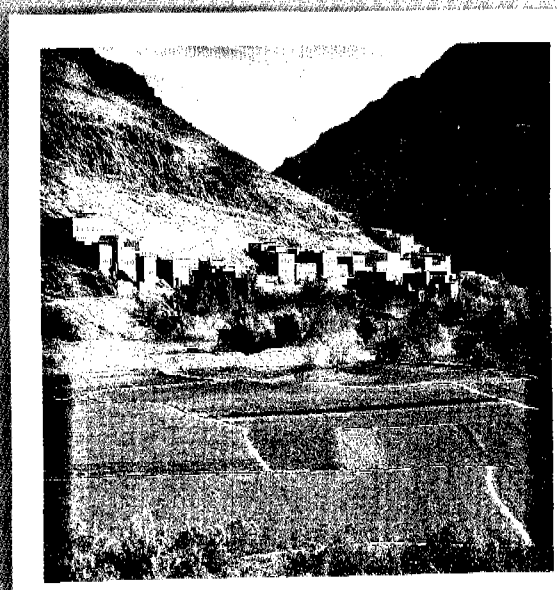
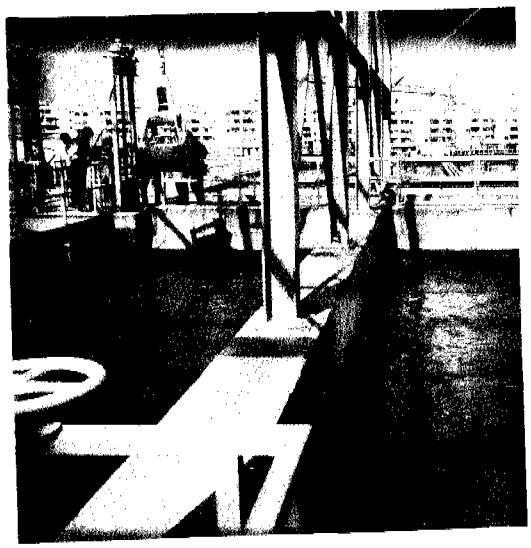
Water Resources Action Plan for the Near East





Bureau for the Near East
U.S. Agency for International Development

ISPAN

IRRIGATION SUPPORT PROJECT FOR ASIA AND THE NEAR EAST

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To: Han Heijnen, IRC International Water and Sanitation Center

From: Peter Reiss, Technical Director

Date: 14 September 1993

Re: Water Resources Action Plan for the Near East

Enclosed is a copy of the recently completed Water Resources Action Plan for the Near East. ISPAN is distributing the document on behalf of the Near East Bureau of A.I.D.

The document provides an overview of water resources issues in the region and discusses the Bureau's strategies for addressing them.

We hope you find the document to be interesting and useful.

Thank you.

Water Resources Action Plan for the Near East

August 1993

Bureau for the Near East
U.S. Agency for International Development

Photo credits (clockwise from upper left):

- Morocco—south of the Atlas Mountains in early spring, by Peter Reiss of Development Alternatives, Inc. and ISPAN.
- Oman—a Ministry of Water Resources officer and young assistant measuring the water level in a *falaj*, by Jonathan Hodgkin of Associates in Rural Development, Inc.
- Egypt—a wastewater treatment plant funded under the USAID Alexandria Wastewater System Expansion Project, by Herb Blank of A.I.D.'s Near East Bureau.
- Tunisia—potable water delivery assisted by the USAID Central Tunisia Rural Development Project, by Doug Gritzinger of Dames and Moore, Inc.

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Letter from the A.I.D. Acting Assistant Administrator

The main thrust of A.I.D.'s policy, as stated by our Administrator, Brian Atwood, is to promote sustainable development abroad through bilateral aid. We must view our work in a global context addressing key objectives of environment, economic growth, democracy and population and health as these relate to sustainable development.

The Near East Bureau's Action Plan for Water Resources supports the Near East Bureau Strategy, which was prepared to provide a concise statement of the objectives of A.I.D. assistance activities and a strategy for achieving those objectives in the Near East over the period FY 1993 through FY 1997.

In the Near East we have identified water resources as the most critical environmental constraint to sustainable development. Sustainable development requires individuals and nations to develop and manage their natural resources in a manner which does not compromise the ability of future generations to meet their own needs. This is an admirable goal but one which will be difficult to achieve given the nature of the resource.

The approach developed in the Water Resources Action Plan represents an evolution in water resource development and management. The approach emphasizes improved management, improved policies and participation by water users in the management of the resource. It also emphasizes the need to protect the quality of the resource, to use water for highest valued purposes first with appropriate downstream reuse, and to manage quality through pollution prevention techniques, reducing pollution at the source.

I believe that the Water Resources Action Plan makes a major contribution to rethinking how U.S. assistance in the water sector can be utilized to promote sustainable development in the region.

Dennis Chandler
Acting Assistant Administrator
Bureau for Near East

Preface

We in the Near East Bureau are continuously reminded that many of the critical constraints to economic and social development in the region stem from problems with water resources. Water resources in this arid region are insufficient to support its rapidly growing urban population. Water supplies and wastewater systems in its cities are severely strained. Increasing industrialization is threatening the quality of the resource. Furthermore, most of the surface water in the Near East originates outside the region and few of the riparian countries have agreements regulating its use.

Over the past two decades, A.I.D. has been an important donor in the water sector in the Near East. More than three billion dollars in assistance to countries in the region has been provided for the development and upgrading of water supply, sanitation and irrigation systems. In the future, we see a continuing role for A.I.D. and host countries to work together to address the myriad problems associated with this sector.

The Water Resources Action Plan (1) identifies alternative means by which A.I.D. may assist host governments in improving the management of available water resources in the Near East; (2) summarizes actions currently underway by A.I.D. in support of the Bureau's strategic objective in water resources; (3) identifies areas where future programs may be desirable; and (4) outlines a strategic agenda for the Bureau and field Missions in formulating future programs and directions in water resources. It represents the culmination of work by Bureau staff and consultants funded under the ISPAN project, together with input from the Near East Bureau field missions. A draft of the plan was reviewed at a workshop held in Cairo in March 1993, and numerous comments were incorporated.

This document reflects a comprehensive approach to water resources in the region, emphasizing increased water use efficiency, enhanced water quality and improved water management. It is intended for wide dissemination to those interested in critical water resource issues in the region and the approaches being adopted to face those problems.

Satish Shah

Satish Shah, Director
Office of Development Resources
Bureau for Near East

EXECUTIVE SUMMARY

There is no question as to the severity of the water resource problem in the Near East. Current water shortages could soon reach crisis proportions since the region has one of the highest population growth rates in the world. Many countries in the Near East have a water deficit. They currently consume more fresh water than is produced naturally within their boundaries; and widespread shortages are anticipated within the next ten years. Furthermore, mismanagement has led to the degradation of water quality and the depletion of water supplies. The inadequate supply of clean water contributes to public health problems and places severe limits on economic growth. The serious difficulties of allocating water among competing sectors within a country are overshadowed by the problems of allocating water across national boundaries. Few agreements among riparians exist on any of the major rivers in the Near East, and conflicts may arise as some users claim greater volumes of water.

Given the importance of the resource in the region, the Near East Bureau has prepared an action plan that identifies the potential means of improving water resources management problems in the region. The action plan summarizes actions, currently underway by Missions and the Bureau, that contribute to meeting the Bureau's strategic objective, and suggests areas where future programs may be desirable. It also provides an overview of water resources in the region, identifies and discusses three priority issues, and offers program options that address these water resources issues.

Priority Water Resources Issues in the Near East

Three priority issues dominate water resources in the region:

Water shortages. Water deficits already exist in some areas of the Near East. Water transfers and reuse positively affect supply by directing water to areas that are drastically short of water, but this merely redistributes existing resources. Transfer and reuse will never satisfactorily augment supply. Such measures are predominantly marginal, short-term corrections that fail to alter the basic problem of finite water resources.

Degradation of water quality. The degradation and the depletion of water resources have exacerbated the limited supply of water and are constraints to economic development in Near Eastern countries. This situation has resulted from many factors, including the lack of an environmental ethic throughout the region, a general lack of public concern with water resources issues, inadequate regulatory and enforcement capability, and restrictions on economic forces that value water in relationship to demand.

Public and private sector resource management performance. Near Eastern governments traditionally targeted specific sectors for investment, usually agriculture. Subsidies that discourage the efficient use of water are common in the agricultural sector. Since only a fraction of the real cost of water is charged, few farmers are willing to invest in water conservation technologies or make efficiency improvements. Energy subsidies are also common; they are reflected in low power rates and fuel costs. These subsidies are a heavy burden since they discourage the consideration of the natural resources.

The three issues directly stem from the region's central problem: the mismanagement of water resources. Scarce water supplies are already diminishing as a result of this mismanagement. The action plan discusses these three major issues and sets the policy framework for Bureau and Mission actions to assist cooperating countries with this vital natural resource.

Near East Bureau Objectives

The Near East Bureau's goal is to achieve sustainable economic growth, high levels of employment, widespread recognition of basic human rights and peaceful relations with neighbors, the benefits of which are shared by a broad spectrum of the population.

The Bureau has identified three subgoals:

- increased efficiency, productivity, and competitiveness of selected economies in the region
- healthier and smaller families
- sustainable development of the region's natural resources

The Near East Bureau has further identified degradation and depletion of water resources as the highest priority among the environmental constraints in the region. Consequently, the strategic objective associated with the third subgoal is "more efficient use and improved quality of water resources."

Under this strategic objective are the following five program outcomes that represent a programmatic summary of results expected from activities currently planned or underway by the Near East Bureau and Missions:

Improved public management, including appropriate policies. Improved management of government-operated water resource facilities, such as irrigation systems and domestic water supply utilities, is a key element of many Mission programs in water resources. Traditional approaches have included provision of technical assistance and training. More recently, Missions are placing greater emphasis on improving water use efficiency through policy change, including implementation of policies to reallocate water to

more highly valued uses, and managing demand through charging fees more reflective of the true economic value of water.

Increased public participation in water resource management programs. Public participation in and support of water management programs can potentially contribute to gains in water use efficiency. In dealing with irrigation water management, many Missions have experience with programs to form and strengthen water users associations. These groups may serve to allocate water among users effectively, to contribute to the operation and maintenance of water distribution systems, and as support for water conservation by individual users.

Increased wastewater treatment and water reuse by public and private sectors. Inadequate sanitary service is a common problem throughout the region. Untreated wastes are a health hazard and contribute to environmental degradation of air and water quality. Many cities in the Near East have only rudimentary wastewater treatment facilities, at best. High urban population growth rates compound the problem and result in municipalities being unable to keep up with the demand for sanitation services. In addition, since many rivers in the region cross national boundaries, degraded water quality is an international concern.

Increased use of pollution prevention and waste minimization techniques by public and private industry. Current thinking has placed emphasizes pollution prevention and the reduction of waste generated in primary industrial activities. As applied to water resources, water pollution is most often solved through the construction of a waste treatment plant. Pollution prevention involves the complete and systematic assessment of the production and/or processing system to minimize the generation of waste products. Steps to be taken in this method include good housekeeping, recycling and reuse, materials substitution, and process modification.

Greater intercountry discussion of joint approaches to water resources management. Much of the history of conflict in the Near East has revolved around water shortages in the region. Given the importance of water in the Near East, discussions of common problems and attempts to resolve national and international problems of water allocation, water use and water quality are critical areas for intervention. A.I.D. can serve as a participant in formal U.S. delegations to these discussions and provide funding either bilaterally or through other means to support the resolution of water problems in the region and further the peace process.

Opportunities for Future Bureau and Mission Programs

The Bureau and Missions tend to work most intensely on project activities involving technology transfer and education. Relatively few programs concen-

trate on policy, improved financial performance, fostering local capacity, and turnover and privatization. However, a review of program strategies found that Missions are increasing involved in policy-related work.

The Bureau will support as long-term objectives Mission efforts in the following broad areas:

- manage demand to cover economic and financial costs and to allocate water to reflect its real value to society
- strengthen legal systems and upgrade monitoring and enforcement of regulations
- introduce and implement pollution prevention techniques
- divest management responsibilities through expanded and strengthened water user organizations
- conflict resolution and long-term peace in the region

The Strategic Agenda

Over the next three years, the Bureau with the support of field Missions will promote sustainable development of the region's water resources with concentration on more efficient use of water and improved water quality. Improved management is viewed as a contributing factor to efficiency and quality objectives. In terms of the five program outcomes that support strategic objectives, the action plan is as follows:

Improved public management, including appropriate policies. The Bureau will continue to support Mission efforts to develop and implement projects directly supporting improved water use efficiency and elimination of subsidies of low-valued irrigated crops and underpricing of water. The Bureau will continue to encourage Missions to work at the national policy level, although site-specific activities may be required to demonstrate policy change. The Bureau will encourage Missions to support cooperating country government efforts to reform and strengthen those policies that lead to more efficient allocations of natural resources, particularly water. The Bureau will consider a centrally funded follow-on to the ISPAN to address these issues from a regional perspective.

Increased public participation in water resource management programs. The Bureau will support work by PRIDE to promote conservation of water and other natural resources through mass media and other means. The Bureau will support efforts, particularly of the Egypt Mission, to strengthen water users associations in irrigated areas.

Increased wastewater treatment and water reuse by public and private sectors. The Bureau will support Mission efforts to fund capital

projects in this area, particularly in Egypt under ESF funding, providing these projects have substantive policy components. The Bureau will encourage Missions to address concerns involving operations and maintenance in such projects, including plans for funding recurrent costs. The Bureau will encourage the Egypt Mission to incorporate results of the Middle East Regional Cooperation Program wastewater activity in the Mission's wastewater program.

Increased use of pollution prevention techniques by public and private industry. The Bureau and Missions will support pollution prevention and waste minimization techniques through a variety of means. PRIDE will support various centrally funded activities, and several Missions are expected to support pollution prevention activities through existing project mechanisms and through the establishment of pollution prevention programs, which will promote these techniques using U.S. technology and equipment. Bureau funds will support these centers through an initial obligation in FY93.

Greater intercountry discussion of joint approaches to water resources management. The Bureau will continue to support the U.S. delegation to the Middle East Peace Talks and will work to establish a source of funding for studies and other costs associated with the talks. If the talks result in actions to resolve or partially resolve long-standing water disputes, the Bureau would be involved in decisions to fund capital costs of the construction of a major project or projects involving one or more of the regional countries. Obviously there would be pressure to "fast track" such projects, and if A.I.D. funds were involved there would be substantial involvement by the Missions involved, particularly Jordan. If the talks result in some form of self-government for Gaza and the West Bank, the Bureau may expand A.I.D.'s portfolio in the West Bank and Gaza to include projects to support the establishment of, for example, a local water authority.

The Analytic Agenda

The Bureau will develop and carry out an analytic agenda intended to further knowledge in specific policy areas related to the strategic agenda and assist policy-makers in improving management of water resources in the region. The agenda will consist of a series of studies funded from Project Development and Support, ISPAN, PRIDE, and R&D Bureau sources, as appropriate. Funding in cooperation with other Bureaus and Missions will also be pursued.

Studies will cover a range of topics and will likely include:

- a study of sustainability of water resource development
- a review of the performance of participatory efforts involving water user organizations

- an analysis of water rights in the region
- analysis of policy options
- a modeling study of projected water use and reuse

Additionally, the Bureau will continue to support such Agency-wide concerns as funding constraints, earmarks, staffing, ESF/Development Assistance, pipeline concerns, Gray Amendment compliance, buying from American sources, and jobs legislation.

WATER RESOURCES ACTION PLAN FOR THE NEAR EAST

WATER RESOURCES ACTION PLAN FOR THE NEAR EAST

The growing problems associated with water shortages, water quality, and water resource management in the Near East present new and continued opportunities for the Bureau to assist cooperating countries. Given the importance of water resources in the region, the Near East Bureau has identified "the more efficient use and improved quality of water resources" as one of five strategic objectives for the region. The Water Resources Action Plan addresses that strategic objective by:

- identifying alternative means of improving the management of available water resources in the Near East
- summarizing actions currently underway by the Bureau and Missions that support the water resources objective
- identifying areas where future programs may be desirable
- outlining strategic and analytic agendas for the Bureau and Missions in formulating future programs and directions in water resources

Background

The Near East is one of the world's most extensive arid regions. Almost three quarters of the land from Morocco through Iraq is desert, lacking in sufficient water resources and adequate soils to support a settled population. Settlement is concentrated along the few major rivers where there are arable soils and in the coastal zone, which is generally better watered than the desert interior.

Current water shortages could soon reach crisis proportions since the Near East has one of the highest population growth rates in the world. With an average annual growth rate of 3.6 percent, the population of the Near East will more than double between 1990 and 2010. Increasing industrialization and urbanization place additional pressure on the limited water resources. Between 1985 and 2000, demand for water will more than double in Jordan and Oman; in Morocco, Tunisia, Egypt, and Yemen, demand will increase by 50 percent.

There is no question as to the severity of the water resource problem in the Near East. Many countries in the region have a water deficit. They currently consume more fresh water than is produced naturally within their boundaries, and widespread shortages are anticipated within the next ten years. Furthermore, inattention to the management of water quality has led to the

degradation and the depletion of water supplies. The inadequate supply of clean water contributes to public health problems and places severe limits on economic growth.

The Near East Bureau has long been a major contributor to water resources development and management in the region. Between 1975 and 1992 A.I.D. funding for water sector projects in the Near East exceeded $3.6 billion. During this period more than three quarters of that amount was invested in water supply and wastewater treatment, while irrigation development projects received 16 percent of the total. The remainder was for other water resource activities including groundwater development, planning, and research. The current portfolio of projects in the region in water resources or with substantial water-related components is more than $2.5 billion (Table 1).

The importance of water resources to the region and the intensifying problems of water shortages, water quality, and the inadequate attention paid to public and private sector resource management present new and continued opportunities for the Bureau to assist cooperating countries.

Near East Bureau Objectives

On the basis of an analysis of current and planned programs, the Bureau has prepared an objective tree (Figure 1), which is a logical diagram syntheszing the goals, subgoals, strategic objectives, and program outcomes of the Near East Bureau (inclusive of Bureau and Mission activities). Strategic objectives represent the highest level of objective within the Bureau's "manageable interest."

As indicated, the Near East Bureau's goal is to achieve sustainable economic growth, high levels of employment, widespread recognition of basic human rights and peaceful relations with neighbors, the benefits of which are shared by a broad spectrum of the population.

The Bureau has identified three subgoals:

- increased efficiency, productivity, and competitiveness of selected economies in the region
- healthier and smaller families
- sustainable development of the region's natural resources

The Near East Bureau has identified degradation and depletion of water resources as the highest priority among the environmental constraints in the region. Consequently, the strategic objective associated with the third subgoal is "more efficient use and improved quality of water resources."

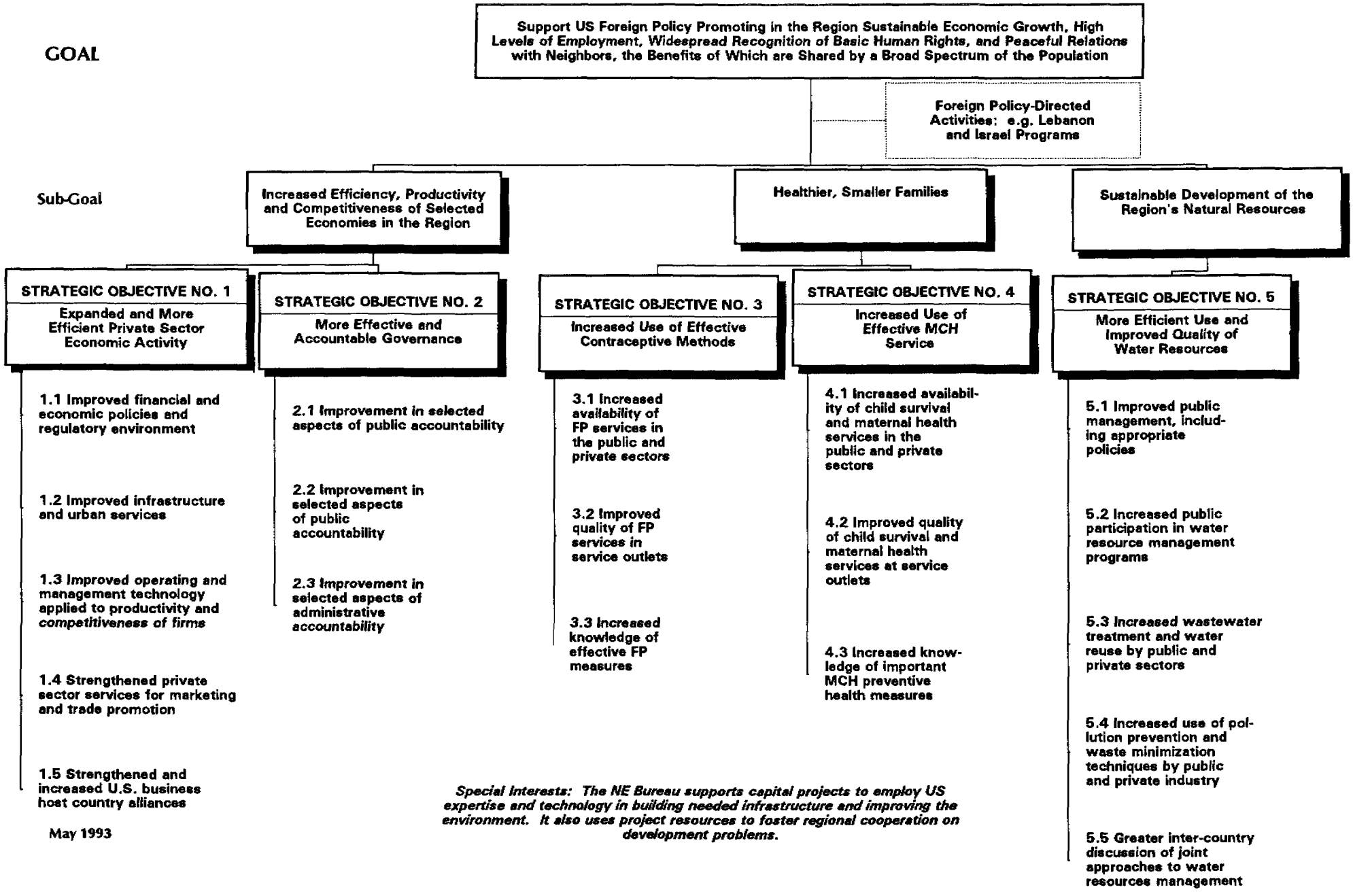
Under this strategic objective the Bureau has identified five program outcomes that represent a programmatic summary of results expected from

Table 1

Near East Water Resources Action Plan
Current Portfolio of Water Resources and Water-Related Projects
(US$ 000s)

Project Number	Country and Project Name	LOP Funding
278-0288	Jordan Water Quality Improvement and Conservation	25,000
608-0194	Morocco Tetouan Urban Development (Sewerage Component)	1,057
608-0213	Morocco Tadla Resource Management	18,750
263-0100	Egypt Alexandria Wastewater Systems Expansion	390,000
263-0140.2	Egypt Science and Technology for Development - Schistosomiasis Research	39,650
263-0160	Egypt High Dam Rehabilitation/Modernization	140,000
263-0161.03	Egypt Provincial Cities Development	99,000
263-0132	Egypt Irrigation Management Systems	340,000
263-0173	Egypt Cairo Sewerage II	816,000
263-0174	Egypt Canal Cities Water and Wastewater II	380,000
263-0176	Egypt Water and Wastewater (Institutional Support)	15,000
263-0193	Egypt Cairo Water II	145,000
272-0104	Oman Water Resource Development	62,491
298-0158.24	Middle East Regional Cooperation - Wastewater Reuse	1,075
298-0158.26	Middle East Regional Cooperation - Cooperative Marine Technology IV	3,000
298-0365	Regional Project in Development and Environment	19,000
398-0249	Irrigation Support for Asia and the Near East	26,100
	Total	$2,521,123

Figure 1
Near East Bureau Objectives



activities currently planned or underway by the Near East Bureau and Missions. Typical activities that contribute to the program outcomes are elaborated below.

Improved Public Management, Including Appropriate Policies (5.1)

Improved management of government-operated water resource facilities, such as irrigation systems and domestic water supply utilities, is a key element of many Mission programs in water resources. Traditional approaches have included provision of technical assistance and training. More recently, Missions are placing greater emphasis on improving water use efficiency through policy change, including implementation of policies to reallocate water to more highly valued uses, and managing demand through charging fees more reflective of the true economic value of water.

Increased Public Participation in Water Resource Management Programs (5.2)

Public participation in and support of water management programs can potentially contribute to gains in water use efficiency. For example, in the western United States, appeals to the public to reduce water consumption during drought periods have been successful. The use of social marketing campaigns to raise the public's awareness of water management issues has been successfully demonstrated in the United States and elsewhere. In dealing with irrigation water management, many Missions have experience with programs to form and strengthen water users associations. These groups may serve to allocate water among users effectively, to contribute to the operation and maintenance of water distribution systems, and as support for water conservation by individual users.

Increased Wastewater Treatment and Water Reuse by Public and Private Sectors (5.3)

Inadequate sanitary service is a common problem throughout the region. Untreated wastes are a health hazard and contribute to environmental degradation of air and water quality. Many cities in the Near East region have only rudimentary wastewater treatment facilities, at best. High urban population growth rates compound the problem and result in municipalities being unable to keep up with the demand for sanitation services. A.I.D. has made major contributions to improving wastewater treatment in Egypt, Jordan, and other countries in the region.

In addition, since many rivers in the region cross national boundaries, degraded water quality is an international concern. Given the water-short

situation throughout the Near East region, many countries are looking to treated wastewater for irrigation and other purposes.

Increased Use of Pollution Prevention and Waste Minimization Techniques by Public and Private Industry (5.4)

The traditional approach to dealing with environmental pollution has been waste control and management after it is generated. Current thinking has placed greater emphasis on pollution prevention and the reduction of waste generated in primary industrial activities. As applied to water resources, water pollution is most often solved through the construction of a waste treatment plant. Pollution prevention involves the complete and systematic assessment of the production and/or processing system to minimize the generation of waste products. Steps to be taken in this method include good housekeeping, recycling and reuse, materials substitution, and process modification. The attractiveness of the pollution prevention philosophy is in its applicability to resolving both existing urban, industrial, as well as agricultural, pollution problems and in providing a basis for developing these sectors in an environmentally and economically sustainable manner. The Bureau can provide information and educate the Missions about these technologies and their potential applications, particularly in the area of water resources.

Greater Intercountry Discussion of Joint Approaches to Water Resources Management (5.5)

Much of the history of conflict in the Near East revolves around water shortages in the region. Given the importance of water in the Near East, discussions of common problems and attempts to resolve national and international problems of water allocation, water use and water quality are critical areas for intervention. A.I.D. can serve as a participant in formal U.S. delegations to these discussions and provide funding either bilaterally or through other means to support the resolution of water problems in the region and further the peace process.

Available Alternatives to Improve Water Use and Quality

An analysis of water resources problems and alternative solutions identified the major water resource problems in the Near East as:

- water shortages resulting from inefficient use
- degradation of water quality
- ineffective public and private sector water resources management

The following section elaborates on each of the three problem areas and identifies specific assistance alternatives that might be considered.

Increase Water Use Efficiency

As demands for limited water supplies increase, countries in the region will need to allocate available water among competing demands for economic growth, environmental enhancement, and basic human needs. Since there are essentially no undeveloped sources of fresh water in the region, meeting basic human needs in some areas may require extremely costly solutions such as desalinization of brackish or salt water. Economic forces may require the displacement of irrigation (typically a low-valued use) to higher valued municipal or industrial use.

Reallocate water resources. Given increasing demand pressures and limits on supply, countries in the region will need to make difficult decisions regarding the allocation of supplies. The Near East Bureau and Missions can provide assistance in improving water resources policy and planning procedures.

Manage demand. Government policies must begin to identify and promote the use of effective economic policy instruments that reflect the true economic value of water supplies. The most common instruments for encouraging changes in demand patterns include pricing, fiscal incentives, and sales, but government can also address demand by issuing regulations and educating end users.

