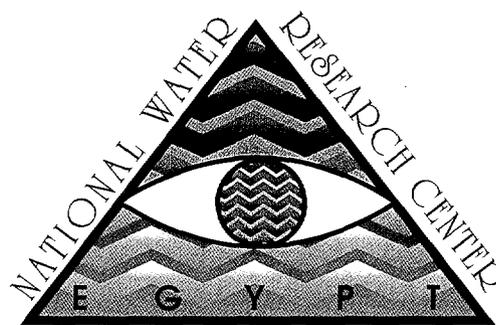


November 1988 - March 1995

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PROJECT REPORT

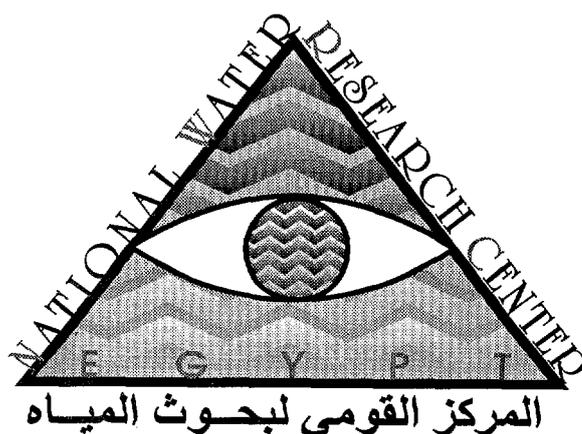
Irrigation Management Systems
National Water Research Center Project

**IRRIGATION MANAGEMENT SYSTEMS
NATIONAL WATER RESEARCH CENTER
PROJECT
END-OF-PROJECT REPORT**

November 1988 - March 1995

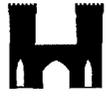
IMS / NWRC

Contract No. 263-0132



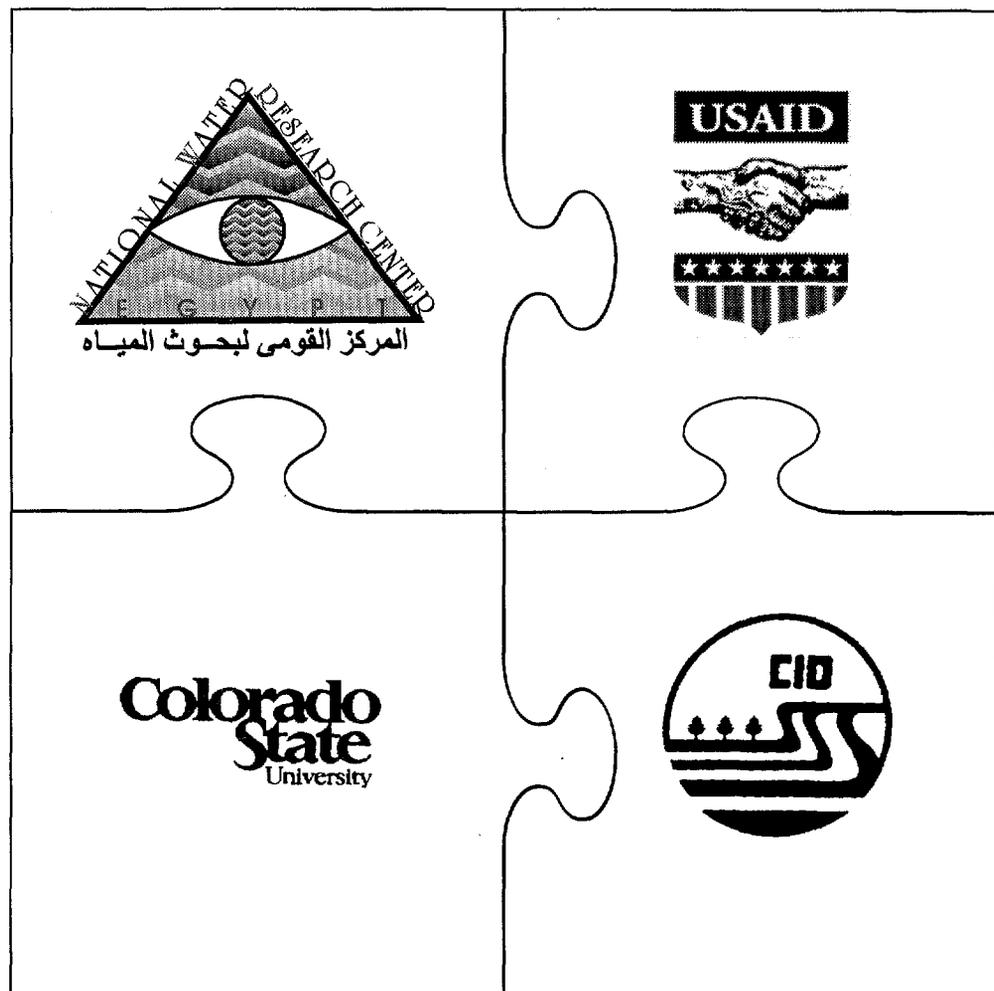
**UNITED STATES AGENCY
FOR INTERNATIONAL DEVELOPMENT**

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I. FOREWORD / ACKNOWLEDGEMENTS

COLLABORATIVE LINKAGES



COLLABORATION:
Doing with others what one cannot do alone.

**Ministry Of Public Works And Water Resources
National Water Research Center
Cairo, Egypt**

IMS / NWRC Project Integration





NATIONAL WATER RESEARCH CENTER (NWRC) FOREWORD

as the nation enters a new era characterized by scarcity of water. Water resources development and human resource development are two sides of one coin—they cannot be separated.

As an institution-building activity, the Irrigation Management System/ National Water Research Center (IMS / NWRC) Project not only assisted the NWRC in the development of hardware and software capability but also increased the sustainability and future impact of the Center through the ability to quickly activate human resources capacity to deal with new water-related issues as they emerge.

New Challenges

Human resources development is a long-term process—short-term impacts are less visible. The rapid development of the National Water Research Center as a research body is clearly visible in the short-run, however. NWRC has become a focal point of interest and pride in the field of water science and a leader in the world relative to water related research.

The output quality of this capacity-building project is due to many contributions and the commitment of the NWRC staff, the United States Agency for International Development (USAID) Mission in Cairo, the Consortium for International Development (CID) as the contractor for the project and the Colorado State University (CSU). Without their faithful contributions, the project could not have fulfilled its obligations.

The IMS-NWRC model is a unique approach to institutional and technical development which could be applied elsewhere in the field of water resources development and management.

Challenges on the horizon for Egypt and many other developing countries are outstripping both past and present challenges



Dr. Mahmoud Abu-Zeid
Chairman, NWRC



CONSORTIUM FOR INTERNATIONAL DEVELOPMENT (CID) FOREWORD

Sustainable development in Egypt, as in the United States, requires wise and efficient use of water resources. C.I.D. is proud to have cooperated with the people of Egypt to meet the multiple modern challenges of water management. Egyptians who have the awesome responsibility to manage this key national treasure now have improved technical and managerial skills to continue their work.

The member universities of the Consortium for International Development have a long history of research, education, and extension informational and delivery systems in the field of water management as well as related issues. Our universities are active in domestic programs in water related issues and have been engaged in international water research and education programs for more than 25 years. We are proud of the Egyptian program and consider it to be a major contribution to international development.

The collaboration between the National Water Research Center and our member universities, particularly Colorado State University, provides benefits to both Egypt and the United States. Outstanding Egyptian scientists have contributed to the international body of research in a wide range of subjects germane to improved water management. As we now look to the close of this project we know that seeds for future collaborative programs have been planted. Friendships, personal and professional, have been established; and our university families are enriched by the bonds forged by common challenges faced over the past several years. These bonds will undoubtedly foster continued collaboration with new challenges into the next century.



Jean Ruley Kearns, Ph.D.
Executive Director, CID
Professor Emerita,
University of Arizona

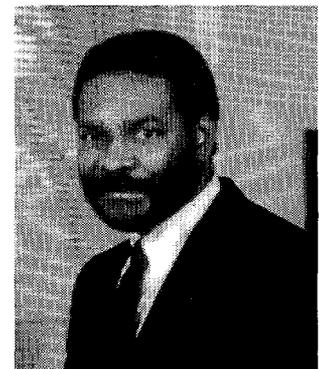


COLORADO STATE UNIVERSITY (CSU) FOREWORD

Colorado State University, as lead University for the Consortium for International Development and with the support of USAID, has worked with the Egyptian Ministry of Public Works and Water Resources (MPWWR) to provide solutions to water resource problems since 1977. During this period, Egypt and the United States have each benefited tremendously from this cooperation and scientific exchange.

The results of our efforts have been presented at various conferences and reported in many scientific journals, thus allowing their use by many agencies within Egypt and the United States and by other nations. In Egypt, the efficiency of water use for irrigation has increased, water quality problems and shortages have been identified and are being addressed. Through the cooperation established with scientists at more than 20 universities and government agencies in the United States and several universities in Egypt, the prospects for better water resources management are excellent.

Colorado State University is proud to have worked so effectively with the Water Research Center and its staff. The successful conclusion of the Water Research Center Project has provided both Egypt and the United States with solutions to many technical problems. Perhaps just as important, it has proved that scientists from the two nations can work together in a mutually beneficial manner.



Dr. Albert Yates
President, CSU



ACKNOWLEDGEMENTS

Development, improving institutional capacity for research, training, outreach and research are keys to sustaining agriculture. The newly trained staff in the Water Research Center will lead Egypt to a more prosperous future and a more stable economy.

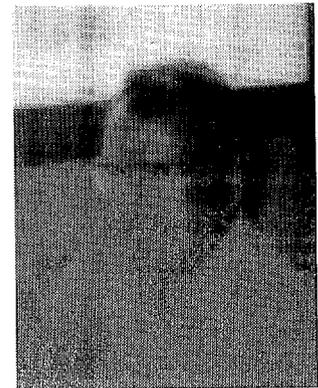
The Consortium for International Development and Colorado State University are proud to have been involved in the development of the research capabilities of the Ministry of Public Works and Water Resources.

In the last six years, many organizations including universities, state and federal agencies and private sector firms have been involved in a collaborative effort of training, technical assistance and procurement to bring the project to a successful completion. Participants were trained at more than 20 sites in the US, adding diversity to the methodology of solving the pressing problems of agriculture and water resources.

The high quality efforts of the many individuals of the organizations that have supported the goals of this project are gratefully acknowledged.

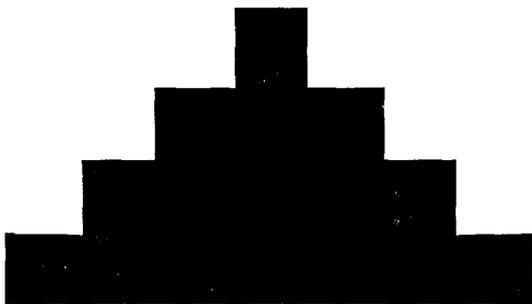


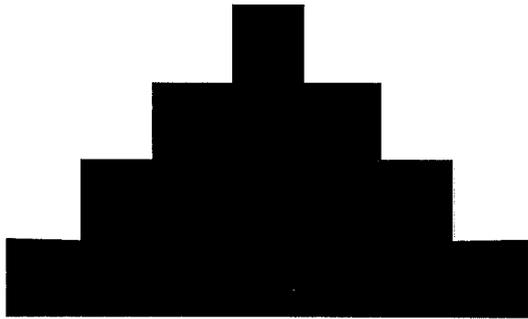
Dr. Dan Sunada
Professor of Civil Engineering, CSU



Dr. E. V. Richardson
Professor of Civil Engineering, CSU

II. HISTORICAL BACKGROUND AND PROJECT EVOLUTION





Two Decades of Institutional Linkages

EWUP

EIP

IMS / NWRC



PREPROJECT HISTORY

Ancient Linkage... Water and Man

The link of man and water is an evolutionary process which is evidenced in the very saline nature of each individual human cell. Thus, the interdependence of human kind and water extends beyond even the dawn of civilization and resides in our genetic common past.

"There was a time when we were not. Then a seed was planted (scarcely different from the same cells in seaweed) and our saline blood resembled the sea water from which we emerged and our tears were salted."

Adapted from Peatie's Almanac For Moderns.

As civilization unfolded (within the Nile Basin) man's use of the precious water resource was acknowledged as the critical link to his survival. With the dawn of Egyptian history the role of water became an important social-economic force in development. The River Nile was not only a conduit of this life-giving resource, but an important distributary of culture and development.

With the cyclic rhythm of flood and flow, nature determined man's timetable as the Nile annually flooded the land. Resource management was still beyond human influence. The forces of nature ebbed and flowed with great impact upon civilization but was not yet impacted by man. The availability of abundant resources of sun, soil and water precluded much concern about resource management.

As civilization in the Nile River Basin developed, use of these natural resources took on more and more social and political importance.

There is evidence of international trade in wheat with a contemporary civilization in Harappa (now Pakistani Punjab in the great

Indus Basin) in Pharaonic times. Agricultural production was not only a matter of national sustenance, but a social-economic force.

The interdependence between civilization and resource development and management grew in the shadows of the pyramids as predecessors of modern irrigation engineers began exploration of water management.

Over time, this work continued and in the eighteenth century more scientific approaches emerged with the development of irrigation data collection on the Nile Basin.

As population grew and agricultural land was diverted to urban use, the need for sound water management became more and more apparent. Nile flow control with the construction of the High Aswan Dam and other seasonal and long-term storage projects began to assert human control over the natural environment. However, the scientific attitude also suggested integration rather than domination of man over nature.

This sense of interdependency of natural and human systems is at the heart of recent work in water resource management. This is evident in a series of linked projects implemented by Egyptian/ Non-Egyptian irrigation specialists which aimed at achieving welfare and prosperity in the Egyptian and international community of mankind.

Two Decades of Collaborative Activity

Since the Camp David Accord in 1979, the United States government, through USAID, has been engaged in a large development program for Egypt. One aspect of this program has been to assist with the Egypt Ministry of Public Works and Water Resources (MPWWR) in developing the nation's capability to manage its water resources and thereby to increase agricultural production.



The need for better water management capabilities is directly related to the fact that Egypt is trying to improve its food and fiber production. Imports account for more than 50 percent of the country's total food requirements. Explanations for the country's shift from a net exporter of food in 1975 to the present net import situation include the high rate of population growth, increased per capita food consumption, and a reduction of irrigated lands along the Nile River due to urbanization.¹ The government of Egypt is seeking ways to solve this problem.

One agricultural component which was targeted for improvement was the water management and water resources sector. The nation's farmlands are almost entirely dependent on irrigation from the Nile. With the completion of the High Aswan Dam in 1964, the ancient methods and management techniques of irrigation have been dramatically altered. The new water management scheme has provided the country with tremendous agricultural potential, but it has also generated new problems of waterlogging, salinity, and challenging management conditions for both the farmers and the MPWWR.

The management of water in the agricultural sector has to be coordinated with the nation's requirements for water in the urban, industrial, power and transportation sectors. To further complicate this required coordination, all of the planning is being done in a water short environment caused in part by the drought in East Africa at the head waters of the Nile.

