PN ABX-485
97504

PRIDE Project in Development and the Environment

Water Quality Monitoring, Data Management, and Information Dissemination in Egypt

Final Report
October 1995

Submitted to:
USAID/Egypt
National Water Research Center, Government of Egypt
Submitted by:
PRIDE

USAID Contract Number:
ANE-0178-Q-00-1047-00
USAID Project Number:
398-0365

Sponsored by:
USAID/G/ENV/EET
Implemented by:
Chemonics International
and its associates

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The objective of the Project in Development and the Environment (PRIDE) is to help the U.S. Agency for International Development (AID) design and implement programs that foster the agency's environmental and natural resources strategy for sustainable economic growth in the Near East and Eastern Europe.

PRIDE provides AID and participating countries with advisory assistance, training, and information services in four program areas: (1) strategic planning, (2) environmental policy analysis, (3) private sector initiatives, and (4) environmental information, education, communication, and institutional strengthening.

The project is being implemented by a consortium selected through open competition in 1991. Chemonics International is the prime contractor; subcontractors include RCG/Hagler, Bailly, Inc.; Science Applications International Corporation; Capital Systems Group, Inc.; Environomics, Inc.; Industrial Economics, Inc.; Lincoln University; and Resource Management International, Inc. In addition, AID has entered into a cooperative agreement with the World Environment Center to support implementation of PRIDE.

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Water Quality Monitoring, Data Management, and Information Dissemination in Egypt

Final Report

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October 1995

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SECTION I
INTRODUCTION AND OVERVIEW OF FINAL QUARTER

A. Introduction

The Water Quality Monitoring, Data Management, and Information Dissemination project in Egypt started on May 20, 1994. The concept for the project was developed by the Government of Egypt (GOE) and USAID/Egypt. The project was implemented through the National Water Research Center (NWRC), of the Ministry of Public Works and Water Resources (MPWWR), with PRIDE (Project in Development and the Environment) assistance through contract number ANE-0178-Q-00-1047-00, Delivery Order #10 (DO#10).

As required in the statement of work (SOW), an Inception Report was written by PRIDE in August 1994. This report contained:

- A project log fram
- A life-of-project work plan including a schedule of activities
- Detailed work plans for the first three months of the project
- Terms of reference for the initial set of short-term advisors
- Computer equipment specifications
- A training plan

In addition, the Inception Report defined the institutional framework.

Documentation of the project's progress has been presented in a series of quarterly reports prepared for four three-month periods and submitted to USAID/Egypt and the National Water Research Center of GOE. These reports summarized progress during the reporting quarter, presented plans for subsequent quarters, and identified problems regarding the following four project components:

- Management
- Data link
- Database/information clearinghouse
- Outreach/communications services.

As the project developed, there have been several changes in management, organization, and goals. These changes can be attributed to a variety of factors, including a shortened time frame and disagreements on the project's role within the NWRC. These, in turn, led to modifications in the final deliverables defined in the project's SOW, which was subsequently modified. The major modification to the SOW was to de-emphasize the development of a Water Quality Monitoring Unit by changing the program to a water quality management program with the institutionalization of the National Water Quality Conservation Unit (NWQCU or the unit).

This final report presents the status of the project, reviews problems that occurred, and makes recommendations for similar programs and for long-term viability of the NWQCU. This report contains an overview of project's final quarter, brief summaries of major achievements of the unit, suggestions for short- and long-term planning once the buy-in is complete, and a final review of the project.

This report fulfills the final reporting requirement of the SOW for DO#10.

B. Overview of the Project's Final Quarter

This reporting period, for June 1 through September 21, focused on:

- Staff training
- Finalizing software development and documentation for the database system
- Meeting with the Strategic Research Program and NWRC on data exchange
- Completion of a series of fact sheets on water quality hazards in Egypt
- Preparation of a communication development program report
- Finalization of a Strategic and Implementation Plan for the unit
- Administrative activities for closeout of the PRIDE program.

To accomplish these tasks, PRIDE fielded four short-term consultants along with the two full-time specialists. The short-term specialists were John Woods, communications specialist, workshop facilitator; Christopher Stathes, database design specialist; Vahid Alavian, water resources and management specialist; and Mamdouh Sharara, environmental statistician. Phillip Brown was the PRIDE team leader.

The long-term specialists were Jane Harris, water quality resources and management specialist, and Vijay Kandaswamy, senior software programmer.

In addition, the following local consultants assisted the unit: Mohamed M. Mowafy, public health specialist; Essam Shawky, sanitary/environmental engineer; Kaml Ibrahim, toxicologist; Ezzat Helwa, public health specialist; Emad Hamdy Imam, sanitary/environmental engineer; and Indhu Balasubramanian, software programmer. Consultants also included quality standards and GIS specialists.

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SECTION II
ACCOMPLISHMENTS

A. Staff Training

Geographic Information System (GIS). Quality Standards of Cairo, an Egyptian company, conducted an introductory nine-day course for the unit on ARCINFO and ARCVIEW that covered practical applications and included limited hands-on training. The course was given at the NWQCU Office at Delta barrage. This was the standard course designed by the creators of the software.

Statistics. Mamdouh Sharara, an environmental statistician, presented a one-week course on statistical applications for environmental problems with emphasis on water quality management issues. There were 15 participants from five NWRC Institutes as well as attendees from the unit. As part of the course work, the class was given a case study that included recent drainage data from the Drainage Research Institute in Assuit. Each participant was asked to write a technical report on the statistical concerns and techniques discussed in class. Homework was also assigned and graded.

Findings of the class included:

- The participants were more at ease with the material presented in Arabic. The use of their native tongue increased their interaction and is highly recommended for future workshops.
- The NWRC institutes have different needs and applications for statistical techniques. It would be optimal to design short courses to meet the specific needs of a particular institute rather than present a generic course.
- Topics worth considering for future classes include experimental design, formulating research questions, and time and space analysis.

Study Tour. Four junior staff of the unit participated in a study tour of the United States. The participants were Sherien Ahmed Zahran. Mohamed Foda Mohamed, Mohamed Abd El Monem, and Amro Helwa.

The objective of the study tour was to help the junior staff better understand how water quality is managed in the United States and gain technical skills by participating in a five-day course on water quality management at Colorado State University.

The study tour originated in Denver, Colorado where the group was met by PRIDE Team Leader Phillip Brown, who was home on leave. Mr. Brown arranged meetings with several state and federal agencies involved in water quality management, including the U.S. Geological Survey, the water quality laboratory and regional operations center of the U.S. Environmental Protection Agency, the GIS and regional enforcement branch of the Bureau of Reclamation, the Hydraulics Laboratory of the Colorado Department of Health, and the University of Colorado. After five days in Denver, the group was taken to Fort Collins for a five-day course on water quality management that included introduction to water quality modeling, statistical analysis, and sampling techniques.

B. Database/Information System Software Development

A major accomplishment of the last quarter was finalizing the Egyptian Water Quality Information System (EWaQIS). EWaQIS is a relational database application designed to bring together water quality monitoring information from a variety of sources to support the work of the unit in water quality management. EWaQIS runs under Microsoft Windows for Workgroups™ and has a range of menu-based command functions that support water quality information input, manipulations, display, and output. Additional analysis and representation of water quality information acquired by the unit is available using statistical and geographical information system software.

The final software package includes step-by-step documentation on using EWaQIS. In addition, the PRIDE team provided demonstrations of EWaQIS to interested parties and a training course to the unit.

C. Data Exchange

During the final quarter some progress was made on obtaining a better exchange of information and data between the NWRC Institutes and the unit. A joint meeting was held on June 27, 1995 by the unit and the Strategic Research Program with the NWRC Institute directors, the unit's Advisory Committee, and USAID. The purpose of the meeting was to develop a working mechanism for data and information sharing. Topics discussed were:

- USAID perspective on data sharing
- Benefits of water quality information and data exchange in Egypt
- How information and data can be shared more effectively
- Perspective of the NWRC directors
- The Draft Protocol

The proceedings of this meeting are presented in Annex A. The overall results of the meeting were inconclusive, and no progress was made toward enhanced information sharing. The directors agreed to make their final comments on the protocol in writing by July, with a revision of the protocol by July 15. These comments were reviewed by the unit. It was noted that the institute directors hold same position on the sharing of data as they had a year earlier. These comments have been reviewed with Dr. Abu Zeid, who agrees with the directors, and feels the unit must show it can do something different from the institutes before complete data sharing can occur.

Further contact was made with the Greater Cairo Water Supply Authority's central laboratory. Each month this lab analyzes water samples from 13 water intakes along the Nile River near Cairo for trace metals, nutrients, organics, and pesticides. In exchange for data, the unit offered assistance in developing a database.

To summarize, it appears that little or no progress was made toward data sharing during this quarter. However, it was considered an accomplishment to get the institute directors' direction on paper and to strengthen the need for the NWRC to review the necessity of the unit.

D. Fact Sheets on Water Quality Hazards

During this quarter, five local consultants were hired by the unit to complete seven fact sheets on water quality hazards in Egypt. The consultants were Emad Hamdy Iman (coordinator), Kamal A. Ibrahim (nutrients), M. Maamoun Mowafy (pesticides), Essam Shawky (salinity), Ezzat Helwa (pathogens/parasites), and D. Fatma El Gorhary (metals/oxygen-demanding substances/oil and grease).

The concept for these fact sheets was developed at the Second Advisory Workshop when participants suggested that water quality hazards presented in the "Assessment of Water Quality Hazards in Egypt" should be evaluated in more detail. These fact sheets define the state of knowledge in Egypt and each includes, at a minimum, answers to the following questions:

- Why is the parameter important in Egypt and what does it indicate? (hazard identification)
- What are the most likely ways receptors could come into contact with the hazards and where is it most likely to happen? (pathway analysis)
- What is known of the potential consequences of high concentrations of this parameter? (consequences)
- What can be done at this time in Egypt to reduce the hazards indicated by this parameter? (management options)

During this quarter, these fact sheets and accompanying working papers were submitted to the unit. An internal workshop was held on September 11 for the unit and the consultants to discuss the fact sheets. Although limited data availability hindered writing the fact sheets, they were completed on time and are considered a major accomplishment of the unit.

E. Communication Program Development

DO#10 SOW specified that one of the four components of this project was to "create and disseminate packages of water quality information to policy makers and water program managers, and to other organizations responsible for public awareness activities." During this quarter, John Woods, on temporary duty to PRIDE, and Wael Soliman developed a document entitled "Communication Program Development for the NWRC National Water Quality Conservation unit" to summarize the work done to date and provide recommendations for further development of the communications program for the unit. This document includes a modified **Communication Strategy** as well as a preliminary **Communication Needs Assessment,** a step-by-step approach on how the unit could develop communication plans in the future and the types of services which could be developed.

F. Strategic and Implementation Plan

Working with the unit staff, Vahid Alavian developed a **Strategic and Implementation Plan** for the further development of the National Water Quality Conservation Unit. The strategy section of that document outlined a framework for further development of the unit into a self-sustained organization with the expressed mission of providing a vehicle for addressing water quality issues in Egypt in an integrated fashion. The implementation section addressed the

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specific activities and resources required to achieve the goals and objectives of the unit and a short-term plan outlined specific activities to be undertaken over the next one to two years.

G. Administrative Activities

Administrative activities concerning establishment of an office and startup of the institutional development component of the program have been finished. An inventory of all office supplies was completed and is presented in Annex B. As part of the closeout activities, all office furniture, supplies, and computer equipment and software have been turned over to the unit in good working order.

SECTION III
PROJECT ACTIVITIES

The following provides a more detailed description of the activities during the quarter for each component in the project.

A. Management

During this quarter, the main management activities focused on:

- The Advisory Committee meeting in regard to data sharing
- Other administrative activities in regard to closeout of the PRIDE project

Advisory Committee meeting. As mentioned earlier, a joint meeting of the unit and the Strategic Research Unit with the Advisory Committee was held on June 27, 1995 at the Cairo Marriott Hotel. The purpose of this meeting was to promote sharing data and information within the NWRC between the unit and the Strategic Research Programs. The proceedings and results of this meeting are presented in Annex A of this report.

Other activities. The table on the following page lists the activities for this component. The NWRC/NWQC staff member responsible for this component is Mona El Kady and the PRIDE team member responsible is Phillip Brown.

B. Data Link

The work of this component centered around the development of seven fact sheets on water quality hazards in Egypt and responding to the institute directors' comments on the data-sharing protocol.

Hazard assessment fact sheets. During the quarter, work concentrated on the development of seven fact sheets and associated working papers of seven identified water quality hazards in Egypt, which were identified as:

- Parasites, pathogens, and viruses
- Nutrients (nitrates, phosphorous)
- Trace metals (trace metals)
- Salinity and physical properties (salinity)
- Oil, grease, and petrochemicals (BOD, COD, and oil and grease)
- Pesticides and insecticides (pesticides)
- Oxygen demanding substances (BOD, COD)

Each fact sheet was completed by the unit working with local consultants and was designed to assist in determining which water quality information is most important in developing a water quality management strategy in Egypt. Each paper included the following four steps:

- Identification of the information available on water quality hazards and their potential consequences.
- Description of the hazard present.

Component #1: Overall Management
Summary of Work Plan Activities

ACTIVITY	END DATE	COMMENTS
PROGRAM DEVELOPMENT:		
Organizational Development Workshops	Completed	Four meetings/workshops conducted with NWQC unit staff and PRIDE team. Issues continued to be discussed in staff meetings.
NWQC Advisory Committee Meeting	June 27	One meeting with the Advisory Committee, Strategic Research Program, and USAID to discuss data sharing. The results of the meeting were inconclusive and disappointing in terms of the development of a final protocol for the exchange of data.
Weekly Staff Meetings	Ongoing	Each Tuesday there is a meeting of the NWQC unit staff followed by the PRIDE team joining in on the discussions on project-related issues. These meetings follow up on many of the issues discussed during the OD workshops.
Negotiate with NWRC Institutes terms and conditions for releasing data to the unit.	Completed	This is a function of the Data Link Division. However, Dr. Mona, as NWQC unit director, has been involved in the discussions and has submitted letters to the institutes on what data is needed and how it will be used. However, these letters elicited little or no response from the institute directors and no progress was made.
Begin preparing water quality discussion papers.	Completed	The Advisory Committee asked for an assessment paper on seven pollution indicator parameters. Local consultants have completed each of the Fact Sheets and Working Papers.
ADMINISTRATIVE:		
Completed Inventory of Office Furnishings	August 1995	All the furniture, curtains, dividers, and office equipment installed have been inventoried and labeled.
Project 4th Quarterly Report	June 1995	The report was finalized after review of NWRC and USAID.
Communication Strategy, Communication Strategy, and Strategic Plan	August 1995	These reports have been finalized and submitted to NWRC.

- Determination of pathways by which susceptible population could be exposed.
- Description of potential consequences of exposure.

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Finally, with the most important problems identified, existing data collection and analysis programs can be assessed by the unit in terms of their ability to describe both these high-priority problems and efforts to control the problems.

Before writing a fact sheet for each of the above hazards, a working paper was completed. The working papers presented the details and data on which the fact sheets were based. The fact sheets were published in both English and Arabic.

Data exchange protocol. A main goal of the data link section was finalizing a Protocol for Data Flow between the NWRC Institutes and the NWQC unit. The purpose of this protocol was to record the terms by which data and other information will be transferred between the Institutes of the National Water Research Center and the National Water Quality Conservation unit. The protocol was also intended to provide a framework of procedures that will expedite the exchange of data and thereby help achieve the goal of promoting the free flow of accurate, up-to-date water quality information in Egypt.

A protocol for data exchange is required to ensure that adequate and proper consideration be given to all parties involved and to provide a reference for procedural matters to expedite routine data transfer. The terms of this protocol are intended to be general enough to cover the cases that are considered most likely to occur, but specific enough to provide clear guidance.

The draft protocol was developed based on the request by the Advisory Committee to help clarify the relationship between the institutes and the unit. The institutes and the unit agree that the goal of improving water quality in Egypt is a worthy one and that dissemination of accurate and up-to-date information will help to achieve the goal. Unfortunately, no agreement could be made for overall acceptance of the protocol.

Other activities. The table on the following page lists the activities for this component. The NWRC/NWQC staff member responsible for this component is Gamal Abdel Nasser and the PRIDE team member responsible is Jane Harris.

C. Database/Information Clearinghouse

The Database/Information Clearinghouse Division is in charge of the unit's water quality information storage and consists of the water quality database as well as an information clearinghouse. The following was completed in this division during the final quarter.

Water quality database system development. The software development for the Egyptian Water Quality Information System (EWaQIS) was completed at the end of August 1995. The system was fully designed and tested. In addition, a Users' Guide was developed for the system and unit staff members were taught how to use the system.

Report design. Mamdouh Sharara assisted in finalizing the statistical analysis capabilities of the system. Graphical and statistical summaries of data were incorporated into the database. Because of the uncertainties of the types of data to be placed in the database, no formal reporting format was designed. However, the unit was taught how to customize reports by using the software available to them.

