ITIS

January 1997 Vol. 3 No. 1

Network Newsletter Published by the International Irrigation Management Institute

Information Techniques for Irrigation Systems

Forum

New Era of Water Resources Management and Information Techniques

Water scarcity and competition will be major global issues of the twenty-first century. At the Consultative Group on International Agricultural Research (CGIAR) Mid-Term Meeting held in Jakarta in May 1996, Mr. Ismail Serageldin, Chairman of the CGIAR, pointed out, "...current work on water—globally, and not only by the CGIAR—is inadequate to solve a problem that is likely to affect large parts of humanity in the first decade of the next century." He added, "widespread interest in water management and the need to conduct research that supports it, is not some passing fad. It is a compelling global need. We dare not neglect it."

Most of the world's population and economic activities are located in only twenty or so large water basins. The annual renewable supply of water in these water basins is essentially fixed. As population and economic growth occurs against this fixed supply of water, competition and conflicts among agricultural, urban, industrial, and environmental users of this increasingly scarce resource will intensify.

Historically, rising demand for water has been met through developing additional water supplies by controlling rivers and building canals and other conveyance facilities. But the best sites for water development have already been utilized in most countries and further development is becoming increasingly expensive. The world is entering *a new era of water management* that requires improved physical and economic productivity of water use in addition to water development programs.

The magnitude of the challenge in the new era of water management should not be underestimated. It is commonly thought that, for example, existing uses of water, especially in irrigation, are so inefficient that even small improvements in water use efficiency would generate large amounts of additional water supply. While this is true in some cases, it needs to be critically examined in others. With recycling, for example, water "wasted" in one part of a water basin or river basin can be recaptured and reused in another part. In such cases, one user's drainage is another user's water supply. And if the user increases the efficiency of water use, thereby reducing drainage, the

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Inside ...

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ITIS - Malaysia 1996
Third International ITIS Network Meeting

The Third International Network Meeting of the Information Techniques for Irrigation Systems (ITIS) was held in Malaysia from 15 to 17 June 1996. This meeting was jointly organized by the Department of Irrigation and Drainage of Malaysia, the Muda Agricultural Development Authority, Cemagref and IIMI. Seventy personnel comprising those working in the irrigation sectors of Egypt, India, Malaysia Morocco, Pakistan, Sri Lanka, and Thailand as well as representatives from IIMI and Cemagref participated in the meeting. The theme of this network meeting was ***Information Techniques for Water Delivery Scheduling.***

The meeting was held at the Muda headquarters in Alor Setar. Ir. Neo Tong Lee, Director General, Department of Irrigation and Drainage of Malaysia, delivering the keynote address presented the main features of the present situation of irrigation in Malaysia. He said that as the economy does not favor new agricultural investments, increasing productivities of land and water on existing schemes is a priority. He added that the importance of information techniques is seen as a key factor to improve water service to the farmers, and to preserve water resources. Irrigated agriculture has also to become more profitable to discourage farmers' migration toward cities. He concluded his speech by insisting on the importance of dissemination and sharing experiences at management level, nationwide, and internationally.

A visit to the Muda irrigation scheme was then an opportunity for all the participants to see how data collection and discharge control were important in this irrigation scheme. It is the last user of water before the sea, and in a context of increasing competition for water, every drop is considered for recycling and losses to the sea are limited.

Experiences from tropical countries like Malaysia, Thailand, and Sri Lanka and from arid countries like Morrocco, Pakistan, Egypt, and India were then used to feed the workshop discussion that centered on water delivery scheduling and the related information system. In tropical countries, a large part of the scheduling decision process focuses on the seasonal planning; water requirement during the season is rather steady and rain harvesting is an important objective of managers. In arid regions, water needs vary during the season and make water delivery scheduling a permanent task.

An information system was perceived to be the organization of observations to help the managers in fulfilling the command functions and in the evaluation of water delivery scheduling. The command function, which is on-line, deals with temporal decisions (when to start/stop delivering water) and with spatial decisions (staggering water delivery to different canal commands). The evaluation function is generally off-line and deals mainly with two questions: (i) are the targets the right ones and (ii) how did the actual water delivery match the scheduled delivery?

Parameters relevant to water delivery can be fixed (e.g., crop choice in Muda, water availability in Egypt and in Pakistan) or dynamic (changing with time, e.g., the progress of land preparation, crop water requirements). When parameters are dynamic they need to be incorporated in the information system to feed the command function, and complexity and responsiveness have to be integrated. For instance, in Egypt intermediate reservoirs in the system simplify the information requirements. In the Muda scheme, however, rainfall has been increasingly monitored in real time to improve rainfall efficiency.

Inputs and outputs of the information system are very much site-specific and depend on the prevailing hydrologic and agricultural situations, as well as on management objectives. Some situations require the use of complex forecasting abilities (Muda) whereas uncertainty in supply is limited in other situations (Pakistan, Egypt). However, common concerns were identified on:

- the need to involve farmers in the decision process (seasonal negotiation, water demand)
- the need to monitor adherence to the scheduling
- the cost-effectiveness of the information system
- the combination of traditional and moderns means

[Network Coordinators]

The Network

The Information Techniques for Irrigation Systems (ITIS) Network links the conceptual to the practical—the world of Decision Support Systems (DSS) to the world of irrigation. This newsletter is intended to serve as that bridge, to facilitate the dissemination of knowledge concerning the application of information techniques for improving the management of water in irrigation systems.

The IIMI-Cemagref Project in Kirindi Oya, Sri Lanka was the foundation on which ITIS was launched. Following the successful development and implementation of decision support tools in Sri Lanka, the Project has entered a new phase with work being initiated in Pakistan and Mexico. Work on the IIMI-Cemagref Project will progress for another five years. It is hoped that ITIS would have gained a sufficient critical mass by that time to sustain itself.

Cemagref

Cemagref is the French institute of agricultural and environmental engineering research. It is a parastatal organization supported by the French Ministry of Research and the French Ministry of Agriculture. It has a strength of more than 500 researchers and conducts research programs in the field of land and water management, environment, and agricultural engineering. Its irrigation division is located in Montpellier, France.

IIMI

The International Irrigation Management Institute (IIMI) is an autonomous, nonprofit international research institute supported by the Consultative Group on International Agricultural Research (CGIAR). The CGIAR is an informal association of public- and private-sector donors that supports a worldwide network of 16 international research centers, including IIMI, conducting global research on agriculture, forestry and fisheries. The CGIAR is sponsored by the Food and Agriculture Organization of the United Nations (FAO), the International Bank for Reconstruction and Development (World Bank), the United Nations Development Programme (UNDP) and comprises more than 40 donor nations, international and regional organizations, and private foundations.

IIMI's mission is to improve food security and the lives of poor people by fostering sustainable increases in the productivity of water used in agriculture through better management of irrigation and water basin systems.

With its headquarters in Colombo, Sri Lanka, IIMI conducts a worldwide research and capacity-building program to improve water resources and irrigation management through better technologies, policies, institutions, and management.

Continued from page 1

downstream user's water supply is reduced correspondingly. At a broader level of analysis, inefficient surface irrigation systems often recharge aquifers on which the highly productive tube well systems thrive.

As these examples show, the macro-efficiency of the water basin as a whole can be high, even though the micro-efficiency of individual units within the basin is low. Thus, in considering water use efficiency, it is important to distinguish between real or "wet" water savings as opposed to paper or "dry" water savings.

The need to enhance water productivity and maintain water quality requires new and creative approaches to water policy, institutions, and technologies. A wide range of options must be considered. A significant shift toward tube wells is already underway in many regions. The use of pressurized (sprinkler and drip) irrigation systems can increase yields by 20 to 30 percent over surface irrigation through better water control and, hence, better plant-fertilizer-water interactions. Even more importantly, reliable water supplies reduce the risk in farming and, thereby, induce investment in better seeds, fertilizers, and other inputs.

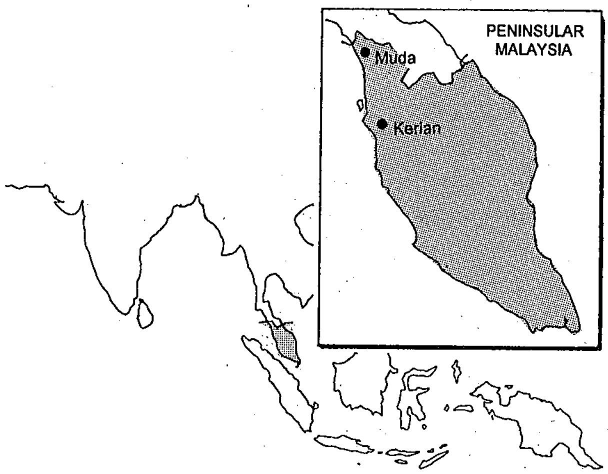
Information technologies—geographical information systems, remote sensing, and computer modeling—have an important role in this new era of water management. These techniques provide the spatial information necessary to more accurately evaluate and monitor the performance of large-scale irrigation systems. With the development of higher resolution satellites, and the ability to integrate the information provided by these techniques with simulation models, it will be easier to explore the short- and long-term consequences of various water resource management strategies.

It is vital to share experiences and integrate the best minds to address the most important problems in the field of water resource management and irrigated agriculture. I see the ITIS Network contributing to this effort and I look forward to reading your articles in the forthcoming issues of this newsletter.