Conserve water. Government policies and programs must focus on ways for all consumers to practice water conservation. Agricultural, industrial, and municipal consumers are targets for improved water conservation measures and can play an important monitoring role to ensure that new government conservation policies are effectively implemented. A range of improved, clean technology options are available for both short- and long-term opportunities to affect water use in the agricultural and industrial sectors.

Improve technology. Technological advances in locating, conveying, and applying water are available, which can potentially contribute to increased water use efficiency. Although these advances will not solve regional water shortages, they have an incremental impact. A variety of technologies for agriculture, municipal use, and reconnaissance are available.

Resolve transboundary disputes. Water rights in the Near East at present are largely based on historical use. As the quantity of the resource shrinks and its diminishing quality restricts broad use, however, future allocations among countries may increasingly be based on "best case" arguments for use and promises of assistance by countries in a single basin or sharing a single aquifer. Appropriate planning tools and accurate analyses are crucial in any future negotiations over transboundary allocations among countries in the region.

Enhance Water Quality

An important alternative to addressing the problem of water shortages in the Near East is to improve the quality of water supplies so that they can be reused or used for higher value purposes. This water quality alternative complements water efficiency and conservation efforts that focus solely on quantities of water. This alternative has increasing importance as demands for industrial and municipal water increase. These users require high-quality water while having the potential to seriously degrade water quality. Preventive action to protect water quality is essential; low-quality water cannot be used or can only be used after expensive water treatment. It is generally more cost effective to prevent water degradation than to treat polluted water or develop new sources of water.

Upgrade monitoring and regulation enforcement. Many of the countries in the Near East already have environmental protection legislation, but few of them have effective enforcement mechanisms in places. As a result, industry and agriculture have been largely unmonitored. Missions can provide assistance in upgrading methods for effective water quality monitoring, assessing the causal relationships with sources of pollution in all sectors, and enhancing staff skills through training programs. In addition, Missions can make a significant contribution by introducing positive approaches, including pollution prevention policies and waste minimization techniques.

Introduce pollution prevention and waste minimization techniques. Pollution prevention and waste minimization techniques offer a broad range of economic benefits. U.S. experience indicates that one quarter to one half of the economic benefits of waste reduction projects are not related to regulatory compliance, but rather derive from the use of state-of-the-art technologies that increase competitiveness. Near Eastern countries can draw on this U.S. experience by introducing pollution prevention techniques, rather than by imposing heavy regulations on users.

Foster local capacity for water protection. Protecting the integrity of water resources is too important to be limited to either technical approaches or government regulations, enforcement, and incentives. While end users are among the most flagrant polluters of water, they are also among the most dependent on the maintenance of its quality. Community members require assistance and training to identify polluters and to monitor water quality using clear, defined standards.

Improve Water Management

The current situation of increasing water shortages and degraded water quality is exacerbated by poor management and severe budget constraints of existing water delivery and disposal systems. Poor maintenance of these

systems undermines the effectiveness of investments in such facilities and limits the benefits that can be derived from those investments. Both donors and cooperating countries are now shifting their financing from development of new systems to the management of existing systems. An option more frequently being considered is to privatize systems or involve the private sector in management.

Strengthen public sector services. Planning and research in water resources, historically a government responsibility, must be long-term, coordinated, and appropriate. Government agencies are best prepared to manage these responsibilities. The private sector is expected to become increasingly active in operating and maintaining existing projects as the public sector takes major responsibility for planning and research, investment in civil works, and resource stewardship.

Expand financial responsibility. Urban and irrigation water systems in the past have generally been provided and paid for by governments no longer able to bear this cost. Existing systems are deteriorating for lack of recurrent funds, and needed new systems and system expansions are not being built. Increasingly, urban water and sewer users are required to cover at least the costs of operations. Cost sharing for irrigation, where all the beneficiaries of these systems contribute to the costs, is an increasingly attractive alternative for some countries. Mobilization of user funds for new works requires determining users' willingness to pay, involving users in the planning process, and, in many cases, establishing local institutions for the creation of capital.

Transfer management responsibilities. Over the past two decades, A.I.D. has been the leading donor to conceptualize and support efforts to shift management responsibilities from government agencies to end users. This shift is one solution to an apparent inability of government entities to provide adequate operation and maintenance support to users. Two models most commonly offered are system turnover, the transfer of management responsibilities to users, and privatization, the transfer of the ownership of system assets to private sector users. Both can result in reduced government subsidies for irrigation and water supply, increased financial autonomy, and decentralized decision-making. Water users associations are a common mechanism for management transfer, but their performance has been largely disappointing to date. The approach requires further examination.

Encourage private sector services. Investment in water resources facilities traditionally has been a public sector responsibility. Because of limited resources for new public investments and inadequate public sector managerial capability, governments are re-examining their infrastructure investment strategies to explore the possibilities for private investment. Experience has shown that privatization supports improved water resources management and environmental protection. Models exist in other sectors for greater

private sector participation. Sharing information about such models and supporting cost recovery programs will encourage the private sector to provide operation and maintenance services.

Current Water Resources Activities

This section, which reviews Mission support in the water sector in cooperating countries, is based on Bureau and Mission program strategy documents and country program statements submitted to the Bureau in the past year.

Egypt

The Egypt Mission's strategy was set out in the May 1992 USAID/Egypt Program Statement. The Mission's water program falls under its own subgoals of increased economic growth and enhanced human resource productivity and quality of life. The relevant program outcomes are the following:

- improved market pricing and cost recovery in sectors/services of USAID emphasis
- power, telecommunications, and water provided to enable the growth of private industry and commerce in urban areas
- increased efficiency of land and water use for agriculture
- increased access to clean water and sewerage systems in urban areas
- increased number of water and wastewater facilities
- enhanced Government of Egypt (GOE) management capacity
- environmental policy and institutional reform
- reduced waste discharge to the Nile River system
- promotion of improved technologies for environmental protection

The Egypt Mission has major projects in water resources including irrigation management, water supply, and wastewater treatment. Over the past 14 years, USAID has provided nearly $2 billion for water supply and wastewater improvements, affecting the lives of roughly one out of every three Egyptians. Future assistance in these areas will place a greater emphasis on policy constraints and will be "... contingent upon the adoption of appropriate cost recovery, administrative and other arrangements to ensure maintenance and sustainability of investments." Furthermore, the Mission will provide the necessary technical assistance to enable the GOE to initiate or raise user charges in these sectors by the mid-1990s.

In irrigation management, the Mission intends to design a follow-on program to the current $340 million Irrigation Management Systems Project to "aug-

ment current progress" and focus on cost recovery. In the water utilities sector, USAID will shift its emphasis from water supply to wastewater treatment because of the greater need for donor assistance in this area. USAID plans to develop a new generation of wastewater activities and will consider supporting projects in Cairo and Alexandria.

The Mission's seventh strategic objective is enhanced protection of Egypt's fresh water and air resources. The Mission's environmental efforts are largely subsumed within activities that are primarily focused on other strategic objectives. The Mission has been reluctant to initiate a major project in the environment until the GOE makes major changes in the legislation and improves administrative support for environmental regulations.

The Egypt Mission's program in water resources is a major contributor to Bureau program outcomes 5.1 and 5.3, improved public management of water resources and increased wastewater treatment.

Jordan

The Jordan Mission's strategy is set out in the July 1992 USAID/Jordan Country Program Statement. The program goal of broad-based sustainable economic growth is supported by three strategic objectives, one of which is more efficient management of water resources. Water is clearly one of the most valuable resources of Jordan (water consumption currently exceeds sustainable supplies due to overpumping of aquifers), yet water is seriously underpriced. The Mission's program outcomes include activities to increase water conservation, support improved on-farm and industrial water practices, increase wastewater treatment capacity to enable water reuse, and establish cost recovery principles.

The Mission's major project in this sector is the $25 million Water Quality Improvement and Conservation Project, which began in early FY93. The project will assist in establishing a policy and planning unit, improve water monitoring, support public awareness of conservation, upgrade wastewater treatment, improve irrigation efficiency, and reduce industrial pollution through prevention and control.

The Jordan Mission's program in water resources contributes to Bureau program outcomes 5.1 through 5.4. The program represents a comprehensive approach and should be fully supported by the Bureau.

Morocco

The Mission's program strategy was established by the December 1991 Morocco Action Plan for FY92-FY95. Recently a country program review that updates and replaces the action plan was prepared.

Morocco's major activity in the water sector is the $18.75 million Tadla Resource Management Project, which was obligated in August 1992. The purpose of this project is to increase the efficiency, economic yield, and environmental sustainability of irrigation resources management and use in the Tadla irrigation perimeter. The project consists of four components: improved irrigation system management, improved on-farm management, sustainable environmental management, and private sector strengthening. The Tadla Resource Management Project is treated as a target of opportunity in the country program review.

Other Mission activity in the water sector falls under the fourth strategic objective, which is increased availability of affordable housing and services for low-income urban families. One of the program outcomes is increased provision of infrastructure and services, including connection of more low-income households to potable water and sewerage lines.

The Morocco Mission's program in water resources contributes primarily to Bureau program outcomes 5.1 and 5.2 on improved public management of water resources and increased public participation in water resource programs.

Oman

In the Approved Program Strategy for the Omani-American Joint Commission 1992-1997, the goal of increasing the productivity of the Omani economy is supported by three strategic objectives. One is to improve the management and conservation of renewable natural resources. The $62.5 million Water Resource Development Project, which has been extended to September 1996, supports improved water use efficiency through preparation of master plans for water supply from groundwater and desalinization sources and wastewater treatment, construction of water supply infrastructure and wastewater stabilization ponds, and training of Omani staff.

The program strategy identifies two follow-on projects in the water resource sector: $15 million Natural Resources Management Project and $25 million Capital Development of Water/Wastewater Systems and Harbors Project. Since the structure of the Oman program is currently under review, the form of the future program is uncertain. The Oman program in water resources contributes to Bureau program outcomes 5.1 and 5.3.

Tunisia

With reductions in staffing from 13 in FY91 to 6 in FY93 and in funding, the Mission reduced its involvement in a number of sectors including potable water. The FY94 annual budget submission (ABS) identifies one major strategic objective—support to the development of the Tunisian private

sector. The FY94 ABS also includes a new project narrative for one project, Private Sector Initiatives in Municipal Development, with $3 million from the Economic Support Fund (ESF) and $50 million in housing guarantees. The ESF grant will focus on policy and institutional reforms necessary to improve shelter and urban infrastructure. Water supply and wastewater infrastructure needs presumably would be included in this program.

West Bank/Gaza

The November 1992 document, USAID Program Strategy for the West Bank and Gaza Strip, identifies a program goal of improved economic and social well-being. The goal supports the strategic objectives of increased marketed production of agricultural and manufactured goods, improved health care, and improved planning and management. Access to water is an especially sensitive issue in the territories because of severe water scarcity in the area and restrictions placed by the Israeli civil administration.

The strategy identifies two potential activities dealing with water. The first is improved agricultural research and technology transfer geared at development, production, handling, marketing, and transport of crops with high export value but low water usage. Preliminary figures allocate $9 million to this activity over the five-year period. The second activity is improved water supply leading to a reduction of water-borne diseases. This activity may involve small-scale village-level potable water systems and/or larger scale municipal-based sewerage systems for Gaza. The total preliminary budget for these two activities is $12 million over a five-year period.

Yemen

The program strategy for Yemen is stated in the May 1992 Management Implementation Plan. State Department policy currently restricts the Yemen program to humanitarian and human resource development activities. Although there is little scope for USAID-funded water resources activities at the current time, improved water management and protection of the country's groundwater resources are critical to the Mission's program goal of improving the quality of life of Yemenis. As stated in the program strategy, there is a rising expectation among the Yemenis for the government to deliver a higher level of services and economic opportunities to a greater segment of the population.

Near East Bureau

The Near East Bureau currently manages and participates in various activities that contribute to the five program outcomes.

The Irrigation Support Project for Asia and the Near East (ISPAN) is a water resources and water policy project jointly funded with the Asia Bureau. It conducts special studies, project designs, and evaluations and provides technical assistance to both Bureaus.

The Project in Development and the Environment (PRIDE) is managed by the Near East Bureau and supports Mission environmental activities. It promotes an agenda of strategic planning, policy analysis, private sector involvement, and public awareness/environmental education.

The Middle East Regional Cooperation Program (MERC) funds various research activities. The primary activity involving water is a grant to the University of Michigan and Israeli and Egyptian research organizations involving wastewater reuse for irrigation.

Since September 1992, Near East Bureau staff members have participated in the Middle East Peace Talks as members of the U.S. delegation for the Multilateral Working Group on Water Resources and the Multilateral Working Group on Environment. As part of this process, A.I.D. has provided technical expertise; contributed to planning, workshops, and special presentations for regional delegates; and conducted studies contributing to the peace effort. Bureau management has established an ESF account to provide formal support for these activities.

The Bureau activities in water resources support the five program outcomes (Figure 1) related to the Bureau's strategic objective on water. ISPAN special studies (e.g., an applied study dealing with environmental sustainability of water resources development and management) contribute to program outcome 5.1, work by PRIDE contributes to 5.2 and 5.4 (pollution prevention and waste minimization is a particular emphasis of PRIDE's private sector work), the MERC wastewater research contributes to 5.3, and the work with the Middle East Peace Talks contributes to 5.5.

Table 2 provides a summary of Mission and Bureau activities that support strategic objective 5. The identified approaches and their relationship to the Bureau's program outcomes and current Country/Bureau program areas are shown in Table 3. For example, the approach of "revise water pricing" is related to program outcome 5.1 and related program activities are underway in Egypt and Jordan. The lack of programs in certain areas may indicate gaps or opportunities worth considering in future country-specific analyses.

Opportunities for Future Programs

The Bureau and Missions tend to work most intensely on project activities involving technology transfer and education. Relatively few programs concentrate on policy, improved financial performance, fostering local capacity, and turnover and privatization. However, a review of program strategies found

Table 2

Contributions to Bureau Strategic Objective 5: More Efficient Use, Conservation and Protection of Water Resources

Country	5.1 Improved Management	5.2 Increased Public Participation in Water Resource Management	5.3 Increased Wastewater Treatment and Reuse	5.4 Increased Use of Pollution Prevention	5.5 Greater Inter-country Discussion
Egypt	1, 4		1, 4		
Israel					
Jordan	2	2	2	2	
Lebanon					
Morocco	2	2			
Oman	1, 4		1, 4		
Tunisia	4		4		
West Bank/Gaza					
Yemen					
Bureau	1	1	1	1	3

Key: 1 - Ongoing project
2 - Newly obligated project
3 - Policy dialogue, studies
4 - Potential project identified in program strategy or ABS

Table 3

Near East Water Resources Action Plan: Approaches, Actions, and Related Bureau Program Outcomes

Approaches	Representative Actions	Related Bureau Program Outcome	Country/Bureau Program
Reallocate water resources	Introduce comprehensive resource planning	5.1	Oman, Bureau
	Improve analytical techniques	5.1	Jordan
	Review water rights	5.1	Bureau
	Conduct discourse with users	5.1, 5.2	—
Manage demand	Revise water pricing	5.1	Egypt, Jordan
	Introduce fiscal incentives	5.1	—
	Encourage water sales between sectors	5.1	—
	Regulate and restrict use	5.1	—
	Institute educational programs	5.1, 5.2	Morocco, Jordan, Bureau
Conserve water	Introduce water conservation technologies	5.2, 5.3	Morocco, Jordan, Oman
Improve technology	Identify magnitude of water shortages and low-quality sources	5.1	Morocco, Jordan
	Determine and assess alternative interventions	5.1	Oman, Egypt, Morocco, Jordan, Bureau
	Introduce and expand use of technologies for agriculture and water supply and sanitation	5.1, 5.3	Oman, Egypt, Morocco, Jordan, Bureau
Resolve transboundary disputes	Examine allocation issues	5.5	—
	Conduct studies and policy analysis to support negotiations	5.5	Bureau

Approaches	Actions	Related Bureau Program Outcome	Country/Bureau Program
Upgrade monitoring and regulation enforcement	Assess agency responsibilities for monitoring	5.1	Morocco, Jordan
	Review and adjust penalty system	5.1	—
	Introduce pollution prevention policies	5.4	Jordan, Bureau
	Support waste minimization techniques	5.4	Jordan, Bureau
Introduce pollution prevention techniques	Institute policies to support pollution prevention	5.4	—
	Determine and facilitate necessary technological changes	5.4	Jordan, Bureau
	Support training and management requirements	5.4	Jordan, Bureau
Foster local capacity for water protection	Initiate policies to extend "stewardship" of water resources to end users	5.1, 5.2	—
	Develop mechanisms for setting levels of pollutants and reporting illegal emissions	5.1	—
Strengthen public sector services	Incorporate environmental concerns into operations	5.1	Morocco
	Establish financial instruments to encourage adoption of improved technologies and management techniques	5.1	—
Expand financial responsibility	Determine costs of water systems	5.1	Egypt
	Identify system beneficiaries and allocate benefits among users	5.1	Morocco
	Identify appropriate assessment and billing mechanisms	5.1	—
	Develop necessary policy instruments and legislation	5.1	Bureau
	Determine appropriate types of tariff structures or charging mechanisms and develop pilot programs	5.1	—

Approaches	Representative Actions	Related Bureau Program Outcome	Country/Bureau Program
Divest management responsibilities	Determine appropriate public and private sector management roles	5.1	Morocco
	Institute and expand participatory programs for end users	5.1, 5.1	Morocco
	Institute divestment programs for turnover and privatization	—	—
	Develop necessary policy instruments and legislation	5.1	—
Encourage private sector services	Review and adjust subsidies for water services	5.1	—

Key: Program Outcomes

5.1 Improved public management, including appropriate policies
5.2 Increased public participation in water resource management programs
5.3 Increased wastewater treatment and water reuse by public and private sectors
5.4 Increased use of pollution prevention and waste minimization techniques by public and private industry
5.5 Greater intercountry discussion of joint approaches to water resources management

that Missions are placing greater emphasis on the policy change than would be inferred from the table, and there is a clear trend toward involvement in policy-related work.

There are many opportunities for Missions to expand work in areas listed in Table 3. In particular, the Bureau will support as long-term objectives Mission efforts in the following broad areas:

- manage demand to cover economic and financial costs and to allocate water to reflect its real value to society
- strengthen legal systems and upgrade monitoring and enforcement of regulations
- introduce and implement pollution prevention techniques
- divest management responsibilities through expanded and strengthened water user organizations
- conflict resolution and long-term peace in the region

The Strategic Agenda

Over the next three years, the Bureau with the support of field Missions will promote sustainable development of the region's water resources with concentration on more efficient use of water and improved water quality. Improved management is viewed as a contributing factor to efficiency and quality objectives. In terms of the five program outcomes that support strategic objectives, the action plan is as follows:

Improved public management, including appropriate policies (5.1). The Bureau will continue to support Mission efforts to develop and implement projects directly supporting improved water use efficiency and elimination of subsidies of low-valued irrigated crops and underpricing of water. The Bureau will continue to encourage Missions to work at the national policy level, although site-specific activities may be required to demonstrate policy change. The Bureau will encourage Missions to support cooperating country government efforts to reform and strengthen those policies that lead to more efficient allocations of natural resources, particularly water. The Bureau will consider a centrally funded follow-on to ISPAN to address these issues from a regional perspective.

Increased public participation in water resource management programs (5.2). The Bureau will support work by PRIDE to promote conservation of water and other natural resources through mass media and other means. The Bureau will support efforts, particularly of the Egypt Mission, to strengthen water users associations in irrigated areas.

Increased wastewater treatment and water reuse by public and private sectors (5.3). The Bureau will support Mission efforts to fund capital projects in this area, particularly in Egypt under ESF funding, providing these projects have substantive policy components. The Bureau will encourage Missions to address concerns involving operations and maintenance in such projects, including plans for funding recurrent costs. The Bureau will encourage the Egypt Mission to incorporate results of the MERC-funded wastewater activity in the Mission's wastewater program.

Increased use of pollution prevention techniques by public and private industry (5.4). The Bureau and Missions will support pollution prevention and waste minimization techniques through a variety of means. PRIDE will support various centrally funded activities, and several Missions are expected to support pollution prevention activities through existing project mechanisms and through the establishment of pollution prevention programs, which will promote these techniques using U.S. technology and equipment. Bureau funds will support these centers through an initial obligation in FY93.

Greater intercountry discussion of joint approaches to water resources management (5.5). The Bureau will continue to support the U.S. delegation to the Middle East Peace Talks and will work to establish a source of funding for studies and other costs associated with the talks. If the talks result in actions to resolve or partially resolve long-standing water disputes, the Bureau would be involved in decisions to fund capital costs of the construction of a major project or projects involving one or more of the regional countries. Obviously there would be pressure to "fast track" such projects, and if A.I.D. funds were involved there would be substantial involvement by the Missions involved, particularly Jordan. If the talks result in some form of self-government for Gaza and the West Bank, the Bureau may expand A.I.D.'s portfolio in the West Bank and Gaza to include projects to support the establishment of, for example, a local water authority.

Analytic Agenda

To support the foregoing activities, the Bureau will develop and carry out an analytic agenda. The analytic agenda is intended to further knowledge in specific policy areas related to the strategic agenda and assist policy-makers in improving management of water resources in the region. The agenda will consist of a series of studies funded from Project Development and Support, ISPAN, PRIDE, and Research and Development Bureau (R&D) sources, as appropriate. Funding in cooperation with other Bureaus and Missions will also be pursued.

Studies will cover a range of topics and will likely include:

- a study of sustainability of water resource development
- a review of the performance of participatory efforts involving water user organizations
- an analysis of water rights in the region
- analysis of policy options
- a modeling study of projected water use and reuse

Additionally, the Bureau will continue to support such Agency-wide concerns as funding constraints, earmarks, staffing, ESF/Development Assistance, pipeline concerns, Gray Amendment compliance, buying from American sources, and jobs legislation.

BACKGROUND, ISSUES, AND OPTIONS

In the Near East, a vast arid expanse where three continents meet and three great religions arose, water has always been a metaphor for life:

For in the wilderness shall waters break out, and streams in the desert. And the parched ground shall become a pool, and the thirsty land springs of water: in the habitation of dragons, where each lay, shall be grass with reeds and rushes.

Isaiah 36.6-7

Then he showed me the river of the water of life, bright as crystal, flowing from the throne of God and of the Lamb through the middle of the street of the city; also, on either side of the river, the tree of life with its twelve kinds of fruit, yielding its fruit each month; and the leaves of the tree were for the healing of the nations.

Revelation 22.1-2

And We send down water from the sky according to due measure, and We cause it to soak in the soil; and We certainly are able to drain it off with ease. With it we grow for you gardens of date-palms and vines: in them have ye abundant fruits: and of them ye eat and have enjoyment.

The Holy Quran, Sura XXIII 18-19

BACKGROUND: WATER RESOURCES IN THE NEAR EAST

1

The Problem of Shortages

The Near East is one of the world's most extensive arid regions. Almost three-quarters of the land from Morocco through Iraq is desert, lacking in sufficient water resources and adequate soils to support a settled population. Settlement is concentrated along the few major rivers where there are arable soils and in the coastal zone, which is generally better watered than the desert interior. The proportion of desert, pasture, and cultivated land varies from country to country (Figure 2). Most of the countries have vast stretches of desert, but several also have extensive pasture lands and forests (Table 4 and Figure 3).

Rainfall varies considerably across the region, both seasonally and annually. The range of rainfall is well below 100 mm in the North African and Arabian deserts to more than 1,500 mm along the Atlas Mountain ranges of Morocco and Algeria (Blake et al. 1987). Flash floods are common even in areas where average rainfall is low. Rainfed agriculture is widespread, but the yields are variable. Usually some of the cropland is left fallow each year. It is used for grazing, along with any unharvested cropland, and returned to cultivation in subsequent years. Crops fail regularly, as much as one year in three depend-

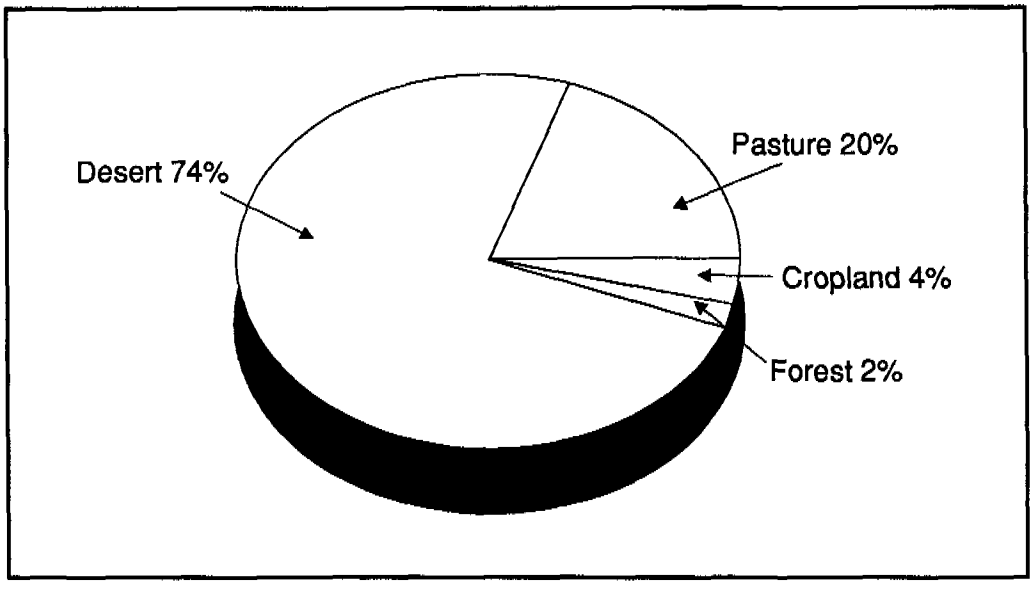


Figure 2

Land Use in the Near East

Table 4

Land Use in Countries in the Near East (percent)

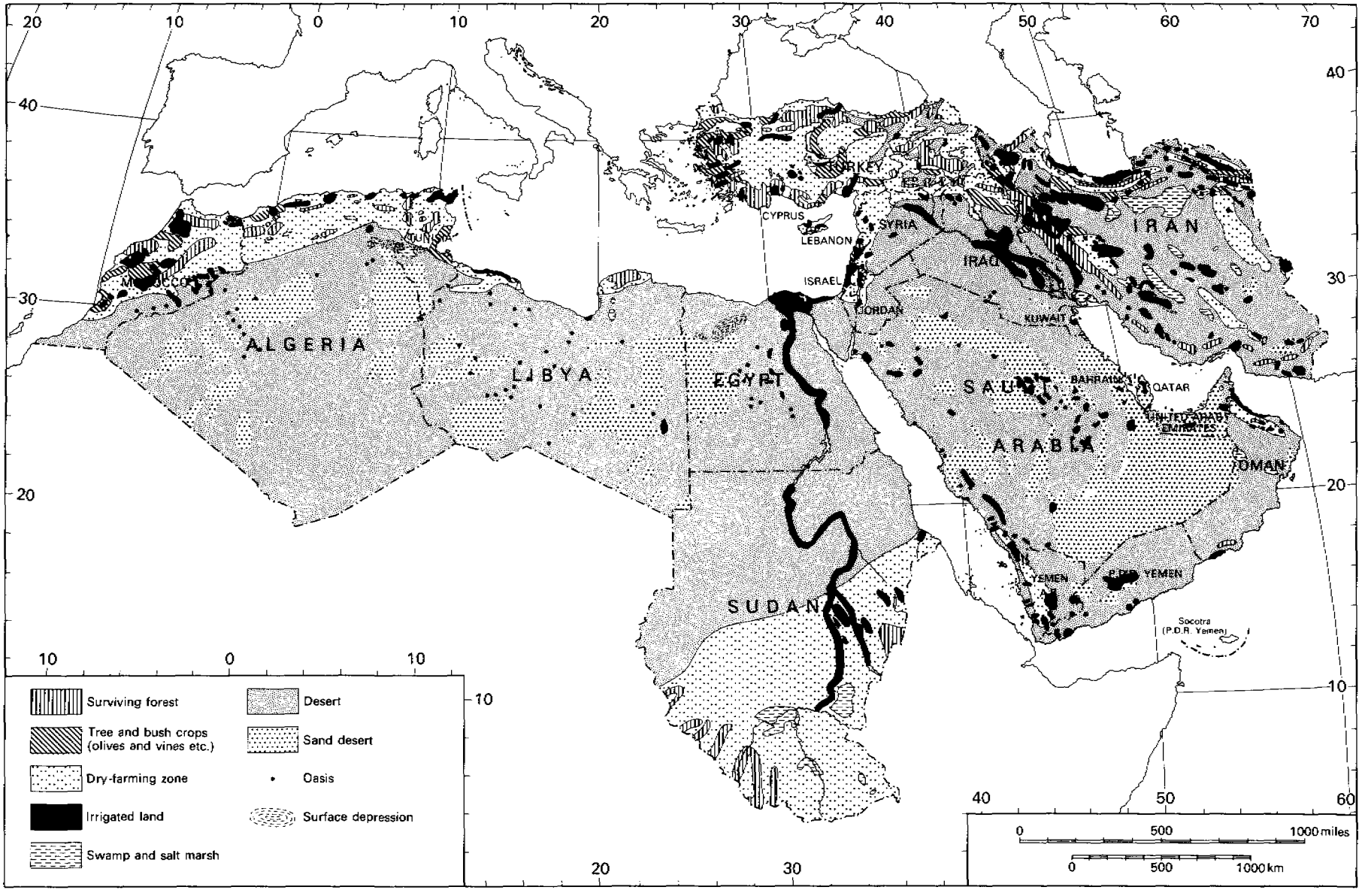
Country	Cropland	Pasture	Forest	Desert
Morocco	20.0	47.0	18.0	15.0
Algeria	3.0	13.0	2.0	82.0
Tunisia	30.0	19.0	4.0	47.0
Libya	1.0	7.6	0.4	91.0
Egypt	2.6	0.0	<0.1	97.4
Lebanon	29.0	1.0	8.0	62.0
Israel	21.0	7.0	6.0	66.0
Jordan	4.0	9.0	1.0	86.0
Syria	30.0	45.0	3.0	22.0
Iraq	13.0	9.0	4.0	74.0
Saudi Arabia	0.6	39.5	0.6	59.3
Yemen	3.0	30.0	6.0	61.0
Oman	0.2	4.7	0.0	95.1

Source: World Resources Institute 1992a

ing on local rainfall. Regular annual harvests are limited to a relatively small percentage of the land area where rainfall is plentiful or where rainfall runoff concentrates. In general, rainfall is scarce and unreliable; water is a major constraint to development in the region.