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Component 2: Data Link
Summary of Work Plan Activities

ACTIVITIES Data Link - Final Quarter	END DATE	COMMENTS
Followup requests for data from Institutes with new, more detailed requests	Ongoing	DRI base maps have been requested. Data obtained from NRI: discharge quantities, TDS at Aswan, Delta Barrage, Rosetta, and Damietta.
Begin assessing availability of data needed for preparation of discussion papers	Ongoing	Data assembled from NWRC Institutes and NRC for use in Hazard Assessment presented to Advisory Committee.
Participate in weekly staff meetings	Ongoing	Dr M na has held regular staff meetings at Delta Barrage.
Prepare fortnightly reports on progress of Section	Ongoing	Verbal reports have been submitted as requested.
Identify specific data needs for preparation of discussion papers	Ongoing	Data identified from NWRC Institutes and NRC for use in Hazard Assessment presented to Advisory Committee. Additional data needs for subsequent work have also been identified.
Begin describing the system distributing water in Egypt	Ongoing	Information collected regarding water distribution system.

Data structure. The process getting the data structure of the databases from DRI, RIGW and Planning sector was also completed. Data from DRI Yearbooks, RIGW reports, NRI results of analysis, and the planning sector have been evaluated. The tables in the database are designed based on the data available in the reports.

GIS interface. A GIS interface with EWaQIS was designed by Quality Standards, a consulting firm, and installed. This allowed for evaluating the data on a temporal, as well as spatial, basis.

Information Clearinghouse and GIS. Design and development of the Information Clearinghouse database. An Information Clearinghouse database was developed earlier and is still being used by the Information Clearinghouse section of the unit. Work continued with Mary Halem, NWRC administrator for information and documentation, on establishing the NWQC program's library as a subunit of the NWRC Library.

GIS software for the unit. A training course on ARCINFO and ARCVIEW was completed by Quality Standards and unit staff received hands-on experience in using the software.

Miscellaneous

Training. Unit staff were trained in how to use the EWaQIS and in GIS applications of the database.

Junior programmer interview. Interviewed and hired Indhu Kandaswamy for the junior programmer position.

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Inventory system for the unit. An inventory system for the hardware of the unit was developed and is being used by the unit. All warranty information on equipment received has been sent to the manufacturers.

The table below lists the activities for the database/information clearinghouse component included in the 4th Quarter Work Plan. The NWRC/NWQC staff member responsible for this component is Gamal Abdel Nasser and the PRIDE team member responsible is Chris Stathes.

Component 3: Database/Information Clearinghouse
Summary of Work Plan Activities

ACTIVITY	END DATE	COMMENTS
Create acceptance test plan, QA/QC & programming standards for database development	Completed	Delayed due to slow arrival of equipment but currently being implemented.
Local programmer on project	Completed	A person has been interviewed and hired.
Identify and design "standard" outputs from database	Finalized	
Design and implement roster database of WQ experts & institutions	Completed	Roster database designed and available.
Database application development	Finalized	Progress was slowed by lack of equipment and continuing questions about data availability.
Begin analysis of available data	Finished	Data availability issues cause delays.

D. Outreach/Communications Services

As described in the Third Quarterly Report, this component focuses on two functions: (1) liaison with clients of the NWQC unit—the users of water quality information; and (2) communications services that focus on packaging information outputs for various clients and producing meetings, workshops and other types of face-to-face communications activities.

John Woods as project manager was in Egypt approximately 50 percent of the quarter helping with the communications services and with the Second Advisory Committee workshop. Achievements of this section included completing the Advisory Committee Meeting, writing a document on communication program development that included a communication strategy and needs assessment, finalizing seven papers and fact sheets on water hazards in Egypt, and completion of a strategic plan for the unit. In addition, other activities based on the fourth quarter work plan were completed.

Working papers and fact sheets. During the second advisory workshop, discussions centered on the next step in terms of water quality assessment. It was suggested at the workshop that each of the pollutant indicator parameters presented in the "Assessment of Water Quality Hazards in Egypt" be evaluated in more detail, which resulted in the fact sheets. These working papers and fact sheets are a concrete example of the work that the unit can produce.

Communication program development. During this quarter, John Woods from PRIDE completed, with assistance from Wael Soliman, a communications program development paper for the

unit. This paper combined the communication needs assessment and the communication strategy, both of which were required in the SOW. The purpose of this paper was to summarize work performed to date and provide recommendations for further development of the communications program for the NWQCU.

The following table contains activities for the outreach/communications service component. The NWRC/NWQC staff member responsible for this component is Wael Soliman and the PRIDE team member responsible is John Woods.

Component #4: Outreach/Communications Services
Summary of Work Plan Activities

ACTIVITY	END DATE	COMMENTS
OUTREACH/CLIENTELE SERVICES:		
Priority list of clientele	January	A list was developed, which should be reviewed with the Advisory Committee
Establish format for reporting on meetings with clientele	Finalized	Several types of meeting reports have been used. More work and experience is needed before a final version can be prepared.
Conduct meetings with potential clientele	Finished	
Prepare proposals for specific followup services	January on-wards	A request was received to help with an assessment of a new lands project in the delta that will be done in cooperation with the NWRC Institutes.
INFORMATION DISSEMINATION:		
Begin producing fact sheets	February on-wards	During the study tour, a number of examples of fact sheets were collected and studied. The unit began producing seven fact sheets on indicator parameters (see above).
Revise communication strategy	Finalized	The original communications strategy was reviewed and revised, and placed in a communication program development document prepared by the unit.
Establish NWQC mailing list	Ongoing	Some work has been done to prepare a mailing list in the unit's database. However, there has not been a concentrated effort to develop a full mailing list. This will be done jointly by the outreach/ communications services and the database/information clearinghouse divisions.
Information dissemination needs assessment	Finalized	A preliminary needs assessment was completed and placed in a document entitled Communication Program Development prepared by the unit. Information was collected from clientele on their needs.

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SECTION IV
PROJECT REVIEW

In general, establishing and operating the project was much slower than expected due to:

- Delays and changes in the DO#10, which shortened the project's duration
- Original project design that did not allow time for the logistics of establishing, housing, and staffing a new unit
- Vague original SOW on the role of the PRIDE team and its relation with the unit
- A perceived duplication of effort between the unit and projects funded by other donor countries
- Lack of an initial strong, unified, and focused group capable of rapidly developing the unit
- Lack of a full-time unit director onsite to keep the project moving and to inspire the junior staff.

Problems slowing the progress occurred in the makeup of the PRIDE Team and the Egyptian staff. For the PRIDE team, personality issues, lack of a clear direction, and differences of opinion in priority activities were the main issues. Despite the Egyptian staff's qualifications in civil engineering and related fields, they lacked experience in water quality issues important to the unit. Because of the time needed to get the Egyptian staff in place, it was not possible for PRIDE to develop a adequate training program in water quality.

Despite the staff problems and inadequate training, the unit staff managed to make good progress toward its objectives, particularly in the second half of the project. Staff members now have adequate basic training to carry out their responsibilities and contribute to the unit. Also during the quarter, Jane Harris left the project and Phillip Brown was appointed as PRIDE team leader. This change seemed to have a positive effect on the project.

As a general conclusion, the main problem with the program is not the staffing or the PRIDE team. It has been the inability for the National Water Research Center to determine and clearly define the role of the unit within the center. The original program design was based on the needs of the NWRC as defined by its president, PRIDE, and USAID. During the early stages, the unit was promised complete cooperation from the NWRC in meeting its overall goal of "increasing the flow of accurate and up-to-date information on water quality in Egypt." Despite these assurances, outside of the efforts of the unit's director, little was done within the NWRC to help the unit meet its goal; therefore, the database system has virtually no data. This makes it very difficult for the unit to assist the NWRC in water quality management issues.

It should be noted that even up to the end of the buy-in, the directors of the various NWRC were talking of cooperating with the unit, but only on their terms. The directors felt that in order for the unit to get their data, it must prove it is worthy by showing what the unit could do that was different. One area talked about was the use of risk assessment in water quality management. Although this is the one area where the unit has done considerable work, it is impossible to perform a proper risk assessment without having a comprehensive database.

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SECTION V
RECOMMENDATIONS

For the long-term viability of the unit, it must develop a balance between the technical needs of the country for water quality information and its role as a communicator of water quality management issues. It must also take a pro-active role in developing an understanding of the water quality problems that exist in Egypt. In doing so, the unit can take steps to reduce risks by using communication and other techniques. At the same time, the unit must be able to react to water quality crises that may occur. By following the strategic and implementation plan while keeping in mind the communication development plan (both developed by PRIDE), unit sustainability can become a reality.

Finally, in developing recommendations for the startup of similar projects, it is important to take into consideration the problems as well as successes of this project. Based on the experience of the unit, it can be recommended that the following issues be taken into consideration before project start-up:

- Enough time should be planned for startup activities, including staff hiring, finding office space, and so forth (it always takes longer than anticipated).
- The goals of the project should be well defined, with the roles of each party made clear (no uncertainty should exist).
- The rules of the contract should be clearly spelled out to all parties (everyone must know his responsibilities).
- Senior-level staff should be identified and a full-time director appointed (a demand for such people exists in Egypt and it takes time).
- Identification of senior-level staff should be made not only for technical capabilities but also for enthusiasm and willingness to mentor junior staff members (this will help the overall attitude of the unit).
- The level of support and cooperation of the Government of Egypt should be understood in detail (without their complete help the project cannot survive).

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ANNEX A

SHARING WATER MANAGEMENT INFORMATION

ANNEX A
PROCEEDINGS OF MEETING ON SHARING WATER MANAGEMENT INFORMATION

NWQCU Advisory Committee Meeting
In Association with SRP Integrated Information System
27 June 1995
Cairo Marriott Hotel

Dr. Mona began the meeting at 9:05 am by welcoming the participants. Dr. Mona explained that Dr. Abu-Zeid was unexpectedly called to the minister's office and, therefore, was not able to attend. However, he was concerned with ensuring that data and information are shared in order to improve water management.

Welcome and Introductory Remarks
Dr. Mona El Kady, NWRC, and Mr. Russel Backus, USAID

Dr. Mona gave an overview of why the committee was meeting to promote sharing of data and information within the NWRC among the institutes, the new National Water Quality Conservation Unit (NWQCU), and the Strategic Research Program (SRP), as well as outside agencies including the MPWWR. Today's meeting involves two contracts to establish the NWQCU and the SRP. Both units are involved in helping integrate data among institutes.

Dr. Mona commented that over the past year the two units have been established and are now utilizing the data and information available. She emphasized that the units do not collect data. They only analyze data and information at a level to address issues related to the water quality management and integrated development of water resources in Egypt.

The purpose of today's meeting is to develop a working mechanism for data and information sharing.

Mr. Russel Backus, USAID, complemented the group for meeting and addressing such an important subject. He pointed out that the USAID's perspective is not much different than that of Egyptian counterparts, as all are concerned with improving water management. In the USAID focus on re-engineering the approach of the agency to development, the importance of information management is beginning to be realized. Egypt is lucky to have much information and, therefore, it is important to focus on how to better utilize this information. Mr. Backus said that many visitors have been impressed with the high priority placed on improving water quality. However, the challenge will be how to develop programs to address water quality problems. The two projects are both avenues to success. Everybody involved should participate in developing these programs.

Dr. John Woods was introduced as the meeting facilitator. He, in turn, asked everyone to introduce themselves and give their affiliation.

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Benefits of Water Information/Data Exchange
Dr. Vahid Alavian, NWQCU/PRIDE

Dr. Vahid Alavian spoke on Benefits of Sharing Water Quality Information/Data. He reviewed the evolution of data scope and objectives. One type is raw data which generally has a point scope and single objective. The next level in information has space and time scope and is used for multiobjective purposes. The next level is knowledge which includes analysis and interpretation and is multiobjective on a regional basis. Finally, wisdom is the relationship to global objectives.

We are concerned with environmental issues and therefore developing environmental data and information programs, Dr. Alavian noted. In our case, we are concerned with fresh water and developing databases of raw data, social and economic activities, environmental impacts and responses to environmental impacts. Each of the agencies represented have data. But as you move to information, knowledge and wisdom levels, you will need to gather information/data from others to develop programs. There can be cases where data could be misinterpreted. Therefore, it might be best in some cases to share at a higher level, such as the information level rather than raw-data level. This will require cooperation in analysis and interpretation and jointly publishing the information.

Questions were raised about the dangers of misuse of data being released outside the Institutes. Dr. Alavian said that often integrating data into trends would help avoid misuse of data. Another participant pointed out that data often is collected for specific users and for specific uses. This needs to be made clear in the data released.

Better Sharing of Information
Dr. Zhu, SRP/EPAT

Dr. Zhu spoke on moving toward better sharing of information. He described the U.S. Geological Survey (USGS) information programs. The basic program is the National Water Information System which data is collected throughout the country and integrated into a national data system. Beginning in 1986, USGS went through a strategic planning exercise to integrate their data and, in some cases (such as with EPA), to be able to link with their databases. They established user groups including roughly 50 people within and 100 outsiders to guide in the program development.

Dr. Zhu said participants of the meeting are building the foundation of what should become a national water information system for Egypt. The first step is to recognize the importance of sharing information and to agree to share regular continuous data that is being collected. The second step is to create a flow of information and data between the institutes. The third step is to establish a system to monitor the flow of information and determine if the information is really being shared. Fourth, more operational experience in necessary order to design the overall water information system. The fifth step will be to develop the software and network facilities. Finally, using earlier steps, it will be possible to establish the Egyptian National Water Information System (NWIS).

A starting point is to agree upon a common database platform, such as Microsoft Access. Selected data should be identified to bring into a central database on identified uses. Dr. Zhu presented a NWRC information flow for water data, GIS and special data. The SRP has so far

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collected approximately 160 files of water related data, most of which are from the ministry rather than NWRC.

He concluded with outlining a SRP database program to be implemented: to identify selected data that should come from each source, have regular updating and maintenance, standardize the platform, figure out how to fund, and work with other projects. This program requires the willingness of the institutes and action.

Data/Information Sharing: The Institutes Perspective
Institute directors and other GOE water monitoring agencies

Dr. Mona took the role of an institute director and said that there are several questions that require attention.

1. Do we have the detailed data needed for a database?
2. Do we have the necessary QA/QC?
3. Will the database be used properly?
4. Will the institutes get credit or be blamed for good use or misuse of the data?
5. What are the cost recovery and staff incentive issues?
6. What are the security and data classification issues within the central units?
7. How should the central units (NWQC and SRP) assist the institutes in updating databases?

Dr. Diaa El Koussy, director, Water Management Resources Research Institute, thanked Dr. Zhu for his insistence on building water databases. The 70s and 80s were the era of modeling; however, the 90s will be the time for databases, he noted. His institute is establishing a network of data sharing. We have a lot of information on water losses that is very important. We are also developing several new databases. Our institute is open to cooperation and sharing.

Dr. Fatma Abdel-Rahman, director, Ground Water Research Institute, said it is essential to know what are the requirements of data which is needed. The type of data needed must be provided. How will the data be used? What is the mandate of the requesting agency and how it will use the data. In other words, we need to know what you need, why it is needed, in what form, and how it will be used. We are willing to shift from our existing database platform to a new platform such as Microsoft Access, but it will take time.

Dr. Shaden Abdel-Gawad, director, Environment, said that sharing raw data is dangerous. We need to share it in a processed form. Do the new SRP and NWQC units have personnel who can actually help others in updating their database platforms?

Dr. Samia El Guindi, director, Central Laboratory, said that they will have their own database and they would be willing to share the data to the central organizations.

Dr. Safwat Abdel Dayem, director, Drainage Research Institute, pointed out that his institute has fully cooperated with the new units. He challenged a statement made that they have not shared all their data, which he said was not true. He questioned the concept of sharing. We must know whom we are sharing with and why. The institutes have been operating for some time with clear mandates. Why are new units being created? How can they help us do a better job? Once we understand how these new units help us, we would be willing to cooperate.

Dr. Safwat went on to say that there are many categories of users, including researchers, policy makers, and the general public. We need to discuss within NWRC an institutional arrangements for sharing data. Otherwise, there will be problems with the flow of information and conflict between the institutes and the central units. Every institute has a mandate to have outreach programs. We need the water quality unit for helping with quality assurance, standardizing the data, etc., he noted. We would be happy to have others use and publish our information. We strongly feel that water quality data sharing is important.

Dr. Mona said that the NWQC and SRP units will not overlap, duplicate, or compete with the institutes. They are to support and help the institutes. They are to fill gaps and help with the integration of the work of the institutes. She also stressed the need to establish the institutional arrangements for data sharing and information flows.

Dr. Motassem Kotb, NWRC vice president and director of the Nile Research Institute, said that he supported the creation of the new units. Each of the institutes needs to have a unit within it to link with the SRP. His institute is selecting data collection sites for specific research and, therefore, the NWQCU and SRP need to understand why the data was collected. He feels that cooperation between the institutes is no problem. However, the integration process should include involvement from more than the institute directors.

Dr. Mona pointed out that both the NWQCU and SRP tried to have the institutes to appoint liaison persons to attend meetings and maintain contacts. Dr. Earl Israelsen, EPAT, said that he did not see the concept of sharing data as just putting information into a common database for everybody to use. There is more to it than that. Dr. Safwat said that there has been sharing of data with users. There are gaps, such as the lack of modern database platforms and integration of the data. However, the USGS model may not be the way Egypt should go. Dr. Israelsen said that we must start with the attitude and willingness of sharing and eventually we can work out the platforms and other details. Dr. Fatma said that the role of the units would be to learn what the institutes need and to help publicize what they are doing and help share the information they generate.