David Seckler
Director General, IIMI

ITIS in the Field

MALAYSIA



Water Delivery Scheduling in the Muda Irrigation Scheme

INTRODUCTION

The Muda irrigation scheme, which encompasses 96,000 ha of rice fields, is the largest granary area in Malaysia. There are four major water resources utilized for irrigation and other requirements in this region. The first is rainfall, which contributes about 52 percent of the water resources. Uncontrolled river flow from the catchment downstream of the dam and recycled drainage water provide 13 percent, and 6 percent, respectively, of the water resources. The rest is contributed by controlled supply from the dams.

Since its commissioning in 1970, the Muda irrigation scheme has experienced water deficits in some years leading to difficulties in sustaining rice double-cropping. The Muda Agricultural Development Authority (MADA) implemented several projects to address this problem. The hardware solutions included the construction of a new storage dam, recycling the drainage water, and tertiary-level infrastructure development. The software type solution was to improve water management using computerized water allocation and scheduling.

FEATURES OF THE IRRIGATION MANAGEMENT SYSTEM

A computer-aided scheduling package of Water Management and Control Scheme (WMCS) is the main tool employed to manage irrigation over the entire project area. Timeliness of data acquisition is a key issue in improving the system efficiency. An extensive data-feedback system, comprising a telemetric network and a VHF voice communication system, forms the backbone of the decision process. Parameters monitored are hydrological data, cropping activities, and crop yield. Implementing the scheduling is expected to make the farmers adhere to the planned irrigation schedule, so that they can take only the amount of water allocated. The cooperation of the farmers will result in smooth canal operations and higher system efficiency.

Since the MADA's primary objective of water scheduling is to optimize the usage of available water resources without jeopardizing the potential crop yield, a crop-based supply system is found to be the most suitable. At the field level, this means maximizing the effective use of direct rainfall and uncontrolled river flow, and minimizing dam release. In this context, recycled water is preferred to dam release to irrigate the crops.

The first step in seasonal planning is running a reservoir storage simulation program to assess the availability of water resources for the coming cultivation season. Alternative irrigation schedules are produced and considered at the joint committee of the agency and the farmers, where a final schedule is decided and announced. Once decided, various features in the schedule such as phasing of the crop planting and water stop dates have to be observed by the farmers. The process allows the adoption of contingency plans in times of water shortage, depending on the severity of the problem.

A water balance model is applied to each irrigation block (the smallest entity in the water management system) to assess the water requirement and to allocate irrigation water. The quantum of water allocated will then be summed up for each canal system to determine the total requirement for the irrigation scheme. When the uncontrolled flow exceeds the field water requirement, the computer program

automatically optimizes the distribution of the excess water over the project area.

The farmer, as the client of the irrigation services, is an important component in the management framework. He plays an important role in the seasonal planning of a crop but has no direct role in the daily operation process as the daily water allocation is crop-based. However, farmers' feedback through close interaction with the agency's field extension staff is essential to resolve localized irrigation and drainage problems. The WMCS allows for manual overriding to overcome such localized problems. A well-structured institutional framework provides efficient communication channels between the farmer organizations and the MADA.

As all farmers in the project have equal water rights, there is no priority area for water resource allocation in times of shortage. When faced with a water scarcity, the authorities take appropriate measures in consultation with the farmers.

Over the years, several management interventions have been introduced such as tertiary development, installation of the telemetry system, and the adoption of the dry-seeding crop establishment method. These management interventions have been evaluated using various performance indicators. The outcome of these evaluations is utilized to improve the operation of the scheme.

CONFLICTS AND CHALLENGES

Some factors have a direct impact on water scheduling and sometimes cause conflicts of interest. Some examples of such conflicts are as follows:

- The different water requirements of different crop establishment methods constitute an in-built conflict.
- Maximizing solar radiation for optimal yield has to be compensated for by higher irrigation water consumption.
- Delaying the first-season crop to maximize the use of direct rainfall may cause lodging problems when harvesting in the wet months.
- Shortening of the irrigation period by expediting farming activities may result in overdemand of farm machinery.

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Malaysian Kerian Irrigation Scheme

INTRODUCTION

The Kerian irrigation scheme is located in the northwest corner of the State of Perak in peninsular Malaysia. This scheme, having a command area of 23,559 ha, is considered as the third largest granary in the country. The Bukit Merah reservoir contributes 61 percent of the irrigation demand, while recycled drainage water and rainfall contribute 14 percent and 25 percent, respectively.

Water resources are generally sufficient to meet the demand except in occasional droughts. However, the reduction of reservoir capacity due to siltation and competition for water from industrial and domestic sectors necessitate the efficient use of water resources while reducing wastage. It is estimated that about 900 mm of water per year are drained from the rice fields, part of which is reused. During the rainy season, about 35 percent of the inflow has to be disposed of, due to capacity limitations of the reservoir. The irrigation managers plan to enhance the efficiency of water resources utilization through effective communication and computerized decision support systems, to meet the likely future challenges.

THE PRESENT IRRIGATION MANAGEMENT SYSTEM

A telemetry system installed in 1990 links 23 rainfall and rainfall-cum-water level stations to the control unit. The water levels are monitored at strategic points in main canals such as near the headworks and at the regulators, at the reservoir, and at critical locations in rivers upstream and downstream of the reservoir. A Front-End processor scans these monitoring stations and interfaces with a supervisory computer which processes the data to be used for canal operations.

Daily operation of the canal system is facilitated by an upgraded version of the irrigation management software "KIMAIN." This software, first installed in 1991, was upgraded in 1995 to operate in the "WINDOWS" environment.

Water balance is computed daily using real-time hydrological data received through the telemetry system at the Front-End processor. Other relevant parameters have to be keyed in manually. Based on the results of this exercise, the daily allocation for each secondary offtake is computed.

Under the present system, flow rates at the outlet from the reservoir and at various locations along the main canal are measured manually. Due to manual measurement, these readings can be obtained only once a day, and variations during the day are not observed. Another drawback is that interfacing problems between the Front-End processor and the telemetry system lead to continuous loss of data. Due to this, the software for water allocation has not been used for that purpose in the recent past.

THE FEATURES OF THE NEW IRRIGATION MANAGEMENT SYSTEM

A real-time water management and control system is being designed for improving the efficiency of the daily operation process. The main components of this system function in the following manner:

- A new telemetry system linked in a Wide Area Network (WAN) collects hydrological and field data. This is supported by a VHF radio system.

- A Local Area Network (LAN) links the computers at the district engineer's office with those at Farmer's Development Centers where the field staff members are housed. This LAN is installed at the Kerian District Engineer's Office.

- The decision support system at the District Engineer's Office will be enhanced by the proposed water optimization model. It computes water allocation for each irrigation subblock serviced by an irrigation canal and a drain, based on hydrological data and the progress of field activities.

Irrigation rates for each irrigation subblock are decided based on the information gathered in the following manner and target depths designed to optimize rainfall utilization.

- A Minimum Water Depth varying with the crop stage is to be maintained to avoid crop water stress. The average value is 50 mm.

- The Desirable Water Depth, in farmers' opinion, is the most desirable for steady plant growth, and it varies with the cropping stage and the planting method. The average value is 100 mm.

- A Maximum Water Depth is defined based on the ridge or bund height, or on the elevation of drainage outlet.

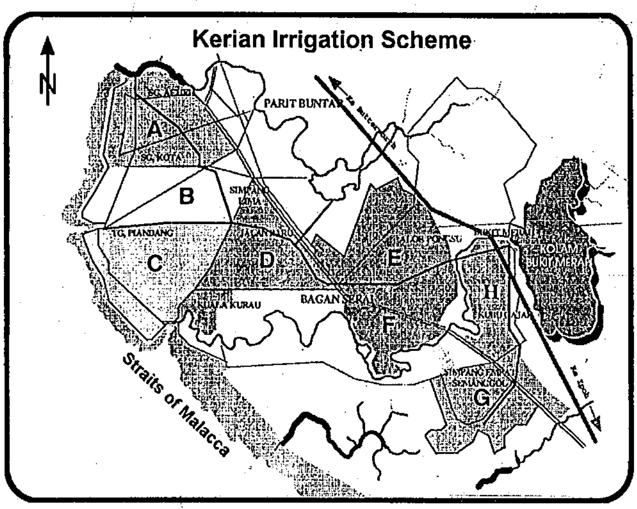
The setting of targets and making operation decisions are carried out in several steps. The effective rainfall is calculated as a function of initial field water depth and rainfall. Evapotranspiration is expressed as a function of the progress of cultivation, pan evaporation, average evaporation loss from saturated and unsaturated surface areas, and the method of planting.

A daily water balance is computed for each irrigation subblock using these results. This can be expressed in formula form in the following manner:

$$\mathbf{D_2 = D_1 + I + Re - Et - SP}$$

where,

D_2 — Final water depth
D_1 — Starting water depth



I — amount of irrigation
Re — rainfall
Et — evapotranspiration
SP — total daily seepage and percolation

The final depth of water computed in this manner will be reset to the actual measured value once a week. Computing irrigation rates will be based on the result of this water balance exercise. Application, distribution, and conveyance efficiencies will be incorporated into the computations. Information on the irrigation rates obtained in this manner, and corresponding gate settings, will be conveyed to the field offices through electronic mail. Another important feature of the management process is the assessment of performance using a set of performance indicators.

Manual collection of data such as evaporation and flow measurements is to be automated to improve operation of the canal system.