USAID ROLE

The U.S. Agency for International Development (USAID) has designed an extensive technical assistance program to help Egypt address its water management needs so that the available water can be used most effectively. USAID initiated this technical assistance effort in 1977 with the Egypt Water

Use and Management Project (EWUP). In 1981 USAID, at the request of the MPWWR, initiated the Irrigation Management Systems Project (IMS) which was designed as a multi-component project.²

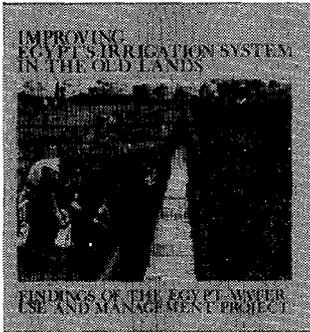
The purpose of this project has been to strengthen the MPWWR's capability and capacity to plan, design, operate, and maintain the highest quality water distribution system possible. The component parts of the IMS include the Irrigation Improvement Project, Structural Replacement Project, Preventive Maintenance Project, Main Systems Management Project, Planning Studies and Models Project, Professional Development Project, Water Research Center Project, Project Preparation Department, Survey and Mapping Project, and miscellaneous operations. The IMS Project is scheduled to end in September, 1995.



CID INVOLVEMENT

The Consortium for International Development (CID), with Colorado State University (CSU) as the lead managing university, has been the contractor for three USAID projects; Egypt Water Use Project (EWUP 1977-1984), the Irrigation Improvement Project (EIIP 1985-1991) and the Water Research Center Project (WRC 1988-1995). The three projects, while related, have addressed different aspects of the MPWWR's responsibility to manage and administer the nation's water resources.





تطوير
نظم الري
في
المنخفض



EGYPTIAN WATER USE PROJECT

EWUP (1977-1984), was a research project designed to develop improved

on-farm water management practices within a local irrigation command area. From that initial effort, practices successfully tested on farmers' fields and in local branch canal command areas were expanded into regional development programs.

EWUP's fundamental purpose was to improve the social and economic well-being of small farmers through the development and implementation of improved irrigation water management in conjunction with improved agronomic practices which would increase agricultural production, develop efficient water use practices and reduce drainage problems.³ An additional explicit component of these objectives was to strengthen the institutional capacities of the MPWWR and the Ministry of Agriculture (MOA) to develop and implement improved on-farm water management programs.

The Project's specific objectives were to:

1. Evaluate and improve on-farm irrigation design and management.
2. Evaluate and improve the design and management of the water distribution system.
3. Develop and implement a methodology for organizing farmers into water users associations.
4. Design and develop an Irrigation Advisory Service.

5. Develop a ground and surface water budget analyzing both water quality and quantity.

6. Analyze the need, and if necessary, implement a land leveling program.

7. Investigate soil fertility problems and the influence of alternative fertilization and micronutrients upon yield and water management.

8. Develop a detailed soil characterization map for the project areas and investigate the influence of general soil properties, and vertisols in particular, upon water management in Egypt.

9. Investigate pest and crop disease problems in Egypt, the influence of these upon water management and the control of these pest and disease problems.

10. Investigate the potential for conjunctive use of water for irrigation from sources such as drains, groundwater, and the Nile River in Egypt.

11. Investigate improved farm management and planning and its economic implications.

EIIP EVOLUTION

The Egypt Irrigation Improvement Project (1985-1989), evolved from the findings of EWUP. The basic objective was to expand the scope of EWUP, an applied research effort, to a large area in Egypt for the purpose of developing MPWWR operational programs. In essence, the goal of EIIP was to improve the operating efficiency of the total irrigation system and to strengthen the MPWWR's ability to plan, design, operate, manage and maintain its irrigation systems.⁴

EIIP had two major foci of interest. The first was to demonstrate a practical procedure to remodel irrigation systems so that the methodology could be applied rapidly to improve

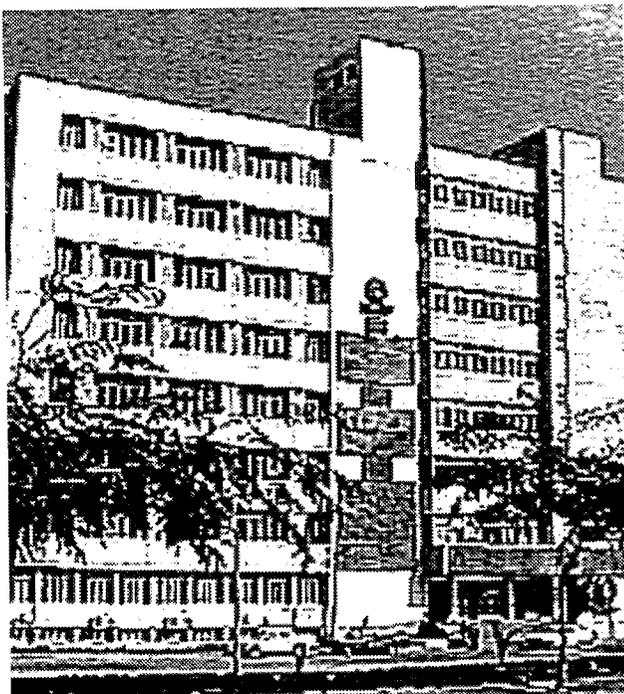


systems in other command areas. Remodeling means the rehabilitation and improvement of the water distribution system including the main, branch, and distributary canals as well as the mesqas.

Rehabilitating and improving the mesqas also requires organizing farmers into water users associations and implementing an Irrigation Advisory Service for the purpose of improving on-farm water management and irrigation efficiency. The second focus was the development of the National Water Research Center (NWRC) by improving the research institutes of the NWRC and by establishing a centralized information data center.

NATIONAL WATER RESEARCH CENTER DEVELOPMENT

The NWRC was established in 1975 when the MPWWR consolidated its water management research efforts. The NWRC is



made up of eleven research institutes. A general description of each institute's function follows.⁵:

1. Water Management and Irrigation Systems Research Institute (WMRI):

To develop ways to improve the water distribution network of Egypt, enhance on-farm water management techniques, implement modern irrigation methods, assess plant-water requirements, and improve irrigation efficiency by minimizing water losses.

2. Drainage Research Institute (DRI):

To conduct research on surface and sub-surface drains, analyze drainage water, develop programs to reuse drainage water for irrigation, and conduct salt balance studies for improved irrigation.

3. Water Resources Research Institute (WRRI):

To develop the water resources in the Sinai and in the upper tributaries of the Nile river, and collect data to be used to design dams and other control structures.

4. Nile Research Institute (NRI):

To predict and determine the impact of changes in the Nile flow regimes as a result of constructing the High Aswan dam; and submit channel protection proposals for regions subject to degradation, bank erosion, or sedimentation. Also, to make regular channel cross-section surveys of the Nile river and Lake Nasser; analyze the data; and by using computer and mathematical models, report status overall degradation, bank erosion and sedimentation along the course of the Nile river.

5. Hydraulics Research Institute (HRI):

To develop and use hydraulic models to solve problems of degradation and sedimentation in the Nile river channel and design the most appropriate irrigation structures, power stations, canal intakes, and barrages.



6. Channel Maintenance Research Institute (CMRI):

To safely control the growth of harmful aquatic weeds in water channels by manual, mechanical, chemical, or biological means.

7. Groundwater Research Institute (GRI):

To assess the capacity of the underground water reservoir in the Nile valley and delta, determine the extent of seawater intrusion in coastal aquifers, develop a hydrological map of the delta and Nile valley regions, and determine the best methods for conjunctive use of surface and ground water.

8. Construction Research Institute (CRI):

To study the soil mechanics and seepage problems relevant to the foundation of hydraulic structures and canals.

9. Mechanical and Electrical Research Institute (MERI):

To study the development, operation and maintenance of the mechanical and electrical machinery which is associated with the gates at water control structures, pump systems, and with the protection of hydraulic devices from corrosion.

10. Survey Research Institute (SRI):

To determine the geodetic surface in Egypt, study the movement of the earth crust in Asia and Africa, and examine the earthquake region at Aswan.

11. Coastal Research Institute (CORI):

To perform hydrographic scanning of the shore line; measure sea currents, wind and waves; record tides and water levels in the Mediterranean; and develop programs to protect the coastal regions from erosion.

The work with the NWRC which began with EIIP continued in an intensive way with the NWRC Project.⁶ The goals of the NWRC project were to:

1. Conduct research to provide solutions to problems facing Egypt in its activities for the control, use, and development of Egypt's

water resources, and ultimately for its economic and social development.

2. Perform research to provide answers to key policy issues in the irrigation sector.

3. Develop the long term capabilities of the WRC and its research institutes to provide the MPWWR and Egypt solutions to their irrigation and water resource problems.⁷

The three projects dealt with an extensive range of water management issues. The training strategies that evolved from these projects were designed to upgrade the Ministry's capability to deal with these various subjects in as comprehensive a way as possible.

The underlying philosophy of the training component of each of these projects was to provide a significant number of people with as broad a training experience as possible so that the MPWWR, in general, and the NWRC specifically could build their respective institutional capabilities from a strong foundation of competent and motivated individuals.

THE IMS / NWRC PROJECT

The NWRC component of the IMS Project was designed in principal as a human resources development and institutional and capacity building for the WRC as a MPWWR research body.

In order to measure the project's impacts on Egypt, one needs to consider that it has impacted individuals, and the NWRC Institutes as well as the different sectors of the MPWWR and Egyptian society in general.

Consequently, both the hardware and the software of the irrigated agriculture system in Egypt have been affected by the project. This section outlines some of the achievements of the project within these domains.



The first generation of USAID programs with the NWRC included the field of applied research (EWUP, 1977-1984), the adaptation of the system approach, and formation of interdisciplinary teams where NWRC has developed and improved these concepts from rehabilitation and improvement type of work to more modernization and optimization of systems. The Egyptian experiences and professional contribution are known throughout the world. The IMS-NWRC/ USAID program is considered the second generation of such programs.

The National Water Research Center and the Irrigation Management System Project are part of comprehensive efforts by the Government of Egypt Ministry of Public Works and Water Resources (MPWWR) to increase agricultural production, reduce the food production-consumption gap and improve the social and economic welfare of the people of Egypt.

Technological, management and research advances in irrigation enable the MPWWR to continue to contribute to Egyptian agricultural and food production.

The Ministry of Public Works and Water Resources and the National Water Research Center comprise the structure through which applied research findings can improve the control and use of water resources.

The IMS Project has had as one of its major objectives the development of MPWWR's research capabilities with a focus on increasing the NWRC's capacity for applied research through its eleven Institutes. Through research, complemented with programs to disseminate research findings to farmers and senior policy makers, the MPWWR can continue to be effective in increasing production of food and fiber. This was the major challenge of the IMS/NWRC activities outlined in this report.

THE NEW SCOPE OF WORK

Egypt is entering a new stage of water problems in terms of quantity, quality, space and time. The present water per-capita share is estimated to be less than 1000 m³/ year. In order to overcome the problems associated with the current situation, considerable work has to be carried out in areas of policies, strategies, techniques and level of technology, legal, organizational as well as institutional, training, public awareness, water economics and users' participation.

TRAINING EMPHASIS COMMON TO ALL PROJECTS

All three of CID/CSU projects not only addressed the need to introduce "technical" improvements to Egypt's water resource management capability, but also worked to improve the institutional capability to sustain such progress.

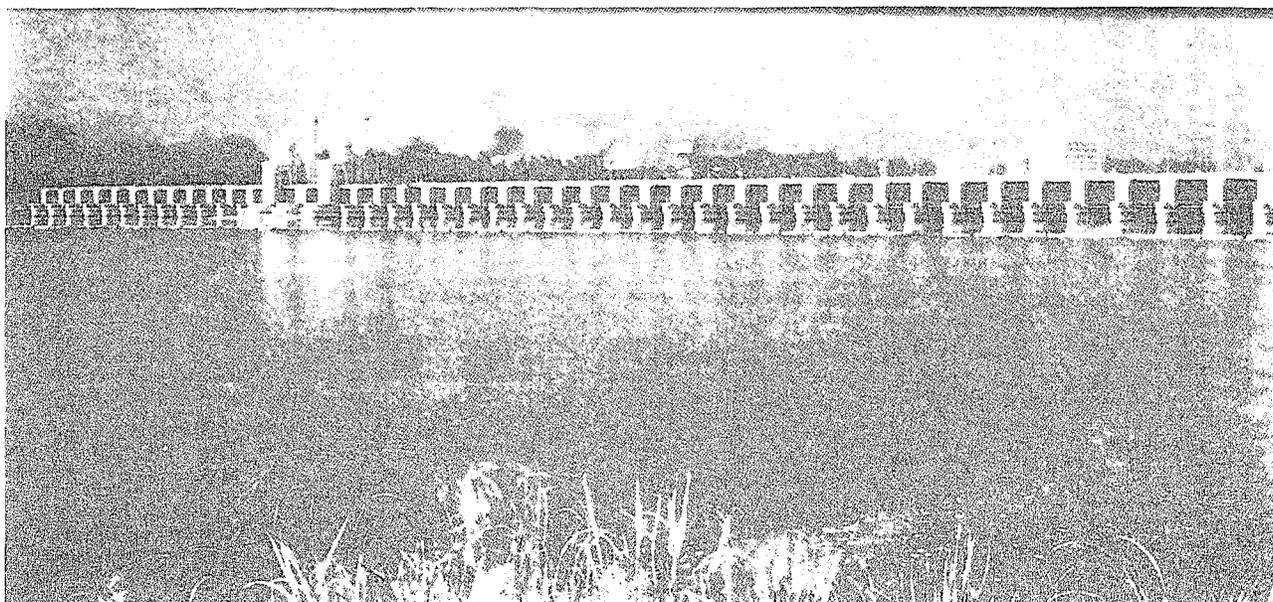
Therefore, in addition to developing new irrigation practices and building new irrigation structures, the projects also concentrated on enhancing the professional staff's capability to manage the organization which evolved through the incorporation of technical innovations.

One critical component to an improved institutional environment is having a well-trained staff.

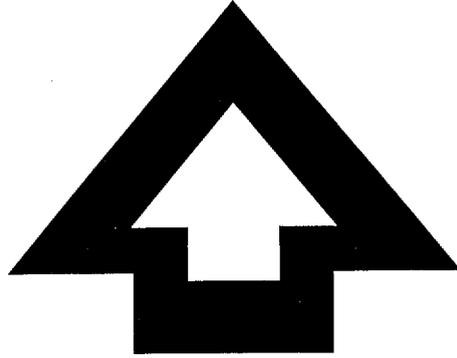
Thus training has been an integral aspect of all three projects. One purpose of this report is to describe the training which has been provided to the professional staff during the three projects. A more detailed discussion of the three projects will first be presented to provide a context from which one can understand the involvement of the training programs. A discussion of the specific training programs will also be provided.



Each project's training programs reflect the nature of that project's respective goals, objectives, and activities. Basically, the purpose of training is to provide skills and knowledge to individuals or groups in order to solve problems. Identified problems in specific water management practices were addressed by the projects and the purpose of the training programs was to provide the means by which the MPWWR staff would be able to address those problems.



- 1 Shaner, W. and S. Karaki. National Irrigation Improvement Program:Vol. 1. Cairo: Consortium for International Development. November, 1986.
- 2 Irrigation Support Project for Asia and the Near East. Irrigation Management Systems Project Interim Evaluation: Report No.35. Cairo: USAID Mission to Egypt. September 1990.
- 3 Richardson, E.V.; et. al. Final Administrative Report: Egypt Water Use and Management Project. Tucson, AZ: Consortium for International Development. April, 1985.
- 4 Karaki, S.; et. al. Egypt Irrigation Improvement Project Final Report. Tucson, AZ: Consortium for International Development/ Colorado State University. February, 1989.
- 5 Karaki, S.; et.al. Egypt Irrigation Improvement Project Final Report. Tucson, AZ: Consortium for International Development/ Colorado State University. February, 1989.
- 6 Richardson, E.V. Project Paper: Water Research Center Project. Ft. Collins, CO: Colorado State University. August, 1986.
- 7 Irrigation Support Project for Asia and the Near East. Start-Up Workshop For the Water Research Center of the Egyptian Irrigation Management Systems Project: Report No.13. Cairo: USAID Mission to Cairo. February, 1989.