Surface Water Resources

The Near East has a variety of surface water resources. Natural springs supply the region's oases, where the supply of water is limited but less subject to seasonal and interannual variation. Irrigation is practiced along the rivers, in the scattered oases, and on the terraced mountainsides of Morocco, Lebanon, and Yemen. Seasonal watercourses, or wadis, concentrate runoff from small and medium watersheds and may discharge tens or even hundreds of cubic meters per second. Although these floods last for only a few hours, their effects can be destructive. Some of the runoff is diverted and used in spate irrigation, stored in cisterns or in small surface reservoirs, or captured to recharge the aquifer. Much of the surface water is seasonal flow, copious



Source: Blake et al. 1987

Figure 3

Landscapes in the Near East

Table 5

Perennial Rivers in the Near East

River	Catchment Area (000 km^2)	Length of Main (km)	Average Flow (bcm)	Riparian Countries
Nile	2900	4800	85.5	Uganda, Egypt, Ethiopia, Sudan
Tigris	258	1718	48.7	Turkey, Iraq, Syria
Euphrates	444	2330	29.0	Turkey, Iraq, Syria
Jordan	18	360	1.8	Syria, Jordan, Israel
Orontes	17	511	1.1	Lebanon, Syria
Litani	2	145	0.9	Lebanon
Sebou	-	500	1.2	Morocco
Om Er Rbia	-	600	1.3	Morocco
Medjerda	23	380	1.0	Tunisia, Algeria

Source: Shahin 1989, U.S. Army Corps of Engineers 1991

during the winter rainy season and negligible in the late spring and summer after the rains cease.

There are a number of important perennial rivers in the Near East (Table 5). Some arise within the region, like the Medjerda and the Sebou, which drain the Atlas Mountains in North Africa, and the Jordan, Yarmouk, Orontes, and Litani in the central Middle East. The major rivers, however, arise in wetter mountainous areas outside the region: the Nile in equatorial Africa and the Tigris and Euphrates in Turkey. Only the Tigris-Euphrates has a significant water surplus, but here, as elsewhere, its quality declines downstream because of urban and industrial effluent, back drainage from irrigation projects, and high evaporation rates that concentrate the salts. Irrigation is expanding in upstream areas, and new dams in Syria and Turkey affect both water quality and quantity on the lower Euphrates. If Turkey uses all the water in its plan, the flow to Syria will be reduced by 40 percent, and if both Turkey and Syria take all they claim to need, Iraq will receive only one-eighth of its current level (Naff 1989).

With few exceptions, river basins in the Near East are shared by two or more countries. The Nile alone has nine riparian states. Long-term political turmoil in Ethiopia and the Sudan limited water development in these upstream

states. Only Egypt has had the political stability, the population, and the organization to develop and use the Nile waters, but its downstream position makes it vulnerable to future development schemes in the other riparian states. To mitigate its vulnerability somewhat, Egypt signed a treaty with Sudan in 1959 to share the water of the Nile. Of the 286 international water treaties worldwide, this agreement is the only one in effect in the Near East (U.S. Army Corps of Engineers 1991).

Jordan and Syria have a less formal agreement for the Yarmouk, but the World Bank has refused to fund the construction of the Unity Dam until an agreement is reached with Israel, the lower riparian, assuring it a share of the water. Most riparians on the region's international rivers have longstanding quarrels over allocations and no clear institutionalized means of resolving their differences. The Jordan basin is small, but there are five riparians: Jordan, Israel, the West Bank, Syria, and Lebanon. All are acutely aware of water shortages and the need to negotiate equitable water sharing agreements in order to avoid the consequences of conflict.

Groundwater Resources

Aquifers both deep and shallow exist throughout the region. The most extensive are the Nubian Sandstone aquifer shared by Libya, Egypt, Sudan, and Chad; the Northern Sahara basin shared by Algeria, Tunisia, and Libya; and the vast aquifers of eastern Arabia, shared by Saudi Arabia and Bahrain. Figure 4 compares annual surface water flows with the annual volume of available groundwater in each Near Eastern country.

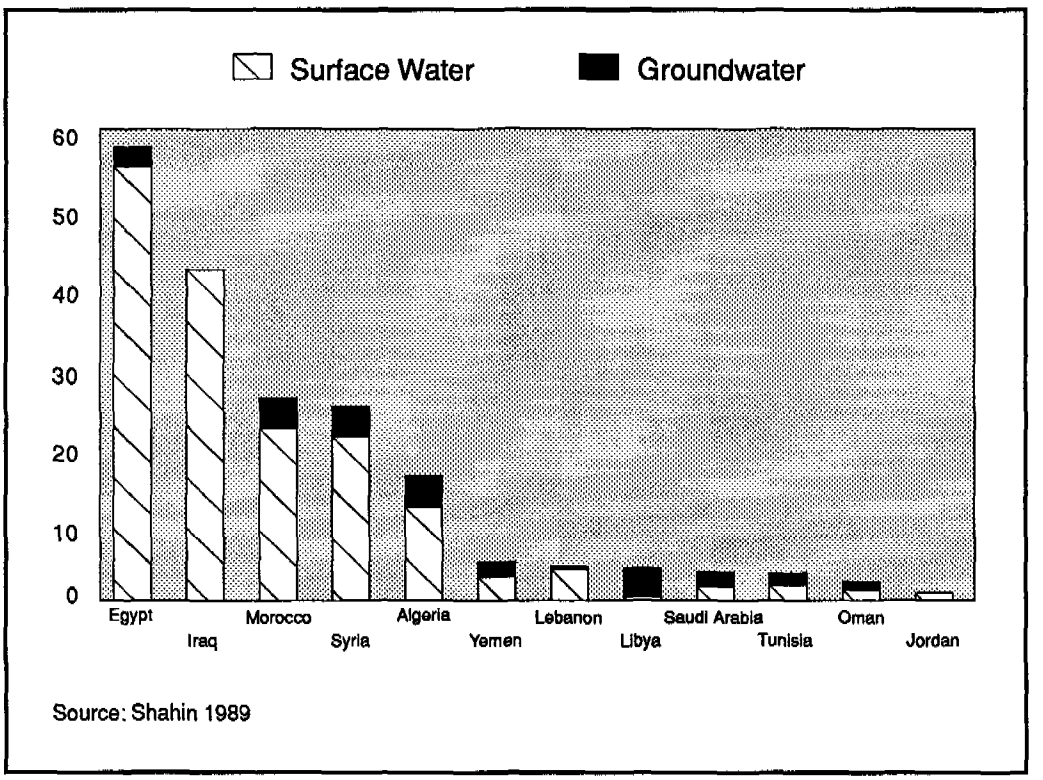
Aquifer recharge is the most serious groundwater problem. Overpumping and exploitation of shallow aquifers, particularly near the coast, can lead to salt water intrusion and aquifer degradation. In the Nile delta, groundwater problems are exacerbated by reduced water levels in the river, which prevent normal discharge. As a result, salt water intrusion has now reached as far as 20 kilometers inland. In Kufrah in Libya and the New Valley in Egypt, nonrenewable groundwater resources are already being exploited. A restriction on well drilling in Yemen's Sanaa basin is not enforced. Some 25,000 wells are overpumping the aquifers, causing an annual decline in water levels of one to seven meters. Saudi Arabia and other states have developed irrigated agriculture by mining groundwater.

The deep fossil water aquifers have a different set of problems since they are nonrenewable resources. Libya has invested $18 billion in the Great Man-Made River Project to pipe prehistoric rainfall deposits under the Sahara for irrigation and municipal water supply along the Mediterranean coast. It is only a medium-term, unsustainable solution since the source is a finite, nonrechargeable water supply. Water from deep aquifers frequently has a

high concentration of total dissolved solids and requires blending with higher-quality water in order to be used for irrigation.

Many important aquifers cross international boundaries (Table 6). Disputes have arisen over the use of the West Bank's limestone aquifers, which provide water for a large proportion of the Israeli population. Restrictions on pumping are strictly enforced in this area. The water table in the United Arab Emirates is being drawn down by the pumping of high-yielding aquifers in Oman. Saudi Arabia withdraws water that would otherwise flow to Bahrain.

Legislation restricting groundwater extraction has been enacted in every country in the region, but institutions to enforce the provisions are not adequately developed. In Syria and Tunisia, because of the diversion of freshwater supplies to urban and industrial users, farmers are drilling for alternative sources and are overpumping, despite restrictive legislation. Historically, custom protected aquifers in most countries in the region from overexploitation. The traditional prohibition on well digging in the vicinity of an existing well was intended to protect both the water supply and capital



Source: Shahin 1989

Figure 4

Surface and Groundwater Resources in the Near East

Table 6

International Water Disputes in the Near East

Water Body	Countries in Dispute	Issues
Nile*	Egypt, Ethiopia, Sudan	siltation, flooding, water flow/diversion
Euphrates, Tigris*	Iraq, Syria, Turkey	reduced water flow, salination
Jordan, Yarmouk, Litani, West Bank aquifer*	Israel, Jordan, Lebanon	water flow/diversion
Desi aquifer	Jordan, Saudi Arabia	shared aquifer, lack of groundwater management program

*Source: Renner 1989

investment. Powerful pumps enable landowners to draw water from beyond the confines of their property and deplete the aquifer they share with other users. When traditional patterns of behavior prove incapable of adjusting to technological changes, the nation state often intervenes to address the problem. In Jordan, for example, where water shortages are acute, pumps must be registered and are limited by size.

Addressing Water Shortages

Scant rainfall and extensive deserts attest to the limited availability of water relative to land area in the Near East. Existing water supplies are also in short supply when measured against population; in fact, present water shortages could easily reach crisis proportions in the near future since the Near East has one of the highest population growth rates in the world. With an average annual growth rate of 3.6 percent, the population of the Near East is projected to more than double between 1980 and 2000 (Blake et al. 1987). The demand for water is also growing. Between 1985 and 2000, demand for water will more than double in Jordan and Oman; in Morocco, Tunisia, Egypt, Jordan, and Yemen, demand will increase by half (Shahin 1989).

Water resources have only a limited capacity for matching the burgeoning population growth. Storm water runoff can be captured and stored for a short-term net gain, as can redirecting and damming surface water and reusing or reallocating water supplies to more critical or higher value uses. Exploiting groundwater reserves, however, consumes a nonreplaceable

resource, and currently available desalinization technology is prohibitively expensive for all but the wealthiest states in the region. Nevertheless, some states are already using desalinization technology non-cost-effectively for purposes that do not require such high-quality water.

None of these measures will adequately expand the resource base enough to meet expected demand. Given the unlikelihood of dramatically expanding resources in the Near East, there are primarily six ways to address the water shortage problem:

- interbasin transfer
- reallocation
- water conservation
- wastewater reuse
- institutional innovations
- technological breakthroughs

Interbasin transfer and reallocation. There have been many proposals for national and international transfers of water to designated areas throughout the Near East. Such transfers would increase local supplies and reduce shortages in specific areas; they do not create new sources of water or increase the supply of water available to the region. Large-scale projects under construction or being discussed would lead to major water distribution changes in the region as noted in the following examples:

- Libya is completing a pipeline to transport groundwater from the Sahara Desert to the Mediterranean coast.
- Egypt has plans to construct the El Salam Canal to carry excess water from lakes in the delta to northern Sinai. The project would irrigate nearly 250,000 hectares of reclaimed land.
- Israel is considering floating 400 million cubic meters of water from Turkey annually in huge "Medusa" bags of woven nylon fabric.
- Turkey has proposed building a $21 billion network of peace pipelines to carry water through Syria to the West Bank, Jordan, Saudi Arabia, and the Gulf states, although downstream users are reluctant to depend upon other states for their water supplies.

The reallocation of existing water resources among economic sectors is one way of addressing shortages created by population growth and changing demands. Presently, irrigated agriculture accounts for the better part of the water consumption in the Near East. Rapid urban growth is placing new demands on local water resources for potable water and sanitation. Industrial

growth will eventually require an adequate water supply although current use is still low.

Water conservation and wastewater reuse. Water conservation still receives scant attention in the Near East even though drip and sprinkler irrigation technologies do exist throughout the region. Drainage water may be recycled within the irrigation system, but there are dangers from the concentration of salts and agrochemicals. Wastewater reuse is one promising approach that requires greater policy support; however, it does present health and environmental hazards, particularly when domestic sewage containing pathogens is mixed with industrial waste rich in chemicals and heavy metals. Despite these concerns, wastewater reuse is now practiced by nearly all the countries in the region, as summarized below:

- Morocco is experimenting with fish farming for wastewater purification.
- By the year 2005, the source of 30 percent of all irrigation water in the Jordan Valley will be treated wastewater from Amman.
- Tunisia is expected to irrigate 6,000 hectares with wastewater in the near future, rising to 20,000 hectares by the year 2000.
- Saudi Arabia and other Gulf states are now using treated wastewater exclusively for irrigation.

Institutional innovations and technological breakthroughs. Governments in the region must experiment with policy and institutional options to improve the management of their limited water resources. Morocco has recently adopted a policy of disengagement from its large-scale irrigation projects. Management responsibility has been shifted from close governmental control to the private sector. Tunisia is actively supporting the formation of water users associations for water supply, and Egypt is creating similar associations for irrigation systems.

All three countries are also developing programs to recover costs for operation and maintenance in order to reduce the government's financial burden and encourage user participation. Integrated planning of water resources remains an issue because responsibility is often divided among a number of ministries and line agencies that compete for resources and authority. Algeria and Libya, however, have made good progress by establishing water authorities that can plan and coordinate supply and use. Jordan has recently established the Ministry of Water and Irrigation, which has absorbed the Water Authority of Jordan and the Jordan Valley Authority in order to coordinate their efforts, thus illustrating the importance of institutional reforms to effect public policy.

Technological breakthroughs may increase water supply in the future. Experiments include seeding clouds in Morocco, towing icebergs from Antarctica to the Gulf, and capturing dew condensation from olive trees in Oman. These

efforts are promising, but none is yet either economically viable or practical on a large scale.

Desalinization of seawater could be expanded if its cost can be reduced. At current cost levels, only Saudi Arabia and the Gulf states can afford to expand their water supply by developing seawater desalinization. Saudi Arabia, Kuwait, and the United Arab Emirates account for 48 percent of the total global capacity (World Resources Institute 1992b). Roughly 20 percent of the water now used in Saudi Arabia is desalinized seawater, making waste disposal an increasing problem. Some Israeli and Jordanian scientists have proposed constructing a canal to carry Mediterranean water inland to desalinization plants, but cost remains a serious constraint.

A.I.D. Investments in the Near East

From 1975 to 1992, A.I.D. committed approximately $3.6 billion to water sector projects in the Near East. During this period, more than three-quarters of that amount was invested in water supply and wastewater treatment (Figure 5). Irrigation development projects received 16 percent of the total, and the remainder was used for groundwater development, aquaculture, planning, and research.

Within the region, Egypt has clearly received the most support for water

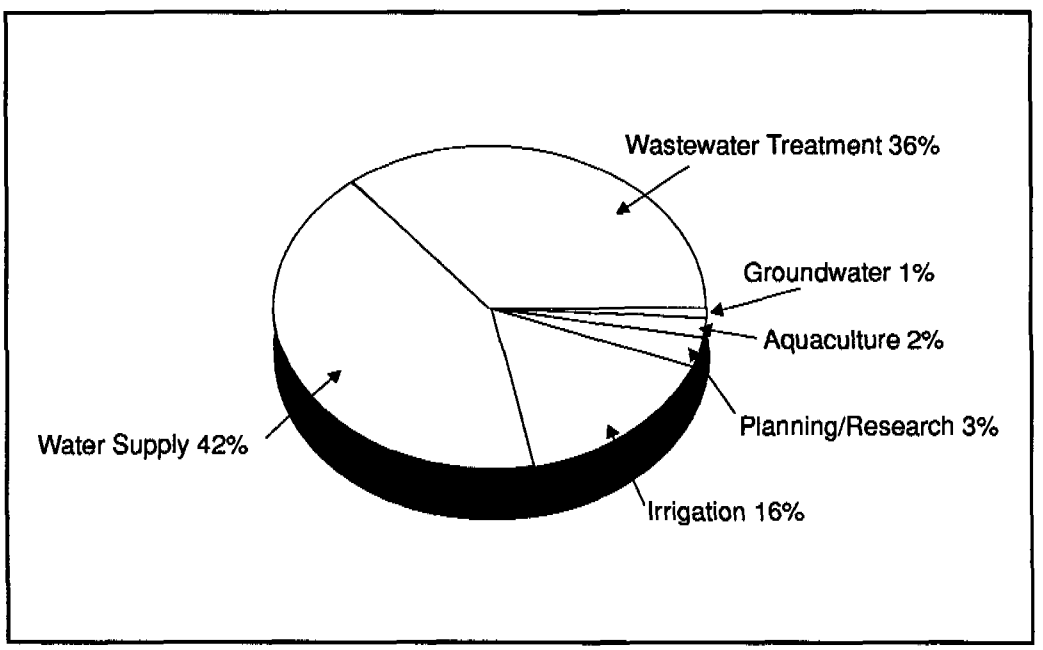


Figure 5

A.I.D. Water Resources Investments in the Near East by Program 1975-1992

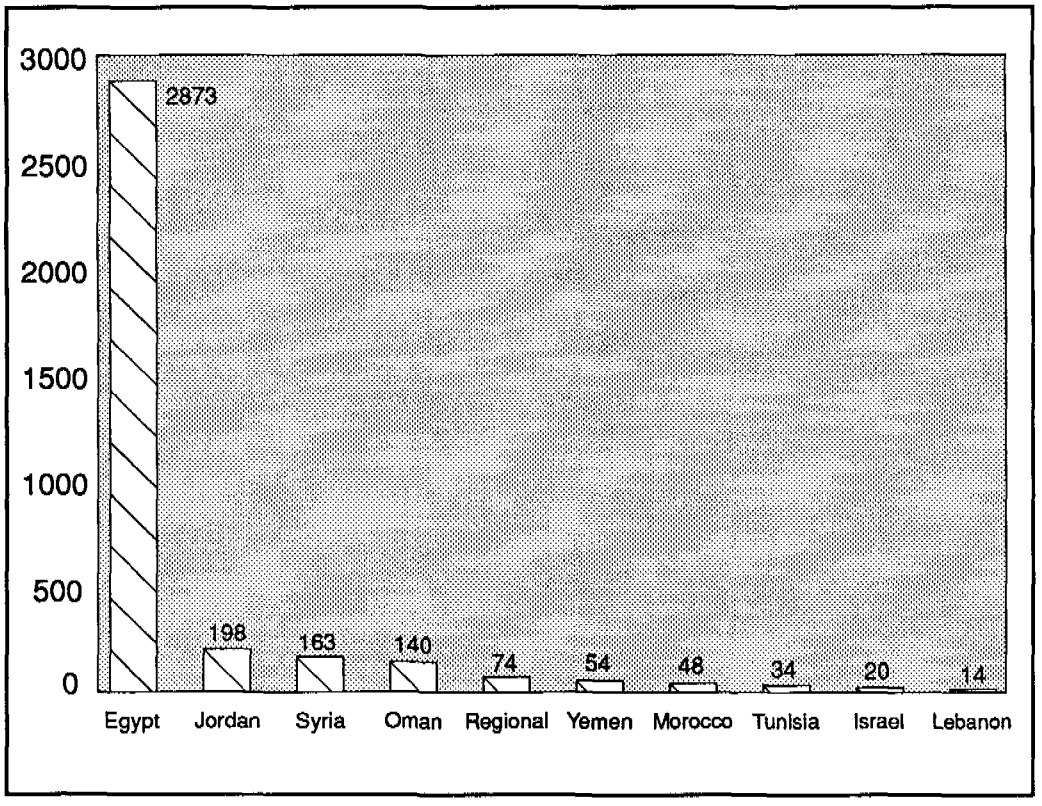


Figure 6

A.I.D. Water Resources Investments in the Near East
1975-1992
(millions of dollars)

resources, more than three-quarters of the total since 1975. The combined funding for Jordan, Syria, Oman, and regional programs amounted to some 14 percent, with remaining countries receiving the smallest amounts (Figure 6).

Despite significant allocations by A.I.D. to the water sector over the past fifteen years, an overall pattern of shrinking investment, particularly in assistance for irrigation, clearly exists. This pattern for the Agency sets the trend for other donors in the Near East, South Asia, and Southeast Asia, including the World Bank, the Asian Development Bank, and the Japanese Overseas Economic Cooperation Fund (Rosegrant and Svendsen 1992). In irrigation alone, there has been a clear, gradual decrease in grants and loans from the donors between 1969 and 1987 (Figure 7). International Bank for Reconstruction and Development funding in irrigation, approximately ten times that of A.I.D., was cut by 50 percent in the decade from 1977-79 to 1986-87. A.I.D.'s funding levels also fell consistently from $93 million in 1980-82 to $83 million in 1983-85, and to $75 million in 1986-87.

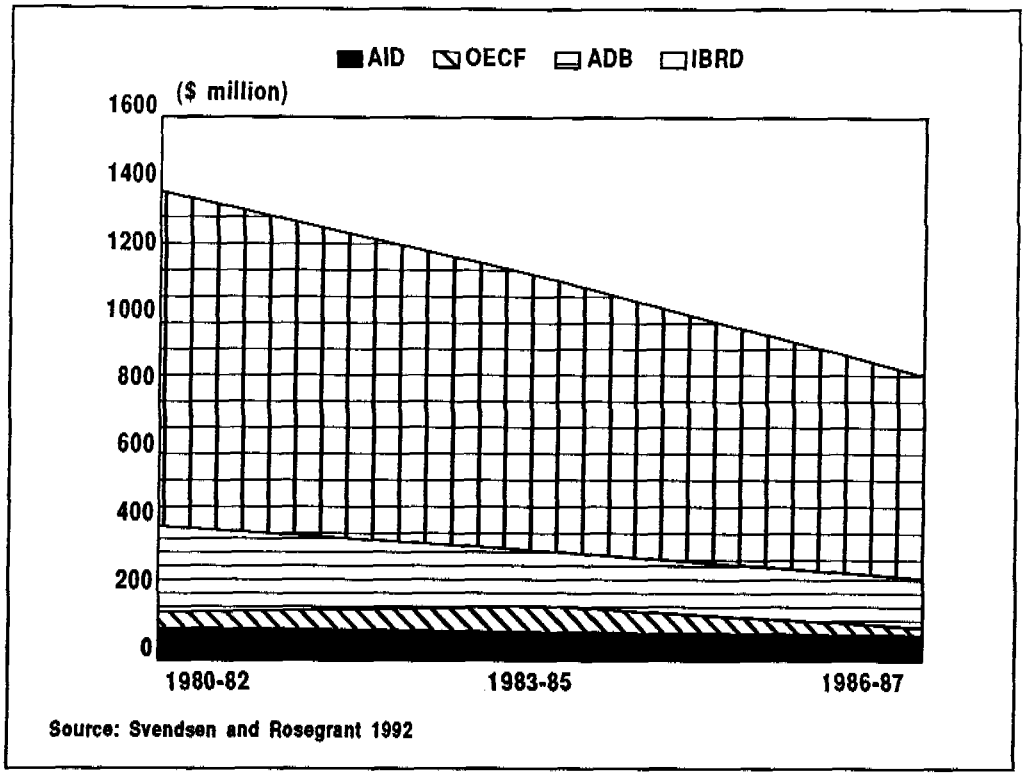


Figure 7

Annual Funding for Irrigation by Donor in the Near East, South Asia, and Southeast Asia 1969-1987 (millions of dollars)

Current Directions in Water Resources Policy

Three decades ago, the highest priorities in water resources development were infrastructure investment and operation of facilities for the expanded use of water for irrigation, power, water supply, flood control, fisheries, and navigation. Conditions then were well suited to rapid development and exploitation.

Good sites were available for water storage and diversion. Costs were low, and groundwater was accessible. Water quality was still adequate for most uses; the best lands were available for development; and the green revolution was about to provide high-yielding cultivars that, with good water control, would double and triple traditional grain production. Old institutions were strengthened, and new agencies were created to manage a large portfolio of investment projects. The emphasis in public policy was on government provision of low-cost inputs to expand agricultural production, subsidized energy costs, and access to safe water.

The situation in the water sector in the 1990s is substantially different. The least expensive water development sites have already been exploited, and the cost of water is rising rapidly. In some areas, only marginal lands remain to be developed. Most large public irrigation schemes and urban water supply systems suffer from poor performance and low efficiency. Water is polluted by agricultural, industrial, and urban wastes, reducing the value of the water for other uses, and resulting in real and perceived water shortages that generate increased competition and conflict among water users.

These constraints and problems are confounded by the general unsuitability of water development institutions to deal with these issues. Policies to conserve water and protect water quality are not the cornerstone of current public policies; these values have not had a high priority in agencies that have historically focused almost exclusively on physical infrastructure development.

In the Near East, the combination of development needs and water shortages has created grave concerns about environmental issues. In December 1991, the Environmental Strategy Framework was approved. It provides guidance for the Agency's investment in the environment and identifies five environmental constraints to sustainable development:

- the loss of tropical forests and other habitats critical to biological diversity
- unsustainable agricultural practices
- environmentally unsound energy production and use
- urban and industrial pollution
- the degradation and depletion of water and coastal resources

The Near East Bureau responded to the Framework with *Natural Resources and Environment: Strategic Approaches for the Near East Bureau,* which identifies four priority issues. The highest priority is assigned to constraints imposed by the degradation and the depletion of water resources. The action plan notes that many Near East Missions and cooperating countries have concluded that the degradation and the depletion of water resources are their most critical problems.