[Teoh Boon Pin, Department of Irrigation and Drainage, Malaysia]

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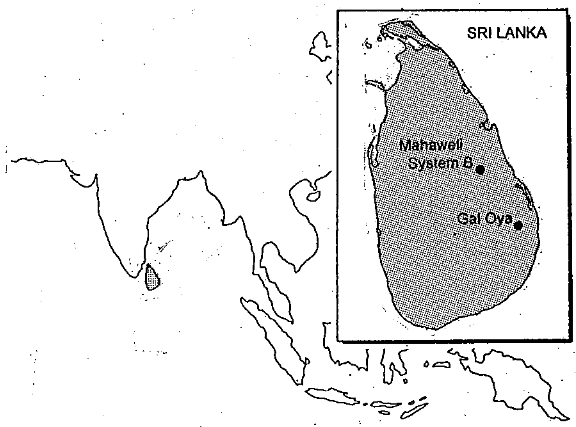
- Shortening of the irrigation period by introducing short-term varieties will have lower yield implications.

A few problems and challenges are anticipated in the future. As the Muda scheme is water-deficit, additional water resources would be required to meet the needs of the region. The full potential of uncontrolled river flow has not been exploited yet. Installation of telemetry stations coupled with rainfall-runoff models in the catchment area will provide real-time data for optimizing their usage. The construction of regulating and storage reservoirs to store the excess 'uncontrolled' flow would mitigate the water-deficit problem in the scheme. The WMCS needs to be continuously modified to accommodate the changes in the crop establishment methods. Mixed cultural practices within a block cause difficulties in water management. The establishment of effective water user groups would improve water management.

Muda Agricultural Development Authority

SRI LANKA



Computer-Aided Water Management Experiences from the Gal Oya Irrigation Scheme in Sri Lanka

INTRODUCTION

The Gal Oya Irrigation Scheme is the largest irrigation scheme managed by the Irrigation Department of Sri Lanka. It provides irrigation facilities to 49,500 ha of mainly rice land in the Eastern province. The irrigation system can be divided into three subsystems: the Right Bank system, the Left Bank system, and the River System division. The major water resources of this scheme include controlled supply from the Gal Oya reservoir, rainfall, and recycled drainage water from the Left Bank and Right Bank areas. Rice is grown in this scheme except for a part of the Right Bank area which is cultivated with sugarcane.

A computer-aided water scheduling system and an improved communication network were implemented in the mid-1980s in a section on the Left Bank system, covering 16,215 ha. The physical infrastructure in this area was rehabilitated late in the 1980s, with improved canal profiles, gated control structures, and flow measuring devices. The main components of the infrastructure in the Left Bank include a 33 km long main canal, 5 branch canals having a total length of 53 km, 170 distributary and field channels taking off the main canal, and 5 intermediate reservoirs.

MANAGEMENT OF THE GAL OYA SCHEME

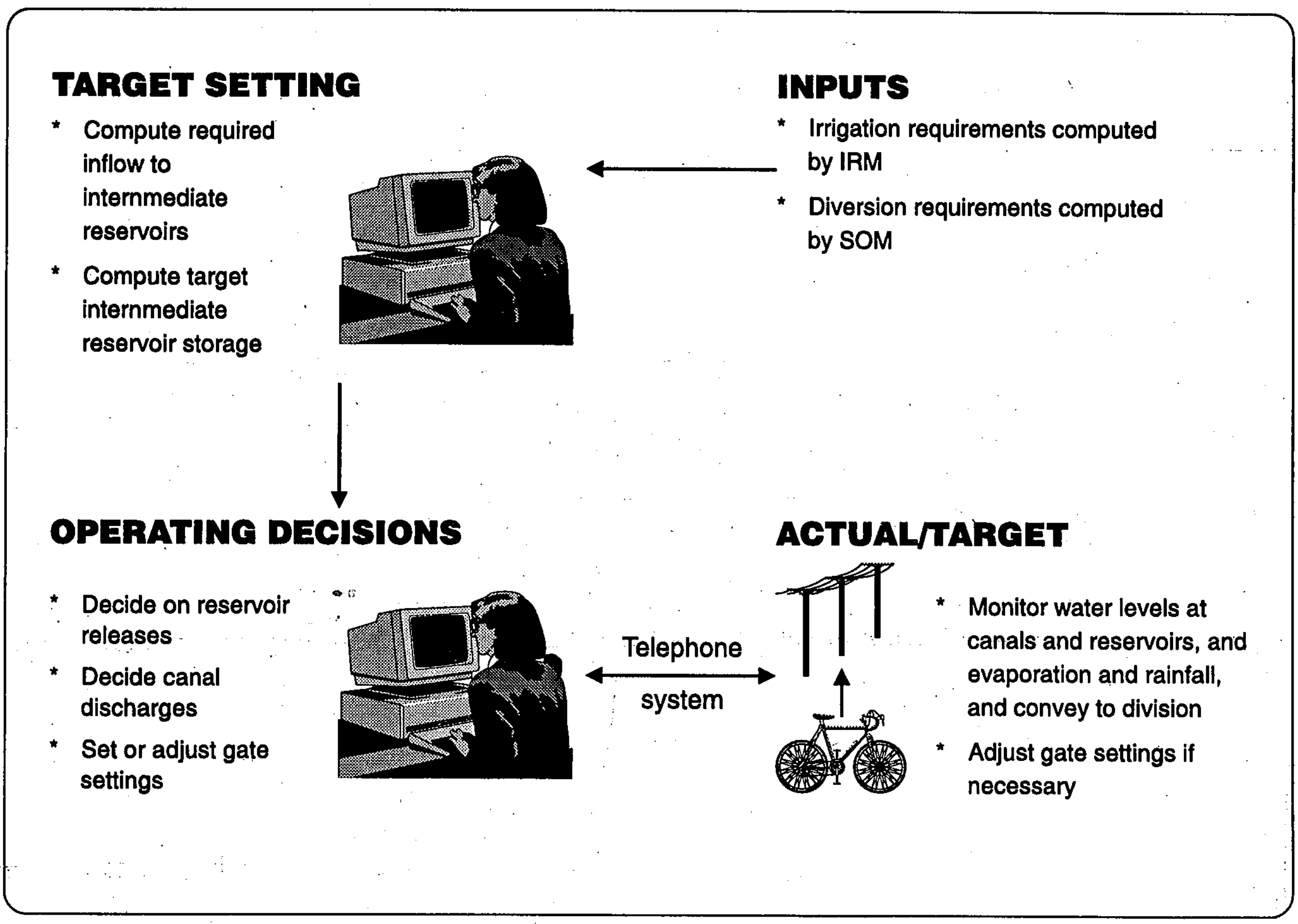
The Irrigation Engineer, Ampara Division manages the Gal Oya Left Bank System. This is further divided into five units, which are separated by clear physical boundaries. A Technical Officer is responsible for the O&M of each unit. The unit is divided into sections each of which is approximately 200 ha. A Work Supervisor and a group of laborers are assigned to these sections to assist the Technical Officer in his duties. In the main and branch canals and distributary channels, the flow is continuous. The rotational principle of water distribution is observed by the farmer organizations that operate the field channels.

Water delivery scheduling in the Left Bank system is facilitated by a computerized decision support system. It consists of software to compute the irrigation requirement and delivery rates at key locations of the canal system. The hardware includes the Radio Shack model 16-B micro-computer installed in 1984.

The monitoring system links all the diversion points and offtake structures from the main canal with the Central Control Center at the Irrigation Engineer's office through a telephone system. While Parshall flumes and calibrated concrete sections measure the flow in main and branch canals, the flow measuring devices located in the distributary and field channels are broad-crested weirs (BCW) and trapezoidal flat bottom flumes.

COMPUTER-AIDED IRRIGATION SCHEDULING

The Irrigation Requirement Model (IRM) and System Operation Model (SOM) are the most important tools of the decision support system implemented in the Gal Oya Left Bank system. These programs are written in BASIC language, to suit the configuration



of the Gal Oya system. Therefore, they are not general purpose models applicable to other systems.

The seasonal planning is done using the IRM. This model uses the norms and equations set up by the Irrigation Department for land soaking, land preparation, and water requirements during crop growth. A cropping calendar is prepared specifying the percentage of irrigated area which falls into each category and the percentage of land that remains idle during each week of rotation. Five different cropping calendars can be inputted to the model to accommodate the variations of farming activities in the five management units. An important feature of the IRM is flexibility in making different schedules for each offtake, accommodating spatial variations in land soaking, land preparation, and crop growth periods. The model can be used for both wet and dry seasons.

The irrigation requirements calculated in this manner are compared with the design canal capacity. After making adjustments if necessary, the cropping plan and the irrigation schedule are implemented.

The SOM uses the weekly irrigation requirements computed by IRM and estimates the flow rates at diversion points of the main canal and branch canals to maintain the required flows at offtakes. The flow measurements are conveyed every morning to the telephone stations by messengers riding bicycles. Similarly, evaporation and rainfall data are also collected and transmitted to the Central Control Center.

ACHIEVEMENTS OF THE COMPUTER-AIDED IRRIGATION MANAGEMENT SYSTEM

The computerized decision support system and the communication system have helped the management to smoothen the operation of the irrigation system throughout the cultivation season. The reliability of the irrigation supply has also improved. As a result, all the farmers have faith in the water delivery plan. Another benefit is the increase in the application of fertilizer, weedicides and pesticides, leading to an increase in the yield. Records show that irrigated area has increased and the use of water from the reservoir has decreased after the new system was implemented.