III. PROJECT OBJECTIVES



IMS/NWRC PROJECT OBJECTIVES

USAID Contractual Expectations

Integration

The technical assistance team in Egypt, under the guidance and control of the Senior Researcher, will be integrated into the organizational structure of the NWRC. Thus, the team will not operate independently but rather as a part of the NWRC organization within MPWWR.

Work Statement Training Component

Objective

Provide current staff with the research and management skills to find solutions to Egypt's current and future water management problems, and disseminate results in a form that can be readily adopted by users.

Expectations

Trainees will:

- Gain new skills or knowledge which will enable them to advance in their work and contribute to the WRC's goal of providing the best information to MPWWR to manage Egypt's land and water resources.
- Develop long-lasting and significant relationships with scientists in the U.S.
- Develop host country staff to monitor staff development through training and in coordination with the MPWWR Professional Development Project component.

Work Statement Commodity Procurement Component

Objective

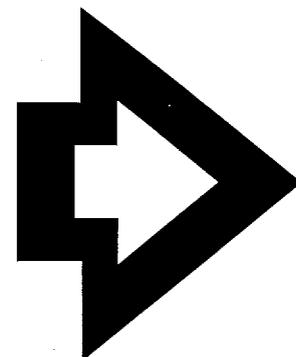
The objective of the commodity program is to reasonably equip the NWRC (The Chairman's Office and Eleven Institutes) with laboratory and field equipment necessary to execute an applied research agenda related to water and land resource management problems and to communicate the findings of this research to the appropriate MPWWR Departments and other users.

Scope of Work

The Contractor is responsible for reviewing the Commodity Procurement Plan with appropriate NWRC personnel, adding or deleting items according to long-term work plans and staff needs.

The Contractor shall be responsible for:

- Development of detailed specifications and all procurement actions including transportation services.
- Insuring a reasonable amount of hands-on training to assure that responsible NWRC staff are thoroughly familiar with operational and maintenance requirements of equipment.
- Development of a procurement schedule identifying priorities and critical steps in the procurement process.





Work Statement Technical Assistance Component

The contractor shall provide technical services to the NWRC. The Contractor will provide three types of personnel:

Long-term experts stationed in Egypt and the home office,

Short-term experts on a Temporary Duty (TDY) basis, and,

Long-term local hire personnel.

Objective

The technical assistance objective is to directly assist the Chairman's Office and the eleven Institutes in setting research agendas, providing research support and disseminating research results.

Scope of Work

The technical assistance team is responsible for implementing the training and procurement components and providing the technical support required by the NWRC to meet project objectives. A home office team is also needed to support the large number of consultants, participant training and the amount of commodities to be procured. Specific tasks include:

Commodity Procurement Task

Joint development of a Procurement Plan and schedule of procurement.

Management of Research Task

- Development of an institutional process for identifying research needs and setting priorities.
- Development and institutionalization of a process of prioritizing relevant research activities.
- Development of a research dissemination plan.
- On-the-job training for technical assistance team counterparts.

- Team members will teach a minimum of one short course per year in the expertise area. TDY personnel should have seminars programmed into their assignments.
- Team members will assist NWRC in documentation of research work.
- Complete and fine tune the establishment of a documentation and management information system for the NWRC which is compatible with Ministry wide systems.

NWRC / Contractor Implementation Perspective

The Water Research Center Project is a component of the IMS project sponsored by USAID. The contractor is the Consortium for International Development (CID) with Colorado State University (CSU) as the lead institution. The contractor provided assistance for academic training, short-term training, on-site training, procurement of supplies, shipment of supplies, and long term and short term technical assistance. This final report presents the results made in training, technical assistance and procurement for the period November 1, 1988 through March 31, 1995 as specified in the amended contract.

The Ministry of Public Works and Water Resources has and will continue to undertake research to define and solve Egypt's water resources problems. This NWRC Project was designed to increase the research capability of the Water Research Center to meet the future needs of Egypt. The objectives of the National Water Research Center are:

1. Conduct research to increase the effective use, control and development of Egypt's water resources.
2. Conduct research on policy issues facing the Ministry of Public Works and Water Resources.
3. Increase the research capabilities of the NWRC and its eleven research institutes.



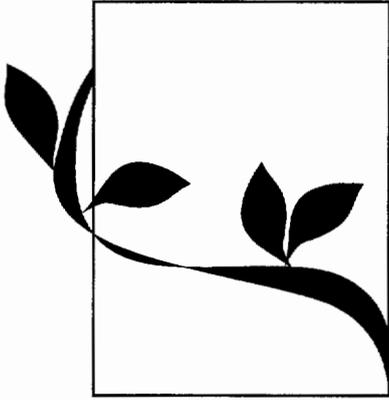
Several short term TDYs went to Egypt to help define the strategy to achieve the above objectives. In November of 1988, Dr. Sunada worked with Dr. Abu-Zeid, Chairman of the Water Research Center, to develop the Life of Project Work Plan (Nov. 1988) and in January of 1989, a team of ten TDYs went to Egypt to work with the directors of the eleven Research Institutes to help define their research agenda and research needs.

This effort resulted in a Travel Plan (accepted March 5, 1989--revised and accepted October 10, 1990), a Procurement Plan (accepted June 1, 1989--revised and accepted Feb. 26, 1992) and a Detailed Life of Project Work Plan (accepted March 5, 1989 and November 13, 1989) which required the following outputs:

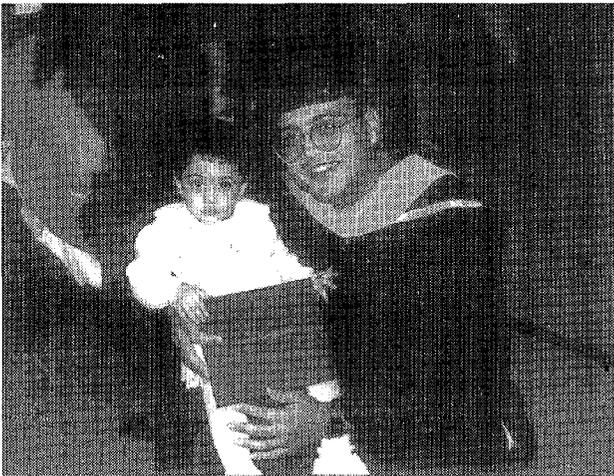
- Provide academic programs for 31 Ph.D. and 46 M.Sc. candidates.
- Provide short term training in Egypt and other countries on specific topics to help establish capabilities to conduct research.
- Provide for invitational training to disseminate the research findings and to establish and maintain professional contacts with other researchers in water resources.
- Provide short-term and long-term technical assistance to help define research objectives, needs and present results.
- Provide equipment for the conduct of present and future research needs.

The above was accomplished with the input of Dr. A. Barnes, Dr. F.W. Smith, Dr. W. Skaggs, Dr. T. Gates, Dr. J. Ruff, Dr. H. Falvey, Dr. G. Sabol, Dr. W. Charlie, Dr. M. Jensen and Mr. R. P. Vandenberg (all TDY's); and the Institute Directors: Dr. Rady, Dr. Khafgy, Dr. Khattab, Dr. El-Kady, Dr. Ibrahim, Dr. Amer, Dr. Gasser, Dr. El-Moattassem, Dr. Hefny, Dr. Tawadros, and the Chairman of the NWRC, Dr. Abu-Zeid.





**IV. TECHNICAL
ASSISTANCE, TRAINING,
AND EQUIPMENT
PROCUREMENT**



“No learned scholar can present to us his specialized knowledge in simple human terms until he has digested that knowledge himself and brought it into relation with his observations of life.”

[Yutang]



A. TECHNICAL ASSISTANCE

Long-Term Technical Assistance

The staff at Colorado State University consisted of Dr. E. V. Richardson, Technical Advisor (1/1989-6/1989), Dr. D. K. Sunada, Training Specialist (1/1989-6/1989) and Project Coordinator (6/1989-6/1994), Ms. D. Rein, Administrative Assistant (1/1989-9/1993), Ms. D. Maybon (9/1993-6/1994) and Dr. J. Layton, Training Specialist (6/1989-9/1991). The long-term technical assistance team in Egypt consisted of Dr. R. Brooks, Senior Researcher (1/1989-5/1992), Dr. K. Seibert, Manager of System Development (1/1989-7/1991), Mr. W. Pope, Manager of System Analysis and Design (7/1991-7/1992) and Mr. J. Hedrick, Program and Administrative Officer (1/1989-5/1994).

Short-Term Technical Assistance

Short-term technical assistance was provided by individuals, many of whom served more than one assignment. These professionals came from federal agencies, state agencies, the private sector and numerous universities. All eleven research institutes participated in the effective use of the TDYs. Table A1 in the Annex lists the TDYs and their assignments. Many of these TDYs presented on-site training and these are described in the training section.



B. TRAINING PROGRAM

Training Plan Response

The NWRC Project's training focus is to provide trained personnel to carry out the NWRC's research and implementation activities for the MPWWR.

One major focus of this project is to provide a trained cadre of M.Sc. and Ph.D. degree staff members to increase the research capabilities of the NWRC. Another training objective is to provide the current staff with the research and management skills to find solutions to specified problems and to disseminate the research results in a form that can be readily adopted by the MPWWR and the nation as a whole.

Overall, the thrust of this project's training is to provide the staff opportunities to gain new skills and knowledge which will enable them to advance in their work and contribute to the NWRC's goal of providing the best information to the MPWWR to manage Egypt's land and water resources.

Another aspect of the NWRC training program provided the opportunity for staff members to upgrade specific skills with short term training programs. These programs are designed to strengthen identified areas of expertise for each research institute.





Areas of expertise which were addressed through various programs include improved administration and management, computers, hydraulics, hydrology, drainage, groundwater, irrigation, hydro-machinery, soil-water conservation, water measurements, coastal protection, geographic information systems, and economics.

The Annex presents a listing of all of the short-term trainees and the description of their activities.

One additional training opportunity offered to NWRC participants is attendance at professional conferences. Such conferences provide the means by which state-of-the-art knowledge can be transferred. Since the NWRC is a research organization, the staff themselves have presented many technical papers at such conferences. The invitational programs which were provided to NWRC staff are summarized in the Annex of this report.

Almost all of these participants presented papers describing the results of their research which adds significantly to the reputation of the Water Research Center.

Academic Training

During the contract period 77 students (46 M.S. and 31 Ph.D.) were working toward degrees. The principal activities of the project staff are to (1) monitor the progress of the students' programs, and (2) provide the necessary administrative counseling support to ensure that the participants successfully complete their programs.

NWRC Student Status Report

A summary of student status is provided in the Annex.

ACADEMIC PROGRAMS AS OF MARCH 1995						
INSTITUTE	TOTAL	M.S.1	M.S.2	Ph. D.1	Ph. D. 2	Post Doc.1
NWRC	8	6	0	1	1	0
CRI	9	1	0	4	4	0
DRI	8	5	0	1	2	0
GRI	6	4	0	1	1	0
HRI	10	6	0	3	1	0
MERI	4	4	0	0	0	0
NRI	6	3	0	2	1	0
CORI	2	0	0	1	0	0
SRI	2	2	0	0	0	0
CMRI	7	5	0	1	1	0
WMRI	10	2	1	4	0	3
WRI	7	5	0	2	0	0
TOTAL	78	43	1	20	11	3
1 Completed 2 Scheduled Completion						



Summary of Degree Status

The preceding is a summary of degrees earned by students on academic programs. They are summarized by Research Institute. In addition, the total number of Thomas Jefferson Fellows for each Institute and their completion dates are also shown.

Training Focus

The NWRC Project's training focus was to provide trained personnel to carry out the NWRC's research and implementation activities for the MPWWR. Another training objective was to provide the current staff with the research and management skills to find solutions to specified problems and to disseminate the research results in a form which would be readily adopted by the MPWWR and the nation as a whole.

Overall, the thrust of training provided opportunities to the staff to gain new skills and knowledge which will enable them to advance in their work and contribute to the NWRC's goal of providing the best information to the MPWWR to manage Egypt's land and water resources.

The NWRC Project had 46 Thomas Jefferson Fellows of whom 44 obtained a M.Sc. and 31 Thomas Jefferson Fellows of whom 30 are scheduled to obtain Ph.D. degrees.

The technical subjects of the degree programs were selected in collaboration with the Institute Directors and the NWRC Chairman. The technical subject areas are listed with each Institute as follows:

- Chairman's Office: water resource planning, computer science.
- Coastal Research Institute: shore protection.
- Drainage Research Institute: drainage computer modeling, drainage criteria.

- Groundwater Research Institute: conjunctive use, groundwater pollution, geophysical exploration.

- Nile Research Institute: geology, hydrology, modeling, structures (dams), hydraulics.

- Hydraulics Research Institute: scour, sedimentation, river hydraulics, hydraulic structures.

- Mechanical and Electrical Research Institute: pump cavitation, fluid power systems, electrical systems.

- Construction Research Institute: soil reinforcement, structural dynamics, soil mechanics, foundations, construction materials.

- Survey Research Institute: geodesy, photogrammetry.

- Water Management Research Institute: irrigation design and modeling, fluid-structure interactions, water management, canal seepage, water quality.

- Water Resources Research Institute: hydrology, geomorphology, hydraulics, hydrogeology.

- Channel Maintenance Research Institute: open channel design, water quality, open channel hydraulics, channel maintenance.

The leadership of the NWRC Project emphasized diversity in academic training. As a result, a total of 17 universities have been involved in long term training and six additional universities have been involved in short term training. One Historically Black University (HBCU), Central State University, has provided short term training to students from Egypt. The list of universities involved in academic training is presented in the Annex.



Egypt Based Graduate Training Program

Colorado State University established a program with the MPWWR whereby CSU's regular academic courses taught by CSU faculty are given in Egypt. Anyone admitted to the Graduate School at CSU and who successfully completes these courses is granted formal CSU university credit as if they were attending the class on the CSU campus. The credits are counted in a normal manner towards an advanced degree. It is possible for a student to take all the course requirements in Egypt and complete much of the research before going to CSU to complete thesis and/or dissertation requirements.

The student need only be in residence at CSU for one semester for the M.Sc. and two semesters for the Ph.D. This program reduces the cost of the student's academic program and provides much flexibility in designing the student's program for a degree. It also results in the student's research area being extremely relevant to the needs of the NWRC.

The academic courses are selected to increase the capability of WRC scientists to conduct research, to prepare staff who have been away from formal course work for academic training; and to allow students to take course work towards their advanced degree requirements while still in Egypt.

Several students who have taken courses in Egypt and received their M.Sc. degree at CSU completed their degree requirements on campus in less than the standard two years (one completed in record time of 12 months). One student will complete his thesis in Egypt.

Training by TDYs

The project took advantage of the expertise of faculty who served in a TDY capacity.

Training by TDYs was an ongoing activity conducted in the field and in seminar format. All of the TDYs did some one-on-one training but some were specifically arranged in a seminar or lecture format. A list of TDY activity is found in the Annex.

Summary

To summarize, the implementation of the training component of the three projects provided more than 300 short term training activities in the U.S. An additional 189 individuals participated in the EWUP on-farm water management training course. There will be almost 100 individuals obtaining an advanced degree in the United States through these projects.

Several of the staff who have participated in the training programs have been successfully integrated into the National Water Research Center research institutes. They have assumed positions of Directors and Deputy Directors of research institutes, Undersecretaries of State and project leaders.