Dr. Fatma El Ghori, NRC, said that she sees the value of both the institute and the central units. However, it does not seem that any progress has been made since last year. Each institute is asking the same questions they did a year ago. We are still talking about what is the mandate of the NWQC Unit. This needs to be resolved. She feels that the NWQCU must be promoting water quality management.

Dr. Mohammed Fawzi, head, Water Division, EEAA, said that we must be concerned about and promote data sharing. He feels that these new units are not institutes and their role should be to facilitate the participation of institutes in the process of development.

Overview of Draft Protocol
Mr. Phillip Brown, NWQCU/PRIDE

Mr. Phillip Brown, PRIDE team leader, expressed concern that some of the issues raised during the morning session were the same as raised a year ago. If the NWQC Unit is to serve policy makers, water managers and the general public, then it needs access to data. The second NWQCU Program Advisory Committee workshop requested that a protocol be prepared. Proposed meetings of the committee and meetings between Dr. Mona and the institute directors did not take place. Therefore, this is still a rough draft protocol. Much work is needed with

definitions and the basic points to agree upon. Mr. Brown pointed out a number of issues that still need attention. For example, the language of the protocol, decree versus guideline, should be decided. Mr. Brown then presented a summary of the key points in the protocol.

Areas of Disagreement with the Protocol
Dr. Shaden Abdel Gawad, Head of the Committee,
Mr. Phillip Brown, PRIDE Team Leader

Mr. Brown pointed out that most of the institute directors were not present in the afternoon session. Since the purpose of the protocol was to work out the issues raised by the directors, any discussion without their presence would be useless and a waste of time. Later in the session two more directors arrived and the discussion continued.

Dr. Shaden said that during the second NWQC Program Advisory Committee the decision was made that a committee would be formed with members of the institutes. On April 10, 1995 Dr. Shaden received the draft protocol. This was forwarded to the institutes asking them for their comments. Dr. Safwat suggested that a meeting of the institute directors be held to discuss the protocol. Several attempts were made to have the meeting and because of scheduling conflicts a meeting was not held. She did not receive any written comments either. Dr. Shaden then tried to meet with the individual directors, but was not successful.

Dr. Shaden felt that the protocol is written too general and vague. The existing protocol is between NWQC Unit and the Institutes, but no mention is given to a third party, that is, the user of the information from the NWQC. The general concern expressed was the relationship between the NWQC Unit and the institutes. Concerns were also expressed about the institutes receiving the appropriate credit for the data they have. The directors are interested in developing the relationship with the NWQC Unit to help them with filling the gaps in data and information, but not to duplicate their mandated activities.

Dr. Wael mentioned that the protocol does not include the value of the data and credit given to the institutes. Dr. Wadie said that there is currently no information system in NWRC. Dr. Mona pointed out that in some cases there could be national security and political issues with data because other countries want to use the water. Dr. Zhu pointed out that it comes back to the commitment of NWRC president and directors. Mr. Backus said that the fear of misuse of data is an excuse, but not a valid one. Dr. Mona said that the protocol could be drawn up as a decree and signed by the NWRC president. However, we chose to involve the institute directors so that they will support the protocol.

Mr. Backus asked if the NWQC and SRP units are official units. Dr. Mona said that they are in the new NWRC organizational structure. The Presidential Decree states specifically the Central Laboratory and the SRP. The NWQC Unit has been added in followup documents as a part of the implementation of the decree. The mandate states that these units are not to collect data, but to rely on the institutes. Dr. Alavian said that the decree and its implementation plan should be the instrument for the development and operation of the NWQCU and SRP and a protocol is needed.

Dr. Safwat said that the working group of the institute directors should meet to work out the details. Dr. Mona pointed out that it has been two months and nothing has happened. Dr. Safwat said that a deadline should be set for comments and then a meeting called. The institutional arrangement is bigger than the protocol, and should include the end users in the

process. The responsibilities of the NWQC Unit and the lines of communications should be clearly defined.

Dr. Mona asked how detailed the protocol should be and if it could be the same for all the institutes. Dr. Diaa said that the NWQC Unit will have a state-of-the-art database. Therefore, he requested assistance to help his institute and others in setting up their databases and to form a network so that sharing can be done.

Mr. Backus said that we need to go back to the basic issues. USAID has signed agreements that clearly state the mandates. He asked why there were still questions raised on the role of the units. We must identify what the basic issues are and move forward.

Action and Schedule for Final Protocol Document

Dr. Safwat suggested that another attempt should be made to get the directors written comments before the protocol is finalized. He suggested that if comments did not arrive from the directors by a given deadline, the matter should move forward without their input. The following actions was agreed upon by the directors and officials present at the meeting:

1. Dr. Shaden Abdel Gawad, head of Protocol Committee, will contact all institute directors and inform them that the final comments on the draft protocol are due to the Unit by July 8, 1995.

2. The NWQC Unit will revise the draft protocol to reflect the comments made by the institute directors and deliver it to Dr. Mona El Kady for review by July 15. The final copy will be sent to Dr. Abu-Zeid, President, NWRC, for review and approval.

3. Obtain Dr. Abu-Zeid's approval and begin implementation by July 25, 1995.

Other Topics and Closing
Dr. Mona El Kady and Mr. Russel Backus

The PRIDE team is currently preparing a Strategic Plan for the overall program and the communications component. We are once again returning to the position that we need to have a meeting with the users of the water quality data/information. The PRIDE project has one more workshop that should include the users. The decision to have a separate users' workshop is to be made after the communications needs assessment is completed. Dr. Wadie said that he hopes that we can move forward in addressing information flow issues.

Dr. Mona thanked everybody for their participation and especially Dr. Woods for facilitating the workshop and Ms. Gehan Fawzi for all the arrangements.

The meeting adjourned at 4:15 pm.

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NWQC Advisory Committee Meeting
In Association with SRP Integrated Information System
27 June 1995
Cairo Marriott Hotel

9:00 - 9:30	Welcome and Why We Are Here Dr. Mona El Kady, NWRC
	Introductory Remarks and Guidance to Group Dr. Abu-Zeid, President, NWRC
	Introductory Remarks from USAID Perspective Mr. Russel Backus, USAID
9:30 - 10:00	Benefits of Water Information/Data Exchange Dr. Vahid Alavian, NWQC/PRIDE
10:00 - 10:15	BREAK
10:15 - 10:45	Better Sharing of Information Dr. Zhu, SRP/EPAT
10:45 - 11:45	Data/Information Sharing: The Institutes Perspective Institute Directors and other GOE water monitoring agencies
11:45 am	Discussion
12:15	RECEPTION
1:15 - 1:40	Overview of Draft Protocol Mr. Phillip Brown, NWQC/PRIDE Team Leader
1:40 - 2:30	Areas of Disagreement With the Protocol Dr. Shaden Abdel Gawad, Head of Committee Mr. Phillip Brown, PRIDE Team Leader
2:30 - 3:30	Revising Protocol Dr. John Woods, NWQC/PRIDE
3:30 pm	Other Topics and Closing Comments Dr. Mona El Kady and Mr. Russel Backus

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Invited Participants
Advisory Committee Meeting
27 June 1995
Marriott Hotel

Dr. Mahmoud Abu Zeid, Chairman, National Water Research Center

Dr. Mohamed El Moattassem Kotb, NWRC Deputy Chairman and Director, Nile Research Institute

Dr. Mona El Kady, NWRC, Chairman and Director, National Water Quality Conservation Unit

Dr. Mohamed Abdel Rahman Fawzi, Under Secretary, Egyptian Environmental Affairs Agency

Dr. Samia El Guindi, Head, Central Laboratory, NWRC

Dr. Bayoumi B. Attia, Head, Central Administration for Water Resources and Its Uses, Planning Sector, MPWWR

Dr. Safwat Abdel Dayem, Director, Drainage Research Institute, NWRC

Dr. Fatma Abdel Rahman, Director, Ground Research Institute, NWRC

Dr. Shaden Abdel Gawad, Director, Climatological Changes Impacts on Environmental Research Institute

Eng. Hussein El Atfy, General Secretary, NWRC

Dr. Fatma El Gohari, National Research Center

Dr. Bahaa Saad

Dr. Diaa El-Koussy

Dr. Gamal Abdel Nasser, Head, Data/Information Clearing Division, and Acting Head, Data Link Division, National Water Quality Conservation Unit

Dr. Wael Soliman, Head, Outreach and Communications Services Division, National Water Quality Conservation Unit and Co-Workshop Facilitator

Eng. Mohamed Foda, Information/Database Officer, Database/Information Clearing House Division, NWQCU

Eng. Shereen Zahran, Information Clearinghouse Officer, Database/Information Clearinghouse Division, NWQCU

Eng. Amr Helwa, Outreach Specialist, Outreach & Communication Division, NWQCU

Eng. Mahmoud Mabrouk, Office of Irrigation and Land Development, USAID

Mr. Russ Backus, Office of Irrigation and Land Development, USAID

Dr. Wadie Fahim Manakarious, Office of Irrigation and Land Development, USAID

Dr. Earl Isrealson, Chief of Party, EPAT Strategic Research Project

Dr. Z. Zhu, EPAT Strategic Research Project

Mr. Russ Mishaloff

Dr. John L. Woods, Project Manager, PRIDE Water Quality Conservation Project

Mr. Phillip Brown, Team Leader, NWQCU

Mr. Mamdouh Sharara, NWQCU/PRIDE

Dr. Vahid Alavin, NWQCU/PRIDE

ANNEX B

INVENTORY OF EQUIPMENT PURCHASED FOR NWQCU

ANNEX B
INVENTORY OF EQUIPMENT PURCHASED FOR NWQCU

Hardware Details:

No	Item Name	Qty	Chkd	Remarks
1	TELCO (4tps) Cable PVC 1000FT	1	1	Some cable left
2	RJ45 Connectors for Solid and TP	20	20	Used for Network
3	ScanJet II cx 220V w/IBM PC /AT	1	1	Foda
4	Revolution MP (PCI/EISA) 60-MHZ	2	2	Amro, Phil
5	540MB IDE Hard Drive	2	2	-do-
6	1.2MB 5.25 Floppy Drive	2	2	-do-
7	2MB ATI Mach 64 Video Card	2	2	-do-
8	ALR 2-Button Mouse	2	2	Amro,Foda
9	CD-ROM Drive Dual Speed /IDE ALR	2	2	Amro, Phil
10	15" EnergyStar Monitor 1024 * 76	5	5	Amro, Phil
11	32 Bit Network Card	2	2	Vijay, Server
12	Revolution MP (PCI/EISA) 90-MHZ	2	2	Server, Wael
13	2.01 GB SCSI Hard Drive	2	2	-do-
14	1.2MB 5.25 Floppy Drive	2	2	-do-
15	2MB PCI ATI Mach 64 Video Card	2	2	-do-
16	ALR 2-Button Mouse	2	2	Wael, Sherien
17	14" Energy Star Color Mon 1024	1	1	Sherien
18	CDROM Drive AT Bus 2x 600MB Toshiba	1	1	Server
19	Revolution MP (PCI/EISA) 4/66d	2	2	GIS, Vijay
20	ALR - 2 Button Mouse	2	2	GIS, Shoubra
21	2MB PCI ATI Mach 64 VideoCard	2	2	GIS, Vijay
22	540 MB IDE Hard Drive	2	2	-do-
23	1.2 MB 5.25 Floppy Drive	2	2	-do-
24	16 Bit Ethernet Adapter (Accton)	2	2	GIS, Gehan
25	Multispin 3Xi Int CD-Rom Reader NEC	2	2	Vijay, Foda
26	Revolution MP (PCI/EISA) 4/66d	3	3	Sherien, Foda, Shoubra
27	1.2 MB 5.25 Floppy Drive	3	3	-do-
28	16-Bit Ethernet Adapter (Accton)	3	3	-do-
29	2MB PCI ATI Mach 64 Video Card	3	3	-do-
30	CDROM Drive Dual Speed/IDE AL	3	3	Sherien, Shoubra, GIS (not working)
31	10 Base T Enet Concentrator 12P	1	1	Network
32	Accura 144B + Fax144 w/SC & SC	4	4	Vijay, Shoubra, Cabinet (1), 1 missing
33	Ether Express 16C	2	2	Wael, Amro
34	Laser Jet IIISi/4/4M/4Si/4SiMX SIMM	3	3	Installed in the 3 HPLJ4 printers
35	Labtech Speakers Headphone & Mic	2	2	Wael, Vijay
36	CDROM Drive AT Bus 2x 600MB Toshiba	1	1	Wael
37	Jazz 16(KTL) Soundcard	2	2	Wael, Vijay
38	ISA-To-Fast SCSI Host Adapter	2	1	Server, Wael

No	Item Name	Qty	Chkd	Remarks
39	Laser Jet 4 Plus 220v 12ppm 600	3	3	Server, Gehan, Wael
40	DeskJet 1200C 220V Color Ink Jet	1	1	Server
41	DeskJet 1200C/PS PostScript Cl	1	1	Wael (under repair)
42	LaserJet 4 Toner Cartridge Black	8	8	Cabinet
43	DeskJet 1200C: Black Ink Cartridge	20	20	-do-
44	DeskJet 1200C:Cyan Ink Catridge	20	20	-do-
45	DeskJet 1200C:Magenta Ink Catridge	20	20	-do-
46	DeskJet 1200C Yellow Ink Cartridge	20	20	-do-
47	Graphics Plotter RS232C 7475A	1	1	Wael
48	Rewritable Optical Disk 1.3Gb	5	5	Cabinet
49	Smart UPS 600LS 600VA	9	9	1 at Shoubra
50	Conner MS 525MB Ext TBU	1	1	Server
51	1300T 1.2 GB Optical Drive	1	1	Server
52	Colorworks 10.4" LCD Panel	1	1	Conf. Room
53	17" Multiscan Monitor	3	3	Vijay, GIS, Wael
54	525MB 1/4" Tape Cartridge	3	3	Cabinet
55	Paintjet Transparencies	20		
56	Sony 3.5" DS HD diskettes	227		
57	Mousepad	8	8	
58	I/O Card	1	1	Server
59	Stabilizer 220V to 110V	1	1	Used for TBU
60	19200 Baud Multitech External Modem	1	1	Server
61	Microsoft Mouse	3	3	Server, Vijay, Phil
62	8 MB RAM	6	6	Server(1); Vijay(2); Wael(1); GIS(1); Phil(1)
63	SCSI Cable	1	1	Server's Tape backup unit

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Software Details:

No	Software	Quantity	Checked	Remarks
1	Norton DeskTop v3.0 WIN 3.5''	3	3	
2	Corel Draw v4.0 WIN 3.5 & CDR	1	1	
3	Corel Ventura v4.2 DOS CDR	1	1	
4	Norton Anti-Virus v3.0 Win/DOS 3.5''	9	9	1 w/o manual
5	Master clips The Art of Business CD	1	1	
6	BookShelf for Windows v1994 CD	1	1	
7	Office Pro v4.3 WIN 3.5''	8	5	5 complete sets.1 empty box.,1 w/ Dr Mona, 1 w/o disks.
8	HG Govt Edition v3.0 WIN 3.5''	1	1	
9	WINFax Pro v4.0 WIN 3.5''	2	2	
10	Project v4.0 WIN 3.5''	1	1	
11	Personal Netware 1.0 1 User 3.5''	10	10	
12	Omnipage Professional v5.0 386	1	1	
13	WP v6.0a WIN 3.5'' INC:L/c/Media/Doc	1	1	
14	Glyph Arabic MS Windows 3.1	4	3	1 with Wael. 1 empty box
15	Windows f/wrkgrps v3.11 AddOn	4	4	1 w/o manual
16	PC Anywhere v1.0 WIN 3.5'' StandAlone	1	1	
17	PC ARC /INFO 3.5'' & CD	1	1	Manuals near GIS computer.
18	ARC View for windows 3.5" and CD	1	1	
19	Arabic Windows for Workgroups 3.11	1	1	no manual
20	MS Office Arabic 3.5"	1	1	with Wael
21	SPSS f/Win Base 3.5"	3	3	
22	SPSS f/Win Advanced Statistics 3.5"	3	3	only 2 were received with manuals
23	SPSS f/Win Professional Statistics 3.5"	3	3	
24	WP 6.1 Novell Perfect Office	1	1	

OIL AND GREASE HAZARDS IN EGYPTIAN WATERS

Fact Sheet

National Water Quality Conservation Unit

The amount of water available to Egypt is limited. Increased demand for clean water has put pressure on this vital resource. Rapid growth in population, new land reclamation, and industrial development waste production are outstripping the capacity of the Nile to cleanse itself. This fact has serious public health and economic implications for Egypt. While problems which affect soils and crops, such as salinity, have been studied intensively, less attention has been paid to water quality characteristics that affect drinking water and other non-agricultural water uses. Of most concern are those characteristics that can cause injury or disease—specifically, pathogenic or parasitic organisms and toxic substances.

The National Water Quality Conservation Unit was recently formed within the National Water Research Center to increase the flow of accurate, up-to-date information on water quality in Egypt. This paper is part of a series of fact sheets that describe seven of Egypt's most serious water quality hazards. These seven hazards, identified by the NWQC Unit as presenting the greatest threat to the Egyptian people, affect public health, food production, and the environment. Oil and grease are among those substances that can affect the aquatic environment by reducing oxygen transfer across the water surface, by coating organisms and reducing respiration, and by their toxic effects on aquatic life.