[Eng. G.G.A. Godaliyadda, Deputy Director of Irrigation
Irrigation Department, Moneragala]

New System Operation toward More Flexibility: Ongoing Study from the Mahaweli System B in Sri Lanka

INTRODUCTION

The System B irrigation scheme is the largest of the development areas under the Mahaweli Development Project. Out of the designed irrigable area of 42,000 ha under System B, 28,000 ha on the Left Bank of the Maduru Oya are in operation now. The remaining area on the Right Bank is yet to be developed.

The irrigation scheme is located in the dry zone of Sri Lanka. The average annual rainfall is about 1,700 mm. Most (75 percent) of this occurs during the northeast monsoon from October to February and the rest between April and September. During this period, the crops depend heavily on irrigation.

The designers of the irrigation scheme assumed that System B would have a reliable and adequate water supply for two crops per year. However, water deficits are predicted for the future due to the high water consumption in the developed area, and the future water requirements of the area have to be met.

THE MANAGEMENT SYSTEM

The Resident Project Manager (RPM) heads the management structure in System B. He is assisted by several Deputy Resident Project Managers (DRPMs), who handle specialized subjects such as land administration, agriculture, water management, and community development. The scheme is divided into 9 administrative blocks of about 2,500 to 3,000 ha, which are managed by Block Managers. A block is further divided into units of about 300 to 350 ha, managed by Unit Managers. The Unit Manager acts as the interface between the users and the management. While the agency manages the main canal, branch canals, and distributary channel system, the farmers have the authority for the operation and maintenance (O&M) of the field channels.

The policy decisions for the seasonal agricultural program are made with due consideration given to the availability of water, climatic conditions, market potential, and other socioeconomic factors. The proposals for each cultivation season are prepared by the Seasonal Agricultural Planning Committee of the irrigation scheme, in consultation with farmers. These proposals are examined at the Mahaweli Secretariat in Colombo, and the general guideline for the season is formulated as the Seasonal Operation Plan (SOP). Any adjustments to the proposed plan could be made at the cultivation meeting, which is attended by the farmers and the agency officials, provided the changes are within the SOP.

The irrigation schedule prepared by the agency staff indicates the volume of water needed at all the turnouts for the forthcoming week. The turnout schedules prepared in this manner are used as the basis for daily water orders. The guidance for canal operations is provided by the Project O&M Manual. Members of the Block Manager's staff furnish water orders following these guidelines. In response to these orders the members of the RPM staff operate the main canal.

The constraints to smooth canal operation include transport and communication problems. As a result, water orders are not placed daily or at prearranged times. In the absence of an order, the main canal operator assumes the block order for a particular day to be the same as for the previous day. Manual canal operations are another constraint. A considerable amount of water level fluctuations in the main canal has been observed due to manual canal operations, making it difficult for the Block Manager's staff to provide a reliable water supply to the farmers.

Farmers in System B are now shifting from rice cultivation to other crops and to nontraditional crops such as gherkin, sweet melon, and baby corn. Therefore, the canal operation strategy needs to be made more flexible, to cater to varying water demands of different crops. The key to flexible canal operation without excessive water use is the ability to change the flow rapidly, with minimum fluctuation of the main canal flow.

It is perceived that the use of a management tool as a computer-aided hydraulic simulation system, which can provide a better understanding of the irrigation system and facilitate the decision-making process, could be useful to improve the efficiency of canal operations.

FEATURES OF THE RESEARCH STUDY TO IMPROVE IRRIGATION MANAGEMENT

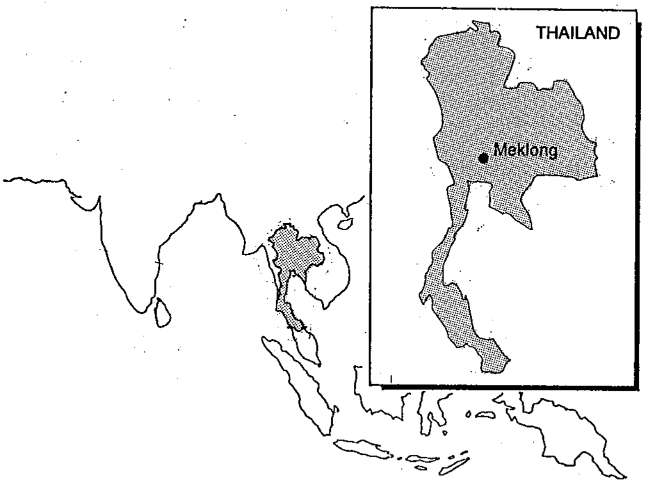
A research program has been implemented to study the possibility of developing computer-based tools to strengthen the canal manager's decision-making power in Mahaweli System B. The main objective of this study is to develop methodologies that provide a better service to farmers, whilst maintaining reliability and flexibility of the irrigation supply. The current study envisages developing operational guidelines for the management of main canals with a variable weekly or daily flow pattern.

The study will be implemented in three different phases. The first phase involves developing methodologies for strengthening the present information system. This includes the installation of measuring gauges for gated cross-regulators, more systematic data collection, and installation of a data storing and processing system. IMIS, a software developed by IIMI-ITIS unit will be used to store and process the data.

The second phase deals with making a better understanding of the main canal behavior with the use of the simulation of irrigation canals (SIC) hydraulic simulation model. The different steps of this phase include the building and calibration of the SIC model, sensitivity analysis, and studying the wave propagation pattern. The last item is needed to assess the time lag between the discharge change at the main sluice and the subsequent steady state in the main canal. The SIC model is completed and the initial calibrations have already been done.

During the third phase an information feedback system will be installed. Information collected and stored in the information system, IMIS, will be initially used to understand the system behavior and its response to different hydraulic conditions. It is also expected to continue the current studies to evaluate the system performance with the simulated impact—with the use of SIC—and real impact on sites (data collection).

[D.C.S. Elakanda, Acting Chief Civil Engineer,
Mahaweli Economic Agency, Sri Lanka, and
H.M. Hemakumara, Senior Research Officer, IIMI]



Water Scheduling in Thailand's Irrigation Projects: The Case of the WASAM Program in the Meklong Project

INTRODUCTION

The irrigation projects in Thailand can be divided into two categories: people's irrigation projects, which are managed by the farmers and the projects initiated and managed by the Royal Irrigation Department. The first category is found mostly in the northern region. The second includes large, medium, and small-scale projects, such as dams constructed for irrigation in the northeast and the extensive river diversion network in the central plain.

The Greater Chao Pharya Project in the central plain was constructed in the 1960s. The project was expanded to provide irrigation facilities to the western part of the delta in the 1970s, after the construction of the Greater Meklong Project. The western part of the delta receives water from the Meklong basin. This area can be considered as water-abundant compared with the Chao Pharya Project. As a result, a certain volume of the waters of the Meklong area is diverted to the lower Chao-Pharya area.

MANAGEMENT STRUCTURE AND THE DECISION PROCESS

The primary and secondary canals in the Greater Meklong Project are lined. The canals, which are equipped with regulating devices, have adequate design capacities to supply water to fulfill the crop demands. These facilities have allowed the management to computerize the canal operation and management, using a software called Water Allocation, Scheduling and Monitoring (WASAM). The software was developed by Euroconsult.

Four levels can be identified in the management structure of the Greater Meklong Project. Starting from the bottom, the first is the tertiary or the farm level, where the farmers manage the farm ditches. The zonemen employed by the agency manage the secondary canal system. The main office of the subproject manages the primary canal system. Finally, the management responsibilities of the feeder canals rest with the Regional Office.

The water requirements calculated by the WASAM model are updated each week according to the observed field wetness. The required discharges at the regulators are calculated using the information on the water requirements. The output is conveyed to the zonemen and gatekeepers, for the gates to be adjusted accordingly. During the weekly canal operations, there is a regular monitoring and feedback process between the zonemen and the computer center. The water allocation is demand-based in principle although the quantities can be modified according to water availability.

CONSTRAINTS AND LIMITATIONS OF THE PRESENT IRRIGATION MANAGEMENT PROCESS

The WASAM computer model requires a substantial amount of field data to be operated. Due to the large number of crops cultivated and inadequacy of staff, data collection has become a very tedious task. This affects the accuracy and precision of the data. Another constraint is that the amount of water drawn from other water sources is not accurately known. This also complicates the use of the computer model.

Unless a substantial water shortage is experienced, a request for the adjustment of flow is not conveyed from one level to the next upper level. As a result, when little or no water shortage is experienced, any

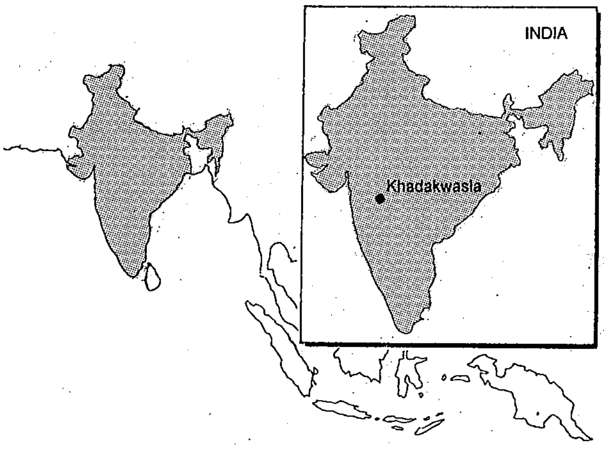
change of the flow rate is unlikely. Further, a certain amount of water is intentionally transferred to the Chao Pharya System as drainage water. Therefore, there is no benefit or reward for matching the water deliveries to the requirements.