In October 1992, the Near East Bureau set as its goal the achievement of "sustainable economic growth, high levels of employment, widespread recognition of basic human rights, and peaceful relations with neighbors, the benefits of which are shared by a broad spectrum of the population." Subgoals include increased efficiency, productivity, and competitiveness of selected economies in the region; healthier, smaller families; and sustainable development and management of the region's natural resources.

Five strategic objectives follow from these subgoals and concern private sector activity, governance, contraceptive methods, maternal and child health services,

and water resources. The fifth, which directly relates to sustainable natural resources development and management, has the following features: more efficient use of water, enhanced water quality, and improved water management.

In June 1993, the new Administrator of A.I.D. identified four policy directives which relate to sustainable development and through which the work of the Agency should be viewed: environment, economic growth, democracy, and population and health. The Near East Bureau's strategic objective on sustainable natural resources development and management is congruent with the Administrator's policy directives since the efficient use of water, enhanced water quality, and improved water management are directly tied to all four directives. Water may be the most critical resource in the region's environment and its shortage the major constraint to economic growth. User participation in water management offers opportunities for expansion of democratic initiatives through increased access to and control over resources, and population and health concerns in the region are closely tied to water quality issues. In the Near East, water clearly encapsulates the four policy directives.

PRIORITY ISSUES 2

Three priority issues dominate water resources use in the Near East:

- water shortages resulting from inefficient use
- degradation of water quality
- poor public and private sector water resources management

All three issues directly stem from the region's central problem—the mismanagement of water resources. Scarce water supplies are already diminishing as a result of this mismanagement. The fragile base is placed in further jeopardy as more restrictions are placed on water use. Unfortunately, existing institutions are not sufficiently responsive to these critical conditions. This section describes the three major water issues in the Near East and sets the policy framework for Bureau and Mission actions to assist host countries with this vital natural resource.

Water Shortages

Demand for water in the Near East grows more intense as the population expands and more people move to urban areas. Between 1985 and the year 2000, regional water demand is projected to increase by roughly 30 percent; by 2030 the demand is projected to more than double from 1985 levels (Table 7). In some countries, demand is projected to rise far more sharply than the regional average. In Jordan and Oman, the projected demand in 2030 will be sixfold and tenfold that of 1985, respectively (Shahin 1989). Despite many water-saving methods already in place, by the year 2000, Israel will face a shortage of 800 million cubic meters per year, which is almost half its present consumption (Sexton 1990). Egypt, which already uses more than its share of Nile waters, is projected to experience a deficit of from 16 to 30 percent by the end of the century (Anderson 1991).

Water transfers and reuse will affect supply by directing water to areas that have critical water shortages, but these methods basically redistribute existing resources. Technological breakthroughs and successful exploration, on the other hand, may augment resources in some countries. In the region's wealthiest countries, desalinization plants are already in operation, but in the absence of increased prices for desalinized water, it is uncertain whether the production of desalinized water will meet demand. Saudi Arabia presently produces roughly 1 billion cubic meters annually, equal to 20 percent of its total demand. If production remains constant, by the year 2030 desalinized seawater will meet only 8 percent of Saudi needs. For most Near Eastern

Table 7

Projected Demands for Water through 2030 (bcm)

Host Country	1985	2000	2030
Morocco	5.193	6.987	14.898
Tunisia	2.282	2.909	5.556
Egypt	59.500	72.400	112.800
Lebanon	0.859	1.448	3.106
Israel	1.926	2.500	**
Jordan	0.499	1.100	3.070
Syria	6.883	8.498	14.915
Iraq	41.020	47.330	73.020
Saudi Arabia	3.530	6.521	13.365
Oman	0.512	1.127	5.246
Yemen	2.156	3.453	6.687
Near East*	147.314	202.575	331.006

Source: Shahin 1989, U.S. Army Corps of Engineers 1991

*Includes all countries in the Arab Near East.

**Information not available.

countries, which lack the financial resources of the Gulf states, increasing the water supply using desalinization is economically prohibitive. Investments in water supplies will have to be evaluated very carefully in the context of other policy and management alternatives and in the context of national priorities.

Transfer and reuse techniques will not satisfactorily augment supply if demand remains unchecked. Such measures generally yield marginal improvements that fail to alter the basic problem of finite water resources. Some argue that transfer and reuse techniques actually distract from the more pressing need of creating methods to reduce demand through water conservation, reallocation, and a major reordering of priorities by countries in the region (Sexton 1990).

Constraints on Policy, Planning, and Analysis

Many countries in the Near East have already attempted to quantify, administer, and control existing water resources, but little progress has been made toward the integrated management of the total water resource. Each country in the region has collected specific data to create thematic maps of parts or all of its territory. Most of the countries have compiled the data in hydrological and hydrogeological maps and have initiated centralized water resources filing systems. Few countries, however, have established institutions for the overall management of water resources (Gischler 1979).

Data bases require continuous updating through adequate monitoring and acquisition of information. The data can then be used in analyses and models for the integrated use of limited water resources in projects that require substantial capital investment in storage reservoirs, well fields, pumping stations, distribution networks, irrigation systems, wastewater treatment facilities, and desalinization plants.

In the past, and to some extent also now, international donors and countries in the region focused on capital investments rather than on effective analysis that could lead to viable regional plans. It is uncertain whether a water resources planning entity can be effective in the context of competing line agencies. It may also not be consistent with widespread attempts in the region to decentralize local and regional water resources management. An important issue for national governments in this changing sociopolitical environment is how to overcome intellectual inertia, tradition, and behavior inhibiting the rational planning and management of local and regional water resources.

Countries in the region traditionally selected specific sectors for particular emphasis and investment. Now a number of countries, including Morocco, Jordan, and soon Egypt, are abandoning policies emphasizing food self-sufficiency that require continuing, massive investments in irrigation infrastructure, diversion of water to irrigation systems, and use of scarce water for grains and other crops that could be more cost-effectively imported. Irrigated agriculture in these countries is shifting toward crops that present a comparative advantage.

The Dominance of Agriculture

Agriculture dominates water consumption in most of the Near East. Roughly 80 percent of the water in the region is used for agriculture (Table 8). Saudi Arabia and some Gulf states are the exception, allocating more than half their water for domestic and industrial uses. The agricultural sector is generally perceived to use water inefficiently. Overall irrigation efficiencies of 50 percent are considered good although the remaining water is not lost. Some

Table 8

Percentage of Sectoral Withdrawal of Water Resources

	Irrigated Land as Percentage of			
Country	Domestic	Industry	Agriculture	Cropland
Morocco	6	3	91	14
Algeria	22	4	74	4
Tunisia	13	7	80	6
Libya	15	10	75	11
Egypt	7	5	88	99
Lebanon	11	4	85	29
Israel	16	5	79	49
Jordan	29	6	65	15
Syria	7	10	83	12
Iraq	3	5	92	42
Saudi Arabia	45	8	47	36
Yemen	5	2	93	21
Oman	3	3	94	85

Source: World Resources Institute 1992a

percolates into the groundwater and is later pumped, and some runs off fields into rivers and is reused downstream.

There are those who advocate dramatic reallocation of water from agriculture to domestic use and industry. Certainly the returns from irrigated agriculture need to be weighed against the necessity for water to supply households and industry and against the cost of extraction and distribution. Despite these demands, a number of factors argue in favor of continuing traditional allocations to agriculture:

- Most industries in the region depend upon the raw materials produced in agriculture.
- Many countries in the region cannot afford to purchase or rely on imported raw materials for their industries.
- Agriculture is usually the largest employer, providing work for one third to one half of the total labor force. Exceptions are Jordan and Israel where services and industry employ more than 90 percent of the labor force.

- Planners in most countries recognize a certain aesthetic and environmental value in having agriculture close to the urban centers.

In the 1990s, however, these factors may become less significant, and agriculture may lose modest amounts of water through reallocation to other sectors. There is evidence that some countries in the region are already making adjustments by restricting water use for selected crops. Jordan is considering banning the use of fossil groundwater for low-value crops (such as wheat) in the southern part of the country, and Israel may limit the production of cotton following the collapse of the export market.

Given the pressures of increasing demand and the relative limits on supply, countries need to make difficult, and sometimes painful, decisions regarding reallocation of water. These decisions are fraught with serious political and social consequences and cannot be made solely on the basis of economic criteria. In most Near Eastern countries, the water management process is severely constrained by the lack of a comprehensive water resources planning capability that responds to critical national needs. In order to be effective, water resources planning must be one component of a national development plan that assigns national priorities. In the Near East, the water resources planning process is further constrained by the lack of adequate expertise to carry out the quantitative analyses required to determine the social, economic, and environmental effects of reallocating regional water resources among the various user categories. (Appendix E, the Full Value of Water and Water-Related Investments.)

Rights to International Waters

The serious difficulties of allocating water among competing economic sectors within a country are grossly overshadowed by the problem of allocating water across national boundaries. Rights to international waters depend more on historical precedent than on mutual or formal agreement. Transboundary allocations of water resources are closely influenced by such factors as internal pressures, military strength, and the hydrological position of the riparians. As demands for scarce water resources become increasingly acute within the Near East, demands for water among riparians on international rivers or among those sharing an aquifer are certain to intensify.

Since few agreements exist among riparians on any of the major rivers, conflicts may arise among them as upstream (such as Turkey and Syria on the Euphrates) or downstream (such as Israel on the Yarmouk or Egypt on the Nile) users claim greater volumes of water. Overdrawing groundwater from an aquifer not only reduces the amount available to others, but it also threatens the quality of the resource. Unresolved transboundary issues further contribute to the geopolitical instability of the region. Any peace efforts in the Near East must include resolving allocation and water rights

issues on the region's international rivers and aquifers. However, shortages can offer a real opportunity for peace: countries may seek to reach an accommodation on long-standing disagreements over resource use.

Water Quality

One of the most critical issues facing countries in the Near East is the accelerated decline of water quality. The degradation of water quality jeopardizes sustainable agriculture, results in production losses, poses serious health problems, and adversely affects the economic well-being of the nation. Water quality has a direct effect on the quantity available for specific uses. As the quality of water diminishes, its scope of use narrows, thereby reducing supplies and intensifying shortages, resulting in increased competition.

Resource degradation is often blamed on local-level mismanagement, but its origins are more often the result of policy decisions designed to address economic and social problems at the national, regional, and international levels. Factors include national debt and structural adjustment to reduce overall government spending, an absence of institutions or other means to monitor water use and enforce existing environmental protection legislation, inadequate means to coordinate public and private development, inadequate resources for infrastructure maintenance, and inappropriate or inadequate technologies. Instances of ineffective protection of water quality may be attributed to the absence of appropriate training and low levels of public awareness, which result in serious misconceptions and misunderstandings about using water in ways that guarantee a continued source of non-contaminated water. Another contributing factor to water degradation at the local level is blind self-interest on the part of users who focus on short-term profits at the expense of the long-term integrity of the resource.

In the Near East, a major source of surface and groundwater degradation is the increasing discharge of untreated or inadequately treated domestic wastes, emissions from agroprocessing plants and unregulated or misinformed agrochemical use, and hazardous and toxic industrial wastes into water bodies serving as a source of supply for other users (Food and Agriculture Organization 1991). Another major source is saline agricultural drainage from large-scale surface water systems and overdraft of groundwater resources, which results in saline intrusions from the sea.

The major issue for cooperating countries is how to take advantage of the important opportunities for applying clean technologies and preventing groundwater contamination in both the agricultural and industrial sectors. Using low-input, sustainable techniques in agriculture can reduce the use of pesticides and fertilizers while maintaining yields and lowering costs. In industries of all sizes, this means implementing a host of methods that include reducing the use of toxic chemical inputs; reducing non-product waste outputs

by improved manufacturing methods, practices, and technologies; and making a commitment to manufacturing and using environmentally responsible, or "green," products that have less negative environmental impact over their life cycles.

The Impact of Irrigation

Irrigation can degrade water quality by increasing salt concentrations and adding toxic organic materials to the drainage water from irrigated lands. Water quality degradation is particularly a problem when drainage water containing nitrates and other soluble salts and pesticides percolates through the soil. Portions of downstream irrigation systems may also be severely affected. In the Tadla area of Morocco, water quality has deteriorated from agrochemical pesticides and fertilizers and the discharge of agro-industrial and urban wastes into drainage canals and rivers (Eriksen et al. 1992).

Surface runoff from irrigation is generally less degraded than percolated drainage water. The increased use of chemical inputs that accompany irrigation results in direct and indirect emissions of chemicals into water sources. Sediments in surface runoff contain minerals and organics, such as phosphates, and pesticides that adhere to the soil particles. These are deposited in slower moving streams or still bodies of water where they adversely affect wildlife.

On a larger scale, the degree of local degradation of waters may be obscured by dilution. Although 2.3 billion cubic meters (bcm) of drainage water are returned to the Nile annually, the salt concentration in the Delta is only 250 parts per million (ppm), 50-80 ppm higher than in Upper Egypt (Abu Zeid and Biswas 1990). The situation is worse on the Euphrates where the river enters Iraq. A rise in salinity to 900 ppm was recorded in 1989, caused by irrigation return flows upstream and reduced summer baseflow in the river.

The quality of water available to downstream users on the Euphrates in Syria and Iraq is expected to worsen in the future. Turkey's mammoth Anatolia Project in the southeast is planned to eventually irrigate one million hectares, which will inevitably increase the salt loading in the river. The regulation of the Euphrates by Ataturk Dam and eighteen others associated with the project will greatly reduce the water available for dilution. Turkey has guaranteed to supply quantities of water for downstream users, but has made no commitment to maintaining the quality of the water it supplies.

Water quality problems associated with irrigation can, in part, be alleviated through management practices such as:

- reduced fertilized applications or split applications timed to coincide with crop needs

- reduced reliance on pesticides, particularly those forms prone to surface loss or leaching
- minimum tillage practices, which can reduce erosion
- water application amounts and methods designed to reduce excess drainage

Irrigation can also be used to improve degraded waters. Application to the land of wastewater through irrigation is one way to use water productively and, at the same time, to improve its quality as it percolates through the soil.

Groundwater Contamination

Groundwater can be seriously contaminated by overextraction. When the level of water in aquifers is drawn down, salt water may intrude. Severe salt water intrusions exist in parts of Oman where water levels have been declining since 1974 as a result of overpumping. In some coastal areas, the water level in wells is as much as 4.5 meters below sea level (Luxton et al. 1991).

In Saudi Arabia, few controls exist on groundwater extraction, and water quality is deteriorating because of overpumping. Water tables are falling, and seawater is intruding into the coastal aquifers (Food and Agriculture Organization 1991).

The situation is similar in Gaza where overpumping is causing acute water shortages of potable water. By 1987, the water table was dropping 15-25 cm. annually; seawater had seeped 1.5 kilometers into the sweet water aquifer; and 60 percent of the regional water supply was believed to contain over 400 milligrams of salt per liter (Benevisti and Khayat 1988). The situation has deteriorated since then, and some predict that irrigated agriculture will eventually cease in Gaza unless it is reversed.

Increasing Urbanization and Industrialization

The proportion of urban dwellers in the Near East has risen dramatically during the past 30 years. In many of the countries, the proportion of city dwellers has doubled. Across much of North Africa and through the central Middle East, roughly half the population is urban, ranging from 18 percent in Oman to 88 percent in Israel (Blake et al. 1987). The combined effect of increasing urbanization and industrialization has greatly increased the competition for water. Urban infrastructure usually cannot handle the increased amounts of water and wastewater it must convey, and financial resources for system maintenance are inadequate. In Egypt, for example, the water and sewage systems are seriously overstressed. Cairo's rapidly growing population is straining the aged infrastructure. Sewers in many parts of the city are

extremely overloaded and cannot be efficiently maintained. Street flooding of sewage from broken and clogged lines is common, but it is greatly diminished as a result of USAID assistance. Water supply and sanitation services are more widely available in urban than in rural areas (Table 9).

Reuse of municipal and industrial wastewater is becoming an increasingly attractive means of augmenting the water supply for irrigated agriculture. The volume of water that must be moved daily poses serious challenges to countries in the Near East, but it also provides real opportunities in an age of scarcity. In Jordan, the volume of wastewater from Amman exceeds treatment plant capacity. The Mission there has designed a project to enlarge plant capacity so that treated water can be used for agriculture in the Jordan

Table 9

Population with Access to Safe Drinking Water and Sanitation (percent)

	Safe Drinking Water		Sanitation Services	
	Urban	Rural	Urban	Rural
Morocco	100	25	100	19
Tunisia	100	31	71	15
Libya	100	80	100	85
Egypt	96	82	100	34
Israel	100	97	99	95
Jordan	100	98	100	100
Syria	91	68	72	55
Iraq	100	72	92	55
Saudi Arabia	100	74	100	30
Yemen*	100	48	66	NA
Oman	87	42	100	34

Source: World Resources Institute 1992a. Data from 1988.

* These figures apply only to the former Arab Republic, since statistics for the former People's Republic are not available.

Valley. Reused wastewater is expected to be a major source of the water for irrigation in Jordan in the future.

Without effective monitoring and treatment of wastewater, the incidence of disease related to poorly treated water is likely to rise. Most pathogenic organisms are easily killed, except for the eggs of intestinal parasites. When treated effluent is used to irrigate vegetables that are eaten raw (lettuce, cucumbers, and tomatoes), cholera epidemics may occur. The use of treated sewage was banned during a serious epidemic in Jordan in 1981; the contaminated vegetables were destroyed, but the country's vegetable exports were affected, causing heavy economic losses (United Nations Economic and Social Commission for Western Asia 1985). More recently, an increased incidence of polio and the reappearance of cholera in Jordan were traced to wastewater use.

Water-Related Health Problems

Many of the most serious health problems in the region are directly related to the declining quality of water. In the densely populated urban areas where waste treatment is nonexistent or inadequate, the water supply is often contaminated by pathogens. In addition, the unregulated discharge of industrial wastes from large industrial complexes and small factories adds toxic wastes and heavy metals to the wastewater. Small factories scattered throughout the urban areas are among the most difficult polluters to identify, monitor, and regulate. In Cairo, small battery manufacturers dump mercury and other metals into the wastewater system, which is then used to irrigate vegetable farms on the city's periphery. Seepage of wastewater into the potable water supply system and poor drainage in urban areas lead to vector-borne diseases. Although malaria is endemic in much of the region, the biggest killers are illnesses like gastroenteritis, which result from poor sanitation.

Cities in the Near East are subject to serious health risks from wastewater. In Cairo, sewage backup is common, increasing the threat of typhoid and cholera (Tolba 1990). Although the child mortality rate is decreasing, approximately 88 of every 1,000 children still die in Egypt before the age of five, largely because of diarrhea; the rate is far higher for those under one year of age.

In rural areas, safe practices for the on-farm storage, use, and disposal of potent agricultural chemicals are virtually unknown, so the use of these chemicals is essentially uncontrolled. The health of the people both in these areas and downstream is directly threatened by the use of polluted surface and groundwater for domestic purposes.

Water-borne diseases may be spread by parasites. Schistosomiasis, a chronically debilitating disease caused by direct contact with surface water, is found in nearly all the countries in the Near East. In Egypt, irrigation systems and practices produce a perfect habitat for the snails that transmit schistosomiasis. Estimates of economic losses due to work lost because of this disease exceed $500 million yearly (Bruce 1990). The disease surfaced in Jordan in 1977, where the extensive development of surface systems using dams, canals, and irrigation systems created new habitats for snails and new patterns of water use (Saliba et al. 1986). Since then, Jordan has successfully eradicated the disease by carefully monitoring Egyptians entering the country and destroying the snails in its waters.

Although external contamination is the major cause of unsafe water in the household, additional contamination occurs within the household. A recent study in two Egyptian delta villages indicates that much of the misuse of water there is a result of users' conceptions of the nature of water and the spread of diseases (El Katsha and White 1989). For example, women believed that schistosomiasis could only be transmitted by swimming in the canals or swallowing water while swimming. As a result, they saw no danger in wading in the watercourses while washing laundry. They also believed that once water was obtained from a pipe, it would remain pure—even when unclean hands and utensils were placed in the water jars.

Issues regarding water quality degradation encompass a wide range of concerns from the management of emissions on international waterways to the maintenance of water's relative purity for drinking in household containers. In nearly all cases, the degradation of the resource is a result either of greed or inadequate management practices that could be eliminated if responsive institutions existed to provide the appropriate education and training.

Public and Private Sector Water Resources Management

Bureau and Mission activities have shifted from projects focusing on construction and technologies to policy and institutional reforms and improvements. Critical to improving public and private sector performance in the 1990s is the support of changes in water resources policy and institutional infrastructure in host countries. Four key issues need to be addressed:

- improving government institutional capabilities to plan and manage water resources
- introducing sound economic principles and market forces into water resources management

- shifting management responsibilities from government to private sector users
- expanding private sector services

Inadequate Institutional Capabilities

Few Near Eastern countries have begun to undertake coordinated government planning and management of their water resources. This planning is a crucial component of resource reallocation among sectors. Currently both planning and management are done at the level of individual ministries, each with significant obligations for water resources within its own area of responsibility. In Morocco, for example, the Division of Water Resources in the Ministry of Public Works cannot include irrigation in its planning. In Jordan, the 7,000-employee Ministry of Water and Irrigation is actually composed of two smaller authorities with separate mandates. In Egypt, the Ministry of Public Works is responsible for irrigation system development, operation, and maintenance, but its activities are divorced from agriculture, inland navigation, and industry, which are all administered elsewhere. Thus, one ministry is often responsible for groundwater and another for surface water. As a result, managing conjunctive use becomes problematic.

In the water resources sector, one of the highest priorities for Missions should be to encourage and support activities that enhance the planning and management capabilities of water resources institutions. The feasibility and need for a national water resources action plan and a central agency to implement it should also receive attention. Without policy and institutional reforms, technical approaches alone to improving water use efficiency and protecting water quality will probably not provide adequate solutions, nor will they necessarily be sound investments.

Subsidies and Cost Sharing

Expanding financial responsibilities for users is an increasingly attractive proposition for governmental consideration, despite the political, social, and economic complexities involved.

Host countries in the region are faced with maintaining massive water sector investments. Although the development of new schemes, particularly in irrigation, is unlikely to receive a high priority, government subsidies to operate and maintain existing water systems are a major burden to governments faced with mounting budget deficits. Water systems are already undermaintained. Unless forceful financial measures are undertaken, systems will increasingly fall into disrepair, and rehabilitation costs may become prohibitive. Governments throughout the region and elsewhere have been reluctant to impose programs to recover the necessary operating costs.

The public sector is likely to remain the source of funds for capital investments since resource exploration and system development are legitimate government responsibilities, and adequate financial resources would be difficult to raise in the private sector. The cost of system operation and maintenance, on the other hand, could be recovered from users, particularly if collected revenues are reserved explicitly for that purpose.

In fact, the collection of charges or fees for municipal and industrial uses is already commonplace, and farmers contribute to the operation and maintenance of the tertiary irrigation system. However, the full cost of water for urban and industrial uses and for irrigation is seldom recovered, and water systems are highly subsidized by society. As recurrent costs for governments escalate throughout the region, the magnitude of these subsidies has come into question. Subsidies that discourage the efficient use of water are most frequently found in the agricultural sector. Since they pay only a fraction of the real cost of water, few farmers are willing to invest in water conservation technologies or make efficiency improvements.

Energy subsidies are also common, usually through low power rates and fuel costs. The results are a heavy burden for host counties. Egypt's total subsidy for water use has been between $5 and $10 billion, more than the combined revenues from its greatest income generators, the Suez Canal and tourism. Irrigation water is subsidized in other Near Eastern countries as well. It is estimated that the actual cost of water in Israel is approximately $.44 per cubic meter, while its price to agriculture is $.25 to $.30. Water pricing in Jordan is quite complicated, varying from region to region within the country and from economic sector to sector. The cost of water in the Jordan Valley is 50 fils per cubic meter, while its price for agriculture is 3 fils (Naff 1989). In this case, the difference in price may reflect the cost of wastewater treatment.

Raising the price of water by taking into account the value added for certain kinds of water use is one means of recovering the cost of system operation and maintenance. Another is to improve collection methods. Water pricing usually faces heavy political and bureaucratic resistance. In many countries, irrigation water is essentially a free good. When government indicates an intention to impose or raise water charges, political reaction can be intense. Under some circumstances, objections from farmers may have validity. For example, the cost for use of the resource may have already been incorporated into existing charges, including crop and land taxes and through undervalued farm-gate products.

Some countries in the Near East are seriously addressing these financial management issues. The Government of Egypt is considering implementing a cost recovery program and has requested assistance from the Mission in Cairo. As a result, the Mission is funding a three-phase cost recovery study that seeks to determine the costs of operation, maintenance, and rehabilita-

tion of the irrigation system, the costs of watercourse renovation alternatives in a major system rehabilitation program, and the identification of suitable charging mechanisms. One effort includes the identification of system beneficiaries and the use of a cost allocation model by the Ministry of Public Works and Water Resources to determine the existing and projected costs of structural replacement and operation and maintenance. (ISPAN 1993).

Local Empowerment and Governance

Shifting the responsibilities for system management from the public sector to private sector users may be a solution to government's apparent inability to provide adequate maintenance. Two models are most commonly offered:

- system turnover–the transfer of management responsibilities to users
- privatization–the transfer of the ownership of system assets to private sector users

Both can result in reduced government subsidies to the irrigation sector, increased financial autonomy, and decentralized decisionmaking. In Morocco, a national policy of disengagement is being followed whereby the public sector is attempting to remove itself from responsibility for system management and to leave the private sector to provide basic services. Whether users can fully meet operating and maintenance costs remains to be seen.

Greater accountability between system managers, most often government officials, and their clientele could lead to improved system maintenance. At present, accountability tends to be upward toward government rather than downward toward recipients of the service. Use of a utilities concept with appropriate pricing for customers would change the direction of the accountability.

Maintenance can be improved and water service fees reduced if users take a more active role in system operation and maintenance. Policy changes permitting end users to be owners or operators of irrigation facilities is likely to encourage better maintenance. All A.I.D. irrigation projects should have institutional components to support this type of change.

In the case of large irrigation facilities, transfer of operation and management functions from the public to the private sector may be facilitated by:

- organizing farmers to operate and maintain the systems for the benefit of all
- vesting ownership (entitlement) in land, water, and physical resources so that users have a stake in the resources

- introducing governing principles that ensure the input of all farmers to reduce the likelihood that powerful individuals dominate systems for the benefit of a few

Tunisia has extended experience with water users associations, which date to the beginning of this century, although they were legalized only in 1913. The increasing involvement of the government through the 1970s undermined the strength of the groups, until the government recognized the expense and inefficiency of their supervision and sought to revitalize the groups. The groups are now strongest in the south where they control nearly all tubewell irrigation schemes ranging from 50 to 200 hectares (The World Bank 1992). USAID has been particularly involved with associations of potable water users in central Tunisia, providing assistance since the mid-1970s. In Egypt, the Mission is assisting the government to create the first irrigation water users associations in the country.

Private Sector Services

Opportunities exist for the private provision of water services in the Near East. Irrigation water supply, normally thought of as a public sector responsibility, in operation is actually a mixed public-private activity. Private sector wells and groundwater pumping provide a portion of the water used in irrigated agriculture in most of the countries in the region. While an increase in privately supplied water is desirable as a means to reduce public costs, unregulated use and poor enforcement risk overexploitation of the aquifers.

Furthermore, the private sector is already the driving force behind the promotion of technological innovation in on-farm irrigation methods. This is especially evident in the drip irrigation system in the Jordan Valley and the center pivot and low-energy precision application (LEPA) systems in Libya, Saudi Arabia, and other countries. Spurred by a desire to expand sales, the providers of irrigation equipment have sought to keep systems operating at high efficiencies, providing an example of how privatized economic development and environmental interests converge.

PROGRAM OPTIONS 3

Overview

The Near East Bureau has long been an important contributor to water resources development and management in the region. The growing problems associated with water shortages, water quality, and water resources management in the Near East present opportunities for A.I.D. to assist cooperating countries.