Conclusion of Training Program

The technical and management expertise of the staff of the NWRC has been significantly strengthened by the training programs provided by the three projects. The objective of the three projects to provide numerous individuals with relevant and necessary training experiences and programs has been accomplished. The human resource base for the NWRC has been increased and the staff of the eleven research institutes are now able to better fulfill the research mission.

The MPWWR staff were provided with modern technology and innovative ideas and techniques to help improve the welfare of the people of Egypt. Additionally, the staff in the National Water Research Center share their expertise by presenting papers at various conferences and journals throughout the



world and thereby interact with other world class scientists. The training provided by the three projects will be effective for several generations of water resources experts in Egypt and other countries where they might work.

The training programs were designed to allow maximum information flow to and from Egypt, which will provide the nation with a comprehensive knowledge base on water management. This in turn will allow Egypt to base its water management policy decisions on the best possible and most up-to-date information.

In addition, the training programs were designed to demonstrate problem solving processes which proved to be successful in various water management situations. The training tours showed the participants field conditions where agricultural production problems were being addressed.



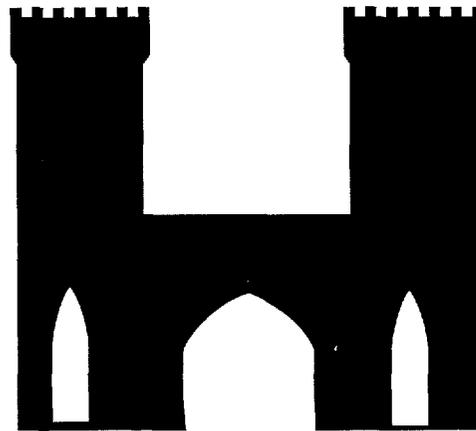
C. PROCUREMENT OF EQUIPMENT

Procurement of equipment was initiated by CSU under an approved (6/1989) Procurement Plan. Separate action memoranda for all the equipment for each research institute were developed and approved by the NWRC and USAID prior to procurement.

Procurement was temporarily suspended by USAID for a period to adjust procedures. A revised procurement plan was developed in July 1991 and approved in February 1992 by USAID. The revision reflected a reduced budget and a reprioritization of equipment by each research institute. The procurement of equipment was transferred to CID in 2/1993 under this new procurement plan. CSU procured about \$5,245,000 of equipment and CID procured the remainder of about \$ 3,000,000.

All equipment was delivered to the NWRC for distribution to the various research institutes. When necessary, training on use and maintenance of the equipment was conducted to assure that trained personnel were available to operate the equipment. TDYs were effectively used for this purpose and the type of training given is summarized in the report section on training. In some instances, staff was trained in the U.S. at various universities and/or at the equipment manufacturers headquarters.

The research equipment purchased for the various research institutes is summarized in the Annex of this report .



V. ACCOMPLISHMENTS OF NWRC MAIN OFFICE AND INSTITUTES

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A. NWRC MAIN OFFICE

THE INFORMATION DOCUMENTATION CENTER (IDC)

With the current diversity of information sources , it was necessary for NWRC to establish an Information/Documentation Center (IDC) based on fully automated offices that enhance better managerial, administrative and technical work.

The IDC, one of the pioneer projects initiated by NWRC in January 1987, was designed to improve the flow of information within the organization, thereby improving its overall capability and efficiency. The primary responsibility of IDC is the compilation, organization and analysis, in a timely fashion, of information important for decision-making. With this perspective, IDC can be considered the most important procedural activity on the administrative scale.

When extended to full operation, IDC will greatly improve the communication of information from the Chairman's Office to the Institutes, and vice versa, via electronic mail. This system will enable the timely spread of information including information brochures, research papers, abstracts, circulars and budgetary reports.

IDC is composed of the following five departments:

- Chairman's Office Affairs Department
- Information Department
- Publications Department
- Documentation Department
- Central Library

OFFICE AFFAIRS AND INFORMATION DEPARTMENTS

Throughout the IMS Project lifetime, the following has been achieved by the Office Affairs and Information Departments:

- 25 international and national conferences, meetings and workshops have been conducted.
- 12 joint CSU / NWRC training courses have been administered.
- 6 pre-departure orientation seminars have been organized.
- 120 NWRC personnel from the 11 Research Institutes have been trained on different computer applications and English courses.
- Several automated database packages have been developed and utilized: software inventory, equipment inventory, in-out country training, short courses, conference announcements, NWRC technical Library, personnel record, NWRC directory of researchers.
- Computer programs have been developed for Main Office use including numerous office automation applications, electronic mail, diary system, records management and telephone directory.





Constraints

Termination of the Project will undoubtedly cause some initial difficulties for the two departments in performing their goals. Opportunities for office automation within a reduced budget will be limited. The following actions will be impeded:

- Acquisition of equipment, computers, software, reference materials and enhancements.
- Keeping support staff who assisted in establishing the IDC and performing its activities.

Sustainability

Sustainability of activities can be possible through:

- Searching for the resources and depending more upon the GOE budget.
- Studying probabilities to hire prominent support staff on governmental basis.

NWRC PUBLICATIONS DEPARTMENT

The NWRC issues both periodicals and special publications in which its goals, activities and achievements are recorded. It also provides translation and editorial services for the Chairman's Office regularly and during conferences.

Achievements (1988-1995)

- Regular publications: including newsletters and the Water Science Magazine
- Special publications: including conference proceedings, announcements and information bulletins.
- Desktop Publishing capacity: including an enhanced graphics system with scanner, film recorder and color printer

Future Plans

Since the Publications Department is responsible for developing impressive demonstration aids for presentations in conferences, seminars and workshops, there is a need to upgrade and efficiently operate the new graphics system to enhance printing facilities and produce original artworks and designs. This facility will also be centralized to serve all NWRC Institutes and the Ministry of Public Works and Water Resources.





Constraints

While operating the system, the following constraints were encountered:

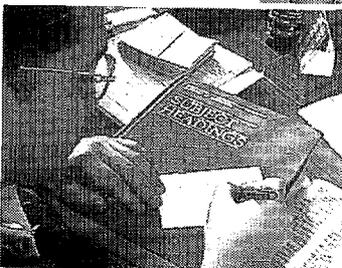
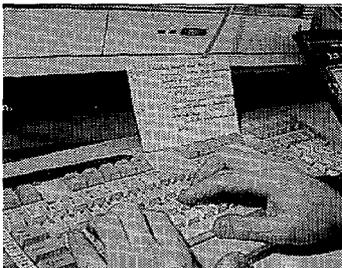
- Management of compatibility of equipment and software programs.
- Lack of trained Staff.
- Continuous upgrading (hardware and software) of the graphics system.

NWRC DOCUMENTATION DEPARTMENT

The main objective of the Documentation Department is the permanent retention of master copies of documents of special interest for NWRC (agreements, contracts, official papers) through a safe record keeping and computer-assisted retrieval system.

Future Plans

Over the years, the original documents of special interest for NWRC have been more and more accumulated, a fact that necessitates the future enlargement of the



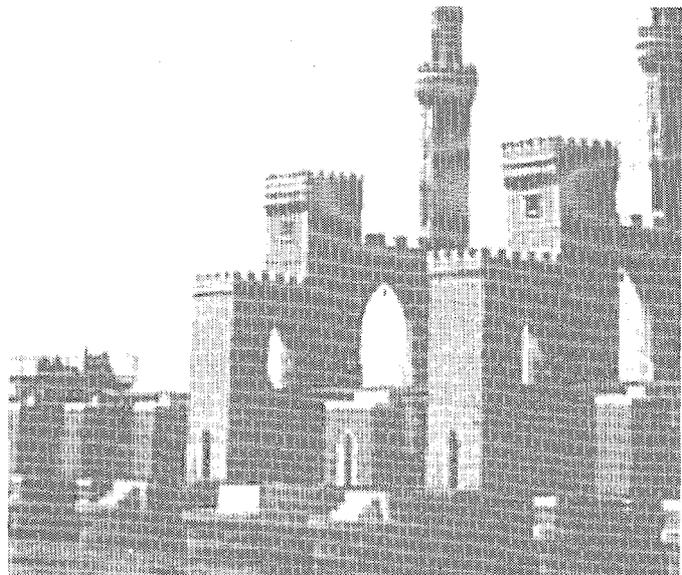
Documentation Department and developing a fully automated retrieval and backup systems. More database programs should be developed to facilitate easy search and an indexed record-keeping and archiving systems should be established.

NWRC CENTRAL LIBRARY

Background

NWRC believes that the library is the indicative parameter of the development of an organization. In 1980, NWRC inherited a very valuable collection of books and periodicals from the Ministry of Public Works and Water Resources (formerly Ministry of Irrigation) and has, since then, added other up-to-date collections of no less importance.

The entire ground floor in the new NWRC building at Delta Barrage is devoted to the library which was modernized by introducing computer equipment and library





software. Relationships will be established with other libraries in Egypt and abroad to provide NWRC professionals access to even larger collections.

One of the major objectives of NWRC library is to provide computerized literature searches to serve as a tool for professionals and researchers from the NWRC institutes, MPWWR and other ministries, universities and authorities in their research work and academic studies.

Achievements (1989-1995)

- Classification and cataloguing of over 17,000 books and periodicals was completed.
- Repair, binding and chemical treatment of old and worn-out books was initiated.
- Treatment and binding of the precious "Description of Egypt" albums was completed.
- An automated library program was developed and tested.
- CD-ROM capacity is currently under development.
- Book acquisition contract with Blackwell was initiated.
- Journal subscriptions have been established.
- Library furnishing and shelving was finished.
- Staff Training (on-going activity) has taken place.

Future Plans

- Establish a Local Area Network (LAN) between NWRC and the twelve Institutes.
- On-line communication (nationally with the Academy of Scientific Research and Technology, Egyptian Universities, ministries, etc. and internationally with CSU and other USA and European universities).
- Establish check-in and out procedures

and inter-library loan system.

- Offer central computerized query and loan services.
- Renewal of software / hardware maintenance contracts for library program.
- Renewal of subscriptions to most scientific journals and periodicals.
- Operate the CD-ROM search system on "Selected Water Resources Abstracts".
- On-the-job training for more librarians (locally and abroad).

Constraints

Throughout the five years of preparation for the Central Library, the following constraints were encountered :

- Lack of qualified staff to work as permanent governmental employees.
- Maintenance and trouble shooting of the NCR tower mainframe was inadequate.
- Delays in purchase and shipping of the ordered NCR computer upgrade due to long procurement procedures.
- New book acquisition and journal subscriptions was suspended for over a year due to lack of funding.





B. NWRC RESEARCH INSTITUTES

WATER MANAGEMENT RESEARCH INSTITUTE (WMRI)

Directors:

- 1985 - 1992 : Dr. Mohamed Abdel Hady Rady
1992 - 1993 : Dr. Fouad Zaki El-Shibini
1993 - Present : Dr. Diaa El-Quosy

The Institute achieves its work through four main departments which are considered the supporting pillars upon which its structural organization is built. These departments include:

- Water Requirements
- Water Distribution
- Water Losses
- On-Farm Irrigation Systems

Research Programs

Different research programs conducted by the Institute and supported by the project were as follows:

- Crop water requirements,
- On farm irrigation methods and systems,
- Conveyance, distribution and on-farm losses, and
- Open and closed distribution systems.

Joint Research Programs

Joint research is a policy of the National Water Research Center and its institutes.

Innovative Programs

The introduction of weighing lysimeters is fairly new to the agricultural/irrigation research in Egypt.

Sustainability of Project Goals

This can be achieved by the full independence of the Egyptian team and reduced contribution of expatriate staff.

Field Applications

Many of the research results were conveyed to the Ministry of Public Works and Water Resources for practical application.

Publications

The NWRC Institutes produced a large number of technical reports and working documents. A complete listing of these documents is available at the Institute.

Training

Short and long term training, academic training and study tours have certainly upgraded the research and knowledge capabilities of the scientists and engineers of the institute on all levels.

Equipment

Over six million dollars of equipment was purchased for the NWRC and its institutes enhancing research and computer systems. Although some of the equipment purchased in the early stages of the project is somewhat outdated, yet it is still beneficial in assisting in the achievement of NWRC objectives.





DRAINAGE RESEARCH INSTITUTE (DRI)

Directors:

1979 - 1992 : Dr. Mohamed Hassan Amer

1992 - Present : Dr. Mohamed Safwat
Abdel Dayem

Research Programs

- Drainage water quantity and quality in the Nile Delta and Fayum.
- Drainage criteria and technology.
- Evaluation of drainage projects.
- Development of Water Management Model for Irrigated Arid Lands.

Linkages

The IMS project has partially supported joint research activities in the areas of:

- Water management and application of mathematical models.
- Environmental impact of land drainage system (on-farm scale)
- Control of water logging and salinity problems.

Innovations and New Approaches

New application of mathematical models using interfaces.

Sustainability of Project Goals

- Financial assistance.
- Technical assistance through TDY, training, workshops, and institutional building.

Significant Outputs

- Quantity and quality of drainage water,
- Pollution awareness,
- Introduction of new materials and design

criteria for covered drainage projects, and

- Development of rehabilitation programs.

Technical Reports, Workshops or Seminars

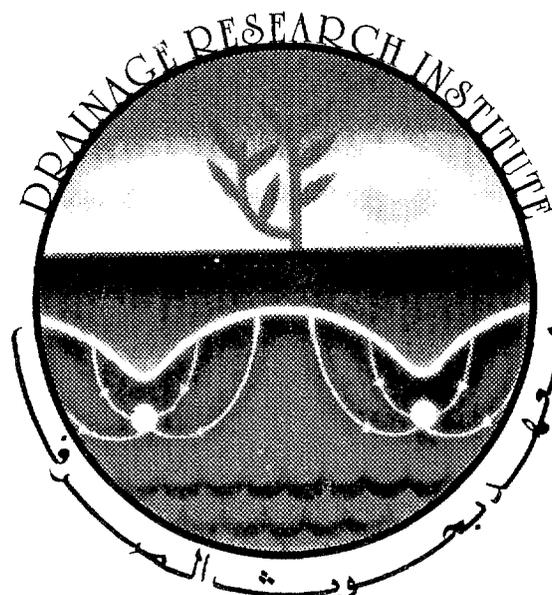
Several technical reports have been published and the results are presented in local workshops and international conferences.

Training

All types of training helped in strengthening the capabilities and skills of DRI staff. Attending international conferences and training enlarges staff experience base, widens their knowledge and improves DRI communications with the different agencies.

Equipment

The office equipment and cars and some field equipment items were delivered on schedule which facilitated the research programs. However, some field equipment was delayed or even not delivered at all, which interrupted, to some extent, the field programs.





WATER RESOURCES RESEARCH INSTITUTE (WRRI)

Directors:

1978 - 1994 : Dr. Hassan Ali Ibrahim

1994 - Present : Dr. Samir Farid

Research Work

The fields of research work are:

- Sinai Water Resources study
- Nile Basin Water Resources Study
- Environmental Water Quality of Delta Wadi El-Arish
- Eastern Desert Water Resources Study

Linkages

The project initiated some joint research programs between the institutes. Examples are joint programs with the Mechanical & Electrical Research Institute and with the Groundwater Research Institute.

Sustainability of Activities

- Supply the institute with equipment
- TDYs working with counterpart personnel.
- Training of staff.

Research Results

- The institute research projects were fully directed towards field problems.
- The research findings have to a great extent affected the decision-making policies of the MPWWR.