These conditions affect the accuracy of data collected and timely transmission, because the zonemen perceive that the data are not effectively used for canal operations. This complacency has led to the monitoring and feedback system to become routine, and threatens the viability of the process too.

However, the water demands from the other competing sectors are on the increase. An example is the increased abstraction of water for the city of Bangkok, upstream of the project area. Therefore, the water management in the Meklong Project needs to be improved in the near future.

[Dr. Kobkiat Pongput, Department of Water Resources Engineering, Kasetsart University, Bangkok,
Dr. Pongsatorn Sopaphum, Department of Irrigation Engineering, Kasetsart University, Bangkok,
and Dr. Francois Molle, ORSTOM, Bangkok.]

INDIA



Introduction of a Canal Irrigation Management System in the Khadakwasla Irrigation Scheme

INTRODUCTION

The Khadakwasla irrigation scheme is located in the State of Maharashtra, India. Originally designed in the early 1870s for irrigating a small area in the Pune district, the irrigation system has been progressively enlarged and developed. The principal components of the present irrigation infrastructure are two storage reservoirs, a pick-up dam, a 170 km long main canal, and an irrigation distributary system consisting of 2 branch canals, 60 distributaries, and direct outlets taking off the main canal. About two-thirds of the designed irrigable area of 62,146 ha under this main canal are in operation now, while the rest is under development.

The main objective of providing irrigation facilities is to provide water for cultivation in the *rabi* and hot weather seasons, which are dry. Water resources are planned to ensure proper utilization of reservoir storage at the end of the *kharif* (rainy season) through the rest of the irrigation year. However, manual canal operations and scheduling of irrigations hinder efficient, timely, and reliable distribution of water along this substantially long main canal. To alleviate these problems, a computer-assisted irrigation management system is being introduced now.

THE DECISION-MAKING PROCESS

Each farmer in the Khadakwasla irrigation scheme has to apply for water before the start of the cultivation season, stating the crops and area to be irrigated. The main canal is operated in "turns" or "rotations" to meet the demand. For each turn, water allocations are made based on the indents generated at the field offices, which are based on supply norms. The finalized schedule of main canal operation is communicated daily to the field offices by the control center, during the turn. The canal flow is monitored at distributary canals and at selected locations of the

main canal. With the previous communication network, the data were transmitted through VHF voice communication links. The irrigation schedule was prepared and adjusted manually.

LIMITATIONS OF THE PREVIOUS IRRIGATION MANAGEMENT SYSTEM

The previous communication and decision-making system had several drawbacks which limited efficient distribution of water. Preparing the irrigation schedule while reducing the fluctuation of daily demand in the main canal was difficult with manual scheduling of turns. Accommodating the daily changes of water demand in the irrigation schedule was complicated due to the long travel time. Furthermore, ensuring both a full reservoir by the end of the rainy season and safety of the dam during the filling period was also difficult.

Some limitations to transmit data from remote locations were imposed by the VHF system. Repeater stations were set up to overcome this. Further, the system covered only the field offices and flow observation while control points along the main canal were not linked with the subdivisions or the controlling division. As a result, timely monitoring of canal flows and comparing them with the planned schedule were not possible. Events such as rainfall or an emergency situation were conveyed with a time lag.

INTRODUCTION OF A CANAL IRRIGATION MANAGEMENT SYSTEM

In the Khadakwasla irrigation scheme, information techniques are being introduced as a pilot project. The purpose of this is to plan, schedule, and monitor canal operation in the scheme more efficiently. The main objectives of this pilot project are to optimize the exploitation of available water resources, to facilitate decision making for effective canal management, and to minimize the variation of demand at the main canal by proper scheduling. The Canal Irrigation Management System (CIMS) being implemented now is the first phase of the project. It comprises the installation of two subsystems: a decision support system for planning and scheduling, and a telemetry system for monitoring and feedback.

The decision support system produces irrigation schedules for each rotation and for individual offtakes, using an optimization technique. It also simulates water levels and flows in the main canal and computes gate settings of control structures. These targets are based on crop water requirements. The telemetry subsystem monitors the water levels at target locations and sends feedback to the controlling division. As a result, real-time monitoring of flow conditions is possible. The data are transmitted to the central computer system through the telemetry system.

In the phases to follow, it is envisaged to increase the number of real-time canal monitoring locations and to simulate canal flow under nonsteady flow conditions to evolve a control strategy for the main canal. A revenue information and billing system is also planned to be developed.

EXPECTED BENEFITS AND CHALLENGES FACED

This new computerized monitoring and decision-making system is expected to overcome the drawbacks of the previous system and improve the efficiency of the operation procedures. For example, the reservoir operation module, which is a part of the decision support system, produces 'rule curves' which facilitate improved operation of reservoirs. These rule curves are developed using historical inflows and incorporating significant differences of cropping schedules.

More efficient and real-time monitoring of reservoir water levels and canal flow conditions are possible with the new telemetry system. Before its implementation, the communication system extended down to the field offices only. Plans are made to use the CIMS for seasonal planning too. As an example, figure 1 shows the manually prepared canal operation schedule for the Daund Subdivision. This schedule required 14 days of canal waterings. The schedule prepared using CIMS illustrated in figure 2, required only 19 days. The reduction of canal losses due to the CIMS-assisted schedule was estimated as 7 percent. It is estimated that, improved irrigation planning and scheduling in this manner, have the potential of saving on losses from 5 percent to 10 percent of the total live storage per year.

An indirect, but an important benefit of the introduction of CIMS is the identification of the

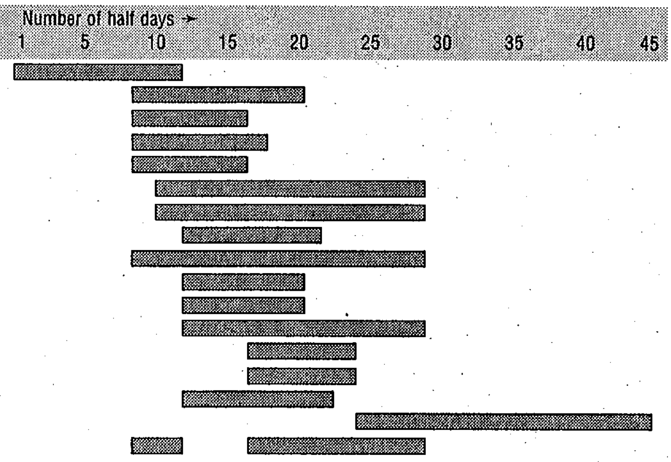
improvement needs of the physical system. This would result in cost-effective enhancement of system operation.

This pilot project encountered a few challenges and problems at the implementation stage. Installation of the telemetry system was delayed due to the construction of shelters for the equipment in remote locations, and there was difficulty in tuning VHF transceivers to the limited range of frequencies prescribed by the government. Unreliability of power supply to some locations continues to hinder the smooth operation of the system.

[P.V. Patil, Pune Irrigation Circle, India,
B.S. Majumdar, CMC Limited, Pune, India, and
S.G. Narayanmurthy, IIMI, Sri Lanka]

Figure 1. Canal operation schedule of the New Mutha Right Bank Canal.
Crop season: Rabi, rotation number: 1. Manually prepared schedule—Period: 12 November 1995 to 14 December 1995.

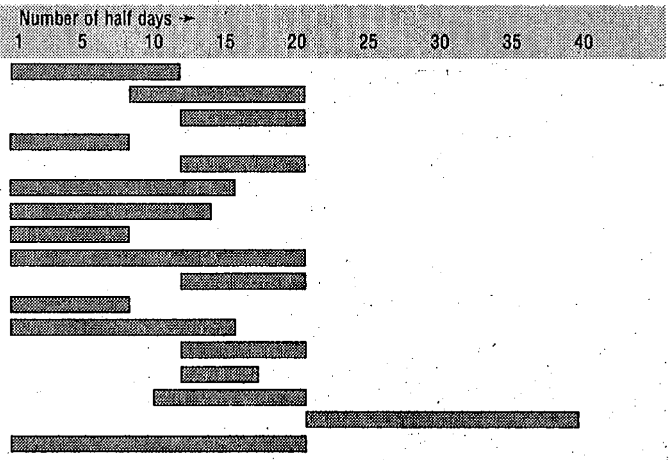
Daund Sub-Division	Capacity (cfs)	Demand (day-cfs)	Supply (day-cfs)
Below km 172	160	1212	1212
Dist - 46	10	60	60
Dist - 45	20	75	75
Dist - 44	20	90	90
Dist - 43	10	39	39
Dist - 41	25	210	210
Dist - 40	12	91	91
Dist - 39	6	26	26
Dist - 38	1	10	10
Dist - 37	3	12	12
Dist - 36	10	40	40
Dist - 35	25	200	200
Dist - 34	3	10	10
Dist - 33	3	7	7
Dist - 32	25	135	135
Bigwan Branch	190	1600	1600
Left-Daund	10	100	100



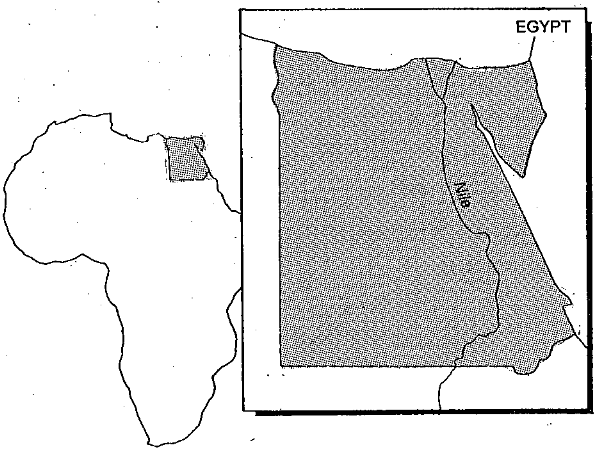
Note: Offtakes are operated with variable flow.
cfs = cubic feet per second.

