of the water delivery system, we found groups and individuals representing different interests turning to political channels in order to initiate a change in the regulation of the water delivery system and the personnel who regulate it. The object of this appendix is to describe the relationships which occur as particular groups and individuals utilize this means of initiating a change in the policy of the Ministry of Irrigation.

Despite their positions of authority, the Undersecretaries, General Directors, and district engineers of the Ministry of Irrigation sometimes feel the need to utilize political pressure to initiate a change in the policy of the Ministry of Irrigation.

For example, one General Director told the authors that upon assuming the job of General Director in a Directorate, he determined that it was necessary to increase the flow of two canals whose headgates were just upstream of a barrage. Crop mix changes, an increase in irrigated land due to private land reclamation, and an increase of weeds infesting the canals had resulted in an increased water need. The General Director asked the office of the First Sub-minister of Barrages and Design for permission to raise the upstream level of the barrage and he was refused.

The General Director then went to the Muhafaz (Governor) and explained the need for more water and asked him to use his influence to

to try to reverse the decision of the sub-minister's office. The Mohafaz was able to have the decision reversed. This is not an isolated case and it raises questions about the entire decision making structure within the Ministry of Irrigation and about where some Ministry of Irrigation personnel believe their responsibilities lie. In this case, the General Director believed that his first responsibility was to provide the farmers with the water he felt they needed.

The influence of political pressure upon the Ministry of Irrigation is not restricted to policy questions and can also be decisive in questions of personnel. We are familiar with a district engineer who was apparently transferred because, according to a Ministry of Irrigation official, he failed to please "certain parties." Although the Ministry official had found the person to be a hard working, honest, and intelligent engineer, the decision to transfer him had been made in Cairo. The Ministry official indicated that there were "certain traditions in the Directorate which this man had failed to respect," and although it was never explicitly stated, we felt he was implying that political pressures had been responsible for the transfer.

Farmers, Ministry of Irrigation and Ministry of Agriculture personnel all stated that those farmers with political connections were accorded a favored position by Ministry of Irrigation personnel. One General Director told us, "If a farmer is able to go to the Governor to complain of a lack of water, the Governor asks that the water be given and the water is given." Another General Director told us, "The engineers are afraid; too much [water] is better than too little. They are not willing to take responsibility [for water conservation] because of the wrath of the farmers and the Governor if a shortage occurs anywhere."

Political pressure can be put on the people in charge of the control points of the water delivery system not only by the Muhafza (Governorate), but also by the Maglis al Markazi (District Council) and its Director or elected President. The Maglis al Markazi became an effective political power under Law 52 passed in 1975. In particular, the Director of the Maglis al Markazi, appointed by the Muhafaz, wields considerable power which the district engineers tell us they must respect. The President and his Council, somewhat removed from the day to day business of the Markaz (District), are also forces to be respected by the Irrigation authorities.

Finally, at the local level also, is the 'Umda (Mayor) and the Maglis al Mahali (Village Council) which can influence not only the local Irrigation policy but also the personnel who implement it.

We also observed a situation where a Ministry of Irrigation engineer was approached by a local leader who was dissatisfied with the performance of the irrigation guard in his area. He accused the guard of being lazy and dishonest and had said that he wanted the guard to be transferred. The engineer told us later that he knew to the contrary that the guard was doing his job well and that the council leader was actually complaining because the guard did not allow the farmers to open the minor canal headgate whenever they wished. He added, however, that even so he might be forced to transfer the guard.

The jurisdiction of the Ministry of Irrigation over the water delivery system is often successfully challenged by the political elements in each Governorate. Unfortunately, this does not simply mean that the Ministry is publically accountable, but rather that occasions exist when the water delivery system can be manipulated by political elements for

their own gain. The resignation and acquiescence of the Ministry of Irrigation personnel to this state of affairs is surprising.

APPENDIX 6

RESPONDENTS

BENI SUEF

Eng. Phillipe, Director General of Irrigation

Eng. Fares Georgi Michial, Sub-Director of Drainage Projects Dept.

Eng. Gerges Nahim, Chief Engineer of Drainage Projects Dept.