Oil and Grease Defined

Oil and grease are not definitive chemical categories, but include thousands of organic compounds with varying physical, chemical and toxicological properties. They may be persistent or easily degraded and may be volatile or non-volatile.

Oils in many forms are the major product of the petroleum industry and contain, essentially, carbon, hydrogen, and oxygen. Kerosene, lubricating and road oils, gasoline, and tar are part of this broad category. Petroleum oils and grease occur from discharges from ships, industrial wastes and occasionally in raw sewage.

Oil pollution has reached major proportions in the last few years. The most well-publicized cause of this pollution are accidents involving supertankers, causing tens or even thousands of tons of oil to escape. Another cause are blow-outs from underwater oil wells. Other sources include leakage from underground storage fuel tanks, spillage from automobiles and boats, and refinery discharge. Pathways to the environment include urban runoff and seepage to ground water supplies.

The term "grease" as commonly used includes the fats, oils, waxes, and other related constituents usually associated with foodstuffs. Non-petroleum oils and fats are compounds of alcohol or glycerol with fatty acids. Fats and oils contribute to domestic wastewater in the form of butter, margarine, and vegetable oil and fats. Fats are also commonly found in meats, in the germinal area of cereals, in seeds and nuts, and in certain fruits.

Petroleum and non-petroleum oils have similar physical and chemical properties. In water, these can be found in the following states:

- Floating on the water surface
- Emulsified in the water column
- Dissolved form
- Sinking to the bottom in the form of sludge

Oil and Grease as a Hazard

Lethal toxicity due to oil spillage is well documented in the literature. Because of the large numbers of compounds included in this category, it is difficult to specify lethal doses for oil and grease without determining the exact products involved. Components of oils such as benzene have been found to cause cancer in laboratory animals and potentially in humans.

The primary threat from oil and grease is to the ecosystem. Any kind of oil can cause:

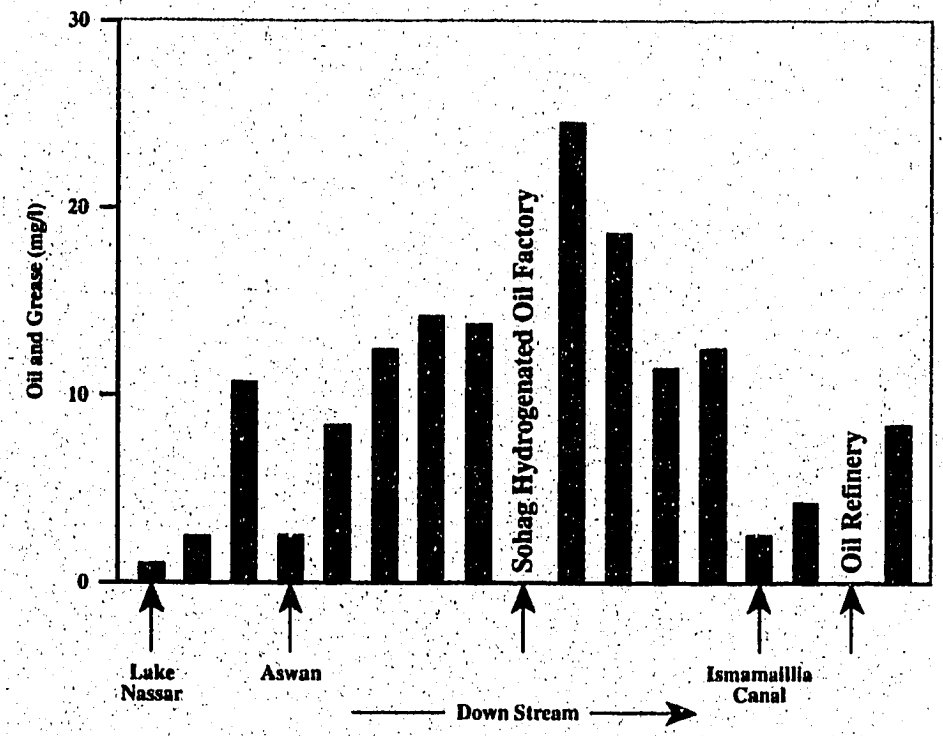
- Harm to waterfowl by causing loss of buoyancy, exposure due to the diminished insulating capacity of feathers, and starvation
- Fish kills due to toxic effects and increased oxygen demand
- Depletion of benthic (bottom dwelling) life due to asphyxiation caused by sludge settling to the bottom of a lake or stream
- Contaminated shorelines and beaches, making them unsuitable for recreational activities

Components of oil such as benzene have been found to cause cancer in laboratory animals and potentially in humans.

Grease and oils from animals or vegetables are generally nontoxic to humans or aquatic life. Floating sheens may have adverse effects on the environment.

Because of the potentially adverse effects on humans and on aquatic life, international standards have been developed for oil and grease. Domestic drinking water should be virtually free from oil and grease, particularly from the tastes and odors that are due to petroleum products. For aquatic life, minimum levels of oils or petrochemicals in sediment that can cause adverse affects to biota have been defined. Surface waters should be virtually free of oil and grease. Criteria for the allowable concentration of soluble fractions vary by compound, but are generally less than 0.1 mg/l.

Figure 1. Concentration of Total Oil and Grease



The Situation In Egypt

Pollution of the Nile River by oil and oil products is a growing problem due to the massive use of the river as a water way. The situation is further aggravated by the uncontrolled discharge from refineries, industrial and domestic wastewater.

Available data on oil and grease reveal that the highest concentrations are found in areas where most of the shipyards, docking facilities, and oil refineries are located. (Table 1 and accompanying figure 1). The concentration decreases downstream from these areas, which may be attributed to dilution, vaporization, biodegradation, and sedimentation. (Mousey, 1982)

The concentration of total oil and grease in water samples collected from midstream around Cairo was found to be around 2.5 mg/l. The most polluted areas in the Cairo region are around the iron and steel factory, boat docks, and electric power stations. At the port of Lake Nasser, on the other hand, oil and grease concentrations of up to 15.2 mg/l were detected. This is probably due to the presence of docking facilities and oil spills from ships. (Moursy 1982)

Chromatographic analysis showed that oil and grease in water samples collected from Lake Nasser port and from the hydrogenated oil factory at Sohag is of gas oil origin (see Figure 1). Meanwhile, those extracted from the samples collected from the river before Assuit barrage, at El-Kanater, and in front of the industrialized area at Kafr El-Zayat are of fuel oil origin (sites 4, 5, and 6 in Table 1).

Recent analysis carried out by the NRI, indicated that the concentrations of oil and grease are still higher than the permissible limits (0.1 mg/l) given by law 48/1982 and are of grave concern. These high concentrations could produce long-term effects on people, agriculture, and the environment unless improved management practices are implemented.

Management Alternatives

The management and prevention of oil and grease contamination in Egypt must be both proactive and reactive. Proactive measures must be developed to limit the contamination of the Nile from oil factories and other industries. Steps must be taken to eliminate point sources to the extent possible. This can be

Table 1. Concentrations of Total Oil and Grease at Points in the Nile River

Site	Total Oil & Grease (mg/)
1. Lake	0.80
2. Lake Nasser port	16.20
3. Between A.H.D. and A.D	2.30
4. El-Sail drain	9.12
5. 500m downstream El-Sail drain	10.39
6. Aswan	2.40
7. Kom Ombo (point of discharge)	8.30
8. Edfo (at the point of discharge)	12.40
9. Kose (at the point of discharge)	14.20
10. Deshna (at the point of discharge)	15.30
11. Naga Hammadi (discharge point)	13.80
12. Naga Hammadi at aluminum port	19.40
13. Sohag (hydrogenated oil factory)	56.67
14. Hydrogenated oil waste discharge	33.82
15. Assuit-by oil distribution system	24.73
16. Before Assuit barrage	18.75
17. After Assuit barrage	11.46
18. 1km downstream Assuit barrage	4.55
19. Rod El-Farag before W.tr. plant	6.52
20. Rod El-Farag downstr W.tr. plant	12.64
21. Intake of Ismailia canal	2.65
22. 0.5km upstream oil refinery	4.32
23. Oil refinery wastewater	28.94
24. Point of oil refinery discharge	15.33
25. 1km downstream oil refinery	8.47

accomplished by designing and installing bioreactors or other treatment systems. In addition, wetland treatment of wastewater could be considered. Other preventive systems could center around underground gasoline and fuel oil storage tanks. Monitoring wells could be installed and a program could be initiated to inspect tanks periodically for leakage. A requirement for double lined tanks or fiber glass tanks would help prevent leaks.

Tour boats are a source of oil pollution.

In Egypt, in particular, an emergency program should be put in place in case of a major accident involving ocean going vessels off the coast or within the Suez Canal. Equipment should be available to reduce the consequences of a massive oil spill. Any existing programs should be evaluated from time to time to determine if they meet the requirements of a major crisis. This would be considered reactive management.

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SALINITY HAZARDS IN EGYPTIAN WATERS

Fact Sheet

National Water Quality Conservation Unit

The amount of water available to Egypt is limited. Increased demand for clean water has put pressure on this vital resource. Rapid growth in population, new land reclamation, and industrial development waste production are outstripping the capacity of the Nile to cleanse itself: This fact has serious public health and economic implications for Egypt. While problems which affect soils and crops, such as salinity, have been studied intensively, less attention has been paid to water quality characteristics that affect drinking water and other non-agricultural water uses. Of most concern are those characteristics that can cause injury or disease—specifically, pathogenic or parasitic organisms and toxic substances.

The National Water Quality Conservation Unit was recently formed within the National Water Research Center to increase the flow of accurate, up-to-date information on water quality in Egypt. This paper is part of a series of fact sheets that describe seven of Egypt's most serious water quality hazards. These seven hazards, identified by the NWQC Unit as presenting the greatest threat to the Egyptian people, affect public health, food production, and the environment. Of these hazards, salinity is probably the best understood and documented. While loss of crop production is a major problem, there are also potential hazards to people and the environment.

What Is Salinity?

Water infiltrating below the ground surface or moving in the ground water system dissolves minerals and carries them as it flows. Total dissolved solids (TDS) content of water consists of inorganic salts, small amounts of organic matter, and other materials. The inorganic salts content of the water is known as salinity.

The salinity of water consists of dissolved major cations (positively charged ions) and anions (negatively charged ions). Major cations in water consist of calcium, magnesium, and sodium, with major anions being chloride, sulfate, carbonate, and bicarbonate. Potassium and nitrate are minor components of salinity. Salinity is measured in mg/l of solution or as total dissolved solids (TDS) in parts per million (ppm). Salinity is also measured in electrical conductivity (EC) in the units of deci-Siemen per meter (dS/m).

Why Is Salinity a Hazard?

Undesirable and hazardous effects of salinity occur in all aspects of water resources, including:

- Physiological consequences, including laxative effects (principally from sodium sulfate and magnesium sulfate), sodium levels hazardous to cardiac conditions and pregnancy, and kidney and urinary track problems (stone formation);
- Irrigation water effects on soil productivity, crop yield, and equipment life;
- Industrial water use effects on treatment requirements and equipment life;
- Aquatic and wildlife effects on fish diversity and health, waterfowl, and vegetation; and
- Impact on livestock health through saline drinking water.

To protect users of water from salinity hazards, standards for water quality in terms of salinity and dissolved solids have been developed both nationally and internationally. These standards are guidelines for assessing the impact of salinity on water quality and its effect on soil, plants, and humans, as well as classifying water based on intended use.

Drinking Water

To reduce the possible harmful effects of total dissolved solids in drinking water, international standards indicate that drinking water should have less than 250 mg/l of chlorides and sulfates and 270 mg/l of sodium. In general, the accepted maximum level of salinity is 1,200 mg/l in drinking water. (WHO, 1984).

Industrial Water

For industrial requirements, total dissolved solids and salinity content of intake water is quite variable and is highly dependent on water use and industrial process. Maximum requirements for selected industries are (Shawky, 1995):

Textile	150 mg/l
Pulp and paper	1,080 mg/l
Chemical	2,500 mg/l
Petroleum	3,500 mg/l
Primary metals	1,500 mg/l
Boiler make-up	35,000 mg/l

Irrigation Water

For irrigation, general guidelines are as follows (Shawky, 1995):

Total Dissolved Solids (TDS). The hazards relating to the concentration of TDS in irrigation waters are related to both drainage conditions and crop sensitivity. In general, the following consequences based on concentrations of TDS in irrigation water should be expected in crop yield:

- Less than 500 mg/l—no detrimental effects are usually noted.
- 500–1,000 mg/l—possible detrimental effect on sensitive plants.
- 1,000–2,000 mg/l—possible adverse effects on many crops. Careful management practices are required.
- 2,000–5,000 mg/l—water can be used only for selected tolerant plants on permeable soils with careful management practices.

In Egypt, irrigation water with less than 750 mg/l usually poses little harm to crops.

Sodium. Sodium is a major factor governing the suitability of water due to its hazardous effects on soil and plants. The amount of sodium and the percentage of sodium in relation to other cations are important. Sodium is toxic to certain plants and frequently causes adverse effects in soil structure, infiltration, and permeability rates. A high percentage of exchangeable sodium in soils containing clays can cause a soil condition that affects water movement and inhibits plant growth.

Sodium Adsorption Ratio (SAR). Whether or not water is suitable for irrigation use is also dependent on the ratio of the various cations present. SAR is the ratio of the relative activity of sodium, calcium, and magnesium ions in irrigation water. For sensitive fruits, irrigation water with an SAR of about 4 is considered usable. For irrigation of other crops and forages, the acceptable range for SAR is between 8 to 18.

Bicarbonate. The bicarbonate anion is important in irrigation water in regards to precipitation of calcium, and to a lesser degree, magnesium in the soil. These processes bring about a change in the SAR in irrigation water, and therefore an increase in the sodium hazard. Eaton (1950) introduced the term "residual sodium carbonate" (RSC). Wilcox (1958) concluded that if RSC is more than 2.5, the water is not suitable for irrigation; at $1.25 < RSC < 2.5$, it is considered marginal, and at $RSC < 1.25$, it is probably safe.

Chloride. Since the chloride ion has no effect on the physical properties of a soil and is not adsorbed on the soil or soil complex, it has generally not been included in modern classification systems. It appears, however, as a factor in certain regional water classifications. Recently, it has been recommended that water should be divided into four groups according to chloride content, with the limits 2, 5 and 8 meq/l.

Boron. Boron is potentially toxic to plants. It is necessary though, in relatively small amounts for plant health. If present in amounts appreciably greater than needed, it becomes toxic. For some crops, if 0.2 mg/ boron in water is essential, 1 to 2 mg/ may be toxic. Surface water rarely contains enough boron to be toxic, but well water occasionally contains toxic amounts.

Magnesium. High magnesium adsorption affects the soil, reducing permeability. In irrigation water, the ratio of magnesium to calcium and magnesium should not exceed 50, to avoid harmful effects.

The Situation in Egypt

Salinity is a major concern in both surface and ground water in Egypt.

The Nile River and Its Branches

The quality of water released from the Aswan High Dam reservoir reflects the combined effects of the watershed area, upstream uses, pollution loads, multi-year storage, and mixing and evaporation in the reservoir. The mineral quality is remarkably good with a total dissolved solids (TDS) of less than 200 ppm. According to NRI (1992) measurement of salinity along the Nile, TDS levels increased slightly from 1977 to 1986, with a decline in inflow and storage. From 1986 to 1991, the trend was reversed with an increase in inflow and storage (see Figure 1). Between 1990 and the year 2000, the river's TDS is expected to rise slightly with increased irrigation use and efficiency.

TDS levels change in the downstream direction, depending on the water use, as the water makes a 960 km journey in 10 to 12 days from Aswan to Cairo. The changes result from major irrigation diversions, irrigation return flows, treated and untreated municipal waste discharges, and hydrodynamic conditions created by flow regulation at the Nile barrages.

At the delta barrage, the water supply of about 33 bcm with an average salinity of about 225 ppm is distributed to the Damietta and Rosetta branches for further distribution throughout the delta, primarily for irrigation.

The Rosetta branch receives wastewater from the following pollution sources:

- Rahawy drain
- Sabal drain
- Zawiet El-Bahr drain
- Manlia and Senaiea industrial waste
- Salt and soda industrial waste

These sources cause an increase in TDS in the Rosetta branch. TDS values reach 290 ppm at Kafar El-Ziate and 391 at Edfina. The same trend of TDS increase is noted for the Damietta branch. The value increases from 380

ppm at Faras Kour to 462 at Damietta. (NRI, 1992)

Drainage Water

An intricate series of agricultural drains exist in the delta. These drains collect agricultural and other wastewater. The water quality of these drains is affected by a variety of sources, including:

- High soil salinity
- Salts originating from ground water
- Unofficial reuse of drainage water which recycles the saline water
- Inland intrusion of seawater

The amount of drainage water officially reused for irrigation has decreased over the last 10 years. This decrease is due to the increase in the overall weighted salinity from 857 ppm in 1984 to 1167 ppm in 1990, which then decreased to 978 ppm in 1994. Many reuse pumping stations have become inoperative due to high salinity levels in the drain water. Official reuse projects are now under construction. These include:

- Omoum Drain Project (western)
- Botita Pumping Station (middle)
- Al-Salam Canal Project (eastern)

Water in these drains is a valuable resource, and with restrictions and proper management can be reused for beneficial purposes. However, there is a tendency by the Egyptian farmers to use drainage water "unofficially" during peak demand periods, simply by pumping from the nearest drain to their fields as soon as they feel the need to irrigate. Field observations and simple mathematical analysis give the estimates that a quantity as high as 1.5 - 2 bcm is being reused every year on an unofficial basis. (El-Quosy, 1989)

Salinity in drainage water varies throughout the delta. The following general description can be given:

- In the southern part of the delta, TDS ranges between 750 and 1,000 ppm.
- In the middle part of the delta, where soil salinity is considered moderate, drainage water salinity ranges from 1,000 to 2,000 ppm.
- In most of the northern part of the delta, parallel to the sea coast, drainage water salinity is considered high and reaches more than 3,000 ppm in some locations.