Figure 2. Canal operation schedule of the New Mutha Right Bank Canal.
Crop season: Rabi, rotation number: 1. Schedule prepared using CIMS—Period: 12 November 1995 to 13 December 1995.

Daund Sub-Division	Capacity (cfs)	Demand (day-cfs)	Supply (day-cfs)
Below km 172	160	1212	1212
Dist - 46	10	60	60
Dist - 45	20	75	80
Dist - 44	20	90	90
Dist - 43	10	39	40
Dist - 41	25	210	2123.5
Dist - 40	12	91	90
Dist - 39	6	26	27
Dist - 38	1	10	10
Dist - 37	3	12	12
Dist - 36	10	40	40
Dist - 35	25	200	200
Dist - 34	3	10	10.5
Dist - 33	3	7	7.5
Dist - 32	25	135	137.5
Bigwan Branch	190	1600	1620
Left-Daund	10	100	100



Note: Offtakes are operated with variable flow.
cfs = cubic feet per second.



Water Allocation in Egypt: An Overview

INTRODUCTION

The 6,825 km long Nile is the longest river in the world. It is the main water resource of Egypt. About 99 percent of the population live in a small patch of land around the Nile valley and the Nile delta. Nine other African countries share the Nile waters with Egypt.

The other water resources are rainfall, drainage water reuse, and groundwater. The annual rainfall in Egypt is about 200 mm. The rains are mostly confined to coastal areas. The drainage reuse is practiced at some locations along the canal network where good quality drainage water is available to be mixed with canal water. Groundwater is also extracted to meet a part of the demand. Most of the groundwater wells are dug in the tail-end areas of the canal system.

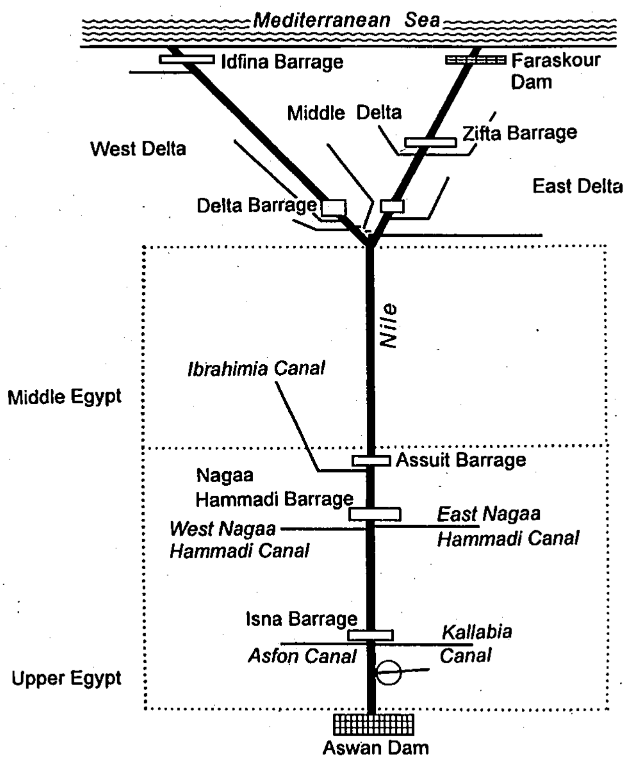
The barrages across the Nile divide the river into seven reaches and constitute the major structures of an intensive irrigation network. The total irrigated area is about 7.5 million feddans (3.15 million ha). About 20 percent of the area is irrigated by pumping from the river to the canal system. The major winter crops are wheat and clover. Cotton, rice, and maize are the major summer crops.

THE MANAGEMENT SYSTEM

The irrigated land in Egypt is divided into five regions. The first two, Upper and Middle Egypt regions, are located in the Nile valley. The others, East, Middle, and West Delta regions, are located in the Nile delta. Five levels can be identified in the irrigation management structure. They are the Central (irrigation sector), Directorate, Inspectorate, District, and the Farmer levels.

The central level management of the Ministry of Public Water and Water Resources (MPWWR) is responsible for the O&M of the irrigation system. Twenty three directorates handle the O&M of the branch and distributary canal system. There are two to three inspectorates under each directorate, and each inspectorate consists of about four districts. The district, which is the smallest administrative unit, manages about 12,000 ha.

The farm ditches are maintained and operated by the farmers under the supervision of the Ministry of Agriculture. The agricultural cooperatives provide the farmers with the agricultural inputs such as seeds and fertilizers. Each cooperative serves one village, representing an area ranging between 500 and 2,000 ha.



WATER ALLOCATION AND OPERATION PRINCIPLES

Municipal and industrial water requirements have to be satisfied as first priority even during water shortages. Other requirements such as navigation or compensation flows for some canals are also considered. Compensation flow is the water used to improve the water quality or raise the canal water levels particularly during the low water-level period.

An annual plan for water allocation is prepared at the central level of the MPWWR. This plan is based on the anticipated cropping pattern. It is discussed with the directorates once every three months. Changes in climatic conditions, cropping pattern, or the time of planting can result in a modification of the plan.

Crop water requirements are calculated in several steps. The first step is to calculate the available water for the crop using soil conditions and rooting depth. The next step is to calculate the water duty, defined as the amount of water needed to be applied for 1 feddan (0.42 ha) for a certain period. A plan for the water releases from the Aswan Dam is drawn using the water requirements. The required data include water requirements downstream of each main barrage along the Nile, the expected gain or loss in the Nile reaches, and the lag time. The daily releases for the Aswan Dam are prepared for each month.

MANAGEMENT TOOLS

Water duties for the Upper, Middle, and Lower Egypt are calculated at the central level of the MPWWR using the Nile Water Management Model. The input data required for this model are evapotranspiration, crop coefficients, irrigation efficiency, and crop-staggering. Crop-staggering is the percentage of crop area planted in a certain period.

The MPWWR, in cooperation with Mott-Macdonald Consultants, has developed a mathematical model called DIRECT to compile the data from crop pattern in each cooperative and compute the canal flow rates in a district. The canal system within a district is operated according to a rotation principle. Using the rotation table set by the irrigation directorate, the software can produce the irrigation schedule for each branch canal for the year.

CONSTRAINTS, LIMITATIONS, AND REQUIREMENTS FOR IMPROVEMENT

All the regulators that separate neighboring general directorates need to be calibrated. The daily water release program prepared by the central directorate of water distribution should guarantee that the water discharge and water level of each point of the irrigation network are enough to cater to the requirements of all the other sectors. A proper monitoring system would reveal the constraints to water allocation.

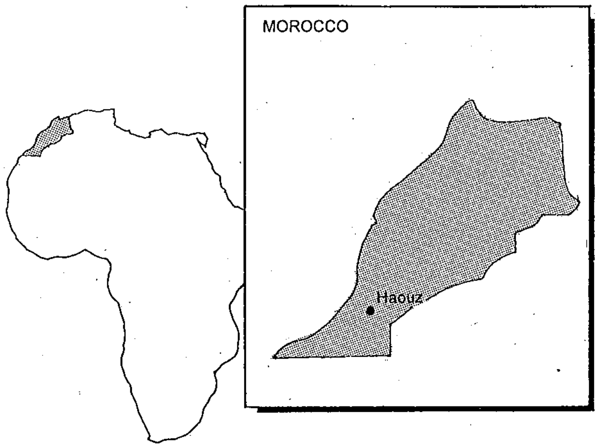
The plan for water allocation and Aswan releases is usually subjected to many alterations of the timing and quantities. Some factors which contribute to this are as follows:

- change in time of planting and staggering
- change in climatic conditions (hot or rainy weather)
- change in anticipated drainage reuse
- change in cropping pattern

The continuous dialogue between the MPWWR and the Ministry of Agriculture to investigate the change in factors such as cropping pattern and time of plantation, would facilitate the modification of the plan of releases, quantification of the sufficient amount of water, and the timing of the deliveries. For example, if the weather in March is cold and rainy, cotton planting time will be delayed till it becomes warmer. If the water is released and if the storage above the barrage is limited, the releases would be in excess of the requirement. Water users would request water again to start planting. Hence, monitoring the canal flow and planting pattern are two important factors to optimize the use of the limited Nile flows.

The drainage water reuse contributes to meet the crop water requirements and thereby raises the water use efficiency of Aswan releases. However, the pollution of drainage water may affect the chances of its reuse.

[Eng. Hussein Elwan, General Manager, Water Distribution in the Public Sector, Ministry of Public Works & Water Resources, Egypt and Eng. Ragab Abdel-Azim]



Scheduling of Water Deliveries in the Haouz Region

INTRODUCTION

The irrigation sector plays an important role in the Moroccan economy. Since 1966, 15–40 percent of all public investments was reserved for irrigation infrastructure development.

The Haouz region, which is a major agricultural area, is situated in the southwestern part of Morocco. It comprises 3 sectors: Tessaout amont, Haouz central, and Tessaout aval. The total area is 663,000 ha. The climate is characterized by low annual rainfall (300-400 mm/year), large variations of temperature (37 °C in summer and 5 °C in winter), and high evaporation (2,300 mm/year).