Because of the importance of water resources to the region, the Bureau has prepared a water resources action plan that is a subset of the environmental action plan. That document identifies the potential means of improving the situation of water resources in the Near East; summarizes actions currently underway by Missions, as well as by A.I.D., that contribute to meeting the Bureau's strategic objective; and suggests areas where future programs may be desirable.

This document is a companion piece to the Near East Bureau's action plan for water resources. It provides an overview of water resources in the region, the identification and discussion of three priority issues, and twelve program options that address these issues.

Statement of the Problem

There is no question as to the severity of the water resources problem in the Near East. Many countries in the region have a water deficit. They currently consume more freshwater than is produced naturally within their boundaries; and widespread shortages are anticipated within the next ten years. Furthermore, mismanagement or a lack of management has led to the degradation of water quality and the depletion of water supplies. The inadequate supply of clean water contributes to public health problems and places severe limits on economic growth.

The Strategic Objective

A.I.D.'s strategic vision or goal is to achieve "sustainable economic growth, high levels of employment, widespread recognition of basic human rights and peaceful relations with neighbors, the benefits of shared by a broad spectrum of the population." The means for achieving this goal are through five strategic objectives predicated on the cooperating countries' having sound policies in place. In the context of the sustainable development of the region's

natural resources, the strategic objective for achieving this goal includes the following components:

- increasing efficient use of water
- enhancing water quality
- improving water management

Program Options

A number of specific approaches for implementing each of these strategic objectives are presented in this document. The approaches discussed are illustrative in nature and are not an exhaustive list of ways to implement the action plan. Rather, they are program options from which individual Missions and cooperating countries will select the most appropriate for specific interventions.

Mission intervention and project support directly or indirectly involve three different groups: the public sector (of which the Mission is a part), the private sector, and the end users. Each of these groups has different responsibilities and a different viewpoint, and each has an important contribution to make to the success of the action plan.

- The *public sector* has primary responsibility for coordinating the comprehensive planning, monitoring, and regulating of the water resource. It also provides the bulk of the capital investment for basic infrastructure and is responsible for resolving international issues related to water use. This group includes national and local government agencies and other government-supported institutions with public policy or program responsibilities.
- The *private sector* provides expertise and develops implementation technologies. It assists in the identification and resolution of water resources issues and contributes to planning. It provides research, education, and training. This group comprises service industries, commerce and finance organizations, universities and research institutes, and nongovernmental organizations (NGOs).
- The *end users* create the demand for water and fund the government through generation of economic wealth. They may also play important roles in water conservation, water quality improvement, and demand management. This group includes farmers, urban and rural households, commercial establishments, and industries—in some cases even those owned by the government.

Table 10 provides the water resources action plan in tabular form and includes the strategic objective, its components, approaches, actions, and illustrative donor interventions.

Table 10

Strategic Objective for Water: Components, Approaches, Actions, and Interventions

Strategic Objective Component	Approach	Action	Illustrative Intervention
Increase effective use of water	Reallocate water resources	■ Introduce comprehensive resource planning ■ Improve analytical techniques ■ Review water rights ■ Conduct discourse with users	■ Design and implement national basin strategic planning projects ■ Develop training programs ■ Conduct participant and in-country training
	Manage demand	■ Revise water pricing ■ Introduce fiscal incentives ■ Encourage water sales between sectors ■ Regulate and restrict use ■ Institute educational programs	■ Determine effectiveness of currently used initiatives ■ Assess major constraints ■ Identify opportunities for introducing new approaches and expanding current measures
	Conserve water	■ Introduce water conservation technologies	■ Implement water conservation projects ■ Distribute information and provide training
	Improve technology	■ Identify magnitude of water shortages and low-quality sources ■ Determine and assess alternative interventions ■ Introduce and expand use of technologies for agriculture and water supply and sanitation	■ Develop bilateral trade relationships and partnerships ■ Improve information dissemination through publications, workshops, and trade shows
	Resolve transboundary disputes	■ Examine allocation issues ■ Conduct studies and policy analysis to support negotiations	■ Facilitate international dialogue ■ Improve planning tools and analysis at national level ■ Involve U.S.-based PVOs specializing in conflict resolution
Enhance water quality	Upgrade monitoring and regulation enforcement	■ Assess agency responsibilities for monitoring ■ Review and adjust penalty system ■ Introduce pollution prevention policies ■ Support waste minimization techniques	■ Upgrade methods for water quality monitoring ■ Enhance staff skills through training ■ Provide technical assistance to promote changes in processes and technologies
	Introduce pollution prevention techniques	■ Institute policies to support pollution prevention ■ Determine and facilitate necessary technological changes ■ Support training and management requirements	■ Disseminate information concerning latest pollution prevention techniques ■ Assist development of decision support systems ■ Conduct pre-investment studies

Strategic Objective Component	Approach	Action	Illustrative Intervention
Enhance water quality (cont.)	Foster local capacity for water protection	■ Initiate policies to extend "stewardship" of water resources to end users ■ Develop mechanisms for setting levels of pollutants and reporting illegal emissions	■ Provide training and public awareness programs to users to identify polluters and define appropriate roles
Improve water management	Strengthen public sector services	■ Incorporate environmental concerns into operations ■ Establish financial instruments to encourage adoption of improved technologies and management techniques	■ Strengthen education and training ■ Provide access to equipment and data bases to improve analysis ■ Encourage interagency coordination and bilateral cooperation
	Expand financial responsibility	■ Determine costs of water systems ■ Identify system beneficiaries and allocate benefits among users ■ Identify appropriate assessment and billing mechanisms ■ Develop necessary policy instruments and legislation ■ Determine appropriate types of tariff structures or charging mechanisms and develop pilot programs	■ Initiate policy dialogue on cost sharing ■ Assist cooperating countries with analytical procedures to determine system costs ■ Conduct workshops and study tours to acquaint officials with cost-sharing issues and initiatives in other countries
	Transfer management responsibilities	■ Determine appropriate public and private sector management roles ■ Institute and expand participatory programs for end users ■ Institute divestment programs for turnover and privatization ■ Develop necessary policy instruments and legislation	■ Provide comprehensive assessments of turnover, privatization, and water users associations efforts to date ■ Conduct workshops and study tours to acquaint officials with divestment issues and initiatives in other countries
	Encourage private sector services	■ Review and adjust subsidies for water services	■ Introduce models for private sector participation on pilot bases

INCREASE WATER USE EFFICIENCY 4

As demands for limited water supplies increase, countries in the region will need to allocate available water more wisely among demands for economic growth, environmental enhancement, and basic human needs. Increasing the efficient use of water requires action in each of these areas. The Near East Bureau and Missions have specified assisting host countries to address water use issues as a strategic objective. This section presents some approaches for achieving this objective and identifies the group or groups responsible for the achievement of each effort.

Reallocate Water Resources

Major investments in the Near East have historically focused on the agricultural sector, which has dominated water use in the region. Country priorities are changing, however, and reallocations are likely to shift water uses from lower- to higher-value uses in order to increase returns to the nation. As a result, some of the water previously used for agriculture is likely to be reallocated to municipal and industrial uses and improvement of the environment. Actions such as these, which use water to produce more value (net benefits), result in a more efficient use of limited water resources.

Political decisions play a definitive role in the allocation process. Thus decisions concerning water use reallocations are made at the most senior levels of cooperating country governments. Adjustments must be consistent with the welfare of the people, regional development, perceived needs for self-sufficiency, and environmental enhancement.

Planning the allocation of a nation's water resources necessitates quantifying the effects of various water resources interventions. (Appendix E.) In the process, planners develop an in-depth understanding of the direct and indirect effects of each potential intervention. Incorporating this information into the decisionmaking process permits a more objective comparison of the options which, in turn, leads to a more efficient allocation of water resources.

The Near East Bureau and Missions can assist cooperating countries by helping their governments improve water resources policy and planning procedures, strengthen information collection, and enhance analytical capabilities of cooperating country staff. These activities are designed to encourage more informed and farsighted decisionmaking by senior government officials.

However, before the Near East Bureau and the Missions can provide assistance, it is important that the cooperating countries recognize a need to address their price policy problems. In the context of this document, this

includes agricultural water pricing, but it also must encompass their overall price policy. Agricultural production will respond positively to high food prices. In contrast, policies that raise input prices relative to those of food products will reduce input use and slow growth in production.

Economic research has proven that overall economic growth, as opposed to that of the agricultural sector alone, is best served by a price structure that reflects underlying economic value. Clearly, in almost all the countries this argues for pricing agricultural water at a cost much higher than it is at present. Yet, as indicated above, if input prices increase, production is likely to fall. In order to ensure that increased water prices do not result in falling agricultural production, A.I.D. assistance to cooperating country governments has to address their wider set of policies and prices in the countries, not just water prices.

Reallocation of water resources has to result from a comprehensive planning process that analyzes needs, benefits, and costs in all sectors of the economy. The Near East Bureau and Missions can provide technical assistance to facilitate countrywide efforts in policy analysis and coordinated, comprehensive planning. This work has to encompass financial and planning ministries as well as water resource agencies to ensure policy discussions address the economy wide price adjustments that are often needed.

Rights to the use of water can be an issue when reallocations are proposed. A frequently mentioned transfer concerns the shifting of water within a sector, for example from farmers at the head of the irrigation ditch to those at the tail. Another is the transfer across sectors, from irrigation to municipal and industrial purposes. Both reallocations can result in substantial gains in the societal value of the water resource, but it can also lead to serious divisions. Whether, and where, water rights are an obstacle to transfers is frequently not well known. The legal standing and institutionalization of these rights vary widely throughout the Near East. Cooperating countries will need to review traditional and modern rights to water. Conducting discourse with users will be an important component of this review and a necessary precursor in any reallocation of the resource.

Manage Demand

Shortages leading to competition for limited water resources have traditionally been addressed in this region by increasing the supply of water. The most common approach was to extend exploration and make massive investments in system development. Over the years most of the water sources have been developed, so the rate of new investment is currently shrinking. Expanding the supply, in real terms, is unlikely to effect dramatic changes in the future. Therefore, an essential part of any water resources program for countries in the Near East must focus on managing demand.

In practical terms, managing demand implies a significant change in the economics of water use. Government policies must begin to identify and promote the use of realistic economic policy instruments that reflect the true economic value of water supplies. The most common instruments for encouraging changes in demand patterns include:

- water pricing
- fiscal incentives
- water sales
- regulations and restrictions
- educational programs

Economic theory dictates that all inputs, including water, should be priced at their marginal value of contribution to a productive activity. In actuality, however, water is rarely treated as an economic good and, therefore, its price is far less than its productive value. With water priced so low, price has no impact on demand and water is used inefficiently.

Where water is scarce, such as in the Near East, water pricing has to set at a level that reflects the marginal value of water. Given the competing demands for water, both agricultural and nonagricultural, this price will be high enough to have a significant impact on demand. In order to make such a pricing system work, water pricing must be based on volume rather than on area served. Volumetric pricing in the past has been a problem because of the costs of installing and maintaining a measuring system. However, once water is priced at its true value, the increased revenue will easily cover all costs associated with measuring the volume consumed.

Tiered-pricing, a system where the price for additional units of water is higher than the price for the initial units of water, is one promising technology for encouraging conservation while still protecting small farmers. This technique can be managed in such a way that initial water withdrawals for domestic use or growing a low-water requirement subsistence crop, such as sorghum or wheat, can be established at an affordable rate. Water use above this, for growing high-value cash crops, is priced at a much higher price and, thus, the irrigation agency is able to capture some of the added economic value of water from larger farmers who can afford to grow higher value crops. Similar systems have been used very successfully to encourage rural electrification in poorer rural areas.

Given that the vast majority of water is presently used in the agricultural sector, it is obvious that water pricing will tend over time to shift water to sectors where it has a higher marginal value. This is normally in the industrial sector not the agricultural sector. Thus, over time, realistic water pricing will shift a significant amount of water out of the agricultural sector. In order

for the agricultural sector to be able to compete successfully for water, it is necessary for agriculture to invest in water-saving technologies such as sprinklers and underground distribution systems.

Fiscal incentives, such as rebates and tax reductions for purchasing water-saving technologies, will need to go hand-in-hand with realistic water pricing. Thus, the burden of the impact can be reduced and at the same time water can be shifted from less efficient to more efficient sectors in the economy.

Water sales, where one sector is compensated for transferring water from that sector to another sector in the economy, is also an effective means of moving water low-value uses to higher value uses. Revenue from the sales can be used like fiscal incentives to encourage a low-value user, agriculture for example, to invest in water-saving technologies. If organized properly, water can be transferred out of agriculture, yet the same acreage can be harvested because of more efficient water use.

While regulations and restrictions are often used to prevent overplanting very high water-consuming crops, they are usually not very effective in ensuring higher value use of the water. Generally, they only work when used in conjunction with water-pricing type schemes.

Educational programs play a role in raising public awareness and are extremely useful when trying to introduce various water-saving technologies. They are rarely effective when used as the sole policy instrument.

All the countries in the region, with varying success, have already introduced some measures to manage demand. Missions can provide assistance in determining the effectiveness of currently used initiatives, assessing major constraints to using other policy instruments, and identifying opportunities for introducing new approaches or expanding the use of currently used measures for managing demand.

Conserve Water

To achieve the most efficient use of water, government policies and programs must focus on ways for all consumers to practice water conservation. Agricultural, industrial, and municipal consumers are targets for improved water conservation measures and for monitoring to ensure that the new government conservation policies are effectively implemented. A range of improved, clean technology options are available for both short- and long-term opportunities to affect water use in the agricultural and industrial sectors. The goal for industrial facilities and farms should be to reduce the use of water inputs per unit of agricultural or industrial production outputs.

Initially, the agricultural sector offers the opportunity to save the greatest amount of water, although as industry expands to a higher fraction of the

Gross Domestic Product, it will become the focus for the most effective water conservation efforts.

The following methods have been found effective in significantly reducing the amount of water needed for irrigation. Some methods involve engineering changes such as lining the conveyance canals and watercourses, adopting water-conserving on-farm application technologies, leveling fields, and installing systems to recycle tailwater. Other methods involve agricultural changes such as crop substitution; improved weed control through mechanical means, herbicides, or use of plastics; tillage practices; and water harvesting to more efficiently use existing rainfall.

Domestic and industrial applications respond proportionately more effectively to conservation efforts because of the rapid rate of change in those sectors. Conserving water in both sectors can be accomplished through controlling leakage, restricting use, and metering. Improved processes that consume less water overall and recycle more water can provide further water conservation.

Resource conservation is a fundamental attribute of clean technologies for industry, including both using less water and converting consumptive uses into nonconsumptive uses by regenerating and reusing water. The major technological approaches to reduce water use in industry include:

- using less water in manufacturing processes
- using less water in cooling systems
- reducing water losses from pipes, valves, and other plant equipment
- recondensing steam
- using less water for cleaning
- dewatering sludges prior to disposal and reusing that water
- recycling water within the facilities

Many of these methods can be implemented quickly with little capital investment, but others are long-term projects requiring more extensive modification of facilities and, therefore, a greater financial investment. Training for plant workers and managers in simple techniques, for example, can lead to immediate water conservation.

Missions can play a central role in implementing this action plan by promoting:

- positive results of water conservation efforts, including protecting limited water supplies, lowering costs, improving efficiency in the manufacturing sector, and addressing national water resources problems

- effective transfer of successful water conservation technologies from similar industrial and agricultural operations in the U.S. private sector
- use of successful techniques to prevent industrial pollution presented in Appendix F

Improve Technology

Technological advances in applying, conveying, and supplying water increase water production and water use efficiency. These advances tend to be incremental, however, as compared to discoveries, which radically alter supply and demand. As a result, the adoption of these new technologies will not solve regional water shortages.

Agricultural Technologies

Existing agricultural technology is designed to obtain the highest possible levels of production from a given level of input. Farmers are striving to increase agricultural output with the same amount of water, resulting in a more efficient use of the resource. To this end, they have recently introduced the following irrigation technologies.

Drip irrigation. This technique places water in the root zone of the crop, thereby minimizing the loss of water to evaporation and weeds. Recent innovations to reduce the level of maintenance required have been introduced, including a modified drip design using "bubbler" technology in Yemen.

Microjet irrigation and low-energy precision applications. These systems deliver water to crops with less evaporation. These methods can also can be used to apply fertilizer.

Surge flow irrigation. Valved gated pipe alternates the flow in furrows. Sealing occurs at the top end of the furrows, thus increasing the uniformity of water distribution and reducing the water loss to deep percolation.

These technologies are both capital and management intensive and so are more appropriate for on-farm water application. Less progress has been made in devising cost-effective and technologically advanced ways to transport water to the farms: lining the reaches of notoriously inefficient channels is one water conveyance improvement less costly than piping.

If municipal or industrial consumers would pay for the improvements, the water savings obtained could be diverted from agriculture to the other sectors.

Water Supply and Sanitation Technologies

Water supply and sanitation technologies in the urban areas have tended to emphasize less expensive technology.

Conserving domestic water. High population growth and urbanization justifies more attention to domestic water conservation ranging from communal and yard taps to in-house plumbing. In areas with standpipes, automatic shutoff valves can be used to reduce wasted water. Low-flow fixtures, such as shower heads and toilets, can be used in hotels and the more developed areas with in-house plumbing. Involving the general public in conserving water also empowers them to support a strong water conservation and environmental ethic. The amount of water needed for water-borne sewage will be reduced if pit latrines or composting toilets are installed as appropriate technology. Water loss from distribution systems can be reduced with the use of leak detection technology. Water meters encourage conservation and also provide a means of measuring water use.

Reusing domestic wastewater. With adequate treatment, domestic wastewater can be reused for irrigation, toilet flushing, industrial uses, or even potable water. Treatment technologies are aimed at removing contaminants, such as suspended matter, organics, nutrients, and disease-causing organisms. Monitoring water quality is essential for safe reuse of domestic treated wastewater. If treatment facilities are in place, water reuse may be feasible with minor modifications. Issues such as public health and surface and ground water contamination must be considered when evaluating water reuse options. The costs of treatment need to be weighed against the marginal costs of using new water supplies.

Composting municipal solid waste. The Near East provides an ideal opportunity for converting ordinary household, institutional, and commercial organic garbage into compost. Compost is a valuable soil additive, which can greatly improve the low-quality soils of the region. Use of compost also increases water retention, therefore lowering water loss; furthermore, it reduces the need for fertilizers, which in turn reduces contamination of surface and groundwater. Increasing population growth and urbanization inevitably increase per capita solid waste generation as the standard of living improves, so solid waste composting becomes more critical. Recent research in Tunisia has demonstrated the feasibility of the composting approach in the region including the subsequent agricultural recycling of municipal solid waste. The sale of compost to farms not only offsets the ordinary costs of municipal waste collection and management, but saves valuable land area from landfills. Composting facilities also provide more jobs.

Using low-quality water sources. Waters containing suspended solids can be improved with coagulation and varying levels of filtration. Salt water contamination requires more complex treatment, such as reverse osmosis or an evaporation process, both of which are energy intensive. Waste heat from electrical power generation can sometimes be used in an evaporation process. Organic contamination can be removed with carbon adsorption, and some ionic species can be treated by ion exchange. These treatment technologies

require long lead times to implement, however, and also add to the cost of water so they may not be appropriate for high volume uses.

Reusing industrial wastewater. Water conservation in industrial applications starts with the modification of manufacturing process to optimize water consumption. Evaluation of options requires a familiarity with the manufacturing process and may incorporate innovative manufacturing technologies. In some cases, it is possible to treat wastewater to a level that is adequate for reuse in the same process. Treatment technologies vary with the contaminant but may include physical, chemical, or biological removal of the pollutant. As with the reuse of domestic wastewater, the effects on public health and water quality must be evaluated. The economics of using this method should include analysis of the true value of using new water in relationship to the value added to water in a specific industrial operation.

Reconnaissance Technology

Other technological advances may assist in addressing water supply needs and should be examined, even though supply is not the main theme of the Near East Water Resources Action Plan. Satellite imagery has been used at the reconnaissance level to help scan large areas for geological formations favorable for groundwater recharge, transmission, and storage. In the 1980s, one of the shuttle missions penetrated desert sands in western Egypt using radar and detected ancient buried stream beds. Reconnaissance technologies are relatively cheap and can identify locations for more detailed follow-up investigations.

Water sources may also be located using the thematic mapper to interpret remotely sensed vegetative and soils information. Multifrequency radar imagery has been used, for example, to quantify the presence of soil moisture. Remote sensing technologies must be accompanied by onsite detailed investigation. Satellite imagery also can be used to determine crop temperatures and to infer crop water status as a guide to scheduling irrigations.

Initially, Missions can assist cooperating countries to:

- identify the location and magnitude of domestic water shortages, available low-quality sources, and available domestic and industrial wastewater for reuse
- determine alternative interventions for each case
- evaluate and rank alternative interventions for each case based on cost, technical feasibility, social factors, and sustainability
- rank locations based on need, impact, and availability of funds

Resolve Transboundary Disputes

Appropriate planning tools and accurate analyses are crucial in any negotiations over transboundary allocations among countries. Water rights in the Near East at present are largely based on historical use. As the quantity of the resource shrinks and its diminishing quality restricts broad use, however, future allocations among countries may increasingly be based on "best case" arguments for use and promises of assistance by countries in a single basin or sharing a single aquifer.

It will be far more difficult to create a new international water resources center in the region or encourage a pooled information base on water resources that would be shared by countries in the region or by riparians in a single basin.

The Near East Bureau and Missions can play a critical role in addressing transboundary water issues by stimulating dialogue among riparians to encourage efficient use of water within countries and throughout the region. The Near East Bureau and Missions should assume a neutral role, drawing on the successes and failures of international water resources dispute management for the examination and eventual resolution of long-standing disagreements. A number of U.S.-based private voluntary organizations focus exclusively on conflict resolution and can support Bureau and Mission efforts.

The Bureau is already facilitating substantive discussions on water resources in the ongoing regional peace negotiations in the Near East. In this role, the Bureau may draw upon its resources to carry out new studies and better analyze existing data, hold workshops, offer training, and provide technical assistance. These services might also be offered to riparians in a single river basin.

One of A.I.D.'s important contributions is its work with other bilateral and multilateral donors in examining allocation issues and coordinating support. Studies and policy analysis would support the continuing discussions on water resources. When countries are able to accurately assess available resources, predict future requirements, and identify reasonable courses of action, they can enter into negotiations with neighbors more confidently and persuasively.

Given the scarcity of the resource and the absence of formal agreements in the Near East, water resources data are usually thought to be closely tied to national security and are not openly shared. Thus the Bureau's resources can be effectively used in supporting individual countries to prepare for negotiations and in facilitating dialogue among them in innovative negotiation forums.

ENHANCE WATER QUALITY 5

Addressing the problem of water shortages requires more than increasing the efficiency of water use; it also requires improving all available, usable water supplies by reducing the water degradation, which diminishes water quality and limits certain water uses. The water quality objective complements water efficiency and conservation efforts that focus solely on quantities of water. This strategic objective has increasing importance as industrial and municipal uses of water increase because these users require high-quality water and at the same time have the potential to seriously degrade water quality. Preventive action to protect water is essential because water treatment is expensive. It is more cost effective to prevent water degradation than to clean up polluted water or to attempt to use historical tactics to improve water production.

Upgrade Monitoring and Regulation Enforcement

One of the most important responsibilities of public sector agencies is the monitoring and enforcement of regulations that govern the use of natural resources. Many of the countries in the Near East already have environmental protection legislation that can be applied to water resources, but few of them have effective mechanisms in place to regulate water use, restrict and prevent pollution, or impose and collect fines for violations of standards and regulations. As a result, industry and agriculture have been largely unmonitored, usually leading to the degradation of water quality.

In countries in the Near East, water use is more commonly monitored and regulated by several ministries than by a single water authority. The Ministry of Health is frequently responsible for maintaining drinking water standards and regulating sewage effluent while the Ministry of Agriculture often oversees industrial emissions. This is the situation in Iraq and Israel, among others. In Egypt, several agencies divide the responsibility: the Ministry of Health is responsible for setting standards for drinking water; the Ministry of Agriculture regulates the use of agricultural chemicals; the Ministry of Housing addresses sewage treatment; and the Ministry of Industry monitors industrial pollution. In contrast, water quality in Jordan is monitored solely by the National Resources Authority.

National assessments should be undertaken to determine if the division of responsibility for monitoring water quality has been effective in detecting and preventing water degradation through regular sampling, testing, and analysis. Attention should be given to the adequacy of staff resources, level of expertise, and appropriateness of facilities to monitor multipurpose water

use. Enforcement of regulations is a more difficult problem to address since it may require changes in the judicial system such as adjusting penalties. To complicate matters, major offenders are frequently politically and economically influential, and many companies are government owned. Nonetheless, little progress will be made in controlling resource degradation if the most flagrant violations are not stopped. The existence of regulations, no matter how restrictive, will be of little consequence without the political will to vigorously enforce them. On the other hand, if attempts to deal with contamination are dealt with only through the imposition of heavy fines and other sanctions, some polluters may not cooperate.

Water quality is a critical issue in the Near East and should be reflected in the analytical and planning activities of government by quantifying the indirect or external effects of various water uses and water interventions. This approach requires the analysis of environmental effects not usually included in the financial assessment of interventions. The environment, human health, and population displacement externalities have already received enough analysis to make useful estimates of their effects. It is now critical to make the economic case for the enforcement of stronger regulations to safeguard water quality.

USAID Missions can provide assistance in upgrading methods for effective water quality monitoring, assessing the causal relationships with sources of pollution in all sectors, and enhancing staff skills through training programs.

In addition to providing support for judicial reforms, Missions in the region could make a significant contribution by balancing the negative principle, "the polluter pays," with support for more positive approaches. For example, introducing pollution prevention policies in core environmental programs and supporting waste minimization techniques for industry and agriculture are ways of achieving regulatory compliance by reducing and eliminating the release of pollutants into the water system. Aggressive technical assistance can promote changes in processes, procedures, technologies, and materials, the costs of which can often be recovered relatively quickly.

Introduce Pollution Prevention Techniques

Techniques to prevent pollution of surface and groundwater provide long-term benefits, particularly as countries in the region expand their efforts to industrialize.

Traditional pollution control, wastewater treatment, and waste management techniques addressed the effects of pollution. Now it is often technically feasible and economically advantageous to make changes within industrial and agricultural systems to address the sources of pollution. Traditional environmental controls, such as wastewater treatment plants and landfills,

also added to production costs, particularly when complicated by government environmental regulations. Regulatory programs in developing countries will inevitably increase, but even without strong regulatory programs authentic pollution prevention techniques offer a broad range of economic benefits.

Experience in U.S. companies generally indicates that one quarter to one half of the economic benefits of waste reduction projects are not related to regulatory compliance. These benefits derive from reducing raw material costs, improving overall efficiencies, reducing energy use, improving yields and product quality, and generally increasing the use of state-of-the-art technologies that increase competitiveness.

In the nearer term, with either minimal government regulation or weak enforcement of environmental regulations, fostering the use of economically advantageous pollution prevention approaches can discourage the indiscriminate dumping and discharge of chemicals and wastes that pollute surface and groundwater and ultimately require very expensive cleanups. Near Eastern countries have an opportunity to mitigate a major contribution to water scarcity and to avoid the costs for groundwater cleanup programs faced by the United States and other industrialized countries. Pollution prevention technologies also generate a safer occupational environment for workers, reduced health care costs, and improved labor productivity.

Missions can identify opportunities to incorporate pollution prevention principles and programs in new and current environmental, water resources, and economic development efforts. Three main targets are critically important for immediate reduction:

- contamination levels of organic compounds and toxic metals in water effluent from both agricultural non-point sources and industrial point sources
- uncontrolled release of toxic chemicals from industrial facilities into the air, which can then reach and pollute surface and groundwater
- generation of solid and toxic wastes which, when treated or disposed on land, may contaminate groundwater

Some key technical approaches for reducing man's chemical impact on surface and groundwater include:

- reducing the use of toxic chemicals in agriculture (pesticides and fertilizers) and industry (organic solvents, solvent-based paints and inks, and lead compounds)
- recycling toxic materials within operations or finding uses for all by-products in other industries

- changing process technologies to eliminate or reduce uncontrolled releases of toxic chemicals into the environment
- improving process control instrumentation in manufacturing
- changing many routine maintenance, materials handling, and chemical inventory procedures and operations to limit the use and loss of hazardous materials

Many techniques to prevent pollution can be introduced inexpensively in a short time frame with rapid payback. Other methods, such as in-plant recycling, require new equipment. Careful economic analysis is required to demonstrate the long-term net benefit of each innovation, especially if government regulations do not provide an economic incentive for pollution prevention.