Lakes

Mariut Lake. Mariut Lake, which is located south of Alexandria, consists of a series of shallow, brackish, interconnected basins that are used extensively as discharge sites for heavy industrial and domestic wastewater. The salinity of southwestern basin (6.3 dS/m) of Mariut Lake is much higher than that of the main basin (3.5 dS/m) because of the effect of drainage water evacuated to the southwestern basin from Hares P.S. Salinity in the northwest basin of the lake is extremely high (12 dS/m) because it is almost closed.

Manzala Lake. Manzala Lake is located on the northeastern edge of the Nile Delta, between Damietta and Port Said. It is separated from the Mediterranean Sea by a sandy beach ridge which has three open connections (bugaz) between the lake and the sea. The lake is very shallow, with an average depth of 1.3 m. The water in the lake is not mixed uniformly, due to the presence of islands. The lake can be divided into five basins, each with its own unique salinity regimes, ranging between less than 2,000 up to 30,000 mg/l.

The lake is of international importance as a wintering area for water birds, mainly ducks (100,000) and coots (150,000), and is used in the summer by many migrating species.

Ground Water

The graded, sandy, alluvial aquifer underlying the delta contains a huge amount of water. The amounts that can be safely withdrawn are governed by sea water intrusion, salt water upcoming and general contamination.

The major alluvial aquifer, roughly south of Tanta, is generally of good quality, with salinity values of less than 1,000 ppm. Salinity increases in a northerly direction with the increasing influence of the sea. In the northern delta, salinity ranges from 5,000 ppm. Salinity just north of Kafr El-Sheikh reaches 40,000 ppm TDS near the northern coastline. South of Wadi El-Natrun, ground water becomes mainly brackish. South of the Ismailia canal to the Cairo-Ismailia desert road, ground water salinity ranges from about 1,000 to 6,000 ppm.

In the Nile Valley, water from the deep aquifer is generally of good quality. Isolated areas, however, do register high to medium salinity levels, ranging from 500 to 1,500 mg/l.

Salinity also varies with the depth of wells. Two main methods are currently used for abstraction within the delta, namely, deep wells of about 50-70 meters depth ,mostly used for public potable water supplies, and shallow hand pumps of up to 15 meters, which are the common private sources of domestic water in the delta.

Chemically, TDS levels in deep wells outside of the brackish and saline ground water areas described above are generally within the maximum permissible levels (MPL) of the WHO (1984) for drinking water.

Management of Saline Water

Economical crop yields are possible with saline irrigation waters if management practices are appropriate and environmental conditions favorable. A

number of management strategies are available to minimize the adverse effects of saline water on agricultural production. The selection of appropriate strategies, however, depends on an accurate assessment of the problem.

Water management practices include appropriate frequency of irrigation for leaching, selection of appropriate irrigation methods, and water blending for acceptable salinity, particularly during critical growth stages. Soil management practices include suitable culture practices, land grading, managed application of chemicals, and establishment of artificial drainage. Crop management practices include consideration of salt tolerance ratings for various crops and crop sensitivity to water.

Reducing the amount of salinity and total dissolved solids entering water bodies from industry, cities, and agriculture will help manage the problem of salinity in Egypt's waters. Proper design of ground water withdrawal systems in aquifers subject to salt water intrusion is another step toward controlling salinity.

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OXYGEN–DEMANDING SUBSTANCES IN EGYPTIAN WATERS

Fact Sheet

National Water Quality Conservation Unit

The amount of water available to Egypt is limited. Increased demand for clean water has put pressure on this vital resource. Rapid growth in population, new land reclamation, and industrial development waste production are outstripping the capacity of the Nile to cleanse itself. This fact has serious public health and economic implications for Egypt. While problems which affect soils and crops, such as salinity, have been studied intensively, less attention has been paid to water quality characteristics that affect drinking water and other non-agricultural water uses. Of most concern are those characteristics that can cause injury or disease—specifically, pathogenic or parasitic organisms and toxic substances.

The National Water Quality Conservation Unit was recently formed within the National Water Research Center to increase the flow of accurate, up-to-date information on water quality in Egypt. This paper is part of a series of fact sheets that describe seven of Egypt's most serious water quality hazards. These seven hazards, identified by the NWQC Unit as presenting the greatest threat to the Egyptian people, affect public health, food production, and the environment. One of these categories is that of oxygen-demanding substances, which are those substances that take oxygen away from a river during bacteriological decay or chemical alteration. Oxygen depletion in a river can be harmful to fish and limits the use of water for drinking or other purposes.

Oxygen in Fresh Water

Dissolved oxygen (DO) in a river is essential for aquatic life. It allows aerobic bacteria to degrade a wide variety of organic substances and oxidize inorganic salts. Most fish species are stressed when DO level falls below 4 milligram per liters (mg/l) for a prolonged duration of time.

DO levels in unpolluted rivers are usually near saturation. The saturation level of DO in water depends on the temperature and is less than 14 mg/l. When certain pollutants, such as organic substances, are introduced to the water body, a reduction or even depletion of oxygen can occur. Such pollutants or substances are referred to as oxygen-demanding substances (ODS). These substances are oxidized by aerobic bacteria present in the environment. In the oxidization process or "biodegradation," the ODS are decomposed into simpler, yet stable, substances (such as inorganic salts) and DO is consumed in the process.

When DO in the river falls below the saturation level, oxygen is transported into the water body from the overlying air. This process is called reaeration, which enables rivers to maintain their DO level and consequently, a better water quality. The measure of a river's ability to decompose ODS and replenish DO is termed "assimilative capacity." The assimilative capacity of a river is not unlimited. The pollution load and concentration of ODS is usually measured in terms of oxygen demand or equivalent oxygen. Biochemical oxygen demand (BOD) and chemical oxygen demand (COD) are two common indicators of the stresses placed on the assimilation capacity of a river by oxygen-demanding substances.

BOD measurement involves determining the amount of dissolved oxygen required to decompose organic material in water through aerobic biochemical action. The standard test is the five-day BOD measure, in which the amount of dissolved oxygen required for oxidation over a five-day period is measured. Another indicator, which involves a much faster test, is the chemical oxygen demand. This test involves measurement of the oxygen required to oxidize ODS chemically and not biologically.

Major sources of ODS in surface and ground water include:

- Untreated or partially treated domestic sewage (see Table 1);
- Effluent from industrial facilities such as starch, pulp and paper, and agro-industries;
- Leachate from improperly designed septic systems, which add organic matter to the subsoil and cause ground water pollution;
- Organic bottom sediments; and
- Decaying vegetation.

Table 1. Pollution and waste loads from domestic effluents

	With Treatment	Without Treatment
Waste volume (m3/person/year)	73.0	7.3
BOD5 (kg/person/year)	19.7	6.9
COD (kg/person/year)	44.0	16.0
SS (kg/person/year)	20.0	16.0
Total dissolved solids (kg/person/year)	36.5	–
Nitrogen(kg/person/year)	3.3	–
Phosphorus(kg/person/year	0.4	–

Source: WHO (1982)

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Health and Environmental Impacts

Consequences of the discharge of oxygen-demanding substances from domestic wastewater and industries include disease transmission and the deoxygenation of streams, with an adverse effect on aquatic life.

Excessive effluent discharge introduces organic matter into streams, which are decomposed by bacterial action. As a consequence, there is deoxygenation of the water to the point where fish and other aquatic life cannot survive. International criteria for fresh water set by WHO indicate that the DO level should be at least 5 mg/l (WHO, 1982).

If oxygen in the water is depleted, aerobic bacteria are replaced by anaerobic bacteria, which continue the decay process. Anaerobic conditions in a stream or lake will not support healthy aquatic life and often cause disagreeable odors.

Oxygen-demanding wastes are classified as water pollutants because their degradation:

- Leads to oxygen depletion, which harms fish, and other aquatic life
- Affects taste, odor and color of water supplies
- May lead to scum and solids that render water unfit for recreational use.

Sources of Pollutants in Egypt

Domestic

Egyptian waterways suffer from an alarming increase in the discharge of municipal and rural domestic wastes. This has led to serious water pollution problems.

About 3.7 billion cubic meters (bcm) of water is drawn each year for domestic use and 2.2 bcm/yr of sanitary wastes are discharged into the Nile system. About 85 percent of the waste receives little or no treatment prior to discharge. Per capita sanitary wastewater production averages about 100 l/capita day. In the larger cities, production ranges up to 200 l/capita/day, but is often less than 50 l/capita/day in smaller villages with individual water supplies. (El-Gohary, 1995)

Large cities in Egypt (i.e., greater than one million people) usually have a sewer system to collect sanitary wastes. The wastes are conveyed to a point of discharge and may or may not be treated. Untreated industrial wastes are often disposed of in sewer systems, particularly in large cities. (El-Gohary, 1995)

There are an estimated 43 cities within the Nile Valley and 17 in the Nile Delta with populations of 50,000 to 1,000,000 or more, excluding Cairo, Alexandria and Port Said. Most of these cities have sewer systems, and 36 have primary or secondary treatment plants, either existing or under construction. (El-Gohary, 1995)

The major problem of inadequate waste treatment is in the rural areas. The rural population of Egypt lives in an estimated 4,300 villages with populations ranging up to 50,000. The majority of these villages are in the Nile Valley and the delta. Problems in these areas include: (El-Gohary, 1995)

- Lack of access to sewer systems and community treatment facilities;
- Inadequate septic systems; and
- Raw sewage dumped on the ground or discharged into drains and canals in buckets.

Currently, an estimated 0.3 bcm/yr of raw sewage either infiltrates to shallow ground water or is discharged into drains, canals, or the Nile.

Industrial

Industrial discharges are responsible for a wide variety of pollutants found in Egypt's waters. High concentrations of organic compounds are discharged from the food, pulp, and paper, starch and edible oil industries. The total industrial use of water is currently about 4.6 bcm/yr, of which 2.9 bcm/yr is cooling water returned directly to the source with little use or quality change. Some 1.5 bcm/yr is used as process water, some of which may also be used for cooling. About 0.2 bcm/yr is consumed, lost in the manufacturing process or contained in the product, leaving 1.3 bcm/yr of generally untreated wastewater discharged into surface waters. The food industries are reported to discharge 45 percent of industrial wastewater and 67 percent of the total BOD load discharged. (NRI, 1991)

Depending on their location, industries discharge directly into the Nile River, the northern lakes, drains, or sewers. Many industries discharge to drains without prior treatment. In the delta, the drains discharge into the Mediterranean or the northern lakes. Drainage water is sometimes reused for irrigation purposes. Some industries discharge to sewers leading to wastewater treatment plants. Because of the toxic nature of many wastes, these wastes can affect the biological processes of the treatment facility and make the treatment ineffective.

Agricultural Drains

There are 72 agricultural drains on both sides of the river, from Aswan to Cairo, which flow into the river. In the delta, five drains are connected to the Rosetta branch and three are connected to the Damietta branch. These drains and their tributaries also serve as receiving water bodies for the disposal of domestic wastewater of the towns, villages, and for the discharge of industrial effluents, as well.

Impacts on Water Resources

Nile River and Damietta Branch

Since the construction of Aswan High Dam, the river quality in Egypt has become dependent on the water quality of the reservoir Lake Nasser.

Downstream changes in river water quality are primarily due to:

- Different hydrodynamic regimes regulated by the Nile barrages;
- Agricultural return flows; and
- Domestic and industrial waste discharges including oil and wastes from passenger and river boats.

These changes are more pronounced as the river flows through the densely populated urban and industrial centers of Cairo and the delta region.

Although the river receives effluents of high BOD from sugar factories, pulp and paper and other industries, the BOD at mid-stream is still, on the average, within the 6 mg/l standard given by law 48/1982 . This could be attributed to the high dilution rate in the river and high width to depth ratio of the main channel. The river banks, however, are much more polluted. (NRI, 1991)

As shown in Figure 1, after the Aswan High Dam, water is highly oxygen-depleted. This depletion is because the Nile water from Lake Nasser is discharged from the High Dam at 30-40 m depth. At this depth, water is deprived of oxygen. As soon as the water is released from the dam and subjected to turbulence, the river gains oxygen over the next 170 kilometers As the river proceeds northward, for another 640 kilometers, it becomes supersaturated with oxygen. After this point, industrial discharges begin to deplete oxygen. Other sources of BOD include the Talkha fertilizer factory on the Damietta branch, which further depletes the system of oxygen. (NRI, 1991)

Rosetta Branch

The Rosetta branch receives discharge from five major agricultural drains. Another pollution source is the industrial area at Kafr El-Zayat City (Superphosphate and Oil & Soap companies). In addition, 55 towns and villages discharge to the Rosetta branch. No estimates on the pollution load from those towns and villages are available.

Studies carried out by the NRI (1991), indicate that the DO in Rosetta branch decreases under low-flow condition, due to wastewater discharges from industrial sources at Kafr El-Zayat City.

Northern Lakes

Major environmental problems in the inland lakes are created by land reclamation, runoff from surrounding areas, direct discharge of untreated wastewater and discharge of irrigation water from drainage canals. Collectively, these problems have contributed to a significant deterioration of water quality, concentration of toxic elements in fish flesh, and the disappearance of several important species of fish. (El-Gohary, 1995)

Discharge of untreated wastewater and irrigation water from drainage canals into inland lakes is a major source of contamination by oxygen-demanding substances. Persistent materials, such as heavy metals, carcinogens, and other toxic wastes, are also present.

Management Strategy

There is no doubt that appropriate treatment of domestic, municipal and industrial wastewater, prior to discharge into water bodies, will improve water quality. Several wastewater treatment technologies are available, including aerobic, anaerobic, and advanced chemical processes. However, because of the cost involved, these systems might not be available for every Egyptian community. To improve the general health of the Nile River, it is therefore important to develop a systematic water treatment strategy.

Proposed actions to reduce oxygen-demanding substances in the Nile River are:

1. The development of an overall water quality management strategy that prioritizes those areas which need the most urgent attention and assistance in water treatment.
2. The wide-scale construction and operation of appropriate sanitation systems on a systematic basis.
3. Promotion of improved technologies in treatment processes for industrial and domestic wastewater.

No one solution can be considered final. Goals must be set and met in the area of water pollution control for Egyptian waters to meet future demand.

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PATHOGEN HAZARDS IN EGYPTIAN WATERS

Fact Sheet

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Micro-organisms and Pollution

A wide variety of bacteria, viruses, and parasites can be found in Egyptian waters. Bacteria are single-celled micro-organisms, whereas viruses are sub-celled organisms. Parasites are single-celled organisms that are dependent on host cells for subsistence. Micro-organisms that cause disease are called pathogens.

With increased generation and discharge of human, agricultural, and industrial wastes, the potential for contamination of surface and ground waters by harmful micro-organisms is on the rise. Fecal pollution can introduce a variety of internal (enteric) pathogenic bacteria, viruses, and parasites. Their presence is linked to microbial diseases. Examples of these pathogens include:

a. Bacterial: vibrio cholera, salmonella, shigella, enteropathogenic E. coli, leptospira.

b. Viral: hepatitis viruses type A and E, poliomyelitis viruses, enteric viruses.

c. Parasitic: endamoeba histolytica cysts, bilharzia, faciola, hetrophes eggs, etc.,

It is possible to eliminate many water-borne pathogens. However, the procedures are often complex, expensive, and time-consuming. It is, therefore, impractical to monitor natural water bodies for every possible microbial pathogen. A logical approach, accepted worldwide, is the detection of organisms normally present in human feces and other warm-blooded animals as indicators of pollution. These indicator parameters are:

Coliform. The term, total coliform, refers to rod shaped, non-spore forming bacteria. The coliform group bacteria are capable of producing acid and gas from lactose in a suitable culture medium at 35 to 37°C.

Fecal coliform. These have the same properties as total coliform at temperatures of 44 or 44.5 C, with production of acid and gas. They are described as fecal (thermotolerant) coliform organisms.

Fecal streptococci. This term refers to those streptococci (spherically shaped bacteria) normally present in human and animal feces. It is used as a supplementary bacterial indicator.

The ratio of fecal coliform organisms to fecal streptococci (>3:1)indicates human wastes and a ratio of <0.7:1 indicates that the source is other animal wastes. This indicator is useful in locating the origin of fecal pollution in heavily contaminated sources of untreated water, provided sufficient data are collected.

Tests have been developed for the detection and enumeration of these indicator organisms. For coliform testing, it is customary to report results as a Most Probable Number (MPN). The MPN is not an exact enumeration but a high probability estimate of a coliform count per 100 ml of water. These counts are reported as MPN/100 ml.