THE HAOUZ REGION IRRIGATION SYSTEM

The major crops produced include fruits such as olives and cereals. The principal components of the irrigation and drainage infrastructure in the Haouz region are three barrages, a conveyance system comprising two main canals—Rocade canal (118 km) and T2 canal (93 km)—and an interconnected system of secondary and tertiary canals.

The Rocade canal is designed for a flow rate of 20 m^3/s. The annual transferable water is around 300 Mm^3, 260 Mm^3 of which are for irrigation purposes and 40 Mm^3 for the drinking water supply of the Marrakech city.

The canal is automatically operated by the central controlling body known as Centre Général de Télécontrôle (CGTC) situated in Marrakech. The role of the CGTC is to manage the distribution of water and to supervise the daily behavior of the canal. An advanced automatic control technique called "Dynamic Regulation" is applied to the canal system through computer programs. The central computer is connected via VHF transceivers to the control terminal locations. This VHF communication network facilitates acquiring, processing, and storing data. The parameters measured by sensors at various points along the canal are stored by the control terminal. The set point values are fed back to the regulation devices to automatically adjust the movable cross gates. These procedures and equipment constitute a decision support system which helps the Moroccan Irrigation Department in planning and monitoring seasonal as well as day-to-day canal operations.

THE DECISION PROCESS

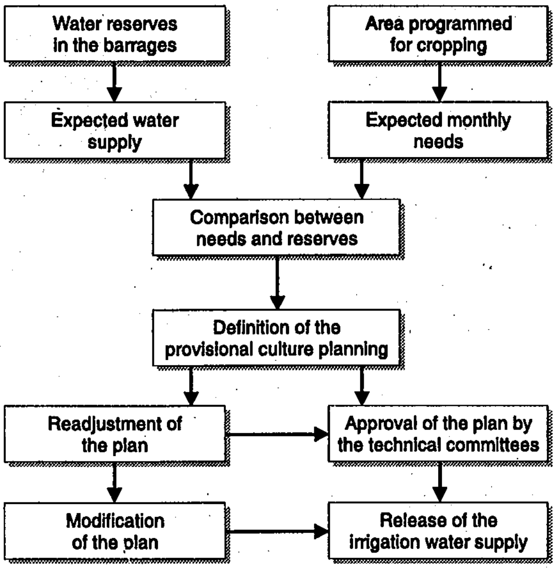
To ensure the planned irrigation operations and water distribution to be at an acceptable level of accuracy, both in terms of rate of flow and duration, the main Rocade canal is automatically operated. The flow rates vary at the canal head end and control points along the canal, because of opening and closing of offtaking channels.

During the irrigation planning process, the preliminary irrigation program is prepared taking into account the existing norms and priorities depending on whether the year is rainy or dry. The planning procedure is schematically presented on p.18.

CONCLUSIONS

The benefits of the present irrigation management system used in the Haouz region can be perceived in terms of water savings through improved agricultural planning and better monitoring of canal operations. However, some of the following enhancements are needed to be adopted to improve the efficiency of the system:

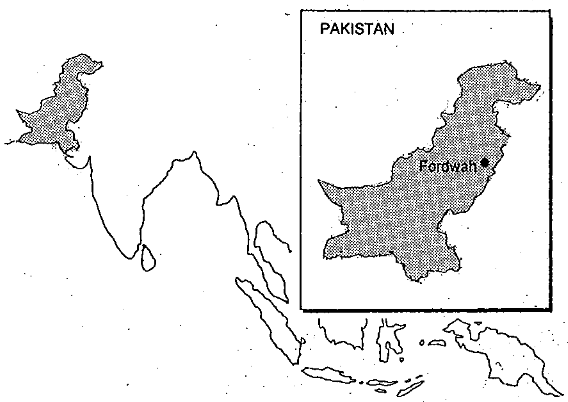
The planning procedure of the Haouz region irrigation system.



- developing a nonsteady state simulation model of the main canal for better understanding of flow and water level conditions throughout the canal operation and to provide adequate guidance for settings of gates
- introducing automatic regulation techniques to circumvent the limitations of the present Dynamic Regulation system
- improving the planning and operational management at field level
- resolving the problem of silting-up in the barrages and in the canal

[Prof. Ahmed Benhammou, Faculté des Sciences Semlalia
Université Cadi Ayyad Marrakech - Morocco]

PAKISTAN



Scheduling of Water Deliveries in the Irrigation System of the Indus Basin

INTRODUCTION

The irrigation network in Pakistan is considered as the largest contiguous gravity flow network in the world. About 27 percent (21 million ha) of the total area of Pakistan (79 million ha) is cultivated. The irrigated area totaling 16 million ha is about 77 percent of the cultivated area. Six rivers feed the irrigation system of Pakistan. Five of them are tributaries of the Indus River, which flows through the Sind province to the Arabian Sea. The climate of Pakistan is semiarid. The maximum temperature rises to 40–44 °C while the minimum temperature in the alluvial planes range from 27 to 32 °C. Rainfall varies between 100 and 1,000 mm per year. Surface evaporation results in a total loss of water amounting to 37,020 million m³. The major crops in *kharif* (summer) include rice, cotton, sugarcane, and fodder. In *rabi* (winter), the crops are wheat, oil seeds, and vegetables.

The canal system in the 4 provinces of Pakistan comprises 3 main reservoirs, 19 barrages, 12 inter-river link canals, 43 main canals, and 107,000 outlets delivering water to the farmers. The aggregate length of the main canals is about 60,000 km. The system has been designed to benefit as large an area as possible and to ensure equitable distribution of water. A large quantity of groundwater is used to compensate for the deficit occurring during the peak demand period.

THE MANAGEMENT SYSTEM

With respect to decision making, three main levels can be identified in the management setup. They are the

provincial, system (the main and the secondary canal), and tertiary levels. Within the limitations set by surface water availability, the farmers have the authority to decide most matters related to crop production and cropping intensity. Exploitation of groundwater is also managed by the farmers and they are free to share and manage this water.

The irrigation system is a run-of-the-river system. Therefore, variability and shortage of surface water supplies are expected. As a result, canal regulation and irrigation delivery scheduling are very important functions of the Irrigation Department. The main objective of the canal operations is to achieve as much equity as possible and to ensure supplies to the tail-end farmers.

OBJECTIVES OF THE IRRIGATION SYSTEM

The objectives of the irrigation system are twofold: global and operational.

Among the global objectives are the following:

- providing maximum water for agriculture and power generation
- flood and drainage control
- ensuring sustainability of the network
- taking care of the environmental impacts
- increasing the productivity
- providing water to all the cultivators on an equitable basis

Among the operational objectives are the following:

- matching the water demand of different systems
- implementing the Water Apportionment Accord between the provinces
- distributing the water shortages or excesses equitably
- minimizing the operational cost
- following the authorized scheduling

Decision Process

The provincial-level canal operations are planned for each crop season using the predicted inflow from rivers and storage in the reservoirs. The canals are operated according to a 10-day schedule. The Indus River Systems Authority (IRSA) distributes the water according to the apportionment accord between the provinces. An account of the provincial-level canal flow for a 5-day period is recorded by the IRSA .

The quantity to be released to a canal is decided based on the allocation made by the Regulation Directorate, or the request by the canal management, whichever is less. This quantity is then released by the engineer-in-charge of the headworks who monitors the canal flow and informs about the variations from the schedule to the central regulation directorate.

The canal system is divided into several subdivisions, which are managed by a Subdivisional Officer (SDO). Each SDO works out the water requirement (indent) of the area under his supervision. This information is conveyed from the tail end to the head end through the respective SDOs. When the supplies are less than the demands, a rotation program is implemented.

State management ends at the secondary canal. The farmer-managed water course receives water from the secondary canal through an outlet which is designed to deliver the authorized share of water. In Pakistan, the water rights related to the canal are linked with the proprietary rights of the agricultural land. A 7-day roster called *warabandi* (to fix the turn) is formulated for all the farmers of a water course. The beneficiaries are expected to operate and maintain the water course and implement the warabandi system. In the case of a dispute, the state management intervenes and fixes the start and duration of the turn of each cultivator according to his landholding size.

IRRIGATION MANAGEMENT PROCEDURES AND IMPLEMENTATION

Within the Chistian subdivision, the Irrigation Department and the International Irrigation Management Institute (IIMI) conduct a joint pilot study to implement the Irrigation Management Information System (IMIS) which enhances the decision-making power of the manager. The IMIS monitors daily operations and analyzes the data.

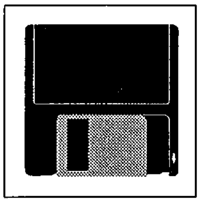
[Ch. Muhammad Shafi, Chief Engineer, Punjab Irrigation Department, Pakistan, and Zaigam Habib, Systems Analyst, IIMI, Pakistan]

Tools and Techniques

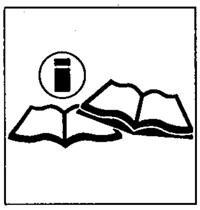
Despite the rapid development in the software industry, the development and application of software in the irrigation sector lag behind the other sectors. There are numerous computer programs written by individuals or groups to solve irrigation problems. However, most of them are either situation-specific or site-specific. Therefore, these programs are rarely used by other computer users. As a result, there has been hardly any improvement in certain sections of the irrigation sector.

The present irrigation software market is not properly structured and functions inefficiently. The potential user looking for the appropriate tools to solve his design or management problem, or some assistance to improve his performance, finds little assistance from the software market.