Outputs

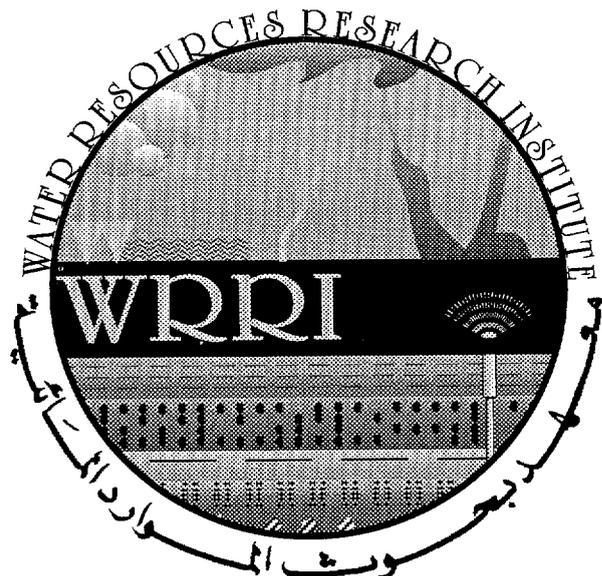
The project outputs were documented in the institute data base, annual reports, technical reports and were presented in workshops and Seminars.

Training

The training which personnel received helped them to participate in solving the research problems of the institute.

Equipment

- Computer facilities should be up-dated.
- Vehicle types are costly in terms of operating expenses.





NILE RESEARCH INSTITUTE (NRI)

Director:

1985 - Present: Dr. Mohamed El-Moattassem

Research Work

The areas of research were:

- River Nile Water quality (sampling equipment, lifting winches),
- Hydrographic survey (Mark-boat, Echo-sounders),
- Sediment Analysis equipment (Lab. Sediment equipment),
- Sedimentation Studies (bed-load helysmith sampler),
- River and Lake Nasser hydrological research studies (water level gauge recorders)
- Mathematical software programs
 - □ Modified Hec-6 Math. Model
 - Software program PC Plus for transfer data from Falcon-4 system to P.C. computers.
- Training Institute Engineers: (use of Falcon-4 hydrographic positioning system)
- Management Information system (through supplying 2-computer sets and 3 H-P calculators),
- Over-seas short courses (2 Engineers + 1 Tech), and
- Study-tours (2 Engineers).

Joint Research

The project encouraged joint research programs with the High Aswan Dam Authority regarding the sedimentation in the High Aswan Dam Reservoir. Three consultants from Colorado State University joined the Mission in the High Aswan Dam Reservoir during April 1992.

Innovations and New Approaches

The project introduced the positioning hydrographic survey through the application of the Falcon-4 system.

Project Sustainability

Unfortunately only limited funds were available for the year 1993/1994, and were directed specifically to the sedimentation research mission in the High Aswan Dam Reservoir.

Significant Outputs

- a. Application to Field Problems:
Preparation of hydrographic contour maps for selected reaches in the High Aswan Dam Reservoir.
- b. Design and Making Policies:
Evaluation of the sediments deposited, front progress and sediment utilization.

Publications / Documentation

- Regular progress reports are issued by the Institute.
- Research papers presented at the Nile-2000 International Conference which was one of the significant events organized by the Institute.

Training

- a. Office Training
Lectures regarding the application of the Falcon-4 system for hydrographic survey
- b. Field Training
Practical application of the Falcon-4 system during the Mission to Aswan Lake in April 1990.



The training mentioned above upgraded NRI Engineers with the application of modern sophisticated hydrographic survey systems.

Equipment

The project provided the Institute with modern equipment. However, equipment ordered in 92/93, totalling approximately \$ 92,000, was back-ordered and was not available as scheduled.

HYDRAULICS RESEARCH INSTITUTE (HRI)

Directors

1976 - 1993 : Dr. Mohamed Gasser
1993 - 1995 : Dr. Fouad Zaki El-Shibini
1995 - Present : Dr. Mohamed Bahaa El-Din Saad

Research Program

The different fields of research work conducted by the Institute and supported by the Project are summarized as follows:

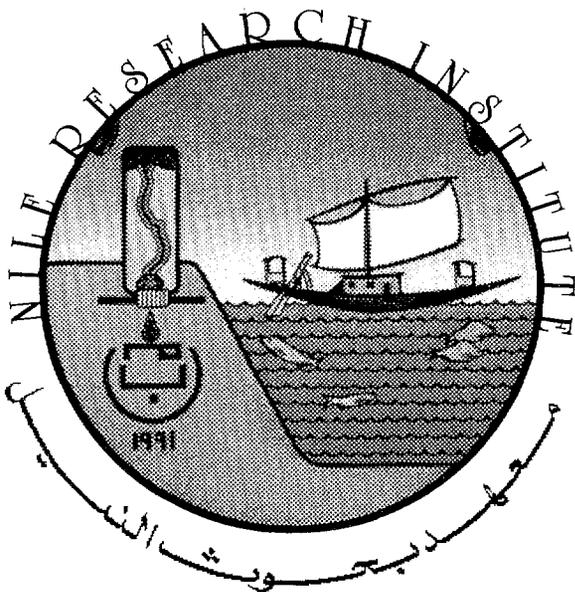
- Fixed and movable bed scale models to study the following subjects:
 - River morphology,
 - Navigation bottle necks,
 - Thermal pollution,
 - Cooling system of the power plants, and
 - Hydraulic structures.
- Hydrographic field survey for different reaches along the Nile River and other branches to study the local parameters, morphological changes, and bank stability.
- Numerical models.

Linkages

During the last three years, the Institute in cooperation with other national organizations studied and solved some important problems. The project encouraged the joint research by providing the necessary equipment and consultants.

Sustainability

The good management and the easy communication between the Institute and the Project Manager were the main tools for ensuring the sustainability of the project goals.





Research Outputs

The annual research plan of the Institute includes applied and basic research for solving real problems. In each problem, the Institute studied different alternative solutions and offered the recommended one for implementation.

- In all cases the solution recommended by the Institute was implemented by the different authorities and was regularly monitored by the Institute.
- There is a steering committee including decision-makers in the Ministry of Public Works and Water Resources (MPWWR), to evaluate the different research conducted by the Institute. In this way the MPWWR is always aware of the progress of the research and consequently this helped them in appropriate decision making.

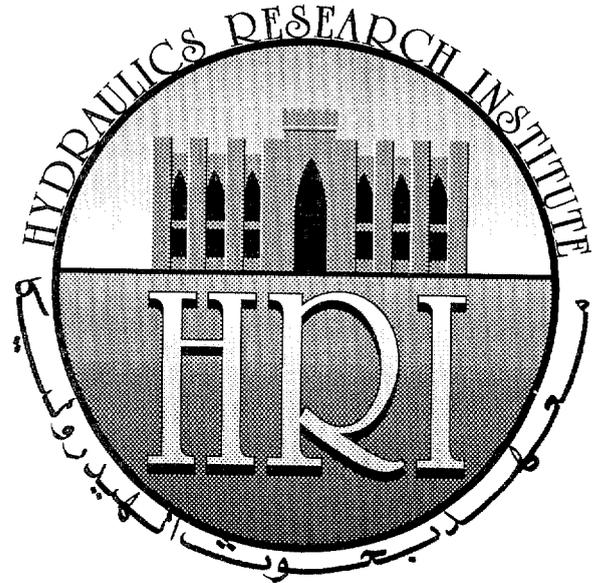
Publications

- Technical reports for the corresponding authorities to implement the final solution.
- Scientific papers were published in workshops, seminars, national and international conferences.

A list of Institute publications is available at the Institute.

Equipment

The project helped in upgrading the workshop facilities and survey equipment which has really improved the Institute capabilities in physical model construction and hydrographic survey.



CHANNEL MAINTENANCE RESEARCH INSTITUTE (CMRI)

Director:

1979 - Present : Dr. Ahmed Fakhry Khattab

Research Program

The different fields of research work are:

- Identification and monitoring of aquatic weeds.
- Biological control using grass carp.
- Design of open drains.
- The effect of aquatic weeds on channel roughness.

Joint Research

The Institute cooperated in research with other organizations, such as:

- Ministry of Public Works and Water Resources,



- Preventive Maintenance Department (MPWWR), and
- Irrigation & Hydraulic Department, Faculty of Eng. Ain Shams University.

Innovations and New Approaches

- Seepage losses from earthen and lined canals.
- Design of Sandy Soil Canals.
- Design of vegetated Open Channels.
- Lining of open channels by different materials as well as ground water problems.
- Fish diseases (especially for grass carp).
- Effect of heavy metals which exist in irrigation and drainage canals on grass carp.

Sustainability of Project Goals

- Focusing on specific research points
- Facilities offered by the IMS project and its continuity to ensure program activity.
- Annual workshops.
- Providing the institute with modern lab and field equipment together with spare parts.

Significant Outputs

- Research in the effect of different types of aquatic weeds on hydraulic efficiency.
- Application of a biological control method using grass carp on a wide scale along irrigation networks after deduction of a new design criteria for stable and vegetated open channels.
- Annual monitoring of aquatic weeds which will help the decision making policies of the MPWWR determination of the correct implementation of weed program using different methods is improving irrigation efficiency.

Publications / Technical Documentation

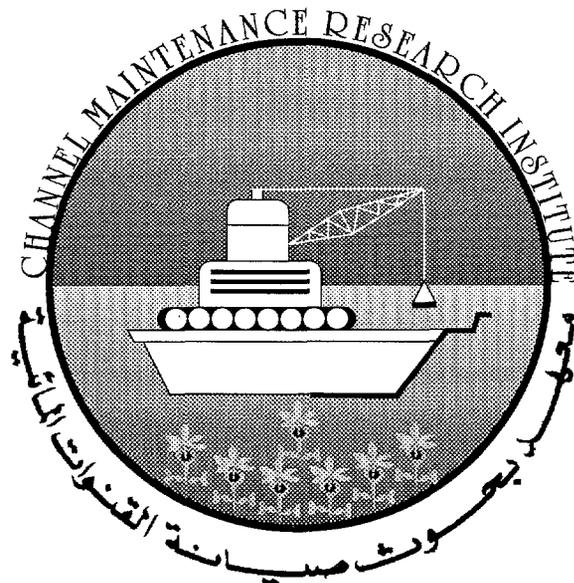
Fourteen technical reports and papers were presented in conferences and seminars. The list of publications is available at the Institute.

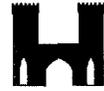
Training

The training programs have improved the staff qualifications in dealing with research problems both practically and theoretically.

Equipment

The project gave a good chance for the Institute to have the measurement equipment for both field and laboratory. Also, the project offered the institute personal access to computers and office facilities.





GROUNDWATER RESEARCH INSTITUTE (GRI)

Directors

1972 - 1993 : Dr. Kamal Hefny
1993 - Present : Dr. Fatma Abdel-Rahman
Attia

Research Programs

- Hydrogeological Mapping.
- Groundwater quality and pollution.

Linkages

- During the hydrogeological mapping program, the Institute was cooperating with various organizations for data acquisition; among such organizations were the Organization for Geological Survey, the Desert Research Center, and the Organization for Military Survey.

- In the framework of the groundwater quality/pollution project various institutes of the NWRC (drainage and Nile) and other ministries have been contacted for integrated work including sources of pollution and impact on the groundwater system. Such institutions include the National Research Center, the Ministry of Health, the general organization for industry, and EEAA.

Innovations and New Approaches

The two projects mentioned above were not new, however, the IMS input provided for the continuation of programs that were started from other funds. The additions may be considered in the form of new simulation models for the treatment of the pollution studies.

Sustainability

A proper training program for the involved personnel, and equipment for the continuity of the work.

Significant Outputs

a) Concerning the hydrogeological mapping, the produced maps have been used by the Institute and other institutions/individuals in: (i) simulation/prediction of future actions; (ii) design of wells/well fields; (iii) post studies; and (iv) teaching/training.

Concerning the quality/pollution program, research results have been: (i) presented to officials; and (ii) presented in national and international seminars/workshops.

b) The data collected during the hydrogeological mapping program and the produced maps helped in the finalization of the "Groundwater potential atlas" which is used by the MPWWR (groundwater department, planning sector) in licensing new wells, and in defining the role of groundwater in the national water policy.

Publications

The outlets of the research programs were documented in technical reports, and presented in workshops:

- The hydrogeological maps are available at the GRI and they are for sale (the printing is funded by the institute).
- The Atlas is sent to the MPWWR and is available at various scales.
- Results of the groundwater quality/pollution program have been used in the



project "assessment of Egypt water quality" funded by USAID and presented with other outputs during the final workshop of the project. The integrated document is available at the NWRC.

Training

The staff involved in the mapping program can prepare similar types of maps and update the existing ones according to need. Those involved in the pollution program can deal with various types of analysis in the field of groundwater pollution and environmental impact analysis.

Equipment

Various equipment has been supplied for the various programs such as a set of computers and plotters used for the production of various types of maps. Recorders have been fixed since they arrived on observation wells located in the drainage well field in Minya Governorate for continuous monitoring of the impact of groundwater pumping on drainage. The laboratory equipment are used in sampling and analysis of groundwater. The drilling rig has been delayed which has resulted in delaying the implementation of the monitoring network.

CONSTRUCTION RESEARCH INSTITUTE (CRI)

Directors

1981 - 1994 : Dr. Seoud Moustafa El-Khafif,
Acting Director : Dr.Ahmed
Khafagy
1994 - Present : Dr. Mohamed Rafik Abdel-
Bari

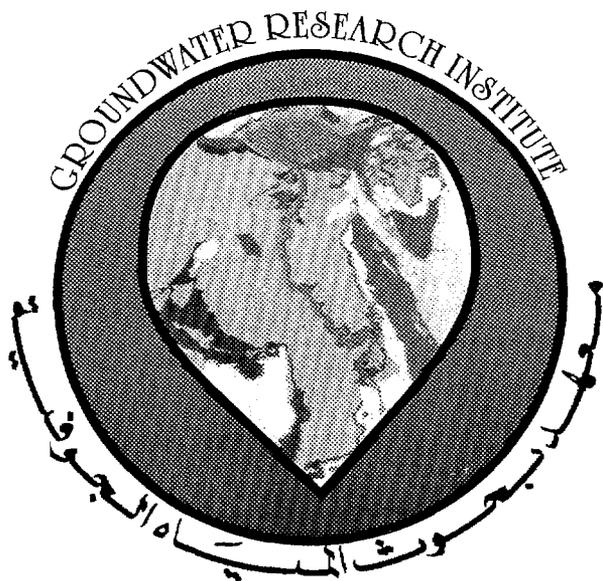
Research Programs

Applied research in soil mechanics includes:

- Monitoring of stability of embankments of irrigation structures,
- Soil stabilization using sand drains,
- Upgrading of lab equipment dealing with soils testing, and
- Development of computer programs for soil structures interaction.

The Institute has and still is giving advice to the Ministry of Public Works different departments on the following projects:

- Rehabilitating of Edfina Barrage
- Monitoring the Behavior of the closure dam of Esna Barrage during and post construction.
- Field, lab soil studies and consulting advice for west Nubaria Drain.
- The stability of El-Salam Canal embankments.
- The stability of El-Salam Syphon under Bahr-El-Bakar Drain.
- Soil studies necessary for clearing the suction and delivery channels of El-Sania pumping station.
- Lining of El-Bostan Canal along the distance from its intake to its end at km (55).
- Rehabilitating of the Delta Shamal El-Tahrir Channel.
- Recording settlement of some piers of the highway bridge above Damietta Earth-Fill Dam.