One technique which has proven very successful is the introduction of new equipment to remove and reuse valuable materials that otherwise contaminate water effluent. Electroplaters use ion exchange or reverse osmosis equipment to remove metals, and metalworking industries use ultrafiltration to separate oily material from water. In both cases, clean water is safely discharged or reused as an input to the industrial operation, thereby reducing the demand for new water. The inevitable losses from evaporation and small leaks can also be minimized through efficient water recycling.

In some industrial cases, it has also proven appropriate to redesign or reformulate the packaging of end products, while in other cases a longer-term action plan of changing the product has proven necessary.

To achieve sustained pollution prevention efforts in both small and large industries, however, certain components are central to success: in-plant education and training for the entire work force; strong support from senior management; economic incentives to workers for waste reduction ideas and accomplishments; information collection about types, quantities, and sources of contamination; and waste reduction audits.

Industries located near water supplies can be targeted for technical assistance and demonstration projects. New networks among technical professionals and academics in Near East countries need to be developed to foster information transfer and advanced training. These programs can be implemented in the near term.

Measuring positive progress in pollution prevention progress is a key ingredient for sustaining programs, justifying new ones, and seeking assistance from international lending institutions. The Near East Bureau is already assisting Missions and cooperating countries to identify industries that are candidates for introducing pollution prevention techniques and establishing linkages between companies in the United States and in the Near East. These

efforts will expand in the future as the Bureau plays an important intermediary role in bringing together complementary groups for the transfer of pollution prevention technology.

Foster Local Capacity for Water Protection

Protecting the integrity of water resources is too important to be limited to either technical approaches or government regulations, enforcement, and incentives. While end users are among the most flagrant polluters of water, they are also among the most dependent on the maintenance of its quality. Contamination of the upstream flow or of groundwater can have devastating impacts on the health and financial resources of households and their surrounding community.

While community-based strategies are presently being employed by NGOs in Southeast Asia to promote forest conservation, the direct relevance of this approach for the water sector is questionable given the nature of the resource. (Water can rapidly change location and composition.) Nonetheless, the concept of shifting responsibility for the protection of a resource to end users is important.

Mobilizing public interest NGOs has proven to be one of the most effective approaches for improving government policies and programs as well as private sector performance in both developed and developing countries. More specifically, community members require assistance and training to identify polluters and to monitor water quality using clear, defined standards. Governments need to participate in this effort by developing mechanisms for reporting illegal emissions and unacceptable levels of pollutants so that penalties can be imposed and violations remedied.

The essential components of resource stewardship are training and public awareness programs for end users who need to better understand the implications of water use for the continued existence of high-quality water, a strong economy, and the health and well-being of community members.

The Near East Bureau and its Missions can identify and assess opportunities to assist countries in resolving their water resources issues by using nontraditional approaches. For example, innovative, community-based tenurial strategies are being used to secure legal rights to natural resources as incentives to users to conserve and manage those resources.

The Bureau and the Missions can explore areas for increased end user responsibility for water quality by extending the concept of "stewardship" over water resources to end users.

For example, upstream users and other polluters in the Near East are not held accountable for contaminating the water supply. Missions can assist

cooperating countries in exploring innovative roles for end and downstream users to accept responsibility for the protection of the resource. With support from Missions, NGOs can parallel government efforts to build local interest in protecting their water supply.

A.I.D. has proven to be a leader among donor agencies at designing and carrying out programs in human resource development and public awareness. This experience should be used by Missions in the region to assist users in playing more participatory roles to protect the quality of their natural resources.

IMPROVE WATER MANAGEMENT 6

For more than a decade, A.I.D. and other donors have joined with cooperating countries in the Near East to develop the physical infrastructure for water delivery and disposal systems for irrigation, potable water, and sanitation. Both donors and cooperating countries are now shifting their financing from development of new systems to the management of existing systems.

Poor maintenance of the physical infrastructure of water delivery and disposal systems, for irrigation as well as for potable water and sanitation, undermines the effectiveness of country and donor investments in water facilities and limits the benefits that can be derived from those investments. In the absence of adequate maintenance, neglected systems deteriorate and may require costly rehabilitation soon after construction is completed. Needless to say, deteriorated systems are unable to meet water delivery schedules.

The source of financing the cost of maintaining system infrastructure is still at issue throughout the region as governments decide the appropriate financial and management responsibilities of users. A major theme of the water resources action plan is to more fully involve the private sector, both in participating countries and in the United States, in improving the management of water resources in the region.

The current situation of increasing water shortages and degraded water quality is exacerbated by severe budget constraints, which prevent addressing the problems directly. Therefore, cooperating countries are seeking innovative, and occasionally radical, solutions to seemingly intractable problems of water resources management. These solutions are likely to include significant changes in financial and management responsibilities.

Strengthen Public Sector Services

Over the next ten years, a modest realignment in the roles played by the private and public sectors in providing services for water resources projects is likely to evolve. The private sector is expected to become increasingly active in operating and maintaining existing projects as the public sector takes major responsibility for planning and research, investment in civil works, and resource stewardship. An understanding of the evolving division of responsibilities between the two sectors is critical to A.I.D. if it hopes to be positioned to influence the change.

Planning and research in water resources, historically a government responsibility, must be long-term, coordinated, and comprehensive. Government

agencies are best prepared to achieve these criteria. The most appropriate role for Missions is to:

- strengthen education and training to promote the development of an adequate human resource base for the water sector
- provide access to equipment and data bases to facilitate analyses
- encourage interagency coordination and bilateral cooperation in water resources management

Investment in civil works for water resources has traditionally been a public sector responsibility and will continue as such.

Missions can assist cooperating countries by:

- providing financial support to projects, while leveraging that support against objectives designed to increase user financing of the services, divest management responsibility to the private sector, and heighten environmental protection
- promoting dialogue among donors to help ensure that lending programs for water resources projects meet common objectives

A central component of resource stewardship for water resources is the establishment of a set of policies, regulations, and means to protect the environment. This will become an increasingly central role for water resources agencies, particularly as their traditional roles in operation and maintenance decline in importance. Missions can assist these agencies to overcome their initial resistance to this new role by working with them to:

- incorporate environmental concerns into their operations
- establish a series of financial instruments designed to reward individuals and corporations for adopting water pollution prevention technologies and to fine others for failure to prevent damaging pollution
- introduce successful consumer-oriented awareness and education programs for pollution prevention and water conservation
- foster the resolution of issues between countries sharing common water resources

Expand Financial Responsibility

Urban and irrigation water systems in the past have generally been provided and paid for by governments no longer able to bear this cost. Existing systems are deteriorating for lack of recurrent funds, and needed new systems and system expansions are not being built. Increasingly, urban water and sewer users are required to cover at least the costs of operations. The collection of

water fees from poor farmers and residents of periurban areas is very difficult. An approach to this problem in urban areas is to combine differences in levels of service between periurban and better off residents and also to provide cross-subsidization.

Cost sharing for irrigation, where all the beneficiaries of these systems contribute to the costs, is an increasingly attractive alternative for some governments, such as in Egypt. Mobilization of user funds for new works requires determining users' willingness to pay, involving users in the planning process, and, in many cases, establishing local institutions for the creation of capital. There is little experience in these areas in most developing and newly democratized countries. Divestiture of existing services and private provision of new services are increasingly becoming goals of governments.

USAID Missions can play an importance role in expanding financial responsibility for water services by:

- initiating a policy dialogue with cooperating countries on the advantages of cost sharing over cost recovery, shifting the focus from extracting payment from water users to determining the appropriate and reasonable contributions and obligations of all parties; assisting cooperating countries in determining the costs of water systems, including the costs of repair, structure replacement, and rehabilitation; identifying system beneficiaries and the allocation of benefits among them; and analyzing and exposing the real costs consumers pay for use of the water
- assisting governments to establish appropriate policies for the financing of urban and rural water supply and sanitation, sewerage, and irrigation systems and developing appropriate legislation in their support
- assisting governments and water, sanitation and sewerage service providers to evaluate costs, and capital and revenue generation options
- conducting workshops and study tours and assisting in setting up twinning arrangements with U.S. service providers to familiarize decision-makers and financial managers with financing and privatization issues and initiatives in the U.S. and with cost-sharing initiatives in other countries, such as Indonesia and the Philippines

Transfer Management Responsibilities

Over the past two decades, A.I.D. has been the leading donor to conceptualize and support efforts to shift management responsibilities from government agencies to end users. This shift is one solution to an apparent inability of government entities to provide adequate operation and maintenance support to users. Two models most commonly offered are system turnover, the transfer

of management responsibilities to users, and privatization, the transfer of the ownership of system assets to private sector users. Both can result in reduced government subsidies for irrigation and water supply, increased financial autonomy, and decentralized decisionmaking. Greater accountability by system managers, most often government officials, to their clientele could lead to improved system maintenance. Operation can be improved and water service fees reduced if users take a more active role in system operation and maintenance.

A common mechanism in Asia is water users associations, which although been variably successful and frequently disappointing, have become part of development rhetoric. They are now seen to be a necessary part of improved system performance and user participation. However, there have been surprisingly few attempts to assess the overall experience critically. A serious examination of the sustainability of these groups and their effectiveness in carrying out system turnover and cost sharing programs is needed.

USAID Missions can support efforts to transfer management responsibility to users make public sector entities more accountable by working with countries to:

- determine appropriate public and private sector management roles
- institute and expand participatory program for end users
- explore models for transfer of responsibilities which require low investment in labor and capital
- conduct workshops and study tours to acquaint officials with divestment issues and initiatives in other countries
- develop necessary policy instruments and legislation to support turnover schemes

Encourage Private Sector Services

Investment in water resources facilities now is largely a public sector responsibility. Because of limited resources for new public investments and inadequate public sector managerial capability, governments are re-examining their infrastructure investment strategies to explore the possibilities for private investment. Experience has shown that privatization supports improved water resources management and environmental protection. Models exist in other sectors for greater private sector participation.

Build-operate-transfer (BOT). The private sector builds an investment, operates it for a limited period, and then transfers it to the public sector or to a community of users. BOTs have been used for privately financed construction of roads and power plants. They would be appropriate for irrigation

systems, municipal and industrial water facilities, and sewage treatment plants.

Build-operate-own (BOO). The private sector entity builds, operates, and continues to own the facility. In either BOT or BOO, the public sector must establish close oversight of the private sector with regard to tariffs charged for the services provided.

The concession. The government builds a water resources facility and leases management of the infrastructure to a private group. If the private group is a benefitted community of users, the concession model is akin to transferring responsibility to users for both management and operations and maintenance.

Government subsidies for water services are a severe disincentive for transfer of operations and maintenance responsibilities. Mission support for increases in water charges will facilitate transfer to the private sector. Anther impediment to transfer is the government's preference to remain involved in management.

Encouragement by Missions for government bureaucracies to assume new roles and responsibilities in support of environmental stewardship may make it easier for those bureaucracies to relinquish traditional functions such as management of water systems.

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APPENDICES

WATER RESOURCE PROFILES OF NEAR EASTERN COUNTRIES

Appendix A

EGYPT

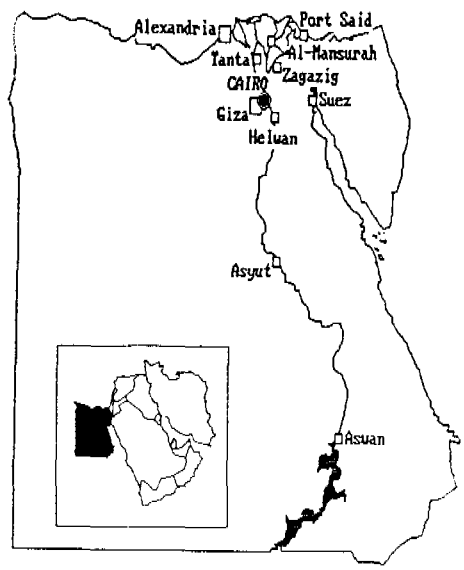
Population (1990)	56.0 million
Population Growth Rate (world = 1.8%)	2.6%
Urban Population	45%
Gross National Product (1990)$	32,926 million
Per Capita GNP (1990)$	590
Land Area	995,450 sq. km.
Potential Water Available (mcm/yr) Surface/Ground	85,500/3,500
Developed Water Resources (mcm/yr) Surface/Ground	85,500/3,500
Projected Water Demands (2000)	70,000 mcm/yr
Surplus/(shortfall)	19,000 mcm/yr
Total Supply Per Capita	3,500 l/day
Water Use by Sector Ag/Ind/Mun & Dom	88/5/7%
Water Resources Originating in a Neighboring Country	90+%
Population Access to Safe Water Urban/Rural	88/64%

ALTHOUGH Egypt is largely desert, its water supply is abundant. Egypt is well supplied with 59 bcm of water, of which 55.5 bcm is its allocation of Nile waters. In addition to Nile waters, Egypt has extensive groundwater resources, withdrawing 3.5 bcm annually. Expanding the water supply will be a high priority since Egypt will be faced with serious annual water shortages in the future as a result of high population growth, an increase in industrial water use from 4 to 6 bcm, and desert reclamation, which annually requires 7 to 9 bcm.

In 1959, Egypt and the Sudan agreed to share Nile waters. None of the other seven Nile riparians participated in this agreement although nearly all the water originates in these countries. The Blue Nile and the Atbara, which originate in Ethiopia, provide 86 percent of Nile flow. Currently, neither Ethiopia nor the other riparians abstract large volumes of Nile water. Fortunately, their economic development is not yet constrained by water availability, but future growth of the upper riparians could cause difficulties for Egypt (United Nations Water Series No. 9).

Development in Egypt has always been dependent upon the Nile River, but groundwater reserves are also available. The Eastern Desert has limited groundwater potential, but the Nubian Sandstone aquifer underlies a large part of the Western Desert and is interconnected with aquifers in northern Sudan and eastern Libya. The Sinai has potentially productive aquifers, recharged from Lebanon, Syria, and Israel, which still require exploration (United Nations Water Series No. 9).

Current estimates of the annual groundwater exploitation rate are at 1 bcm. Land reclamation, the expanded agricultural sector, and a population growth rate of 2.4 percent have required a great deal of groundwater. Consequently, sprinkler systems and drip irrigation methods have been successfully implemented to control the harmful effects of past inefficient practices. Salinated water, fertilizer, and pesticides runoff from marginal irrigated land have damaged the fertile soil and now threaten drinking water supplies. Drinking water supplies are also polluted by industrial waste and poorly managed wastewater. Crude oil threatens Egypt's coastal resources and unique ecosystems (Shahin 1989).



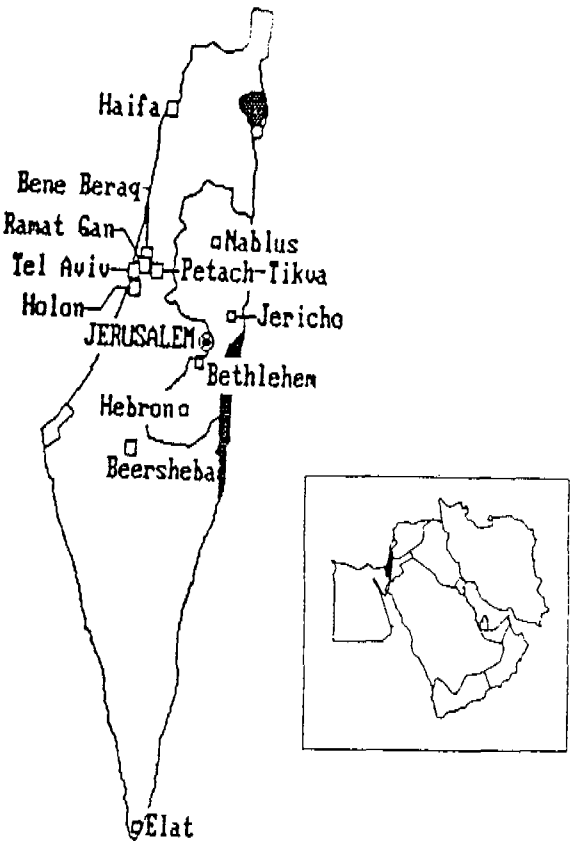
ISRAEL

Population (1990)	4.6 million
Population Growth Rate (world = 1.8%)	1.7%
Urban Population (1960/65/90)	77/87/90%
Gross National Product (1990)$	38,441 million
Per Capita GNP (1990)$	8,360
Land Area	20,325 sq. km.
Developed Water Resources (mcm/yr) Surface/Ground/Other	500/1,230/220
Projected Water Demands (2000)	2,500 mcm/yr
Surplus/(shortfall)	(550) mcm/yr
Total Supply Per Capita	1,500 l/day
Water Use by Sector Ag/Ind/Mun & Dom	79/5/16%
Water Resources Originating in a Neighboring Country	15-50%
Population Access to Safe Water Urban/Rural	100/97%

ISRAEL is one of few countries in the Near East region that relies more on groundwater than on surface water, requiring an extensive and complex program of recharge. Water supply statistics of 1972, compared with the statistics of 1990, show a dramatic shift away from conventional means of water resource management. The distribution breakdown of 1.5 bcm water consumed in 1972 was 56 percent from groundwater, 41 percent from surface water, 3 percent from renovated wastewater, and .1 percent from desalinized waters. In 1990, total water consumption was 1.9 bcm, drawing 45 percent, 34 percent, 19 percent, and 2 percent respectively. Through nonconventional water supply methods, Israel has increased its total water consumption, but it has decreased its extraction of ground and surface waters. Nonetheless, the Israeli population may exceed 6 million by the year 2020, implying severe water shortages in the future (Kolars 1992).

Israel has already developed virtually all its fresh water resources. It has emphasized water conservation in household use and through dryer processes in industry and recycling. Major savings, however, came in the agricultural sector through innovative sprinkler and drip irrigation methods. Innovations like these will be necessary to cope with the large number of immigrants and the subsequent added demand for safe water. Water supplies are already tainted by salt water and chemicals used in its agricultural sector, and development along the Mediterranean coast has polluted the coastal ecosystem (World Research Institute 1992a).

Israel reinforced its control over disputed water resources through its occupation of the Golan Heights and the West Bank. Control of the Golan Heights gives Israel access to both banks of the Jordan River above the Sea of Galilee, providing Israel with 40 percent of its potable water and 80 percent of all water allocated to its agricultural sector. Control of the West Bank gives additional access to the Jordan River and, more importantly, access to the productive West Bank groundwater aquifers.



JORDAN

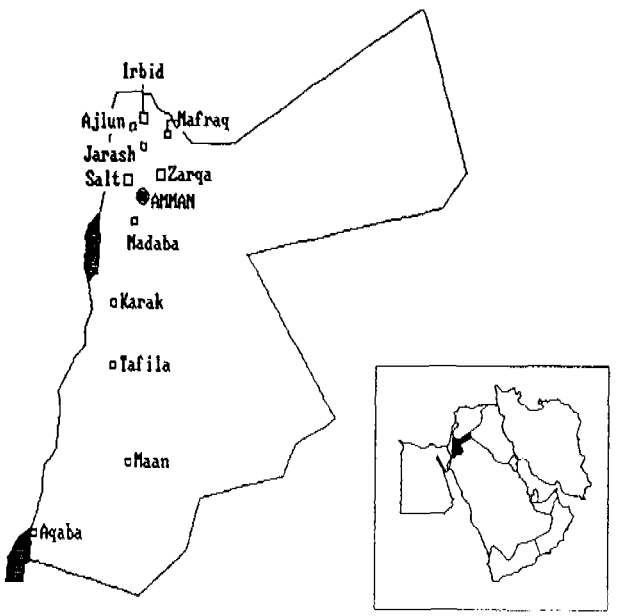
Population (1990)	4.0 million
Population Growth Rate (world = 1.8%)	3.4%
Urban Population (1960/65/90)	43/55/68%
Gross National Product (1990)$	5,906 million
Per Capita GNP (1990)$	1,480
Land Area	89,207 sq. km.
Potential Water Available (mcm/yr) Surface/Ground	1,000/600
Developed Water Resources (mcm/yr) Surface/Ground	395/400
Projected Water Demands (2000)	1,100 mcm/yr
Surplus/(shortfall)	(370) mcm/yr
Total Supply Per Capita	750 l/day
Water Use by Sector Ag/Ind/Mun & Dom	71/5/24%
Water Resources Originating in a Neighboring Country	15-50%
Population Access to Safe Water Urban/Rural	100/88%

JORDAN is mostly desert and rocky terrain, with fertile uplands west of the Jordan River and in the plateau east of the Jordan Valley. In the mountainous plateau area east of the Jordan Valley, rainfall amounts are the highest, and they decrease rapidly to the eastern desert areas and then more gradually to the south toward the Gulf of Aqaba. The Gulf of Aqaba is the final destination of surface waters from the Jordan Valley, the Dead Sea Basin, and the Wadi Araba catchments.

Freshwater available to Jordan will be adequate to meet demands through the year 2000. Surface water annually available to Jordan is currently under 1 bcm. Groundwater is important for settlements, from cities to villages throughout Jordan, providing about 600 mcm, from which about 400 mcm is withdrawn annually, and is also used for irrigation. The Jordan Valley, where the bulk of its irrigated agriculture is located, is the most productive agricultural area, demanding about 65 percent of its annual water consumption. Greater conservation efforts in the agricultural sector are being considered by Jordan to cope with less than half the resources available to meet the demand for water in the year 2030 (Shahin 1989).

Since water is so valuable in Jordan, investment in physical infrastructure to allocate its water resources better is central to development. Some examples include the East Ghor Canal, which parallels the Jordan River at the foot of the escarpment on the east bank, and the King Talal Dam and reservoir on the Zarqa River. A few smaller dams on other streams serve many of Jordan's immediate demands for water.

Jordan faces other serious problems indirectly related to its limited water resources. Water management and conservation practices are ineffective in meeting current demands, and they will become more necessary in any effort to stem rapid population growth. Indeed, population growth remains unchecked in a country where 97 percent of its population lives in a narrow area east of the Jordan River. Without proper planning, urban sprawl could consume its most fertile cropland. Urban cesspools containing industrial waste and raw sewage already jeopardize drinking water supplies and general sanitation (World Resources Institute 1992a).



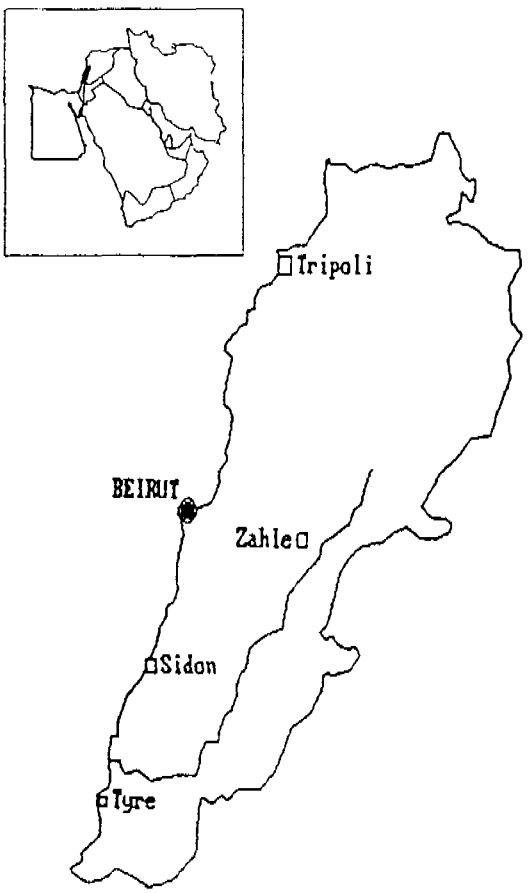
LEBANON

Population (1990)	2.9 million
Population Growth Rate (world = 1.8%)	2.1%
Urban Population (1960/65/90)	40/69/84%
Land Area	10,400 sq. km.
Potential Water Available (mcm/yr) Surface/Ground	4,380/600
Developed Water Resources (mcm/yr) Surface/Ground	700/200
Projected Water Demands (2000)	1,400 mcm/yr
Surplus/(shortfall)	(500) mcm/yr
Total Supply Per Capita	1,300 l/day
Water Use by Sector Ag/Ind/Mun & Dom	84/4/11%
Water Resources Originating in a Neighboring Country	15-50%
Population Access to Safe Water Urban/Rural	94/18%

SIXTEEN perennial rivers, fed by springs or runoff from the Lebanon Mountains, supply the country with most of its water resources. The Beqaa Valley in eastern Lebanon is drained by the Orontes and the Litani Rivers. The Orontes flows north into Syria and then into Turkey, carrying substantial amounts of water out of Lebanon. The Litani flows south, turns sharply west and empties into the Mediterranean, providing Lebanon with its only large permanent storage reservoir.

An estimated 5 bcm of annual water resources are available to Lebanon. Only a little more than 500 mcm of renewable groundwater are available to Lebanon annually. All other water supplies must be withdrawn from its surface waters. Nevertheless, current demand estimates extrapolated to the year 2030 predict that Lebanon will eventually require about 3 bcm of water and is well supplied for that amount (Shahin 1989). Lebanon's water surplus could be used for export and could bring much needed income to its economy.

Although the problems associated with rebuilding Lebanon after its civil strife may be somewhat alleviated by its plentiful water supply, the quality of that water is an important national water resources policy issue. The civil war is responsible for the destruction of much vegetation, causing widespread soil erosion and permanent damage to the watershed. Large amounts of chemicals and raw sewage dumped into the Mediterranean pollute Lebanon's coastal waters. The coastal ecosystem has been so damaged that fish shortages are expected (World Resources Institute 1992a).



MOROCCO

Population (1990)	25.0 million
Population Growth Rate (world = 1.8%)	2.5%
Gross National Product (1990)$	19,854 million
Per Capita GNP (1990)$	800
Land Area	445,000 sq.km.
Potential Water Available (mcm/yr) Surface/Ground	22,500/7,500
Projected Water Demands (2000)	7,000 mcm/yr
Surplus/(shortfall)	9,000 mcm/yr
Total Supply Per Capita	1,300 l/day
Water Use/Sector Ag/Ind/Mun & Dom	91/3/6%
Water Resources Originating in a Neighboring Country	>50%
Population Access to Safe Water Urban/Rural	73/17%

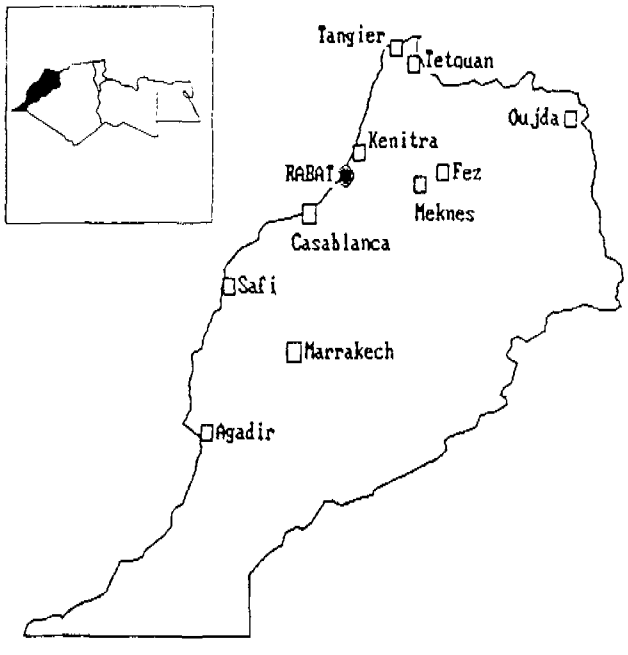
MOROCCO lies in a moderate zone, but its climate varies from desert to subtropical within an area slightly larger than California. Its topography varies as much as its climate and includes both rich fertile plains along the coastal areas and the three Atlas Mountain ranges in its interior. They form an enormous catchment area for one of the Near East's most extensive river systems.