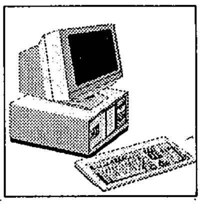
To rectify this situation, several attempts have been made over the past years to prepare an inventory of the available irrigation software. The main objective of these attempts was to provide an overview and description of them. Three recent attempts are given below.



I. **LOGID** is a database developed by the ICID (France). It allows the user to browse through the existing software and to add the details of new products to the database. This software is distributed free in a diskette. *For information contact:* Gilles Bonnet, Secretary, ICID working group on systems analysis, Cemagref, Domaine de Luas, 63200 Riom, France. Phone: (33) 473 38 20 52, Fax: (33) 473 38 76 41, E-mail: gilles.bonnet@cemegref.fr



II. **An Inventory of Irrigation Software** is a manual published by the International Institute for Land Reclamation and Improvement (ILRI). It provides a very comprehensive description of the existing software. *For information contact:* Rien Jurriens, ILRI, P.O. Box 45, 6700, AA Wageningen, The Netherlands. Phone: 0031 317 490144, Fax: 0031 317 417187, E-mail: jurriens@iac.agro.nl



III. **IRRISOFT** is a World-Wide-Web (www) database on irrigation and hydrology. This is installed at the University of Kassel (Germany), allowing a worldwide free access and exchange of information through the Internet. *For information contact:* Thomas-M. Stein, University of Kassel (FB11). Department of Rural Engineering and Natural Resources Protection, Nordbahnhofstr. 1a, D37213 Witzenhausen, Germany. List Owner: irrigation-l@listserve.gmd.de, Phone: (+49)-5542-98-1632. Fax: (+49)-5542-98-1588. E-mail: stein@wiz.uni-kassel.de, www: http:/www.wiz.uni-kassel.de/kww/

IV. **CROPWAT through WINDOWS.** For those who have been playing with the famous CROPWAT software, there is good news coming from Southampton where K.M.S. El-Askari and Derek Clarke are currently developing a WINDOWS equivalent to the FAO CROPWAT program. It is being finalized in collaboration with the FAO.

For infomation contact: Derek Clarke, Institute of Irrigation Studies, University of Southampton, Southampton, United Kingdom. Fax: 44-1703 667519,E-mail: d.clarke@soton.ac.uk

A NEW WORLD WATER AND CLIMATE ATLAS FOR AGRICULTURE

Forthcoming

IIMI, with the collaboration of Utah Climate Center, is currently developing a new climatic database built specifically for planning, design, operation, and management of agricultural systems. Compared to existing databases, major improvements are:

- 10-day data on temperatures, rainfall likelihood, evapotranspiration
- monthly and annual summaries, and statistics
- extreme climatic events
- daily time series given for selected reference stations
- coverage: 25,000 stations
- quality control: provision of an index of station data quality

This ATLAS will be available from the beginning of 1997, on two media:

- one paper ATLAS (with limited information)
- one on a CD-ROM with the whole set of information

For information on Word Climate Atlas, contact: David Molden, Performance Program Leader, IIMI.
E-mail: david molden@cgnet.com

Workshops and Seminars—1996

Reports on the Workshop on Computer Application for Irrigation

The Workshop on Computer Application for Irrigation was held in Montpellier (France) at the Research Center for Agriculture and Environmental Engineering, France (Cemagref) from 22 to 24 January, 1996, organized by the International Institute for Land Reclamation and Improvement, the Netherlands (ILRI), and Cemagref with the participation of the International Commission for Irrigation and Drainage, France (ICID), the Institute of Irrigation Studies, University of Southampton, UK (IIS), the International Irrigation Management Institute, Sri Lanka (IIMI), and the Department of Rural Engineering and Natural Resource Protection, University of Kassel, Germany (GhK).

BACKGROUND AND OBJECTIVES OF THE WORKSHOP

Although there are general developments in the software industries the development of suitable software in the irrigation sector is lagging far behind. The whole irrigation software market presents itself as an unstructured and inefficient field. Little assistance is given to the potential user who is looking for appropriate tools to solve his or her design and management problems or to assist him or her in the improvement of his or her work and irrigation practice.

To improve the irrigation software situation, several attempts have been made over the past years to build up inventories of existing irrigation software. Their main objective has been to give an overview and description of existing software.

The aim of the workshop was to discuss the irrigation software situation and developments and to find ways of improvement of information flow and the coordination of efforts.

Besides recent developments and the general irrigation software situation, the following topics were extensively discussed:

- ways and problems of the establishment of clear and complete inventories of irrigation software
- the structure of irrigation software and the classification/categorization of existing irrigation software
- criteria for software descriptions and assessment
- availability of irrigation software
- quality and usability
- structure and contents of the existing inventories ("LOGID," "AN INVENTORY OF IRRIGATION SOFTWARE" and "IRRISOFT") (See p.20)
- ways of coordination and collaboration among the participants in the improvement of the software and information situation
- the cooperation among the three inventories/databases
- future steps and developments

RESULTS AND FURTHER INFORMATION

It was generally agreed that there should be a strong cooperation among the participating organizations of the workshop to improve the provision of information and to reduce individual work loads.

All three databases/inventories will be continued to ensure a broad audience is reached. Cross references will be included in every database pointing to the cooperating partners and information.

It was also decided upon a strong collaboration among the three databases/inventories to update and exchange existing information and to assist in the future information findings.

Detailed results of the workshop discussions and findings including presentations of the three different inventories will be published by ILRI. Further information and publications may be obtained through:

Rien Jurriens ILRI - International Institute for
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P.O. Box 45, 6700 AA Wageningen, The Netherlands
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Workshops and Seminars—1997

Regulation of Irrigation Canals: State of the art of research and applications—International Workshop in Marrakech, Morocco to review and compare experiences in the theoretical development and in field application of canal regulation techniques with a view to improve global water management, 22–24 April 1997. *For information contact:* Ahmed Benhammou, Université Cadi Ayyad, Faculté des Sciences Semlalia, Départment de Physique, Av. Prince My Abdellah, Marrakesch-Morocco. Tel: (+212) 443 46 49 n°456, Fax: (+212) 443 75 52; or Pierre Olivier Malaterre, Cemagref - Division Irrigation, 361, Rue J-F Breton - BP 5095, 34033 Montpellier Cedex 1 - France. Tel: (+33) 67 04 6300, Fax: (+33) 67 63 5795, E-mail: pierre-olivier.malaterre@cemagref.fr

Information Techniques for Irrigation Systems: Modern Techniques for Manual Operation of Irrigation Canals—Fourth International ITIS Network Meeting in Marrakech, Morocco to exchange experiences obtained on the application of information techniques in irrigation systems and to obtain insights in the requirements for the successful development and application of information techniques, 25–27 April 1997. *For information contact:* Dr. Daniel Renault, IIMI ITIS Unit, P.O. Box 2075, Colombo, Sri Lanka. Tel: 94-1-867404, Fax: 94-1-866854, E-mail: d.renault@cgnet.com.

Call for Papers

Fourth International ITIS Network Meeting

The Fourth International ITIS Network Meeting is planned to be held from 25 to 27 April 1997 in Marrakech, Morocco. The meeting will be jointly organized by the International Irrigation Management Institute, Cemagref, and Faculte des Sciences of the Cadi Ayyad University with the support of Moroccan authorities. The objective of the ITIS meeting is to exchange experiences obtained on the application of information techniques in irrigation systems and to obtain insights in the requirements for the successful development and application of information techniques.

The theme of the Fourth Network Meeting will be "Modern Techniques for Manual Operation of Irrigation Canals" and the goal will be to review the latest improvements and techniques related to fully manually operated canals and partly automated canals.

Type of Contribution

The unique feature of the International ITIS Network Meeting is to provide a forum for the managers and researchers to share their own experiences and achievements in the management field. Contributions from researchers and managers, (if possible joint-contributions) on real-life applications of information techniques are invited.

Topics

Improvements of manual canal operation is the focus of the Fourth Network Meeting. The contributors are expected to address the issue with practical considerations, preferably supported by some efficiency (hydraulic, economic, and sociological) assessment as well.

Format

Papers should be a maximum of eight (8) pages long (including maps, figures, and tables) and should follow the grid presented in the "Introduction Paper" document which could be obtained from the Coordinators, ITIS Network.

ITIS On-Line

Electronic mail is fast, reliable, and cheap. It is also an intrinsically ideal platform for the development of the ITIS Network. Almost all the countries represented in the Network have some form of access to the Internet. It is only a matter of time before most, if not all, ITIS members gain network access.

Now is the time to sow the seeds for a future harvest. The first step would be to compile an e-mail database and start a discussion group. If you have an e-mail address, and would like to participate in an electronic exchange of information and experiences with other ITIS members, please send your e-mail address and a short note to:

d.renault@cgnet.com

Next ITIS Newsletter:

Application of GIS & RS Techniques in Irrigation and Drainage Fields

Many applications, trials, and pilot projects have been conducted to study ways and means of using GIS and Remote Sensing (RS) techniques to improve irrigation and drainage technology. Applications of these modern high-tech tools in some interventions were highly successful and some of these were even integrated into the normal management process. Therefore, we have decided to dedicate our next issue of ITIS to our colleagues who are interested in using GIS and RS as management tools.

We gladly welcome your valuable experiences in this field which will be shared with our network members. Please send your contributions direct to the IIMI-ITIS Unit prior to June 30, 1997.

Thank you.

Daniel Renault and Manjula Hemakumara
Coordinators
IIMI ITIS Newsletter
PO Box 2075, Colombo, Sri Lanka