Innovations and New Approaches

- Soil dynamics investigation using seismograph to evaluate the dynamic properties of the soil.
- More accurate evaluation of soil bearing characteristics using the 20 tons Dutch cone penetrometer system.
- Introduce new material testing technique using the humidity chamber and the universal testing machine.
- Full automation and control of monitoring system using SINCO, IDA system.

Sustainability

Procedures to ensure the system sustainability are summarized as follows:

- Upgrading of the Institute's technical facilities through provision of advance equipment
- Training of the technical staff particularly the training for degree (academic training) and on-the-job training. Nine engineers have been in Ph. D. programs.
- Technology transfer through international consultants and study tours.
- Enhancing staff capabilities in planning through preparation of annual and five-year plans.

Significant Outputs

- Establishment of a team of experts to deal with irrigation construction projects. This team will assist the Ministry in modifying, design and execution of irrigation works.
- Production of research papers and technical reports dealing with soil mechanics and foundations, irrigation structures, properties of materials and major field problems.

- Providing the Ministry with technical advice in the design and implementation of irrigation projects and project information to facilitate decision-making.

Publications

The output of research programs was documented in the form of technical reports, research papers and M.Sc. and Ph.D. theses.

Training

Nine engineers have participated in the academic training to obtain Ph.D. degrees in areas covering the research mandate of the Institute. One has finished his academic work and is implementing the research plan of the Institute.

The other eight students have not completed their programs. However, they are expected to strengthen the institute capability through the knowledge they have acquired through their training.

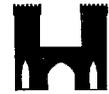
The Institute now has the nucleus of an expert team. When the other trainees return, the capabilities of this team will be enhanced and the area of specialization will be broadened.

Equipment

The project provided the Institute with the following:

a) Field Equipment

Twenty ton Dutch cone penetrometer, the IDA SINCO system for controlling the monitoring system already available in the institute.



b) Laboratory Equipment

Universal testing machine, humidity and temperature controlled room which includes a relative density system

c) Office Equipment

- Laptop computer (PC 286)
- 2 Plotters
- 4 Printers
- PS/2 IBM system

MECHANICAL AND ELECTRICAL RESEARCH INSTITUTE (MERI)

Directors:

1985 - 1991 : Dr. Twadros Guirguis
Tawadros

1991 - 1994 : Dr. El-Husseiny El-Shirbeeney

1994 - Present: Dr. Mohamed Ali Helal

Research Programs

- Energy Auditing in Pumping Stations.
- Water Lifting by Windmills.
- Centralized Control of Water Resources in Sinai.

Research Collaborators

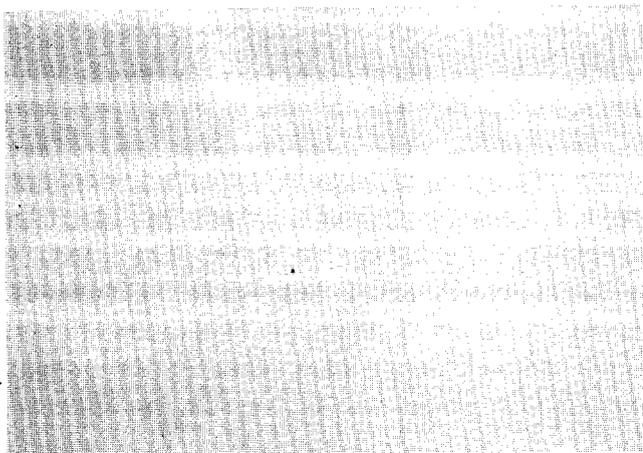
- Mechanical Electrical Department. Ministry of Public Works and Water Resources.
- Water Distribution Research Institute, NWRC.
- Water Resources Research Institute, NWRC.

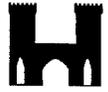
Contribution of IMS-Project to MERI Research Programs

- Upgrading MERI-infrastructure and laboratories.
- Improving research and mangement skills of staff
- Exchange of experience and research literature with American fellow workers

Sustainability of Project Goals

- Establishing modern computing facilities.
- Assisting in preparing research staff.
- Provision of modern experimental equipment and apparatus.
- Organizing annual meeting for following up work-progress.





Significant Outputs

Research papers were published in national and international journals and presented at meetings.

Although the research work supported by the Project has not yet been concluded, preliminary results identified important issues which should be reflected on MPWWR-decisions in future development projects in Egypt. Mainly they are:

- Sources of energy losses in pumping stations,
- Database establishment for energy management in pumping stations,
- Potential site identification for wind energy utilization for water lifting in Egypt,
- Development of a solar chimney concept for irrigation schemes,
- Identification of an appropriate telecommunication schemes for centralized control of water resources in Sinai, and
- Development of a Novel Hyacinth-Processing machine.

Publications

MERI published a number of research papers and technical reports. A list of these publications is available at the Institute.

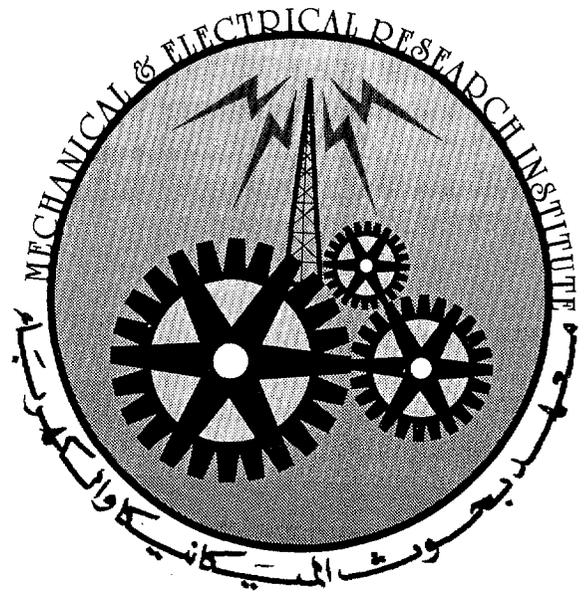
Training

The training activities were directed to develop the capability of junior staff. Three of the MERI staff received M.Sc. degrees from US Universities.

Equipment and Facilities

The Project was very slow in responding to MERI equipment needs. Until the final months of the project, only about 40% of the

requested procurement had arrived. Delays in funding and bureaucratic red-tape on ordering high-tech equipment caused a serious problem in assisting the research work. However, laboratory and other facilities were improved very significantly to provide operating laboratories in the Institute. Also, a mobile research laboratory truck was provided to support the on-going field research projects of the Institute.





SURVEY RESEARCH INSTITUTE (SRI)

Directors

1989 - 1993 : Dr. Mona El-Kady

1993 - Present : Dr. Dalal El-Naggar

Research Program

The different fields of research work conducted by the Survey Research Institute and supported by the project are:

- Applications of Global Positioning System (GPS) technology in the field of geodetic surveying. The objective of these applications was to establish and update the geodetic reference in Egypt.
- Gravity and geoid modeling in Egypt. The objective of this research was to define the true shape and size of the geoid, and the geoid-ellipsoid separation in Egypt.
- Construction and Calibration of a precise base-line. The objective of this research was to establish a base line for calibrating surveying EDM instruments, such as Total Stations.

Joint Research

There were no joint research programs between SRI and any other institute of the NWRC. The SRI has a joint program for establishment of ENGN-93 with the Egyptian Survey Authority (ESA).

Project Innovations

The Project introduced the GPS technology to SRI. During the 2nd-Five Year Plan, SRI received five geodetic receivers (Trimble 4000ST, 4000SST). Also, Lacoste Romberge equipment, and gravimeters instruments were provided. The use of this "cutting edge" equipment made SRI the leader in this field in Egypt.

Sustainability

The project provided the facilities to SRI staff to advance their knowledge and skills through short course studies in the USA. In addition, in-country training and direct contact with foreign and local consultants assisted the personnel to acquire information which was helpful to the work of the Institute.

Research Outputs

- The SRI has applied its research by introducing the GPS technology for studying the accuracy of the Egyptian geodetic network as well as studying the crustal movement around Lake Nasser in Aswan.
- The project also provided academic training in the field of Geographic Information System (GIS) that helped in contributing by this experience in one of the main projects in SRI.

The SRI was the leader of ESA in using these technologies to improve their work, which impacted decision-making policies of MPWWR.

Publications

All SRI publications are documented in a list available at the Institute.

Training

SRI, through this project, has received very advanced and developed systems, equipment and techniques. As well, SRI's staff has been given the facilities to advance their knowledge and skills through short course studies in USA, in-country training and through direct contact with foreign and local consultants.



Equipment

SRI has received a variety of up-to-date equipment which is documented in the Annex and featured in a subsequent section of this report.



COASTAL RESEARCH INSTITUTE (CORI)

Directors

1982 - 1994 : Dr. Ahmed Abdel-Wahab
Khafagy

1994 - Present : Dr. Alfy Morcos Fanous

Research Program

a) Research in Coastal Protection and Hydrodynamic Engineering fields; such as:

- Monitoring the global evolution of the Nile Delta shores and design of protective measures for critical zones.
- Study the erosion phenomenon started recently at the eastern side of the Damietta Branch.
- Response of Nile Delta coastline to the coastal structures along the Nile Delta coast.
- Study the behavior of the Nile Delta coast contours beyond 6 m depth.
- Study the cusp phenomenon at Baltiem sea resort.
- Marine factors affecting a straight parallel beach.

b) Research in Marine Geology and Sedimentation included:

- Study the development of gentle slope sandy beach face inside Alexandria Eastern Harbor.
- Study of the pattern distribution of the sediment drift in Ras El Bar using fluorescent tracers.
- Estimating the sediment drift at nourished beaches of Alexandria by fluorescent tracers.
- Study of mineralogical and textural composition of beach sand in relation to shoreline erosion along the Nile Delta coast.
- Construction of a geographical information system (GIS) for coastal/morphological information.
- Detecting shoreline morphological changes and coastal processes along the



Nile Delta coast using remote sensing techniques.

c) Research in Physical Oceanography include:

- Study of the distribution of coastal currents beyond the breaker zone and up to 20 m depth along the Nile Delta coast.

d) Research in the field of applied electronics for upgrading marine measuring equipment included:

- Modifying the directional wave recording array, named the CAS system.

Joint Research Programs

The Coastal Research Institute has collaborated and developed joint research programs with the following international and domestic organizations:

- The Egyptian Shore Protection Authority (SPA), which is responsible for executing coastal protection projects in Egypt. The CORI provides SPA with scientific advice and data for beach behavior prior to and after construction. CORI has furnished almost all the data needed for the development of the Egyptian Master plan for protection of the Nile Delta Coast.

- CORI has worked closely with "Delft Hydraulics" of the Netherlands to quantitatively evaluate the impact of sea level rise on the Nile Delta Coast and identify the vulnerability assessment to accelerated sea level rise.

CORI has contracted research with the following authorities and governorates:

- The Academy of Scientific Research and Technology and the Egyptian General Fishing Authority to stabilize the inlets of El-Bardawil lagoon and Burullus Lake outlets.

- The Northern Sinai Governorate and the Academy of Scientific Research and Technology to study the effect of El Arish port on the adjacent beaches.

- The Executive Organization for the Industrial and Mining Complexes (IMC) to study the water turbulence problem inside El Dikheila Harbor.

- The Sinai Company for Manganese (SCM) to study the renovation and development of Abu Zenima Port, on the Gulf of Suez.

- The Egyptian Drainage Authority to study the protective works needed for the Nobariya West Drain Outlet.

Innovations and New Approaches

The project has introduced the following innovations and new approaches to CORI work:

- Provision of international experts (TDY) who supplied staff with their research experience and prepared joint research papers.

- Development and manufacturing support for instruments to fit CORI requirements:

- Development of sand trap samplers to collect the bed load and suspended load moving along the Delta shoreline.

- Modifying the CAS system to record wave data on a solid state memory instead of cassettes which improves analysis.

The project also supplied the institute with the most recent measuring equipment (i.e. S4D current meters).



Project Sustainability

The project has supplied CORI with the following inputs to ensure sustainability of project goals:

- Equipment such as the rubber boats and outboard motors.
- Computing facilities including computers and software.
- International experts who provided the Institute with the state of the art coastal engineering knowledge and experience.
- Short-term training for the CORI staff who became acquainted with international scientific circles by attending International Conferences and becoming aware of international scientific publication in the Institute's field of interest.

Significant Outputs

The CORI has developed solutions to the following problems:

- Siltation of El-Bardawil Lagoon exits, No. 1 and No. 2.
- Siltation of El-Burullus Lake Outlet.
- Coastal erosion of the Baltim sea resort.
- The hazardous condition of the Marakia touristic village.
- Development of a safe alignment for the south Hurgada region on the Red Sea created by the shore infringements made by erection of new tourist villages.
- Siltation of the exit of the West Nobariya drain.
- El-Arish coastal erosion due to the execution of El-Arish harbor.

Policy-Making Inputs

The Institute research work has helped generate decision-making policy within the Ministry of Public Works and Water Resources in the following two major projects:

- Development of the Egyptian Master Shore Protection Plan, and
- Design and execution of the West Nobariya Drain outlet (Stages 1 & 2).

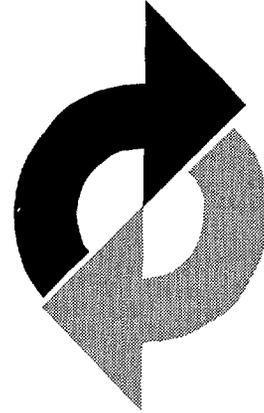
Training

The long-term training input of the project was limited to one staff member who received a Ph.D. from Colorado State University. Six staff members participated in short-term invitational travel to attend International Conferences.

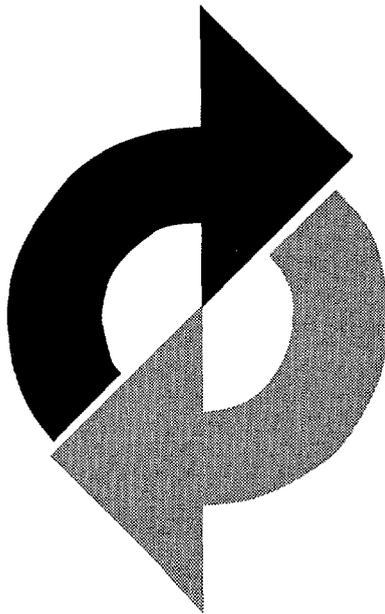
Equipment

A list of received equipment is documented in the Annex. However, many items were not delivered on schedule and caused delay in the execution of the research topics mentioned earlier. Research activity involving study of coastal process beyond 6 m water depth were particularly hampered.





VI. Significant Project Outcomes and Impacts on Egypt's Water and Agricultural Policies



“Transferred technology is the result of a mixture of energy, solutions looking for problems, choice opportunities, and problems looking for solutions. The model is not unidirectional. Feedback helps participants reach convergence about the important dimensions of the technology. Both problems looking for solutions (technology pull) and technology solutions looking for problems (technology push) are encountered.”

Williams in “Technology Transfer”.



Policy Impacts

During the past decade, the NWRC has drafted many policies which were adopted and are now under implementation. Because of the dynamic nature of such policies, they are under continuous updating through research and development of new field data. The following is a list of the most important policies which the NWRC staff helped draft:

- The Irrigation Improvement Policy,
- The National Irrigation Improvement Program,
- The Shore Protection Master Plan,
- The River Nile Development and Management Plan,
- The Drainage Improvement Program,
- The Agricultural Drainage Water Re-Use Plan, and
- The Delta and Nile Valley Groundwater Development Plan.

The essential cooperation between different disciplines related to water use promoted during the NWRC Project included major inputs from the Ministries of Agriculture, Land Reclamation, Power, Transportation and others. Such cooperation contributed to the initiation of water users' associations, irrigation extension services, conjunctive use of surface and groundwater and other programs.