Water resources are plentiful in Morocco, yielding annually rechargeable water resources of about 30 bcm, of which 20 are supplied by its dense river system. Principal rivers in Morocco are the Moulouya, Bou Regreg, Om er Rbia, Tensift, Sous, and Sebou. The Sebou and its tributaries supply 45 percent of Morocco's surface water resources. Spring water provides an additional 2.5 bcm to their supply, and rechargeable groundwater is estimated at 7.5 bcm.

Morocco's record on water supply management is mixed. All its urban population has access to safe drinking water and sanitation services, but only a small fraction of its rural population has similar access (World Resources Institute 1992b). Nonetheless, estimates suggest that Morocco has twice the amount of water it needs for the year 2030, leaving enough for potential export (Shahin 1989).

The institutional capacity of Morocco to manage its water resources environmentally and economically will determine the fate of its water resources. For example, the agricultural sector of Morocco's economy employs about 46 percent of the labor force, yet it only accounts for 16 percent of the Gross National Product. Such a small return on agriculture, requiring such a large percentage of the labor force and annual freshwater withdrawal, suggests a growing need for careful and efficient management of its watersheds.

Additionally, poor wastewater management in Morocco implies increased potential for disease in drinking water supplies. Pollutants from oil and other industries endanger Morocco's highly profitable fishing trade off its Atlantic coast, which is one of the most fertile fishing areas in the world (World Resources Institute 1992a). Careful attention to these issues is paramount to long-term sustainable development in Morocco.



OMAN

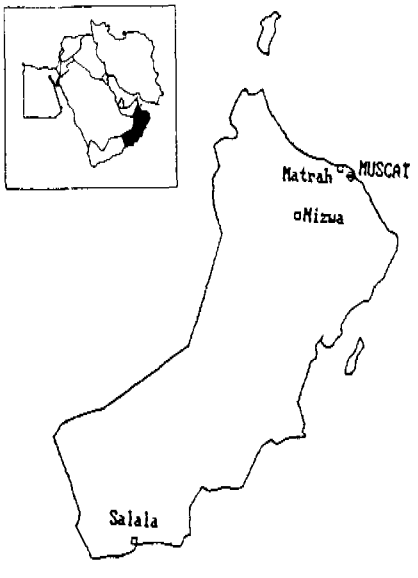
Population (1990)	1.5 million
Population Growth Rate (world = 1.8%)	3.8%
Gross National Product (1990)$	7,100 million
Per Capita GNP (1990)$	4,740
Land Area	212,455 sq. km.
Potential Water Available (mcm/yr) Surface/Ground	1,470/560
Developed Water Resources (mcm/yr) Surface/Ground	470/560
Projected Water Demands (2000)	1,100 mcm/yr
Surplus/(shortfall)	900 mcm/yr
Total Supply Per Capita	2,000 l/day
Water Use by Sector Ag/Ind/Mun & Dom	94/3/3%
Water Resources Originating in a Neighboring Country	>50%
Population Access to Safe Water Urban/Rural	90/55%

THE northern part of Oman is dominated by the Oman Mountain range, with a fertile coastal plain in the east and gravel plains leading to a desert in the west. Runoff from the mountains is discharged partially into the sea, but it also penetrates the gravel and sands of the wadis and is released as perennial flow. Oman has both deep fossil aquifers, which extend over large portions of the Arabian Peninsula, and shallow aquifers in the alluvial fans and coastal plains of the north and Dhofar in the south.

The freshwater supply in Oman is currently adequate to meet demand. Oman has an annual water supply in excess of 1.4 bcm in surface runoff and possibly an additional .6 bcm in groundwater. Most groundwater extraction comes from the shallow aquifers, from which the people use drainage galleries, called *aflaj,* for drinking water and irrigation supplies. The introduction of water pumps into Oman threatens the formerly productive aquifers, not enabling them to recharge adequately. Future estimates reveal a very substantial deficit by the year 2030, possibly exceeding 3 bcm (Shahin 1989).

The Oman Water Resources Council is responsible for the administration of its national water resources. Responsibilities include coping with the technical problems of salt water intrusion into the shallow aquifers of the northern coastal area, net surface water losses to the sea or the desert, inefficient water use, legal problems of existing water rights, and the assignment of the priorities for using water (United Nations Water Series No. 9). The Council may also need to address social issues associated with the transition toward nontraditional methods of water resource usage. Farmers can no longer count on community support during a drought because of changes in property rights associated with the changes in irrigation methods.

The assignment of water user priorities is becoming increasingly critical to the environment. As the level of the water table falls in northern Oman, the irrigation pumps draw water that is sometimes too saline to use in farming. The coastal resources of the Gulf of Oman and the Straits of Hormuz are polluted by the heavy traffic associated with the oil industry. These and other environmental concerns may require attention in order to maintain existing water resources.



TUNISIA

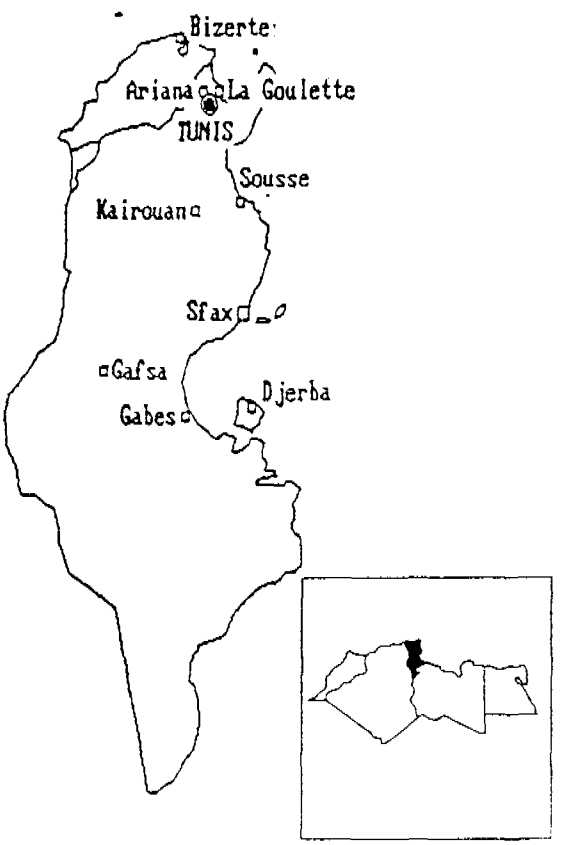
Population (1990)	8.2 million
Population Growth Rate (world = 1.8%)	2.4%
Gross National Product (1990)$	9,589 million
Per Capita GNP (1990)$	1,170
Land Area	155,360 sq. km.
Potential Water Available (mcm/yr) Surface/Ground	2,500/1,500
Developed Water Resources	1,100 mcm/yr
Projected Water Demands (2000)	3,000 mcm/yr
Total Supply Per Capita	1,000 l/day
Water Use by Sector Ag/Ind/Mun & Dom	80/7/13%
Population Access to Safe Water Urban/Rural	97/17%

TUNISIA has one perennial river, the Mejerda, which flows from Algeria's northern region and empties into the Gulf of Tunis. In addition to the Mejerda, Tunisia has the Malyan, a tributary of the Mejerda; intermittent streams in the northern hydrographic region; a few streams in the central region; and very few in the southern desert, which contains some artesian springs. Tunisia's highest rainfall area is in the north; rainfall is lower in the central region and even lower in the southern region, which is part of the Sahara Desert.

Because of the great climatic and hydrographic variations from north to south, Tunisia has developed a water master plan for each of the three regions. Tunisia must still cope with the health hazards of untreated urban sewage and an annual groundwater exploitation rate of .7 bcm. Tunisia's annual water balance is expected to become negative around 2030 (Shahin 1989).

All water resources in the country are under the jurisdiction of the Ministry of Agriculture, and 40 percent of the agriculture sector budget in the 1982-1986 National Plan was allocated to water resources development. Heavy emphasis was placed on water resources development in the late 1960s in order to provide irrigation, hydropower, and public water supplies. Government investment resulted in sixteen or more dams and reservoirs, which are primarily in the north with some in the central region, and a very substantial deep and shallow well drilling program.

Large irrigation projects are related to serious environmental concerns in Tunisia. Most of the arable land in Tunisia is rainfed (97.5 percent). Thus, the poorer land requires irrigation, and large-scale erosion potential is very high for the marginal land of Tunisia's central region. Indeed, such widespread land degradation could diminish vegetation and watersheds and result in desertification. Desertification implies serious consequences for a country where water is already precious and the annual population growth rate is 2.4 percent.



YEMEN

Population (1990)	11.7 million
Population Growth Rate (world = 1.8%)	3.7%
Gross National Product (1990)$	6,426 million
Per Capita GNP (1990)$	550
Land Area	537,000 sq. km.
Potential Water Availability (mcm/yr)	
Surface/Ground	3,800/1,400
Projected Water Demands (2000)	3,100 mcm/yr
Total Supply Per Capita	800 l/day
Water Use by Sector	
Ag/Ind/Mun & Dom	93/2/5%
Water Resources Originating in a Neighboring Country	15-50%
Population Access to Safe Water	
Urban/Rural	89/31%

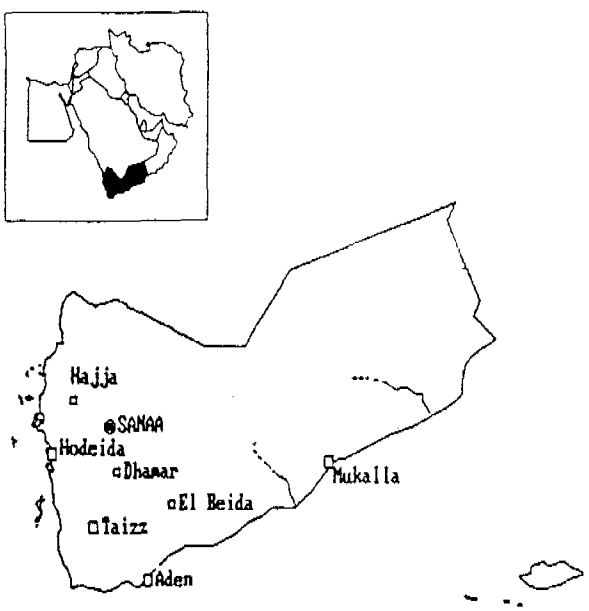
SHARP contrasts in Yemen's topography reveal the unstable nature of its weather patterns and its water resources. Rainfall is often torrential, causing severe floods. The annual rainfall of the western slopes, amounting to 1,000 mm, drains mostly into the Red Sea. However, annual rainfall amounts to only 80 mm on the Red Sea Tihama coastal plain and the eastern desert. Yemen's perennial streams are fed intermittently by springs in the north; these streams supply agricultural areas on the western and eastern mountain slopes. However, streams in the south flow erratically and floods are common, making their resources difficult to harness.

Yemen has adequate water resources through the end of this century. Surface water potential is estimated at about 1.5 bcm. However, the most reliable resource is groundwater, supplying Yemen with about 1 bcm every year, available from dug or drilled wells in both large cities and rural villages. Projected water demands for northern Yemen in 2030 will exceed available supplies by more than 50 percent, whereas the south will still be adequately supplied (Shahin 1989).

In 1991, the People's Democratic Republic of Yemen and the Arab Republic of Yemen merged into the Republic of Yemen. More than half of Yemen's population lives in what was the north, yet most of its water resources are in the south.

The Government recognizes the importance of water resources in the development of the country. Many water supply projects are either underway or planned; they will supply urban areas with drinking water and enable cropland to be irrigated. However, these efforts are severely constrained by the lack of countrywide knowledge of water resources, inhibiting Yemen's capacity to plan and coordinate the development. For instance, rainfall has traditionally provided Yemen with water from cisterns. Unfortunately, since the catchments are not protected, the cistern water is a major health hazard. Yemen also lacks adequate sewage and wastewater treatment systems. (World Resources Institute 1992a).

Freshwater supplies are endangered by a number of other factors as well. Many aquifers are pumped beyond their recharge capabilities, especially in the south. Irrigation systems are also inadequate to withstand the severe floods that occur in the marginal semi-desert land in the Tihama plain. The management of its water resources by the Government of Yemen may be one of the greatest challenges faced by any Near Eastern country.



STAGES OF DEVELOPMENT IN WATER RESOURCES MANAGEMENT IN THE NEAR EAST

Appendix B

This section presents a historical overview of water resources management in the Near East with emphasis on the Islamic context, the colonial period, and the modern nation state. Although characterized by water scarcity, the Near East has a long history of innovative and successful attempts to deal with problems of water supply and demand. A historical examination of water resources management in the region provides insight into contemporary patterns of resource use.

The Ancient Near East

In the ancient Near East, civilizations flourished in the Nile and Tigris-Euphrates valleys. There, plentiful river flow enabled relatively dense populations to produce an agricultural surplus that supported a variety of economic activities and a complex social structure.

In Egypt, basin irrigation prevailed from antiquity until the nineteenth century. Dikes were breached when the floods came in mid-August, and the flood water would remain on the land until the silt settled. Once the flood receded, excess water was drained back into the Nile through a system of canals, and crops were planted in the fresh sediment. This method produced a single winter crop each year. Productivity was closely tied to the volume of the flood waters. If they were too high, the land remained flooded past the time of sowing and the crop was lost. If they were too low, the cultivated area was restricted and food scarcity followed.

The regime of the Tigris and Euphrates differs from the Nile. The volume of water is more variable, and, until recently, spring flooding was extensive in the alluvial plain. The annual floods were controlled to some extent by embankments and canals. These were maintained by forced labor and an irrigation bureaucracy. Waterlogging and salinity have been problems from ancient times, especially in the Tigris-Euphrates plain, although the practice of alternate-year fallowing slowed the accumulation of salts. Over the centuries, salt-tolerant barley gradually replaced wheat as the main crop, but barley eventually declined in productivity. This decline indicates that excessive irrigation degraded the productivity of the land. (Jacobsen 1982).

In Mesopotamia, wheat and barley were equally important around 3500 B.C., but by 2000 B.C. wheat had disappeared. Barley yields declined by two thirds between 2400 and 1700 B.C., and there are references in the cuneiform documents of the time to salty patches on the land. A new canal from the

Tigris increased the supply of water from 2400 B.C.; over-irrigation is thought to be responsible for the spread of salinity in the south (Walters 1970).

Although water was plentiful in the Nile Valley and Mesopotamia, it was used primarily for winter cereals and the cropping intensity was low. Outside the great river valleys, water was scarce. Vestiges of Roman aqueducts, built to carry water to provincial cities, can be found throughout the region. There is archaeological evidence in Libya and the Negev that runoff farming was practiced in areas of very low rainfall where there was a need to establish permanent settlements to guard the frontier. In the countryside, much of the population was engaged in small-scale farming and herding.

Groundwater was used on a small scale by wells with a variety of water-lifting devices. It was also exploited on a larger scale with continuous flow from the *qanat*. This system of wells and tunnels for delivering groundwater by gravity flow originated in Persia in the first millennium B.C. and spread to the Mediterranean and South Arabia with the Achaemenian Empire.

A variety of water-lifting technologies, which were available in ancient times, are still in use today. The *shaduf* uses a counter-balanced bucket, while the Archimedes' screw draws water up through a cylinder. Both rely on manpower and the lift is limited to a few feet. Devices using animal traction increase the volume of water and the lift. These include the waterwheel, or *saqia*, which uses gears and the *dalu*, where the draft animal uses an inclined ramp to draw up well water in a large skin bag. Finally, waterwheels using water power were also in use in antiquity.

The Rise of Islam

Islam arose in Arabia in the seventh century and spread quickly to the Mediterranean coast, across North Africa and into Spain, and eastward into Iran and India. The early centuries of Islam were especially dynamic, and the new civilization provided the context for innovation and development in many areas.

Islamic Cities

With the rise of Islam and its rapid spread through conquest, many new and cosmopolitan urban centers emerged. Some, like Damascus and Baghdad, were built in the vicinity of pre-Islamic cities and differed only in their composition. Others grew from military camps, such as Basra, Cairo, and Kairouan. All were dependent on a productive agricultural hinterland, and all had a reliable water supply.

Kairouan, located in the interior of Tunisia, was supplied by enormous cisterns that collected runoff in an area far drier than the coastal site of ancient Carthage and modern Tunis.

Where rivers existed, aqueducts and waterwheels were used for urban water supply. In Syria, a large waterwheel about 20 meters in diameter with 120 compartments in the rim raised water from the Orontes to an aqueduct that supplied Hama. A similar waterwheel raised water 12 meters to an aqueduct that supplied a thirteenth century hospital and a sixteenth century mosque in Damascus. Waterwheels were sometimes used in conjunction with dams to increase the headwater.

Often, the earliest urban structure in the Islamic city was the mosque, a gathering place for communal prayer. Because of the Islamic obligation for ritual washing before each of the five daily prayers, water supply was an important cultural requirement. Every mosque had water for washing. In most Islamic cities, water supply and sanitation were well developed in comparison with European cities of that time. Public baths were found in most cities, along with public water points. These were usually the donation of pious individuals rather than the result of a state-sponsored program of public works.

In the later Middle Ages, most of the public water works were the personal property of the rulers. In prosperous times, revenues from agriculture and trade were used to improve the urban infrastructure, including canals, aqueducts, and baths. The Emir had the legal right to condemn and remove latrines that polluted the water supply. Soldiers supplied some of the labor to build canals and bridges, but corvée labor, beggars, and prisoners were also used. Householders who were riparians were expected to dig and clear the canals, or to pay for having it done (Lapidus 1967).

While public works slowed in periods of disorder when the Islamic state was threatened by incursions, maintenance of adequate water supplies always had a high priority. Cities depended on an irrigated hinterland for their food supplies. Fruit gardens have a high cultural value in Islam because they are associated with the gardens of paradise. Water purity was essential for beverages and for ritual washing. Water was brought to mosques and schools, and from there it supplied the baths and fountains of the surrounding quarters. It was used to wet down the dusty streets and to cool the cities. Water was also used in important urban manufactures: water, paper, leather, soap, and dyed cloth.

Commerce and Industry

Commerce and industry flourished in the early centuries of Islam. Although the new Islamic cities were initially established by conquest, they survived

by overland trade. The camel caravan was uniquely suited to transporting goods across the long stretches of uninhabitable land that characterize the region. Camels do not require an investment in roads or frequent access to water, and they can be raised on drier, relatively inaccessible land that is agriculturally unproductive.

After the initial burst of conquest, Islam continued to spread through the activities of traders and travelers. New crops and new processes diffused within the empire. Sugar cane was grown in the lower Tigris-Euphrates before Islam, and from there it reached Egypt in the eighth century; Damascus, the Jordan valley, and the coastal Levant by the tenth century; and North Africa by the twelfth century. Cotton may have been grown in the Jordan Valley just before Islam, but by the tenth century it was grown throughout the Islamic world. Most of the goods traded in the Islamic world came to be grown or manufactured there as well. Paper using cotton fiber was manufactured in eighth century Samarkand and Baghdad, and the technology spread to Syria—including Damascus, Tiberias, and Tripoli—as well as to Cairo and Fez. There were floating paper mills on the Tigris in Iraq as early as the tenth century. Water-powered hammers were used to process paper.

Commerce and industry were important activities from the earliest days of Islam. Textile manufactures included cotton, wool, silk, and linen. Mining, paper making, tanning, and dyeing all used water as part of the process. All major Islamic cities had their own leather industry; the process used salt and alum, fat, or vegetable tannins. Some of the processing undoubtably affected water quality.

The processing of agricultural products for the urban market used water power when available. Upper Mesopotamia supplied much of the grain for Baghdad. Milling took place on ships moored in the Tigris and Euphrates rivers from Mosul and Raqqa down to Baghdad. Each mill had a capacity of ten tons a day. Tidal mills existed in Basra as early as the eleventh century. In Jordan, thirty-two water mills were used to process sugar cane between the twelfth and fifteenth centuries.

Agriculture

New hot weather crops from the east were established in the region in the first centuries of Islam. These crops included sugar cane, cotton, rice, sorghum, and hard wheat. Their growing season was in the hot summer months of seasonal water shortage.

Some of the new crops were especially suited to marginal lands in the region and contributed to the intensification of agriculture by bringing new land into cultivation. Rice could be grown in marshy areas, flood plains, and oases. Sorghum could be grown in poor soils with little moisture. Hard wheat was

well suited to the dry steppe region, and it stored well. Sorghum and hard wheat were less water hungry than some of the other new crops.

Irrigation development was a priority in the early centuries of Islam. Although the basic irrigation technology was well developed in antiquity, the systems had decayed by the seventh century, and they had never been equipped for summer irrigation. The introduction of new crops was accompanied by the diffusion of irrigation technology within the Islamic world. In particular, the qanat spread from Persia across North Africa and into Spain.

The agricultural revolution fueled Islamic expansion and prosperity. Cropping intensity increased fourfold in areas where alternate-year fallowing of winter crops had been practiced. However, these new crops placed heavy demands on local water resources. At the peak of expansion in the eleventh century, virtually every known source of water was exploited to its potential, whether river or stream, oasis, spring, aquifer, or predictable flood (Watson 1983).

The decline of intensive agriculture was due to many factors. Successive invaders destroyed irrigation works and permanent crops, preferring the familiar pattern of extensive land use: ploughland and grazing land. Changing political relations and forms of land tenure discouraged investment. Competition from New World sugar brought about the decline of the sugar industry in the Near East in later centuries. Even at the time of greatest expansion and prosperity, settled agriculture was discontinuous and precarious.

In the great river valleys, settled life was relatively stable. The Nilometer, built in the ninth century to measure the height of the flood, was used as the basis for assessing taxes on crop production in Egypt. The agricultural hinterland of Baghdad and Basra depended on an extension of the pre-Islamic canal system. The eastern tributaries of the Tigris were dammed, and a number of large canals allowed water from the Euphrates to flow into the Tigris. In Basra, the first feeder canal was constructed during the first half century of Islam, followed by a network of canals to develop agriculture during the following century.

Outside the river valleys, traditional agriculture involved a combination of rainfed grain, irrigated fruits and vegetables, and pastoral nomadism. The relative importance of these three elements depended on both environmental and political factors. In the early centuries of Islam, the state was strong and settled agriculture reached its greatest extent. In subsequent centuries of invasion, disruption, and decay, nomadism often took precedence over agriculture in the more marginal regions. Drier areas tended to be the domain of nomads, whose tribal structure enabled them to make efficient use of unpredictable rainfall. Rainfed farming was widely practiced although yields were erratic in most areas. Small-scale irrigation used well water, runoff,

spring flow, or wadi (seasonal watercourse) flow. Irrigation communities in the terraced mountain settlements of Yemen, the qanat-fed settlements of Oman, and the oases of the Arabian Peninsula and North Africa were stable as long as investment in terraces and irrigation infrastructure was maintained.

The Colonial Period

Most of the Arab Near East was ruled by the Ottoman Empire centered in Turkey. By the mid-sixteenth century, the Ottoman Empire stretched as far west as Algiers and included most of the central Middle East. By the mid-nineteenth century, however, the Ottoman Empire was in steady decline, and many countries achieved considerable autonomy. At the same time, European influence and control grew as more countries became indebted to the European powers.

North Africa

France occupied Algeria in 1830. There, European settlers developed a highly profitable modern agricultural sector that focused on production for the market. Water resources were in the public domain, but less than 10 percent of the land held by settlers was equipped for irrigation. The colonial legacy included eight major irrigation systems covering one third of the irrigated land; the remainder comprised 200 smaller systems. Large-scale irrigation involving storage dams was three times as costly per unit of irrigated land as the small-scale projects. Because of erosion, there was also a tendency for the reservoirs to silt up.

Tunisia became a French protectorate in 1881. Early water development focused on deep wells in the arid south of the country. No perennial surface water existed in this frontier between French North Africa and the Ottoman Empire. Tunisian dissidents found a safe refuge across the border in Ottoman Tripolitania. Water development in the south supported the French military occupation and secured the frontier. Of the ten water users associations in the country in 1905, most were for deep wells and springs in the south. Only two were for diversion dams on wadis.

The importance of groundwater resources in Tunisia was reflected in the first water code, written in 1920. It prohibited well drilling beyond a depth of 50 meters and imposed a limit on withdrawals of 200 cubic meters per day in order to protect groundwater reserves. Deep wells with gushing water were also illegal.

Proposals for water development in Tunisia included constructing numerous multipurpose dams for flood control, energy, water supply, agriculture, and industry as well as creating an interior sea by flooding the low lying salt flats,

or *chotts*; few of these plans were ever realized. Dams had not been very successful in Algeria because of silting and leakage. Furthermore, the settlers' lands depended on mechanized rainfed farming rather than on irrigation.

In fact, only four dams were built in Tunisia during the protectorate. The first dam was begun in 1927 on the Medjerda and was later used for flood irrigation. Another dam built between the world wars supplied Tunis with drinking water. Two more dams were built by the time of independence, one for drinking water and power, the other for power and irrigation of 40,000 hectares in the Medjerda valley.

Morocco was a French protectorate from 1912 to 1956. The colonial administration issued decrees within the first decade claiming all surface water, groundwater, and marshland. Wetlands in the Gharb plain west of Fez were tribal territory and important summer pastures for the nomads. Most of these seasonal pastures passed into the public domain and were subsequently sold to settlers. Once drained, the Gharb became prime irrigated land. This depended on the construction of a large storage dam to prevent winter flooding and provide water during the dry summer months. Dam construction was far more costly than anticipated, and when irrigation water first became available in the Gharb in 1935, settlers were required to grow high-value crops such as citrus.

Throughout the protectorate in Morocco, water development centered on hydroelectric power. A concession for the first hydroelectric facility was granted in 1914 for Fez, and the first large dam was begun in 1926 to supply Casablanca with power and water. By the time of independence in 1956, the protectorate government had constructed fourteen dams. Most of these were multipurpose: nine for irrigation, ten for power, seven for drinking water, and one for industry. Although 246,000 hectares were potentially irrigable, the network of canals was not complete, nor was all the irrigable land prepared for irrigation. As a result, only about 10 percent of the potential area was actually irrigated by the end of the protectorate period (Swearingen 1987).

Central Near East

The 1858 Ottoman Land Code changed the legal basis of landownership in much of the region by enabling individuals to obtain full title to tribal and communal land. A new class of absentee landlords emerged in the vicinity of cities, while the traditional cultivators became sharecroppers, or landless laborers, on large estates growing commercial crops, particularly cotton. In tribal areas, traditional pasture land was registered in the name of tribal leaders and used for the commercial farming of grain in areas of rainfed cultivation and cotton in areas where irrigation was possible.

Nineteenth century Egypt was dominated by Mohammed Ali. A Turk from Macedonia, Mohammed Ali came to Egypt with the Ottoman forces to repel the Napoleonic invasion (1798-1801). He became governor of Egypt and secured the right for his descendants to rule after him. Mohammed Ali and his successors undertook extensive public works financed by foreign capital. First, Mohammed Ali built the delta barrages in the 1840s. Next, the Ibrahimia Canal was dug alongside the Nile to provide water for summer cultivation in Middle Egypt. At the end of the century, the Aswan and Asyut barrages were built to provide year-round control of the water in the 300-kilometer-long Ibrahimia Canal, from Asyut to the pyramids in Giza. Perennial irrigation gradually replaced the traditional system of basin irrigation.

The shift to perennial irrigation made commercial cotton production possible. Cotton was exported, and production increased significantly in the 1860s as a result of reduced supplies caused by the American Civil War. At first there was a labor shortage, for land that had lain fallow under the flood water could now be planted. Cotton is a labor intensive crop, so larger families were desirable and population growth was encouraged. However, as Egypt turned into a monoculture, the land reserved for food production decreased. While population increased, the consumption of cereals and pulses declined, and there were restrictions on wheat imports. By the 1940s, when Egypt was nominally independent, the labor shortage of the previous century had turned into a problem of overpopulation, and there were famine riots.