Water Quality Criteria

Water and public health authorities in many countries have adopted water quality criteria for various parameters to describe minimum quality requirements for each beneficial water use. Among these parameters are total coliform, fecal coliform, and fecal streptococci organisms.

In Egypt, criteria are stated in the following laws and standards:

P.L. # 48/1982:

This law was enacted to protect the Nile River and inland waters from

pollution. The law provides water quality criteria for:

a. Fisheries in lake waters: "The number of fecal coliform organisms must not exceed 70 per 100 ml of lake waters and should not exceed 230/100 ml in 10 percent of water samples collected during the fishing season."

b. Recipient water bodies: Standards exist for fresh waterways, brackish waters and lakes, and drain water. The standard for drain water applies to pumping and/or mixing with fresh water in canals.

Law # 48/1982 also requires that the filter-washed waters from treatment plants—which is heavily loaded with bacteria, protozoa, and pathogenic organisms—be treated before discharged into watercourses.

Public Law # 27/1978

This law specifically relates to drinking water sources and supplies. This law gives the Ministry of Health the authority, through the Higher Committee on Drinking Water, headed by the Minster of Health, to formulate drinking water standards and health requirements for treatment facilities.

Drinking Water Standards

The Minister of Health issued ministerial decree # 108/1995 for drinking water standards. It includes physical, chemical (inorganic and toxic), heavy metals, organic chemicals (insecticides, herbicides and others), radioactive substances, biological and bacteriological standards. The bacteriological standards are as follows:

a. Total bacterial count should not exceed 50 bacteria per one cubic centimeter at 37°C for 24 hour incubation period or at 22°C for 48 hours.

b. Total coliform must be absent in 95 percent of all water samples examined during the year in 100 ml. None of the samples should contain more than 3 coliform/100 ml, and this level should not appear in two consecutive samples.

c. All water samples examined must be free from fecal coliform organisms and fecal streptococci.

These standards went into effect in March 1995.

Contamination of Egyptian Waters

Factors responsible for the presence of fecal contamination and pathogens in Egyptian waters include:

1. A total of 23 percent of the urban population and 74 percent of the rural population have no access to public sewage systems or to sanitary waste disposal.

2. About 20 percent of the total population (5 percent urban and 25 percent rural) lacks safe public drinking water supplies and rely instead on potentially contaminated, untreated surface water or hand pumps which tap often contaminated shallow ground water.

3. Existing sewage treatment facilities are not providing complete secondary treatment for water, and the effluents discharged are either only partially treated or left untreated. Many industries combine their wastes with sewage, discharging them into fresh waterways.

4. The continued discharge of contaminated agricultural drain waters into fresh waterways constitutes a health hazard due to fecal contamination and the presence of pathogenic organisms.

Hazards Caused by Pathogens

Epidemics

Throughout history, epidemics related to water-borne or water-related pathogens have plagued Egypt. Some of these events are briefly recounted here. (Helwa, 1986; Helwa, 1995)

1. The 1942 malignant malaria epidemic (water-related): Anopheles Gambia mosquitoes invaded Egypt from Sudan. The epidemic affected tens of thousands of people from Aswan to Assuit, with high case fatality.

2. The 1947 cholera epidemic affected the whole country. During the epidemic 23,623 people were taken ill, of which 11,748 died (49.7%).

3. The 1973 typhoid epidemic was localized in a small village in Damietta Province, where about 400 students and villagers fell ill.

4. In the summer of 1983, infective diarrhea started in a small village in Guiza Province and later spread to other areas in the country. The causative organisms were isolated in the drinking water network, which was contaminated by an overflow of sewage caused by broken pipe connections.

5. The 1985 typhoid epidemic affected the old section of Suez City. It was the result of heavy contamination of the old water treatment plant intake by untreated human wastes.

6. The 1986 infective summer diarrhea outbreak occurred in many villages in the Housania District, Sharkia Province. The city water supply used by villagers was contaminated due to a loose pipe connection submerged in contaminated water.

Pathogens in Natural Water

The Ministry of Health monitors routinely for pathogenic bacteria, viruses, and parasites in natural water around Egypt. Results of these surveys indicate that the following pathogens have been found in Egyptian waters:

Salmonella. Salmonella organisms have been detected in Alexandria sewage discharged into Mariut Lake in El- Mahmoudia and at Alexandria beaches. Some of the strains which were isolated and other gastrointestinal diseases are common among patients in the fever hospital in Alexandria and elsewhere in the area.

Shigella. Shigella organisms, the causative agents of bacillary dysentery, were isolated from Mariut Lake. Entamoeba histlita and Entamoeba coli were detected in tap water in Abbis II village even though water is treated and chlorinated. The Entamoeba cysts resisted chlorination treatment.

Vibrio Cholera. As a preventive measure, local health authorities in Egypt collect 110 water samples daily from the Nile and main canals, at the intake point of water treatment plants, and from drains and sewage discharges. The samples have been analyzed for vibrio cholera, with results so far negative.

Parasites. The Ministry of Health, through the technical departments in the provinces, examine regularly the snail intermediate hosts for schistosomiasis, bulinus (S. haematobium) and biomphilaria (S. mansoni), for the presence of the infective stage to humans, namely, the cercaria. The results show a decreasing infected snail population. The rate of infection potential was 3.7 for bulinus and 2.98 for biomphilaria per 10,000 snails examined during 1994. These rates are much less than those found in 1993—4.4 and 6.5, respectively. Infected canals are treated by molluscicide.

Pathogens can also affect humans through the food chain. Fish and shellfish concentrate viruses and bacteria present in contaminated water and transmit an infective dose to humans. Cases of salmonella food poisoning, cholera, hepatitis and typhoid have been traced to fish and shellfish. The presence of snails in contaminated waters, the intermediate hosts of parasitic diseases, allows for completion of the life cycle of the parasites. The infection is spread to humans through contact with such infected water.

Fresh vegetables, irrigated by contaminated water, transmit E. histolitics cysts causing amoebic dysentery as well as the eggs of ascaris parasite. Outbreaks of amoebic dysentery have been reported among tourists who eat fresh vegetables and salads. Milk-producing animals grazing on soils irrigated by polluted waters harbor the pathogenic organisms on their udders. These organisms are then transmitted to milk and eventually to humans, causing milk-borne diseases.

Viruses in Egyptian Waters

Common viruses found in contaminated waters include: (Helwa, 1995)

- Hepatitis A virus. No figures are available for Egypt.
- Hepatitis E Virus: Twenty-two percent of Egyptian children with acute hepatitis have been infected by the hepatitis E virus.
- Viral gastroenteritis: Gastroenteritis and diarrheal diseases are the most common diseases transmitted by water. These viruses are responsible for 40 percent of diarrheal diseases among children under five years of age in Egypt. These diseases are spread by fecal contamination and transmitted to humans via contaminated water supplies and food.
- Poliomyelitis viruses: These viruses have been detected in sewage in Egypt. It is the only water-borne disease which has a potent vaccine giving lasting immunity to vaccinated children. For this reason, the disease is now being eradicated in Egypt.

Assessment of Water Quality

Local water surveys were done as early as 1959 to evaluate pollution problems or assess the feasibility of improvement of drinking water supplies or wastewater facilities. In 1959, the bacteriological quality of two main drains and one canal in Shoubra El-Khema were assessed and the count of total coliform was 100,000/ml (MPN). These drains were heavily polluted by industrial and human wastes. In 1979, a section of Manzala Lake, which receives untreated sewage from Port Said, showed total coliform count up to 440,000/100ml (MPN). In Behera and Kafr El-Sheikh provinces, canal water used for water supply showed total coliform count varying from 400 (Nubariya canal) to 34,000/100ml at the Fayara canal.

The 1984-1986 and 1992 Bacteriological Surveys

Between 1984 and 1986, fecal coliform (FC) analyses of the Nile River showed a marked increase in counts. The average FC counts per /100 ml were 624, 751 and 8,127 for the Nile River in 1984, 1985, and 1986, respectively. The FC counts from discharge points also increased for 1986 as compared to 1984 and 1985. The FC counts per 100 ml for point source discharges were higher upstream (Aswan) at 28,152, as compared to downstream (Cairo) at 3,884. Cross sectional FC counts per 100 ml increased in the downstream direction (Aswan 567, Cairo 2,570). The 1992 survey has shown marked improvement for both the discharge points and the cross sectional samples. The FC count per 100 ml for the discharge points was (2,910 Aswan, 2,032 Cairo), while those for the cross sectional samples were 384 (Aswan) and 700 (Cairo). (NWRC, 1992)

Rosetta branch water quality has been degraded from the bacteriological point of view. The fecal coliform counts increased progressively from 1984 to 1992. The count in 1984 was 1,206 for the discharge points and 33,000 in 1992. (NWRC, 1992)

It should be noted that the information presented above is based on limited water quality survey data. The specific data and numbers given apply only to specific measurement points and the particular survey time. A more comprehensive database would be needed before specific conclusions can be drawn regarding the overall quality of Egypt's waters.

Impact of Pathogens in Egypt

Contamination of natural water results in increased water purification costs and rates. Furthermore, water quality can become a limiting factor in regional development. Currently, there are a total of 63 water treatment plants drawing from surface waters, 13 from the Nile and 50 from canals. There are 11 water treatment centers supplying the greater Cairo area alone. Cost of treatment at these facilities is quite high due to the quality of the raw water.

In 13 of the 26 provinces, drinking water comes from unsafe sources. During surveys in 1993 and 1994, water samples collected from these provinces showed a higher percentage of samples not complying with the bacteriological standards. This was more evident in northern delta, in Damietta, Ismailia, Port Said, Matrouh, and Giza, where the rate of noncompliance varied from 5.8 to 22 percent in 1993 and 1994 for treated surface water, and from 10.5 to 42 percent for shallow underground waters. (Ministry of Health, 1995)

There are 308 compact water treatment units located on secondary and tertiary canals receiving drain waters, 50 percent of which are located in the northern delta, namely in Dakahilya, Behera, Kafr El-Sheikh, and Damietta. Due to poor operation of these units, frequent power failure and contaminated intakes, people are consuming water of questionable bacteriological quality. Consequently, the potential for the spread of water-borne and oral fecal diseases is high.

Water Quality Management for Pathogens

The following actions and water management practices will ensure that Egyptian waters meet the published criteria for pathogen-safe water:

- Provide basic sanitary measures in terms of safe water supplies and human waste disposal.
- Treat wastewater at the source to prevent pollution of the waterways and water bodies.
- Enforce law # 48/1982 and its standards.
- Regularly monitor water quality and wastewater discharges throughout waterways.
- Modify existing water quality criteria and standards to meet Egyptian requirements for safe water.
- Develop a public educational campaign to disseminate information on water quality, uses, availability, needs, and hazards.

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For further information on this subject or any other water quality issues, please contact the National Water Quality Conservation Unit: Tel. 218-4757; fax 218-8733

PESTICIDE HAZARDS IN EGYPTIAN WATERS

Fact Sheet

National Water Quality Conservation Unit

The amount of water available to Egypt is limited. Increased demand for clean water has put pressure on this vital resource. Rapid growth in population, new land reclamation, and industrial development waste production are outstripping the capacity of the Nile to cleanse itself. This fact has serious public health and economic implications for Egypt. While problems which affect soils and crops, such as salinity, have been studied intensively, less attention has been paid to water quality characteristics that affect drinking water and other non-agricultural water uses. Of most concern are those characteristics that can cause injury or disease—specifically, pathogenic or parasitic organisms and toxic substances.

The National Water Quality Conservation Unit was recently formed within the National Water Research Center to increase the flow of accurate, up-to-date information on water quality in Egypt. This paper is part of a series of fact sheets that describe seven of Egypt's most serious water quality hazards. These seven hazards, identified by the NWQC Unit as presenting the greatest threat to the Egyptian people, affect public health, food production, and the environment. The use of such chemicals as pesticides has long been a concern due to their possible harmful effects on human health. Although beneficial in many ways, pesticides in water are potentially harmful, even in low concentrations.

What Are Pesticides?

Over the years, farming techniques have grown more sophisticated and agricultural products have improved in both quality and quantity. A considerable portion of this improvement is due to the use of chemicals to control insects and rodents pests as well as unwanted vegetation including weeds, grasses, and fungi. These chemical substances are collectively known as pesticides.

Pesticides are generally divided into various categories, including:

- Insecticides—used to control insects and in general, most toxic to humans
- Herbicides—selectively or non-selectively eliminate plants
- Fungicides—used to eliminate fungi
- Rodenticides—used for control of rodents

Pesticides are also classified according to their chemical structure. Major groups include:

- Organochlorine pesticides. These contain chlorine. This group is characterized by long persistence in the environment and bio-accumulation in fatty tissue. Of these, the most famous is DDT. The use of DDT and others in this group have been banned because of their persistence in the environment and their potential for causing cancer in humans.
- Organophosphorus pesticides. These pesticides contain phosphorous. This group includes the most popular pesticides, such as dimethoate, malathion, and diazinon.
- Carbamate pesticides. These contain carbamic acid and include carbaryl, benlate, and lanate.
- Thiocarbamate pesticides. These are characterized by containing sulfur in their structure instead of oxygen in carbamates.
- Synthetic pyrethroids. These are similar to natural products extracted from the toxic plant Chrysanthemum, found in Kenya.

Others include herbicides made from urea derivatives and other chemical compounds.

How Do Pesticides Affect the Environment?

The main concerns regarding pesticide use are their effects on man and other warm-blooded animals. There are two main types of pesticide intoxication: acute and chronic.

Acute Toxicity

Acute toxicity usually occurs when symptoms appear within a few minutes or hours upon contact with pesticides. Pesticides enter the body via inhalation, dermal contact or through the digestive system. Acute toxicity is divided into different categories according to the lethal dose capable of killing 50 percent of male rats (LD50) orally.

- ***Extremely toxic*** (up to 5 mg/kg), such as parathion, methyl parathion, and others, used as a rodenticide on cotton crops.
- ***Highly toxic*** (5–50 mg/kg), such as endrin, gusathion, and others, also used as a rodenticide on cotton crops.
- ***Moderately toxic*** (50–500 mg/kg), such as endosulfan, toxaphone, and

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DDT, used on field crops, vegetables, fruits, and vegetables.

- ***Slightly toxic*** (500–5,000mg/kg), such as akar, erazin, and MCPA, also used on field crops, fruits, and vegetables.

- ***Relatively safe*** (over 5,000 mg/kg), such as demilin, used on field crops, fruits, and vegetables.

Chronic Toxicity

Chronic symptom could appear after a year or more after continuous exposure to a pesticide at low concentrations. Chronic symptoms include diseases of the heart, blood, reproductive system, and others.

The effects of pesticides on the aquatic environment are determined by such factors as toxicity, persistence, and accumulation. If the concentration of a pesticide in the aquatic system is high enough, it may have an acute impact such as killing fish. Lower concentrations may not kill the organism, but may affect its ability to function. With continual or chronic exposure to low concentrations, a pesticide may also have an impact on aquatic biota (e.g.,development or reproduction), particularly if the compound has the ability to accumulate to toxic levels. The high bioconcentration factor, and long environmental half lives of organochlorine pesticides such as DDT and chlordane, are two important factors leading to the banning of their use. If over-applied, pesticides can also affect crop production by reducing yield.

What Are the Pathways to the Environment?

Pesticides are used and applied in a number of ways. Some are applied to the soil before crops are planted. Some insecticides are applied aerially or by spray machinery operated on the ground. These different application methods can affect the potential for water contamination. The potential for contaminating water bodies is generally higher when more of the applied pesticide reaches the ground. This usually occurs when the crops are young and the leaves do not yet form a canopy. Pesticides enter the aquatic environment through a number of different routes, including surface water runoff, spray drift, domestic sewage, and spills. Surface water runoff from agricultural lands is considered to be the major route of transport of pesticides into the aquatic environment, although other routes are also important.

A mature crop is able to reduce the potential offsite movement of pesticides by:

- Reducing the amount of soil moisture

- Deflecting and intercepting rainfall

- Adding pesticides to microbiological decay through the crop root zone

The pathways to man and the environment are dependent on a variety of factors. These include persistence, movement in the soil, and solute transport in water.

Persistence

Persistence of pesticides in soil depends on many factors. The major important factors are chemical structure, soil pH, soil type, water contents, and organic matter contents. Organochlorine insecticides have been found to persist for long periods of time in the soil. DDT, the first insecticide discovered in the organochlorine group, has been reported to persist over 20 years, and its derivative DDE even longer. The alternatives to organochlorine insecticides which are used are organophosphorus, carbamates, and synthetic pyrethroids. These are characterized by their short persistence (not more than three months at most in small detectable amounts), but are more acutely toxic.

Movement of Pesticides in Soil

The movement of pesticides in soil depends greatly on soil absorbability and persistence. The rapid movement of pesticides in soil could have negative effects on ground water when it is used for drinking or if leached into the drainage system. Among the pesticides that move freely in soil are atropine, alachlor bromacil, butylate, atrazine, cyanazines 2,4-D, metolachlor, simanize (herbicides), aldicarb, aldrin, lindane, carbofuran, and oxamyl (insecticides). Other pesticides are strongly absorbed into clay soil. These include pesticides such as parquet, round up, and terbutryne, and are not likely to pollute ground water because they are strongly attached to the upper surface soil.

What Is the Existing Situation in Egypt?