Extensive data collection and monitoring of surface and groundwater have highlighted the serious implications of water pollution and impact of water quality deterioration. The assessment of water quality and the drafting of a water quality management program are examples of increased awareness among policy makers.

Applied Research / Policy

The language experts who compile technology dictionaries have defined technology as the application of scientific knowledge to production. Such a definition excludes practical knowledge.

In the experience of the NWRC, the definition requires expansion. The NWRC definition would note that the largest single source of a technology is the combination of experience and knowledge, not simply the application of formal science. Significantly, in ancient Greek, one word alone designated both science and technique: "technē."
[Chris DeB24resson]

Education / Training Impact

In-Country Degree Capacity Memorandum of Understanding

The CSU campus in Cairo was innovative and resulted in academic development as well as providing an effective reduction in cost and time required for a student to complete a degree program.

CSU's regular academic courses were taught by CSU faculty in Egypt. A student admitted to the Graduate School at CSU was





granted formal CSU university credit as if he were attending the class at CSU. It is possible for a student to satisfy course requirements in Egypt and conduct much of the research before going to CSU to complete his / her requirements.

Residence requirements was one semester for the M.Sc. and two semesters for the Ph.D. This reduces the cost of the academic program and provides much flexibility in designing the student's program for a degree. In addition, the time required to complete degree requirements in the States was reduced by as much as one year.

The courses that have been offered are:

- CE546: Water Resource Systems Analysis.
Spring, 1989
- M550: Partial Differential Equations.
Summer, 1989
- CE689C: Foundations on Expansive and Collapsing Soils.
Fall, 1989
- CE622: Risk Analysis in Water Resources.
Fall, 1990
- CE580: Expert Systems InEngineering.
Spring, 1990
- CE716: Erosion and Sedimentation.
Summer, 1990
- CE549: Design of Water Quality Monitoring Systems.
Spring, 1989

Award-Winning Papers and International Credibility

An important additional training impact offered to NWRC participants is attendance at professional conferences. Such conferences provide the means by which state-of-the-art knowledge can be transferred. Since the NWRC is a research organization, staff members have presented many technical papers at such conferences.

A significant example was provided by the Hydraulics and Sediment Research Institute. At the 1991 meeting of the American Society of Civil Engineers in Nashville, NWRC Institute input resulted in a Special Session of the ASCE on Nile River Hydrology. The Institute was also featured in the Society's publication, the "ASCE News."

Many NWRC staff members have attended conferences as short-term trainees. Almost all of these participants presented papers describing the results of their research which added significantly to the reputation of the National Water Research Center.

Several of the staff were session chairs and have been involved in other international committees, all of which attests to the effectiveness of the training program in increasing the technical capabilities of the staff of the NWRC.





In addition, several students presented papers featuring their research for their advanced degrees, some winning awards, further adding to the reputation of the National Water Research Center and to their respective universities.

Sharing Training Experience With African Nations

South-to-South Technology Transfer

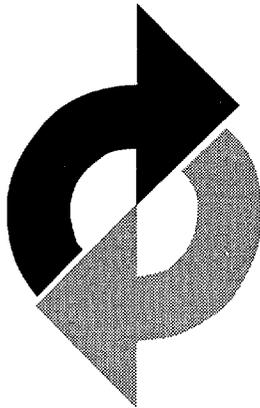
Several Institutes have developed key roles in transferring Project-gained education and training to other nations through workshops and other learning experiences.

For example, the Hydraulics and Sediment Research Institute (HRI) has initiated regional cooperation and the South-to-South transfer of technology through training courses on River Hydraulics and relevant measurements.

In February 1992, HRI was chosen as a focal point of the Eastern Region of the African Regional Division (ARD) of the International Association for Hydraulic Research (IAHR). This region includes Egypt, Sudan, Ethiopia, Kenya, Uganda, Tanzania, Burundi, Rwanda, Zaire and Somalia.

Drainage Research Institute Water Quality Course

The impending implementation of the new water quality and environmental impact laws requires renewed training efforts to meet these challenges. The Drainage Research Institute initiated a Water Quality Course which links expertise from the National Research Center, Central Laboratories of Pesticides at the Agricultural Research Center, Faculty of Medicine and Engineering at Cairo University, the Planning Sector of the Ministry of Public Works and Water Resources, the Egypt Environmental Action Agency and other NWRC Institutes.





Equipment / Technical Assistance Impacts

The finest training in the world has little impact unless the scientist has the proper tools with which to pursue applied research. Although the procurement program of the Project experienced some difficulties, the addition of equipment produced some significant impacts.

Survey Research Institute Introduces GPS Technology

The Project introduced Global Positioning System (GPS) technology to the Survey Research Institute. In fact, Lacoste Romberge equipment and gravimeter capacity within SRI was a first for the Institute and the nation. The Institute was also a leader in adopting GPS technology in the form of five geodetic receivers (Trimble 4000ST and 4000SST).

With the infusion of this technology, SRI has studied the accuracy of the Egyptian geodetic network as well as studying the crustal movement around Lake Nasser in Aswan. A major activity has been a cooperative effort with the Academy of Science to accomplish the "official determination of the geoid."

- Institute research facilitated by equipment procurement included:
 - Applications of Global Positioning System (GPS) technology in geodetic surveying,
 - Gravity and geoid modeling, and
 - Construction and calibration of a precise baseline for instrument calibration.

Such work is fundamental to all other NWRC Institute activity.

Environmental Impacts

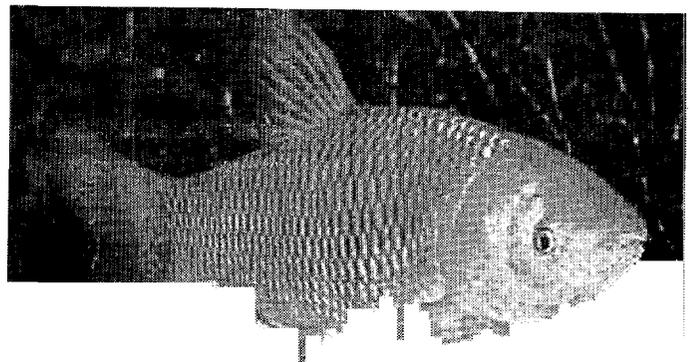
The political/policy decision surrounding the impact of environmental quality and the use of herbicidal treatment of aquatic weeds and algae is a good example of research / policy interdependence.

The Governmental desire to reduce use of herbicides spurred the Irrigation and Drainage Channel Maintenance Research Institute to look at biological control alternatives. One alternative was to research the introduction of grass carp for controlling submerged weeds.

Part of the training to accomplish this research came from project resources for training in cooperation with Florida State University. Necessary research to investigate grass carp introduction include:

- Artificial mass propagation of the fish under Egyptian circumstances
- Rearing fries and fingerlings in basins, ponds and cages to stocking size.
- Stocking rates for canals and drains.
- Fish food technology
- Stocking size management
- Bilharzia impact
- Physiological studies of the species, and
- Economics of this biological control alternative

As the result of this research, some of the data was "exported" back to the United States in 1990 and helped the Salt River Project in the American Southwest adopt grass carp as a biological alternative to the herbicide Acrolein.





Three-Pronged Approach to Channel Maintenance

Between 1983-85, Egypt's 48,000 km of irrigation and drainage channels were 82 percent infested. Through improved weed control, channel design and channel maintenance, the current level of infestation has dropped to about 9 percent. Institute research provides continuing input to the Ministry's Annual program of weed control.

- Drainage Research Institute
- Nile Research Institute
- Water Management Institute
- Organization for Geological Survey
- Desert Research Center
- Agricultural Research Center
- The Ministry of Health
- The Egyptian Environmental Action Agency
- Industrial organizations

Environmental Impacts / Institutional Linkages

Groundwater Research

The Groundwater Research Institute (GRI) has become the official body responsible for groundwater development. With this responsibility also comes the task of developing sound linkages with other Institutes and organizations to provide a holistic view of groundwater resources. Collaborative activity is essential.

The GRI currently collaborates with the following organizations in its hydrogeological mapping and groundwater quality efforts:

One of the major activities being undertaken by the Institute and its collaborators is the management of groundwater quality. The health risk of polluted groundwater in Egypt's rural areas is of particular concern.

Aswan High Dam Sedimentation

The MIS/NWRC Project also has aided Nile Research Institute collaborative research related to sedimentation in the reservoir of





the Aswan High Dam through provision of equipment, technical assistance and a fellowship program for staff training in U.S. universities.

The equipment and training has assisted assessment of sedimentation in rivers and reservoirs by sampling and analysis of suspended matter, bed load sediment and study of sources, movements, characteristics and impacts on channel and reservoir management.

The Institute has developed important linkages with the High Dam Authority to provide field training and has worked with Cairo University on deposit utilization studies.

Water quality is particularly important to the nation since the Nile passes through eight countries making Egypt the "end-user." Water quality issues include the ability to predict quality downstream (from Aswan to the Mediterranean Sea) and temperature effects on quality.

future implications for Egypt. Several NWRC Institutes are focusing research on important water management issues.

The Water Management Institute is one of the lead organizations looking at this concern. Since agriculture consumes about 85 percent of the Egyptian water budget, reduction in crop consumption means additional resources for new lands and extra crop production.

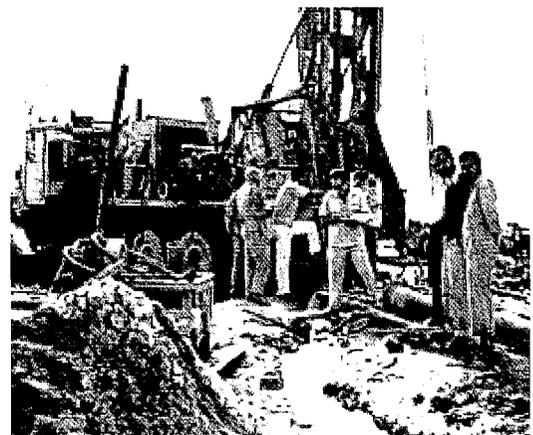
Project-provided equipment such as weighing lysimeters helped the Institute research alternatives for reducing crop consumptive use of water with a minimum effect on production. The historical perspective for crop and water management was based on an abundant supply of water. Now, conditions require research based on reduced water availability and new work turns to plant response under stress conditions.

Collaborative research with the Drainage, Groundwater and other Institutes and organizations also is turning to use of low quality water for irrigation (i.e. wastewater) and its effect on crops and soils. An important linkage has been established with the Ministry of Agriculture's Agricultural

Agricultural Production / Food Security Impacts

Water Management Issues

There is general acknowledgment that water scarcity is a developing issue with serious





Research Center in studying the effect of treated sewage use on crops.

Finally, research on improved surface irrigation which reduces conveyance, distribution and on-farm irrigation losses increases in importance as the Year 2030 water shortage scenario is approached. At that time it is estimated that there will be a population of over 100 million competing for the available water supply.

The Water Resources Development Research Institute is most interested in the amount of water available in the Nile basin and in Egypt including the Sinai Peninsula. Of particular interest is the impact of groundwater mining.

This Institute is collaborating with Groundwater Research Institute in an Eastern Desert Water Resources Study. The effort, aided by Project technical assistance and project procured equipment will help integrate surface and groundwater information into the making of a master plan for the area.

Energy Impacts on Production

The NWRC Mechanical and Electrical Research Institute (MERI) indicates Project input has yielded some preliminary results which impact the following development issues:



- Sources of energy losses in pumping stations.
- Databases for pumping station energy management.
- Identification of potential sites for wind energy use for water lifting.
- Development of solar chimney concepts for irrigation schemes.
- Identification of appropriate telecommunication schemes for centralized control of Sinai water resources.
- Protecting coastal lands.

Ph.D. Proposal Directed Toward Applied Research

A Construction Research Institute staff member is applying his dissertation activity to pilot project work on soil reinforcement techniques applied to earth retaining structures. Earth reinforcement research issues include:

- Costs of earth retaining structures compared to conventional methods,
- Reduced time for execution,
- Use of local materials,
- Relatively "low tech" skill requirements,
- Adaptation to remote areas, and
- Use in areas with problematic soils.

The IMS/NWRC Project has aided CRI research through soil dynamics investigations using seismography to evaluate dynamic properties of soils and introduction of new material testing techniques using the humidity chamber and the universal testing machine.

The CRI also is active in evaluation of the performance of irrigation structures under dynamic conditions such earthquakes and conducts safety monitoring in cooperation with the Grand Barrage Sector.

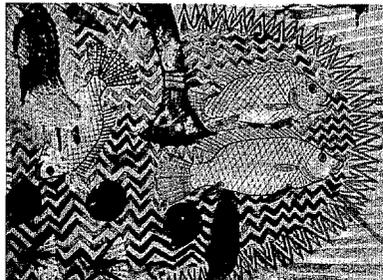


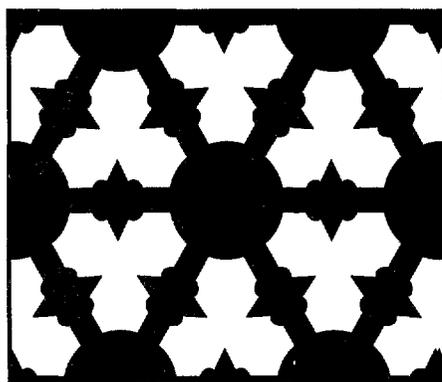
Coastal Protection for Agricultural and Natural Environment

Coastal Protection Institute work has helped the decision-making policy of the Ministry of Public Works and Water Resources in the development of the Egyptian Master Shore Protection Plan. The CRI has furnished a great deal of the data for the plan which is designed to protect the Nile Delta Coast.

A major CRI role in plan development has been research on the expected evolution of the coast. The IMS/NWRC Project inputs included technical assistance, training and equipment to support Institute research efforts. Support included help in the development and manufacturing of instruments like sand trap samplers to collect bed load and suspended load moving along the Delta shoreline.

Continued building of the International Coastal Road will bring increased development. Therefore a Master Plan is essential to guide this growth.





VII. NWRC's Response Capacity and Implications for Meeting Future National Needs



Looking Ahead...

"To plow is to pray..to plant is to prophesy."
-Robert G. Ingersoll-

The New Scope of Work

Egypt is entering a new stage of water problems in terms of quantity, quality, space and time. The present water per-capita share is estimated as a value little less than 1000 m³/ year.

In order to overcome the problems associated with this new situation, considerable work has to be carried out in terms of policies, strategies, techniques and level of technology, legal, organizational as well as institutional, training, public awareness, water economics and users' participation.

All of the above mentioned were new issues to be tackled which required two levels of interventions:

- Technical considerations, and
- Managerial and institutional concerns

The Project has helped the NWRC in the first level through intensive programs of academic training, hands-on training, exchange of views and ideas on policy and implementation strategies and updating knowledge.

Tools and facilities were strengthened by supporting research facilities, laboratories and field and experimental stations throughout the nation.

To help cope with life in the information age, the Project has helped in improving and updating the NWRC library, developing computer networks, archiving reports and listing all researchers and their research.

The Project not only enabled NWRC in the development of information and computer sciences, but increased the sustainability and future impact of the Center through the ability to quickly gather the human resources capacity for new water-related issues as they emerge.

Future emphasis needs to be placed on the second level. As needs increase and organizations grow and financial resources diminish, emphasis needs to be placed on the administration and financial management systems in order to be more effective in the care, keeping and efficient use of personnel, equipment and financial resources.