Eng. Mehlet Ibrahim Abd el Shashed, Engineer of Drainage Project

MINYA

Eng. Samaha Yassin, Director General of Irrigation

Eng. Munir Kaldas, Director General of Drainage Project Dept.

Eng. Gamal, Director General of Pumping Stations of North Upper Egypt

Eng. Mahoriot, Inspector of South Region of Minya Governorate

Eng. Esmat, Egypt Water Use Project

Eng. Sammi Labib, Dept. of Pumping Stations

Eng. Samir Sammi, Samalut District Engineer

Eng. Mohammed Ahmed, Beni Mazar District Engineer

Eng. Michael, East Dairut District Engineer

Eng. Mohammed Ali, West Dairut District Engineer

ASSYUT

Eng. Ali Zaitoun, Undersecretary of Irrigation

Eng. Abdel Sallam Abdel Maghid Ibrahim, General Director of Irrigation

Eng. Georges Ghali, Assistant General Director of Irrigation

Eng. Morsan Munir

Eng. Adli Asheri

Eng. Sobhy Naguib, Manfalut District

Eng. Helmi Fouad, Irrigation Systems Designer

Eng. Abdel Salam Abd El Megid

Eng. Gamal Ghoneim, Inspector of Agricultural Extension Service

Eng. Laura Labib, Agricultural Engineer

Eng. Rifaat Khalat, Agricultural Engineer, Assistant Manager of Vice-Minister's Office

Eng. Selwa Korashy, Horticultural Engineer

Eng. Mohamed Amin, Agricultural Engineer

Eng. Ali Hammad, Agricultural Engineer

SOHAG

Eng. Hanna Boutros, General Director of Irrigation

Eng. Mohammed Abdulla, District Engineer

Eng. Machram, Director of Works

Eng. Lifit Aziz, District Engineer

Eng. Mohammed El Masri, Director of Agricultural Extension Services

Eng. Sarwat Ferris, Inspector of Extension

Mr. Ibrahim Briesha, appointed President of the Maglis al Markazi, Johina City

QENA

Eng. Abd El Ghany-Bakr, General Director

Eng. Melad Rizk Michael Gamel

Eng. Essam Menoufy, Assistant General Director

LUXOR

Eng. Mohamed Abd El Miniem El Otefi, Inspector of Luxor

ASWAN

Eng. Abd El Ghani Masri, Chairman, High Dam Lake Development Project

Eng. Fawzy Helwa, Chairman, High Dam Authority

Eng. Rasmi Murhat, Assistant Chairman, High Dam Authority

Eng. Rashwan, Ex-Chairman, Aswan High Dam Authority

Eng. Emil Taib Klada, High Dam Authority

Eng. Achmed Hassanein Mohammed, General Director of Tushka Canal Project

APPENDIX 7

ITINERARY

The following is a list of nearly all the localities where the authors stopped during their felucca voyage from Cairo to Aswan and Lake Nasser.

In those places where we actually talked with farmers about the water delivery system, as asterisk (*) is placed.

1979

El Maadi

Nov. 29
Helwan
El Aiyat*
El Maharraqa*

Dec. 2
Beni Suef
Southern Fayoum IBRD Tile Drainage Project*
El Fashn
Maghagha
Sharuna*

Dec. 9
Minya Governorate
Beni Mazar*
Samalut, Reclamation Project*
Abyuha*, Egypt Water Use Project
Mallawi
Dairut
Il Harika*
Abu Qurqas
Tell el Amarna*
Umm El Qusur
Mankabad

Dec. 28
Assyut
Manfalut
Durunka
Abu Tig*
Sidfa*
Megris*
Nagar el Maadi*
Tima*

Jan. 14
Sohag
Johina*
Kitfaw*
Akhmim
El Mansha
Balyana*
Nag Hamadi

(Sohag)

El Raissiya
Faw Bahari
Dishna
Nag Awlad Amr*

Jan. 27 Qena

Dendera
El Marashda*
Nag Ghazar
Nag Bishbay

Feb. 3 Luxor

El Dabhya
El Mahamid
Haikal*
Idfu*
Nag El Hosh
Kom Ombo
El Raqaga*

Feb. 16 Aswan

Lake Nasser

Mar. 12 Aswan City

Mar. 12 Return to Cairo