Pesticide Residues in Water Surface

In Egypt, part of the dramatic increase in recent years in crop production is attributed to the use of pesticides. The use of synthetic organochlorine pesticides began in the 1950s. This class of chemicals is characterized by its long persistence in the environment. Although different pesticides in this group were banned in the 1970s, they remain in the soil and in the rivers and stream sediment.

The Nile River. Water from the Nile River and fish (as an indicator of chemical pollution) have been targets for pesticide residue analysis programs from time to time. In 1992, beta and gamma HCH, aldrin, dieldrin, heptachlor, endrin-p,p-DDT, and its metabolites DDE and DDT were detected in the river. The highest concentration of detected DDT-complex in water was at Aswan Dam, reaching 1.048 ppb, which is considered slightly above World Health Organization (WHO) guideline of 1 ppb in the drinking water and far less than that of American (43 ppb) and

Canadian (30 ppb) standards. The highest concentration of total organochlorine was found at 7.5 km upstream Aswan, at 2.275 ppb.

In general, concentrations of organochlorine insecticides (OCI) in Nile water, according to the results of analysis, are still within safety margins, compared to the guideline limits set by WHO, Canada and the United States.

A study of drains in 1991 showed that DDT and its metabolites were common at all locations, reaching the maximum in the delta barrage and the minimum in the pesticide factory out-fall . The highest level of DDT complex was detected after winter closure period in the delta barrage. This increase of OCI residues could have come from illegal DDT use. Total organochlorines were, however, at the permissible levels according to Canadian standards (100 ppb for the total OCI).

The analysis of water taken from Aswan upstream during the winter closure period indicated a high concentration of p,p-DDT. Application of the product by some upstream countries may be responsible for this high reading.

Canals. Little information is known about canal pollution with pesticides in Egypt. However, canals are probably polluted with organochlorine insecticides that come from the Nile River.

In Mohmoudia canal, the main source of drinking water supply in Alexandria, organochlorine insecticides have been measured. Water analysis results indicate that organochlorine insecticide residues are far below WHO, American or Canadian guidelines.

Drains. Drains are of concern because their water is reused for irrigation. El-Serw and Hadous drains are of significance as they will play a major role in the north Sinai development project. Water from the two drains will mix with the Nile River at Damietta branch at 1:1 ratio to go through El-Salam canal. Although there are no guideline values for pesticide residues in water used in agriculture, pesticide residues in the two drains are acceptable compared to drinking water standards. The highest amount of total DDT was found in Hadous drain (1.8 ppb) while in El-Serw drain it reached 0.451 ppb (1991 analysis) .

Organochlorine insecticides were analyzed in 1992 from water taken from different drains to Upper Egypt. The major common insecticides detected in drains were DDT and HCH + Heptachlor at low concentrations. Desamy drain was the most polluted drain.

In Alexandria, the level of pesticide residues in different drains at various seasons indicated the presence of HCH and DDE. Pesticide residue in all drains did not exceed the level of safety margins as set by WHO for drinking water.

Lakes. Water, sediments, and fish from different lakes were analyzed to detect pesticide residues. In Alexandria, the analysis of 1978–1979 (when OCI was recently banned) showed that water taken from Maruit Lake was polluted with lindane, p,p-DDE, DDT and others. None of these pollutants exceeded 2 ppb. Sediments were highly polluted with OCI, compared to water. The ratios of OCI in sediments compared to water were as high as 1072: 1. In Nozha hydrodrome, both water and sediments were found to be polluted with OCIs. The maximum concentration of the pesticides was 1.5 ppb for p,p-DDE. The ratio between the pesticide in sediments to water was as high as 564:1.

High concentrations of OCI residues in sediments is a continuing source of pesticide pollution, as the attached pesticides dissolve in water. Water samples taken from Manzala, Maruit and Wady El-Rayan were the most frequently polluted with lindane, DDT-complex, and others. The highest concentrations of lindane, aldrin chlordane and DDT-complex was detected in Wady El-Rayan Lake.

Accumulation of Pesticides in Fish. It is well established that fish bio-accumulate rapidly water soluble organic chemicals in their fat organs. Organochlorine pesticides and the non-pesticide chlorinated biphenyl (PCBs) are among the major chemicals that pollute fish. Even now, DDT and its metabolite DDE have been found to contaminate fish, even though these pesticides have been banned since the 1970s.

In Egypt, fish contaminated with these pesticide residues have been found. During August 1981 to July 1982, Bolti fish (Tilapia spp) was selected as the most dominant and favorable fish in the Nile River in order to detect OCI residues in their bodies. Different sites were chosen along the Nile River in addition to two canals (El-Mahmoudeia and Abu El Gheit canals). Fish from the two canals were the most contaminated with OCIs. Chlorinated pesticide levels in fish taken from all locations did not exceed the maximum residue level set by FAO. Fish from Fayoum and Beni Suef were analyzed in 1986. Bolti fish samples were highly contaminated with heptachlor and its epoxide. Eight of eight samples exceeded the MRLs, which range from 0.01 to 0.3 ppm.

Fish from Manzala Lake, which is considered one of the most polluted lakes in Egypt, were evaluated for pesticide residues. The 1992 pesticide residues analysis indicated that Tilapia is highly contaminated with p,p-DDT, ranging from 0.314 to 11 mg/kg, exceeding the MRLs (the FOA MRL is 0.2–0.5 mg/kg for DDT in fish).

Pesticides Residues in Animal Milk. Pollution of milk with organochloride insecticides or PCBs is a global problem. Milk samples were taken in two subsequent years: 1985 (seven samples) and 1986 (nine samples) from Beni Suef and Fayoum Governorates. The most common insecticides detected in the milk were lirldanes DDT, Heptachlor and its epoxide, aldrin, dieldrin, and HCB.

The 1986 analysis in Beni Suef and Fayoum found that seven and four samples out of nine exceeded the MRLs of lindne and DDT complex, while in Fayoum, every one of the nine samples exceeded the MRLs of DDT complex, aldrin +dieldrin and endrin. The results showed lower concentrations of OCI in 1986 compared to 1985, indicating a decline in residues in the milk. The risk is likely to further decrease with time.

Pesticide Residues in Human Milk. Human milk samples (31 samples, in 1987) were found to be contaminated with OCI residues. DDT-complex was the insecticide most frequently detected at relatively high concentrations because of its metabolite DDE, and was detected in 30 samples of 31, followed by HCH (16 samples of 31). The acceptable daily intake (ADI) for the OCI residues in human milk is 0.1 mg/kg body weight and that for aldrin +dieldrin is 1.22 mg/kg body weight.

Pesticide Residues in the Human Body. DDT and HCH residues were common in adipose tissues (fat organs) in samples taken from Behaira Governorate from adults above 25 years. The mean value of DDE in the fat organs was 4.7 ppm (mg/kg).

Management of Pesticide Applications

The Current Situation

In the last few years, the Ministry of Agriculture has taken several measures to reduce pesticide application and limit its hazardous effects on the environment. Among these actions, implemented under the Integrated Pest Management (IPM) program, are:

- Application of less toxic pesticides (pheromones).
- Releasing predators to eat rodents and insects in cultivated areas.
- Seeking suitable cultural methods and balanced fertilizer use to help decrease pest populations.
- Introducing genetic engineering technology to increase plant resistance to pests.
- Improving sprayer techniques.
- Use of non-toxic bioregulators to increase plant resistance to pests.
- Use of database systems in pest control programs.

Techniques Which Could Be Used

There is no doubt that pesticides have had a positive impact on the crop production in Egypt even while application of these chemicals has had a negative environmental impact. In the last five years, a gradual but significant decrease in pesticide consumption has taken place. In 1994, only 5,484 tons of pesticide was used, compared to 15,380 tons in 1989. This decrease was largely the result of integrated pest management (IPM) programs. Pesticide consumption is expected to increase again in 1995, however, because of increased cotton infestation.

This fact sheet considers only pesticide residues in water and is focused on organochlorine insecticides. There are other toxic pesticides, however, including nematicide and insecticide furadan, which are applied in rice fields, and can be acutely toxic to fish. Furadan can remain in the soil for over four months. No data regarding these kinds of pesticides are available.

Phonelic compounds and their derivatives (chloro derivatives), are produced by decayed plants. Aquatic weeds secrete high amounts of phonelics, which upon chlorination—the main treatment for drinking water in Egypt—produce chloro derivatives of phenol that are of concern. Collection of aquatic weeds around drinking pump stations is also another problem in need of management.

Drinking water standards in Egypt should include limits for organic chemicals such as organochlorine insecticides. Other inorganic compounds chemically related to the organochlorine pesticides, even though not used as pesticides, are dioxane and PCBs. These chemicals are used in connection with industrial processes and can cause serious health hazards in the water environment. They have been detected in Egyptian waters.

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NUTRIENT HAZARDS IN EGYPTIAN WATERS

Fact Sheet

National Water Quality Conservation Unit

The amount of water available to Egypt is limited. Increased demand for clean water has put pressure on this vital resource. Rapid growth in population, new land reclamation, and industrial development waste production are outstripping the capacity of the Nile to cleanse itself. This fact has serious public health and economic implications for Egypt. While problems which affect soils and crops, such as salinity, have been studied intensively, less attention has been paid to water quality characteristics that affect drinking water and other non-agricultural water uses. Of most concern are those characteristics that can cause injury or disease—specifically, pathogenic or parasitic organisms and toxic substances.

The National Water Quality Conservation Unit was recently formed within the National Water Research Center to increase the flow of accurate, up-to-date information on water quality in Egypt. This paper is part of a series of fact sheets that describe seven of Egypt's most serious water quality hazards. These seven hazards, identified by the NWQC Unit as presenting the greatest threat to the Egyptian people, affect public health, food production, and the environment. Nutrients, including nitrogen and phosphorus, are among those substances that pose a risk.

Nutrients Defined

Nutrients, chemicals present naturally in water or added by human activity, are essential to the growth of aquatic organisms. The most dominant aquatic plant nutrient elements are nitrogen and phosphorus.

Various forms of nitrogen exist in the environment, including ammonia, nitrite, nitrate, organic nitrogen, and nitrogen gases. The ammonia ion is either released from proteinaceous organic matter and urea during the nitrification process, or is synthesized by industrial processes. The nitrite ion is also formed from the oxidation of ammonia ions or by the reduction of nitrate by certain micro-organisms found in soil, water, sewage, and the digestive tract. The nitrate ion is formed by the complete oxidation of ammonia ions by soil or water micro- organisms.

Phosphorus as phosphate is one of the major nutrients required for the plant nutrition and is essential for life. Excessive phosphate concentrations stimulate plant growth. Phosphates enter water bodies from several different sources. The human body discharges about 0.4 kg of phosphorus per year. The use of phosphate detergents and other domestic phosphates increases the per capita contribution to about 1.5 kg/year. Industries also contribute large amounts of phosphates. Agricultural drainage water, cattle feedlots, tree leaves, and atmospheric deposition all contribute varying amounts of phosphates.

Understanding Nutrients in Water

Eutrophication and Water Pollution

Eutrophication is defined as the increase in nutrient concentrations followed by a rapid increase in primary production (algae and aquatic plants) and drastic change in an aquatic ecosystem. The phenomenon of eutrophication can be observed not only in lakes but in various water bodies such as slow-flowing streams, shallow rivers, drains and bays.

Indexes for the state of eutrophication of a water body include:

Nutrients and Algal Growth. Many field experiments reveal that phosphorus is the most probable limiting nutrient for algal growth and the best criterion for trophic state classification of a water body based on nutrients.

Chlorophyll a. A photosynthetic pigment that exists in all species of phytoplankton, considered a good indicator of phytoplankton biomass concentration.

Transparency Measure. A measure of water clarity or transparency called Secchi disk transparency (SD) is used as an indicator of phytoplankton concentrations in water bodies. SD measures the maximum depth for visual identification of a standard 25 cm white disk.

Dissolved Oxygen Concentration. Since the specific gravity of phytoplankton is generally greater than water, these organisms precipitate slowly and settle on bottom sediments. During precipitation, they consume dissolved oxygen (DO) by respiration and/or decomposition by bacteria. The vertical concentration of DO in the water column is therefore considered to be an index of eutrophication.

Detrimental Effects of Nutrients

The excessive input of aquatic plant nutrients in water bodies is one of the most significant causes of water quality deterioration. In general, eutrophication is associated with excessive algae or

macrophyte growth, which can hinder industrial, irrigation and recreational water use. The determinate effects of eutrophication are summarized below:

Health Effects

Nitrate itself is not toxic to human or animals at reasonable concentrations. Nitrate becomes a problem when it can be converted to nitrite. High concentrations of nitrate (more than 10 mg/l in drinking water) can lead to stomach cancer and other health problems.

Water Quality Deterioration

The progressive eutrophication of water bodies brings about the following undesired changes in the ecosystem :

- A change in algae population levels and reduction in water transparency
- Overgrowth of emerged and submerged macrophytes
- Occurrence of particulate substances, such as phytoplankton, zooplankton, detritus, bacteria, and fungi
- Occurrence of organic substances which impart odors and tastes
- Formation of organic compounds with complex properties
- Occurrence of water colored by plant pigments
- Increase in pH due to CO2 extraction
- Oxygen depletion due to the decomposition of biogenic organic substances.
- Incomplete mineralization of organic substances near the sediment
- Denitrification processes that reduce nitrate to nitrogen and/or ammonia
- Increase in the concentration of iron and manganese in water due to their release from bed sediments

Impacts on Drinking and Industrial Waters

These include:

- The problem of trihalomethane formation. In water treatment plants that extract water from highly eutrophic water bodies, pre-chlorination is often carried out in order to exclude problems during coagulation and filtration. This process, however, leads to the formation of the halogen-substitution products of methane and ethane.

- Interruptions in flocculation processes. During this process, doses of iron III ions and aluminum ions are usually added to the water to create suitable conditions for the flocculation of particulate substances. However, low concentrations of certain algal organic substances and their decomposition products prevent the formation of positively charged polynuclear hydroxo complexes. This causes a complete breakdown in the flocculation process.

- Filter clogging. A massive population of algae can rapidly clog filters and limit water treatment plant operation, shorten the filter run time or require increased quantities of flushing water.

- Tastes and odors. Adverse tastes and odors in drinking water is often due to mass populations of certain algae.

- Interruptions to the disinfection process. The presence of ammonium ions and amino-compounds deteriorate the disinfection process using chlorine and may form a hazardous material, methaemoglobinaemia.

- Increased levels of iron and manganese.

Impairment of Fisheries and Agriculture

Although eutrophication usually increases fish production, it may lead to a change in species of fish, leading to financial losses in commercial fisheries. In addition, fish will concentrate elemental phosphorus from water containing as little as 1.0 ug/L. Agricultural production can be affected when farms are irrigated from eutrophic water bodies. Particularly, nitrogen concentration in irrigation water with higher than 5.0 mg/L can damage rice production.

Impacts on Water Recreational Areas

Nutrients also damage the use of lakes, rivers, or reservoirs for recreational activities. The excessive growth of macrophytes in the littoral zones and the decrease in water transparency may endanger bathers.

What Is the Situation in Egypt?

Sources of Nutrients

Man-made sources of nutrients may be divided into two categories, point sources and non-point or diffused sources.

Point Sources: A point source means the nutrient loads are discharged at a discrete point into the stream or lake. The major point sources of nutrients in Egypt are industrial wastes and sewage outlets. During the last 30 years, Egypt has established most of its industries along the Nile River and its two branches. The government of Egypt owns and operates more than 360 industrial facilities with little or no disposal treatments that may violate national effluent regulations and standards. The disposal of untreated domestic effluent is also a common practice along the Nile River from Aswan to Cairo, where more than 40 major towns and 1500 villages are located.

Non-Point Sources: Non-point sources of nutrients enter water courses at numerous and widespread locations, rather than at a single discharge point. Any soluble substance containing nutrients deposited on the drainage basin of the water body, such as fertilizers, animal droppings, plant remains, waste products or eroded soil, is eventually carried into the water course.

Egypt is known to be a heavy user of chemical fertilizers, with a fertilizer consumption of more than 10 times the nutrients per hectare than the world average.

Nitrogen fertilizer consumption, for example, approximately doubled in 1993 as compared to 1980. Nutrient loads into drainage water systems have consequently increased dramatically.

Table 1. Nutrient Levels in Selected Point Sources (NRI, 1992)

SAMPLING LOCATION Km from Aswan	NITROGEN (mg/l)			PHOSPHORUS (mg/l)		
	(AMMONIA)	(NITRITE)	(NITRATE)	(ORGANIC)	(ORTHO)	(TOTAL)
El Sail Drain at Aswan (9.9km)	110.00	1.520	350.0	69.79	2.272	7.000
Radisia Drain (99.85 km)	0.05	0.008	60.0	0.01	0.070	0.152
El Zawia Drain (841 km)	0.90	0.020	7.0	0.80	0.330	0.357
Ghamaza El Soghra Drain (884.5 km)	0.19	0.323	105.0	0.08	0.055	0.148
Khour Sail Badrasheen Drain (910.15 km)	2.40	0.028	2.1	0.12	1.013	1.850
Chemical Industry (911.4 km)	0.01	0.022	1.7	0.60	4.288	6.800
El Hawamdia Sugar (912.10 km)	0.01	0.350	1.3	0.90	2.800	3.600
El Rahawy Dr. Rosetta Br. (962.85 km)	2.30	0.022	4.4	0.32	2.320	3.250
Salt &Soda Ind. Rosetta Br. (1074.52 km)	0.14	0.033	150.0	0.06	0.530	1.780
Talkha Fertilizers Damietta Br.(1098 km)	700.00	6.500	6000.0	0.01	0.352	1.240

Nutrient Levels and Trends in Water

River Nile and Its Branches: An overview of the nutrient concentrations are presented in Table 1 for 1992. In general, nitrogen levels at most sites were below the standard values, indicating that the water in the river between Aswan and Cairo is fairly free of nitrogen compounds, except at some localities downstream from pollution point sources. However, nutrient levels are increasing in the Nile.