New Challenges

Human resource development is a long-term process—short-term impacts are less visible. The rapid development of the Water Research Center as a research body is clearly visible in the short-run, however. NWRC has become a focal point of interest and pride in the field of water science.

The outcomes of the quality of the product has also been due to many contributions and commitment of all the staff of NWRC, the USAID Mission in Cairo, the Consortium for International Development (CID) as a contractor for the project and Colorado State University as a lead team. Without their faithful contributions, the project could not have fulfilled its obligations.

The IMS-NWRC model is a unique approach to institutional and technical development which could be applied elsewhere in the field of water resources development and management.

Challenges on the horizon for Egypt and many other developing countries outstrip both past and present challenges since we



are entering a new era characterized by scarcity of water. Water resource development and human resource development are two sides of one coin—they cannot be separated.

Improved technologies in terms of modeling either by using mathematical or physical modeling plus the new capacity in field equipment will help Egypt tackle the many technical problems facing the nation.

Some of these technical problems include:

- River shore erosion along the Mediterranean coast,
- Sedimentation of intakes of domestic water treatment stations, and
- Erosion and sedimentation of navigational routes along the main stem of the River Nile and its Damietta and Rosetta branches and the main navigational canal of Nubaria.

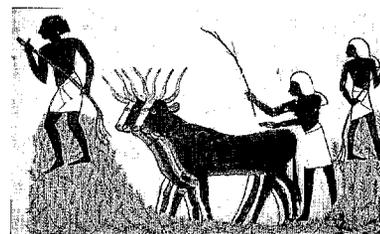
The establishment of databases and GIS systems was only possible through the hardware and software introductions to the systems.

The development of the five-year workplan (1992-1997) of the National Water Research Center and its Institutes has been a benchmark in the development of the Center in terms of achieving institutional goals and addressing problems facing the MPWWR.

Problems and projects characterized by the interests of people and the society have been carefully studied by the NWRC. Examples include: Esna Barrage, Naga Hammadi Barrage, El Salam Canal, and El Boustan Canal. Additional projects include the El Hammami-Canal storage of winter closure water in the Northern Lakes, conjunctive use of both surface and

groundwater, the water resources in Sinai and the reuse of drainage water.

Long-term planning and strategic research and environmental impact assessment are topics which have come to the top of the list of the NWRC research agenda. With the new institutional capacities and increased understanding of the challenges, NWRC is ready to face a new research agenda which includes the study of desalinization and the socio-economic cost of environmental impact assessments.





Future Prospects

A) NWRC Main Office

The future plans of the Information Documentation Center can be summarized as follows:

Library

- Establish a local Area Network (LAN) linkage between NWRC and the Institutes
- Develop on-line communication (nationally and internationally)
- Develop an interlibrary loan system
- Establish a computerized query and loan service

Publications Department

- Operate the new graphics system to enhance printing facilities and produce original artworks and designs for presentations

Documentation Department

- Enlarge the Documentation Department and develop a fully automated retrieval and backup systems

B) NWRC Research Institutes

The most important research issues as foreseen now for the next decade from the viewpoint of each of the eleven NWRC Institutes are:

Water Management Institute (WMRI)

- Reducing crop consumptive use with minimum effect on production.
- Use of low quality water for irrigation

(e.g. land drainage water, treated domestic sewage, treated industrial wastewater) and its effect on soil and crop.

- Improved surface irrigation techniques which aims at the minimizing of conveyance, distribution and on farm irrigation losses.
- Agriculture consumes about 85% of the Egyptian water budget. Reduction of crop consumption means the addition of new lands and extra crop production.

Drainage Research Institute (DRI)

- Pollution problems and water quality deterioration of the drainage water and its environmental impact on soils and crops.
- Rehabilitation of existing drainage system.
- Economic evaluation of drainage projects.

The most important issue is pollution problems and water quality deterioration of the drainage water and its environmental impact on soils and crops.

Water Resources Research Institute (WRI)

The main research issues are:

- Water Resources in Sinai.
- Eastern Desert and Red Sea Water Resources. (joint research program with the R.I.G.W).
- Nile Basin Water Resources.

The most important issue is:

- The Water Resources Study in Sinai.
- The Sinai suffers from a shortage of water to meet the demand for drinking, domestic and other activities.



Nile Research Institute (NRI)

Continuation of HADR sedimentation studies:

- The application of two and three mathematical modeling.
- River Nile Modeling Environmental problems.

The most important issue is the continuation of the sedimentation studies in the High Aswan Dam Reservoir and the application of two and three dimensional modeling to predict sediment distribution in the lake and front progress.

Hydraulics Research Institute (HRI)

- Hydraulic studies of the New Nagga-Hammadi Barrage and its Power Project
- Water hammer studies of the pump stations of El-Salam Canal, as well as any pump station to be constructed by MPWWR.
- Rehabilitation of inland navigation through Damietta Branch.

The most important issue is the New Nagga-Hammadi Barrage which helps in minimizing the water losses as well as increase the efficiency of the irrigation system in the area.

Channel Maintenance Research Institute (CMRI)

The most important future prospects are:

- Computer modeling for the canals behavior under the effect of weed growth.
- Effects of water pollution on fish; particularly grass carp which is widely used in Egypt as a biological means of aquatic weed control.
- Regime behavior of open drains.
- Physical models for irrigation canals.

The most important issue from the above is the effects of water pollution, especially in the Nile River and its branches is increasing due to many factors including effluent from factories and industrial activities. Run-off from agricultural fields also impact aquatic life. The effect of such pollution impacts grass carp growth and weed control programs.

Groundwater Research Institute (GRI)

- Management of groundwater quality especially in the regions with fossil groundwater and extensive pumping/recirculation for various purposes. Recharge of groundwater, conjunctive use.
- Management of coastal aquifers. Recharge of coastal aquifers with fresh water or treated sewage water.
- Health risks associated with polluted groundwater in the rural area of Egypt. Suitable design and implementation of rural wells, their protection from pollution.

Construction Research Institute (CRI)

- Evaluation of the performance of the irrigation structures (Barrages, dams, spillways, pump stations... etc.) under dynamic conditions such as credible design, earthquake, vibration of pump stations, etc.
- Earth reinforcement
- Lining of water canals under dry and wetting conditions

The most important issues are :

- How the cost of earth retaining structures compares to conventional methods relative to the following factors :
 - Needs much less time for execution
 - Uses local material
 - Doesn't require high technology or skills
 - Can be used easily in remote areas
 - Can be used in areas of problematic soils.



Mechanical and Electrical Research Institute (MERI)

The most important research issues in the next decade are:

- Desalination techniques for water systems.
- Automation, control and telemetry in water schemes.
- Developing Energy Analysis and Diagnostic Center for energy saving and management in pumping stations.
- Corrosion protection of metallic structures and equipment in water schemes.
- Development of predictive maintenance procedures for electromechanical equipment in pumping stations and water systems.

Survey Research Institute (SRI)

- GIS for planning and managing water resources in Egypt.
- Application of Remote sensing data of spot and land sat imagery in the mapping fields.
- Establishment of a national deformation and monitoring network for the North-coast and Red-Sea coast.

Remote sensing is gaining great attention as a practical tool for supplying irrigation, drainage, climate, and crop data. These data are essential to the management of irrigation systems in Egypt. SPOT and Landsat provide continuous information and high frequency coverage which is very helpful in updating medium and small scale maps, and in studying objects of dynamic nature such as lakes and rivers.

Coastal Research Institute (CORI)

- The need to contribute to the development of a national integrated coastal zone management plan for the Egyptian

Mediterranean and the Red Seas. Construction of the International Coastal Road will accelerate development (in the now undeveloped north middle Delta) and the nation must have a plan which insures scientific input to proper management and environmental protection.

- Extension of studies of coastal processes to 20 m water depth.
- Enhancing the ongoing use of GIS. The goal is to integrate GIS with remote sensing technology



NEW ACTIVITIES IN THE NWRC

**DIRECTED BY
DR. MONA EI-KADY
FUNDED BY USAID**



STRATEGIC RESEARCH PROGRAM (SRP)

Goal

Institutional strengthening of the Water Research Center (NWRC) of the Ministry of Public Works and Water Resources (MPWWR).

Objectives

- Strengthen NWRC's a) inter-institutional research collaboration and b) inter-Ministry research collaboration and assess long-term water strategies from the economic, environmental and health perspective (in the context of national water scarcity and resource degradation).
- Integrating the work of individual institutes into long-term perspective on sustainable water management.
- Building a culture of strategic thinking across all existing NWRC institutes.
- Strengthening the quality of technical analysis and research in the WRC to support the MPWWR in its role as Egypt's leading water planning and policy agency.

EPAT'S contractor is responsible for provision of inputs noted in the scope of

work listed in the SRP proposal.

Strategic Research Program Components

The SRP will address the following five program areas during the upcoming eighteenmonth period:

1- Integrated Irrigation Reuse and Efficiency (IIRE)

Objective

The objective of the IIRE program is to develop and test strategies and long-term policies which can be used to effectively increase the usable water supply in the Nile Valley-Delta water system. The research efforts will be focused on seeking the optimum trade-offs between irrigation efficiency and drainage water reuse throughout the system.

The following four concepts of water use will be integrated into a systems framework in order to capitalize on the synergism:

- Improvements in irrigation distribution and application efficiency (efficiency);
- Management of irrigation, drainage and ground water quality (quality);
- Enhancements of conjunctive use and recycling (reuse); and
- Reduction of salt load that results from brackish seeps and sea water intrusion (salt loading).

2- Water Conservation Operations (WCO)

Objective

The objective of this program is to provide decision support to enhance the MPWWR's



ability to meet system-wide water demands in a cost-effective way while, at the same time, conserving water by reducing operational losses.

The program will focus on:

- Understanding the nature and consequences of the imbalances between water delivery and demands throughout the Nile Valley-Delta system; and
- Possibilities and strategies for coping with existing and potentially avoidable as well as unavoidable imbalances in the future.

The program objective can be achieved through:

- a) Water demand forecasting.
- b) Various surface and ground water uses.
- c) Use of models and planning tools.

3- Desalinization

Objective

The desalinization program is a short-term effort principally focused on the role of ocean and estuary-based desalinization applications as an element in Egypt's long-term water management strategy. Its major role is to assess the state-of-the-art desalinization technologies from a cost, scale and performance perspective.

The research team of this program will investigate:

- Methodologies.
- Facility characteristics.
- Cost factors for salinity control.

4. Economic and Environmental Impacts (EEI)

Objective

The objective of the EEI program is to provide an integrated assessment of the economic and environmental aspects of water resource utilization through cooperative effort employing the present technical expertise of the NWRC with that of other institutes and ministries.

The research team will investigate the interaction among:

- Crop requirements.
- Water recycling.
- Crop substitution.

from an economic and environmental perspective.

5- Integrated Data Systems (IDS)

Objective

The IDS is designed to meet the need for reliable, easily retrievable, usable and updatable data to contribute to the MPWWR's policy and planning activities.

The data will include information about:

- a) Various sources of supply (fresh, drainage, groundwater):
 - Quantity
 - Quality
- b) Demand configuration for various users:
 - Agriculture
 - Industrial
 - Municipal
- c) Hydraulic and hydropower structures:
 - Discharges
 - Heads
- d) Economic data:
 - Cost
 - Benefit



WATER QUALITY PROGRAM

Title

Water Quality Monitoring, Data Management, and Information Dissemination Program

Objective

To create a National Water Quality Monitoring Unit within the Water Research Center (NWRC), Ministry of Public Works and Water Resources (MPWWR). This unit will provide the leadership in the design of a national water quality program and, over the long-term, the oversight in (1) collecting and analyzing samples, (2) maintaining a database and publishing periodic reports on the status of water quality, and (3) disseminating information to other Government of Egypt (GOE) agencies, EEAA, non-government organizations (NGOs), and the public. The overall goal is to increase the flow of accurate and up-to-date information on water quality in Egypt to policy-makers, water managers and other public and private sector groups, including the general public.

The program contains four components:

- 1- Assist NWRC establish the national water quality program and create the institutional structure and operating procedures.
- 2- Strengthen the capabilities of the WRC to design a monitoring plan, collect samples and analyze the samples for critical pollutants.
- 3- Establish a water quality database system, compatible with existing GOE database systems, for archiving, analyzing, retrieving water quality data on the River

Nile, canals, drains, Northern Lakes, groundwater and discharges, and generating quarterly and annual reports on the status of water quality in Egypt.

4- Create a dissemination program to create packages of water quality information for policy makers and water program managers throughout GOE, and to other organizations such as EEAA, NGOs, mass media, schools which integrate the information into their reduction/awareness activities for governmental agencies, non-government groups, and the general public.

The following activities will be undertaken:

- Establishing a national water quality monitoring unit and program
- Strengthen the water quality sampling and analysis program.
- Create a water quality data management system.
- Establish a water quality awareness communications program.





Future Implications

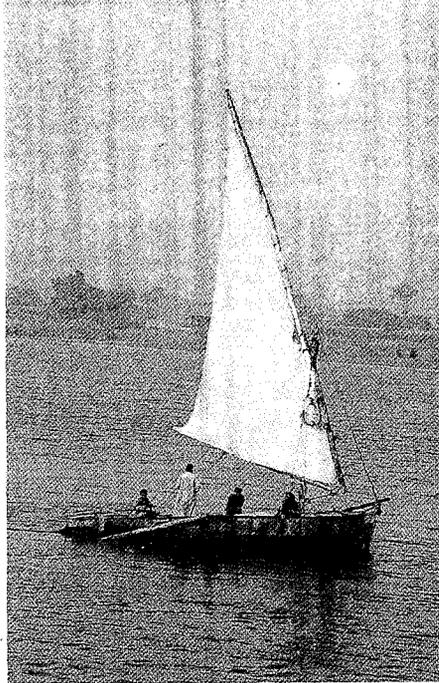
Lessons Learned for Future Projects

The following are some preliminary observations drawn from experiences with the IMS / NWRC Project. Additional lessons and more definitive conclusions and recommendations will develop from the interaction of all significant stakeholders during the planned End-of-Project Seminar / Workshop

- Plan on a minimum of four years for a Ph.D. program. Some students will complete their degree requirements earlier but most will take 4.5 to 5 years. All Ph.D. programs should be planned to meet long-term objectives of the Research Institutes.
- A two-year program for M.Sc. students is adequate.
- Have as many universities participate in the training as possible. This project has involved 23 universities in academic, short term and hands-on training. This enables the Egyptians to establish an international scientific network critical to excellent research.
- Have students start their programs with a general research topic area and have a proposed thesis to discuss with their advisor at the start of the academic program.
- Have much short term training to meet specific short term objectives. This project had an excellent balance of long term, short term and in-country training.
- Equipment should be purchased early in

the project so that research activities can be more effective. Every effort should be made to expedite the procurement process.

- All active agencies in the project should be a party in the contract. It is difficult to accomplish project activities when the controlling agency is not a party to the contract. Host country contracts should be designed so that the majority (if not all) decisions are made by host country project leadership.
- TDYs provide diversity in research approaches while long term staff provide continuity. This project could have had one more long term staff to help integrate the research activities of the TDYs and the institutes. One person for eleven institutes was not enough.
- Continue to secure services of TDYs from as many universities, federal agencies and private consultants as possible. This project had more than 30 different sources of TDYs which was one of the reasons for the success of the technical assistance program.
- Continue to encourage dissemination of information by having staff present papers at conferences and in local and international refereed journals. During the last five to six years, Egypt has established an excellent international reputation in water resources and irrigation. This must be continued.
- Continue to encourage students to present papers at conferences and in journals. Several students have been recognized for their excellent contributions. This contributes to the excellent reputation of the NWRC.



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