Phosphorus is a problem even inside the High Aswan Dam reservoir, and tends to gradually increase downstream.

Higher flow rates of the river in summer tend to bring down phosphorus levels by dilution, with phosphorus flushed downstream. In winter, river discharges are minimal and water moves slowly. Consequently, many stretches of the river show fairly high phosphorus levels, contributing to the undesirable growth of algae and aquatic weeds.

The situation in the Nile branches is different from the main river. The two branches exhibit higher pollutant loads with sharp increases in nutrient levels. Phosphorus is above the standard value along both branches, and ammonia-N reaches extremely high levels in the Rosetta branch. High nutrient concentrations can be attributed to the high population density and intensive agriculture in the delta region, along with contributions from the El Rahawy drain and industrial effluents from the Kafr El Zayat area. Equally important is the impact of low flow rates in the Rosetta branch, which end up with very little dilution. Consequently, water quality is seriously deteriorating.

Main Irrigation Canals: The main canals vary in size and flow rates, but it is evident that several canals have poor water quality at the supply point. Although little data is available on water quality in the canal system, the nutrient levels are expected to follow the same pattern as that of the Nile and its branches. For instance, in irrigation canals at Sharkia Governorate, Abdel Dayem and A. Ghuni (1992) reported that nitrate reaches concentrations of over 85 g/l during the summer season.

Main Drainage Systems: High ammonia and nitrate concentrations in drains was reported by El Guindy, 1989. Ammonia levels ranged between 1.2 mg/l and 3.9 mg/l, while nitrate levels ranged between 11 mg/l to 49 mg/l (Ibrahim, 1995).

The most recent results from the Drainage Research Institute of MPWWR show excessive levels of phosphate and ammonia. Phosphate levels ranged between 0.22 mg/l and 7.11 mg/l. These high levels of phosphate explain the undesirable growth of algae and aquatic weeds in drains. Ammonia concentrations in many drains are also at levels high enough to cause fish kills. These alarming nutrient levels have already affected natural lakes, irrigation canals via drainage reuse pumping stations, and the El Salam main canal, which is fed largely from Bahr Hadous and El Serw drains.

Natural Lakes: Egyptian northern lakes usually receive a great deal of untreated domestic and industrial waste discharges and agricultural return flows. The discharge of such wastes add a huge loads of nutrients to lake waters. Consequently, the lakes and their beaches exhibit serious eutrophication problems in many locations. For instance, the chemical analyses of Manzala Lake waters by P. Lane and Associates, 1992, indicated extremely high nutrient concentrations.

In conclusion, it is evident from the available data that eutrophication processes have developed along most of the drains, many irrigation canals, and the lower ends of the two branches of the Nile River. However, the most alarming examples of the water eutrophication problems are in the northern lakes, especially Manzala Lake, Maryut Lake, and El Temsah Lake at Ismaellia Governorate.

Ground Water: The pollution of ground water in the Nile Valley and the delta may occur at points, such as septic tanks and poorly sealed hand pumps or wells, or linearly from drainage ditches. Pollution is also caused by excessive fertilizer use and animal manure. For instance, most of the nitrogen fertilizer applied to fields converts to nitrate in the soil. Since nitrate is highly soluble in water and very mobile, a large portion of it may leach into the groundwater

system. Abdel Monem et al. 1994 monitored nitrate concentrations in a groundwater well 10 meters in depth. They reported high nitrate levels of over 234 mg/l during the summer season.

Deep and shallow wells were also sampled in south Beheira and Kafr El Sheikh by Binnie & Partners, 1979. A large number of samples showed evidence of nutrient pollution, particularly in the case of hand pumps. Deeper aquifers appear to less affected and are a safer source of drinking water.

Management of Nutrients

A major problem with respect to water quality in Egypt is the lack of reliable data. A field inventory should be taken of all point and diffused sources. In addition, measurement samples must be increased. There should also be a service to exchange water quality information among all concerned parties such as universities, research institutes, and governmental departments. Equally important are modeling studies for water quality which should be performed to determine dispersion characteristics. Such steps will help develop suitable strategies to restore and maintain the chemical, physical, and biological integrity of Egyptian water resources.

Control Strategies

An effective control program has to be a well-coordinated effort that considers the projected population and economic growth of the water basin as well as present conditions. Furthermore, economic and legal implications should be addressed when control measures are planned. Such control measures should be based on a clear set of priorities to prevent economic waste.

Since the recovery of water bodies is influenced by various factors, several restoration techniques exist. These techniques are summarized below:

Source Controls

- Treatment of inflows
- Diversion of inflows
- Watershed management practices including land use and cropping patterns
- Water use and user regulation practices for various uses
- Product modifications for detergents and pesticides

In-Water Controls

- Dredging
- Dilution or flushing
- Selective discharge
- Nutrient inactivation or precipitation
- Sediment sealing or covering
- Sediment oxidation via chemical application

Treatments

- Aquatic plant harvesting
- Algaecide herbicide pesticide application
- Aeration or improved water circulation

Protection Strategies

Once nutrients enter the aquatic ecosystem, their removal is tedious and expensive. For instance, phosphates are consumed by algae and higher orders of aquatic plants and stored within the plant's cells. The composition of such cells releases phosphorus immediately through bacterial action for recycling within the biotic community, while the remainder is deposited in bed sediments.

There are two basic rationales for establishing a phosphorus criterion for flowing waters: the first is to control the development of plant overgrowth within flowing waters and, in turn, to control animal pests associated with such plants; the second is to protect the downstream receiving waterway. Generally, some of the phosphorus entering water streams would eventually reach a receiving lake or estuary, either as a component of the fluid mass, as bed load sediments , or as floating organic materials.

Therefore, in order to prevent the development of biological nuisances and to control eutrophication, total phosphorus should not exceed 50 ug/l in any stream at the point where it enters any lake or reservoir, or 25 ug/l within the lake or reservoir itself. A desired goal for the prevention of plant nuisances in flowing streams not discharging directly to lakes is 100 ug/l total phosphates.

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TRACE METAL HAZARDS IN EGYPTIAN WATERS

Fact Sheet

National Water Quality Conservation Unit
NATIONAL WATER RESEARCH CENTER
المركز القومي لبحوث المياه

The amount of water available to Egypt is limited. Increased demand for clean water has put pressure on this vital resource. Rapid growth in population, new land reclamation, and industrial development waste production are outstripping the capacity of the Nile to cleanse itself. This fact has serious public health and economic implications for Egypt. While problems which affect soils and crops, such as salinity, have been studied intensively, less attention has been paid to water quality characteristics that affect drinking water and other non-agricultural water uses. Of most concern are those characteristics that can cause injury or disease—specifically, pathogenic or parasitic organisms and toxic substances.

The National Water Quality Conservation Unit was recently formed within the National Water Research Center to increase the flow of accurate, up-to-date information on water quality in Egypt. This paper is part of a series of fact sheets that describe seven of Egypt's most serious water quality hazards. These seven hazards, identified by the NWQC Unit as presenting the greatest threat to the Egyptian people, affect public health, food production, and the environment. Trace metals produced from industry and automobile exhaust are of particular concern. The toxic effects of many trace metals, including lead and cadmium, are well known. Discharge from factories in Egypt add millions of tons of metals to the Nile River system each year.

Trace Metals in the Environment

Trace metals including copper, cadmium and numerous others occur in solution in natural waters. They appear in relatively small quantities of less than 1.0 mg/l or 1 milligram per litre of water. They are also termed heavy metals because of their high atomic weight. Common heavy metals are arsenic, lead, mercury, copper, chromium, nickle, and cadmium.

Natural sources for metals in water include rocks and soils. Metals are brought into solution by the action of acid rain and through ground water movement. The solubility of any particular metal is highly dependent on the acidity of the water. The more acid the water, the higher the metal concentrations.

Human activities have had a strong impact on the incidence of trace metals in water. Industrial societies use large quantities of metals, which would otherwise not be readily available for solution in water (Hem, 1992). Analysis of lake sediments, ice-sheets, and museum specimens has shown increasing concentrations of metals with time.

There are three main man-made sources of heavy metals in the environment:

1) Process of extraction and purification: mining, smelting and refining.

2) Release of metals from fossil fuels such as coal or oil when burned. Cadmium, lead, mercury, nickel, vanadium, chromium, and copper are all present in these fuels.

3) Production and use of metals in industrial products, the chemical industry, plastic manufacturing, and as additives to gasoline and lubricants.

Pathways to the Environment

The release of metal wastes into the environment occurs in many forms. These include:

- Direct discharge of industrial wastewater
- Air emissions from factories and automobiles
- Urban and agricultural runoff
- Seepage into ground water from waste disposal sites

Metals in an aquatic system may be occur in the following forms:

- In solution or adsorbed on solids
- In organo-metallic or hydroxide forms
- In the crystal structure of suspended materials

Three factors govern the distribution and potential hazard of metals in natural water:

1. ***Particulate matter*** has been recognized to be the major means of transport of metals through natural waters and one of the major pathways of these pollutants to biota. The capacity of sediment to exchange inherent cations (positively charge ions) for metal ions varies with grain size distribution and is dependent on the type of clay mineral. For instance, montmorillonite clay has a greater exchange capacity than kaolinite clay. Most sediments, mixtures of clay, silt and sand minerals, have varying exchange capacities.

2. ***The chemistry of water*** also affects metal concentration and toxicity, as well as the availability of trace metals to biota or their toxicity. For instance, two metals mixed in water may have a lethal effect, while either one alone may be relatively innocuous.

3. ***Microbial and biological processes*** are important factors in the concentration and distribution of specific metals. These processes can affect the solubility of mercury, tin, arsenic, lead, and others in the aquatic environment. Metals can also bind to cell surface of algae. Plant enzymes can also leach metals from sediments and release them in the environment.

Environmental and Health Effects

The concern over the presence of trace metals in the environment is not simply because such substances are toxic to humans. Metals also have a long lasting effect on the aquatic ecosystem and the food chain. Once they have been discharged to waterways, they attach readily to sediment particles on the bottoms of canals, drains and lakes. They can then be taken up by bottom-dwelling organisms which are in turn eaten by fish. At each stage, they are further concentrated. Fish can concentrate metals to extremely high levels, harmful to humans.

The effects of metals on ecosystems are not well known. Some appear to affect the rate of basic processes; molybdenum deficiency, for example, may inhibit bacteria responsible for the fixation of nitrogen, while small amounts of copper may slow the decomposition of forest litter. Small amounts of copper and zinc are, however, essential nutrients for most organisms.

Some plant species can tolerate high levels of lead while mercury and cadmium in the soil are toxic to most organisms. Some crops, including wheat and rice, can take up so much cadmium from the soil that they become hazardous to consumers. (Peterson, 1971)

Attention to the effects of metals on humans is focused first on acute poisoning following industrial exposure or through diet. Many metals have been known for centuries to be toxic. Inhalation of mercury vapour in the mining industry used to cause many cases of damage to the central nervous system. Lead poisoning was for decades a well-known hazard to smelters, and later to those engaged in storage battery production. Inhalation of manganese has been known to cause irreversible damage to the central nervous system. Cadmium, mercury, tin, lead, vanadium, chromium, molybdenum, manganese, cobalt and nickel are all known to pose hazards to those working with them.

Metals are indestructible and have the potential to accumulate in the body, thus leading to chronic effects. Pathways affecting man and other targets are, therefore, crucially important.

The Situation in Egypt

Since late 1960s, there has been a great deal of interest in Egypt concerning the contamination of the Nile River and other aquatic ecosystems by trace metals. In general, sources of pollution by trace metals have been attributed to improper management and disposal of industrial wastes, atmospheric deposition, and agricultural runoff. Industries responsible for ocurrence of heavy metals are generally those in the heavy engineering, electroplating, tanneries, or chemical categories.

In modern manufacturing facilities, particularly those that have been constructed in the last 10 years, special care has been taken to control the amounts of metals lost during the production process. The entire process is designed around conserving as much of the metals as is economically possible. Plants that were built more than 10 years ago do not necessarily have efficient waste recovery systems. High concentrations of metals in wastes and high volumes of wastewater discharges lead to several kilograms a day of metals being discharged to drains or the Nile.

In Helwan, the Iron and Steel Factory and the El Nasr Automobile Company discharge large quantities of toxic wastes. According to the Helwan Wastewater Master Plan (1978), the industrial wastewater discharged from the Helwan area amounts to 42,314,000 cubic metres per annum. (El-Gohary, et al., 1982)

In Shoubra El Kheima area, which represents one of the highest concentrations of industry in Egypt, industrial activities include metal production, food processing, detergent and soap manufacturing, textile finishing, and paper production. Huge volumes of untreated wastewater are discharged into agricultural drains daily. In a recent study, carried out by the National Research Center's Water Pollution Control Department, 89 industries were identified as being major sources of water pollution in the area. The metal industry, which represents only 15 percent of the total number, discharges almost 50 percent of total wastewater (El-Gohary et al. 1990).

Studies of spatial and seasonal distribution of trace metals in river water and sediments during the period from 1976 to recently, have shown that mean concentrations of trace metals in river water were well below the acceptable limits for potable water sources. Trace metals, however, have accumulated in high concentrations in river sediments.

High concentrations of trace metals have been found at Helwan, Kafr El Zayat and Talkha (see Table 1, Lasheen, 1981). Results of a survey carried out by El-Sokkary (1992) indicated a marked increase in total metal concentrations in the sediment northwards down the Nile River.

Table 1. Concentration of Trace Metals in Nile River Sediment

Sample Location	Concentration (ug/gm)		
	Co	Cr	Pb
Assuit	95.4	622.6	61.4
Upstream Helwan I&S	98.1	347.3	57.7
At Helwan I&S	92.3	187.7	49.7
Downstream Helwan	106.2	226.3	61.3
I&S	103.0	193.7	50.0
Meridian	88.4	246.8	94.6
Rod El Fara	110.5	249.0	47.0
El-Manashi	96.0	276.3	69.0
El-Quantir	87.0	526.7	39.4
Karf El-Zaiyat	96.0	254.2	82.8
Kafr El-Sheikh Ali	104.0	354.5	75.1
Idfina	81.3	144.7	74.0
El-Mansura	78.1	398.3	53.2
Talkha	99.3	337.7	50.3
Fariskur			

Source: Lasheen, 1981

In the same survey, analysis of surface bottom mud samples, collected from canals, drains, and lakes in the Nile Delta varied in trace metal concentration, with the sediment of El Mahmoudiya canal containing the highest levels of cadmium, lead, and mercury. The northern part of this canal (south Alexandria City) exhibited the worst condition. This area receives untreated effluents from various industries, raw domestic wastewater and atmospheric fallout from industries and vehicles. The southern part of Rosetta branch also had high concentrations of trace metals. This was most likely a result of the inflow of wastewater from El Rahawy drain.

Sediment samples collected from the Indku and Mariut Lakes were contaminated with cadmium and lead, while those of Mariut Lake had high concentrations of mercury, as well. In general, the five freshwater canals are not polluted with trace metals, except for the El Khandak and El Mahmoudiya canals.

The levels of dissolved and particulate mercury were higher in waters of Mariut Lake than in those of Edko Lake. Also the levels of particulate cadmium and lead were higher in waters of Mariut Lake than in those of Edko Lake.

Trace metals concentrations in agricultural drains water have been measured by the NRI (RNPD No. 515, 1989). According to their data, annual load of zinc and chromium were estimated to be 1,115 and 235 tons per year, respectively. Results from the same campaign indicated high chromium levels downstream of El-Rahawy drain and industrial outfalls along Rosetta branch.

Though data on trace metal concentrations in industrial effluents are available, their loads could not be estimated because of lack of information on the discharge rates. Data regarding trace metal concentrations is fragmented, which makes it difficult to precisely describe the current pollution patterns and levels of trace metals in the Nile system.

How to Manage Trace Metals

Toxic metals, such as chromium, mercury, cadmium, copper, nickel and zinc, have traditionally been tightly regulated. Current international public and aquatic health criteria require further reduction to little more than background concentrations.

Historically, end-of-pipe treatment of industrial wastewater via single-stage precipitation has been adequate for metal removal to parts per million concentrations. But to reliably achieve metal concentrations of less than 100 parts per billion, expensive advanced technologies will be required.

Controlling environmental pollution from industrial sources is best achieved by controlling pollutant emission and discharge at the source. Experience gained during the last two decades suggests that in many circumstances it is more efficient and less expensive to incorporate pollution preventive techniques than corrective techniques. Consequently, the immediate institution of improved housekeeping measures and operations and maintenance procedures could potentially reduce environmental risks significantly. Simple environmental management practices such as cleaning oil traps, controlling leakage, and separating cooling water from other process water, as well as waste nutrilization, are recommended.

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