Following World War I and the collapse of Ottoman rule, Syria became a French mandate. Land registration followed the Ottoman Code and enabled individuals to assume title to group resources. Urban investors rented land from tribal sheikhs, and, in time, the sheikhs also invested in commercial agriculture. This began with mechanized grain farming, but soon expanded to include pump irrigation of cotton using water from the Euphrates. During the French mandate, water development was funded more by private investment than by public support, and Syrians rather than colonists were the main actors.

The Modern State

In most of the Near Eastern countries, the state has rights to all surface and groundwater resources. With multilateral financing, most states have undertaken water development projects that are beyond the reach of local communities or private investors. In both Morocco and Syria, wetlands that served as seasonal pasture and flood control at the beginning of the century have been drained for irrigation. Major dams include the Aswan high dam completed in 1964, the large-scale irrigation perimeters in Morocco, and the Tabqa dam on the Euphrates in Syria. Emphasis on dam and reservoir

construction has required the relocation of increasing numbers of affected people.

Agrarian reform is a common theme in the region. Settlers and local landlords had acquired extensive holdings prior to independence, in part through the registration of tribal and communal land. The state expropriated the property of private investors and the estates of large landlords. Some of the lands were allocated to landless laborers who were encouraged to form cooperatives, while elsewhere large state farms were worked by hired labor.

Land reclamation became a national goal and the symbol of a powerful state. Nasser promoted the reclamation of the desert, and that remains a source of hope and pride for Egyptians. Progress has been impressive, but as new land is reclaimed, old land is lost to urban development or degraded through poor drainage. In Syria, the Tabqa dam has brought new land into cultivation, but it has also flooded valuable land along the Euphrates, brought water to inappropriate soils, and uprooted approximately 60,000 people. There has been little net increase in cultivated land despite reclamation efforts, and the population continues to grow.

Population growth and the demand for water are closely linked to the intensification of agriculture and investment in water infrastructure. As the standard of living increases, the per capita demand for water also increases.

Water development often creates temporary labor shortages. Sometimes they are resolved by steady population growth, as in Egypt in the nineteenth and early twentieth centuries. Sometimes labor migration shifts population. Egyptian farmers have provided much of the agricultural labor in Iraq and Jordan.

Elsewhere, stable irrigation communities have experienced a decline as labor emigrates toward more lucrative employment. In Yemen, emigration to the oil rich neighboring states in the last decades has threatened the survival of irrigation communities in the highlands, where terraces have long been an effective way of managing scarce soil and water resources. Without regular maintenance of the terraces, soil is washed away by seasonal torrents, causing silting problems downstream.

Remittances are more readily invested in individually owned pumps than in labor intensive maintenance of traditional irrigation systems. With earnings from abroad, Yemenis have begun to develop the Tihama, an arid coastal region. Small pumps are easily obtained, and without regulation, the aquifer is being drawn down and contaminated by salt water intrusion.

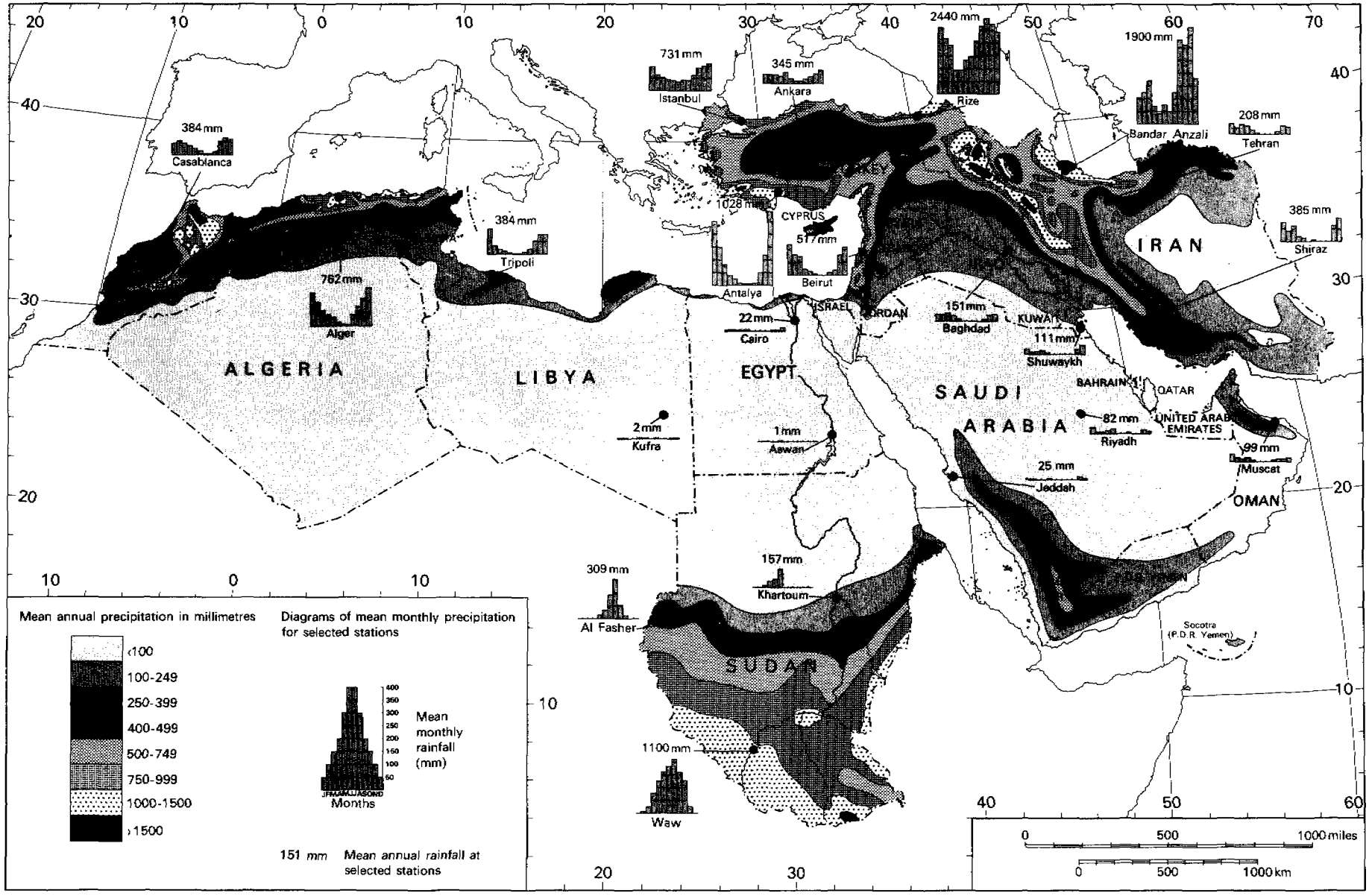
Throughout the region, intensive irrigated agriculture and commercial crops such as wheat, cotton, and sugar beets are promoted in place of subsistence agriculture and pastoral nomadism. The direction of modern agriculture

continues toward greater investment in water infrastructure, higher value crops, and greater consumption of water.

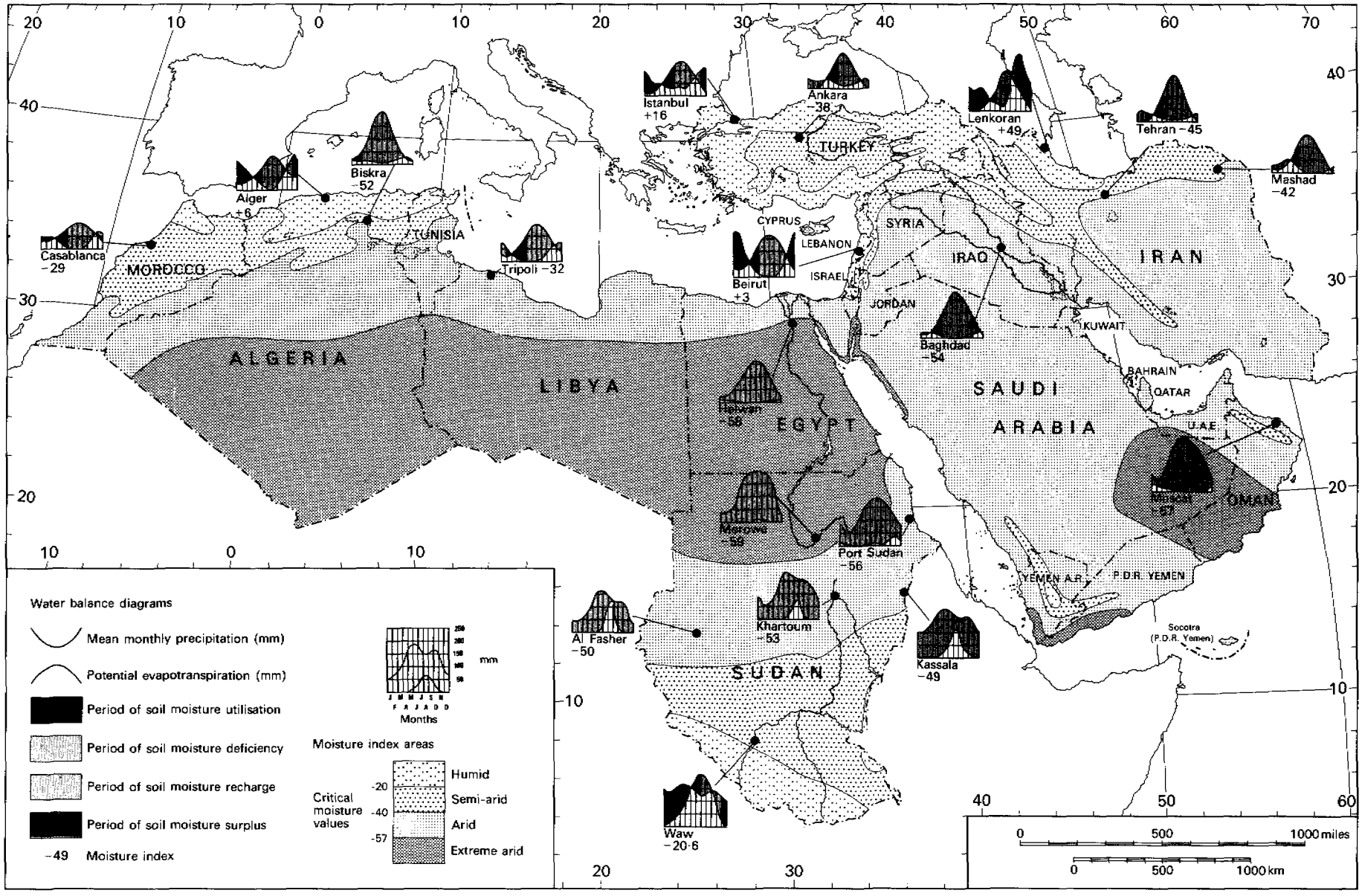
Appendix C

WATER RESOURCES MAPS OF THE NEAR EAST

Source: Blake, Gerald, John Dewdney, and Jonathan Mitchell. 1987. The Cambridge Atlas of the Middle East and North Africa. Cambridge: Cambridge University Press.



Precipitation



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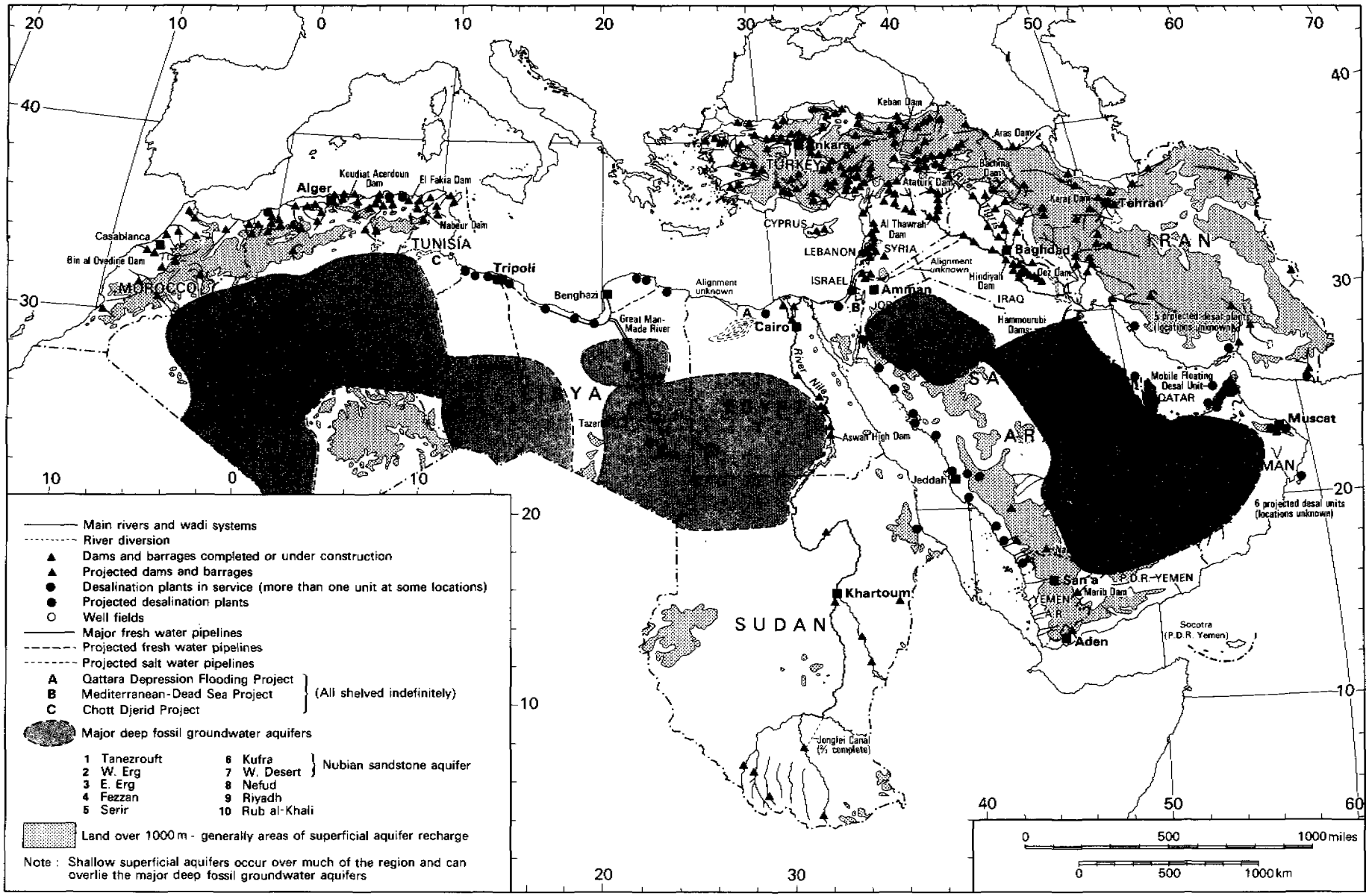
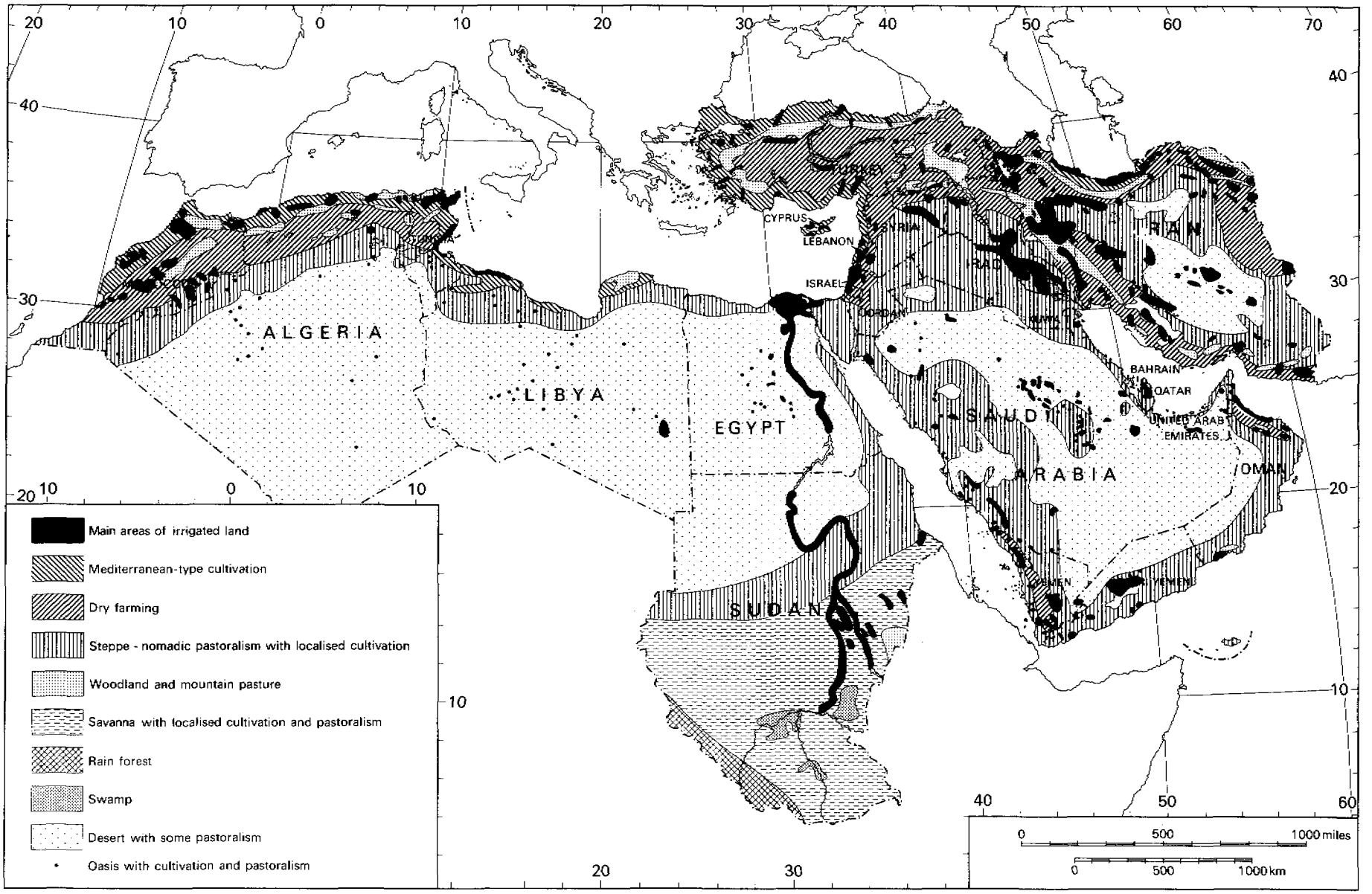
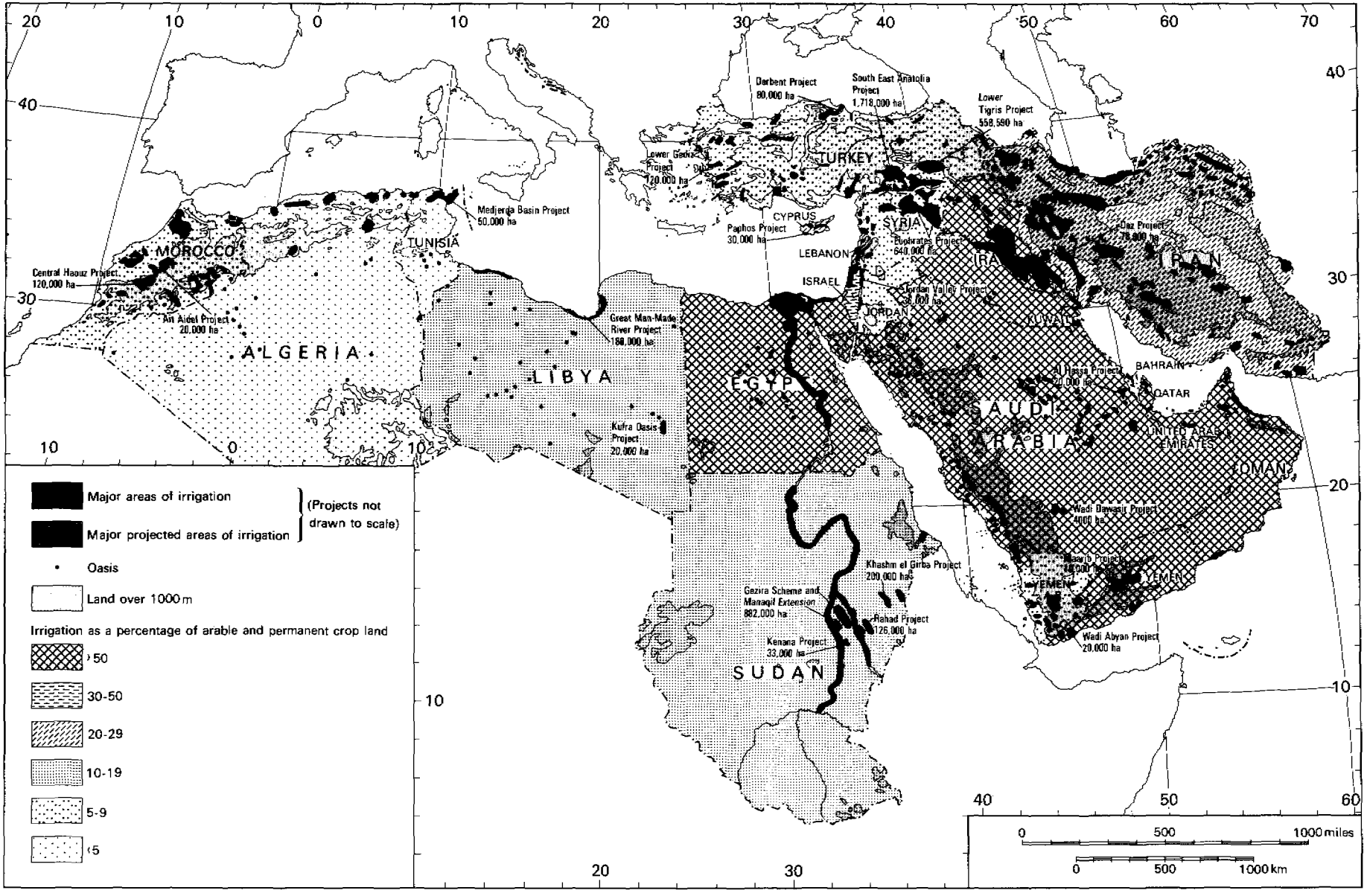


Fresh Water Supply



Agricultural Regions


Major areas of irrigation
Major projected areas of irrigation
(Projects not drawn to scale)
Oasis
Land over 1000 m
Irrigation as a percentage of arable and permanent crop land
› 50
30-50
20-29
10-19
5-9
‹5
Derbent Project 80,000 ha
South East Anatolia Project 1,718,000 ha
Lower Tigris Project 558,590 ha
Lower Gediz Project 120,000 ha
Medjerda Basin Project 50,000 ha
Paphos Project 30,000 ha
Euphrates Project 640,000 ha
Diez Project 75,000 ha
Jordan Valley Project 30,000 ha
Central Haouz Project 120,000 ha
Ain Aidel Project 20,000 ha
Great Man-Made River Project 168,000 ha
Kufra Oasis Project 20,000 ha
Al Hassa Project 20,000 ha
Wadi Dawasir Project 4000 ha
Khashm el Girba Project 200,000 ha
Gezira Scheme and Managil Extension 882,000 ha
Rahad Project 126,000 ha
Kenana Project 33,000 ha
Wadi Abyan Project 20,000 ha
TURKEY
CYPRUS
SYRIA
LEBANON
ISRAEL
JORDAN
IRAQ
IRAN
KUWAIT
BAHRAIN
QATAR
UNITED ARAB EMIRATES
OMAN
YEMEN
SAUDI ARABIA
MOROCCO
TUNISIA
ALGERIA
LIBYA
EGYPT
SUDAN
0 500 1000 miles
0 500 1000 km

Irrigation

USAID WATER SECTOR PROJECTS IN THE NEAR EAST (1975-1992)

Appendix D

Country	Project	Fiscal Year	Rural/Urban	Funding (US$ 000s)	Focus	Assistance
Morocco	Morocco-Triffa High Service Irrigation (6080126)	1976-1978	Rural	8,000	Irrigation, Groundwater Development	Technical Assistance, Construction, Commodities
	Doukkala Irrigation (6080127)	1976-1984	Urban	13,000	Water Supply, Irrigation, Institutional Development	Technical Assistance, Construction, Commodities
	Rural Development Grant (6080138)	1978-1979	Rural	145	Irrigation	Construction, Commodities
	Winter Snowpack Augmentation (6080190)	1984-1990	Rural	7,000	Water Supply, Groundwater Development, Policy Analysis	Technical Assistance, Training, Commodities
	Tetouan Urban Development (Sewerage Component) (6080194)	1986-1994	Urban	1,057	Water Treatment, Planning, Institutional Development, Studies	Technical Assistance, Training, Construction, Commodities
	Tadla Resource Management (6080213)	1992-1999	Rural	18,750	Irrigation, Institutional Development, Water Resources Planning	Technical Assistance, Training
	Subtotal			47,952		
Tunisia	CARE Bizerte Wells (6640286)	1975-1976	Urban	225	Water Supply, Water Treatment, Water Resources Development	Training, Construction
	Le Kef Wells Rehabilitation (6640288)	1976-1978	Rural	45	Water Supply, Sanitation, Water Treatment	Technical Assistance, Training, Construction

Country	Project	Fiscal Year	Rural/Urban	Funding (US$ 000s)	Focus	Assistance
Tunisia (cont.)	Siliana Water Improvement (6640299)	1976-1978	Rural	215	Water Supply, Sanitation, Water Treatment, Water Resources Planning	Training, Construction
	Kairouan Water Facilities (6640298)	1977-1979	Rural	346	Water Supply	Training, Construction
	Science and Technology Program (6640300)	1977-1983	Rural	2,029	Water Resources Planning, Institutional Development, Research/Studies	Technical Assistance, Training, Commodities
	Le Kef Potable Water/Rural Hygiene (6640313)	1978-1980	Rural	204	Water Supply, Sanitation, Water Resources Planning	Technical Assistance, Training, Construction, Commodities
	Siliana Rural Centers Water Systems (6640318)	1978-1983	Rural	1,650	Water Supply, Water Resources Planning	Construction, Commodities
	Central Tunisia Rural Development (6640312)	1979-1989	Rural	22,321	Irrigation, Groundwater Development, Policy Analysis, Institutional Development	Technical Assistance, Training, Construction, Commodities
	Rural Potable Water Institutions (6640337)	1986-1991	Rural	6,500	Water Supply, Groundwater Development, Institutional Development	Technical Assistance, Training, Construction
	Subtotal			33,535		
Egypt	Water Use and Management (2630017)	1976-1984	Rural	13,000	Irrigation, Water Resources Planning, Institutional Development	Technical Assistance, Training, Commodities
	PVC Pipe Drainage (2630019)	1976-1985	Rural	20,025	Irrigation	Technical Assistance, Construction, Commodities
	Canal Maintenance (2630035)	1977-1983	Rural	30,200	Irrigation	Technical Assistance, Training, Construction, Commodities

Country	Project	Fiscal Year	Rural/Urban	Funding (US$ 000s)	Focus	Assistance
Egypt (cont.)	Cairo Water System (2630038)	1977-1989	Urban	97,400	Water Supply, Water Treatment, Water Resources Planning	Technical Assistance, Training, Construction, Commodities
	Irrigation Equipment (2630040)	1977-1985	Rural	19,000	Irrigation, Water Resources Planning	Technical Assistance, Training, Construction, Commodities
	Agricultural Development Systems (2630041)	1977-1986	Rural	14,900	Irrigation, Water Resources Planning, Policy Analysis, Institutional Development, Research/Studies	Technical Assistance
	Hydrographic Survey (2630071)	1977-1981		8,000	Research/Studies	Technical Assistance, Training, Commodities
	Port Said Saline Production Plant (2630072)	1977-1985	Rural	13,000	Water Treatment	Technical Assistance, Training, Construction, Commodities
	Canal Cities Water and Sewage Systems (2630048)	1978-1988	Rural	169,000	Sanitation, Water Treatment, Water Resources Planning	Technical Assistance, Training, Construction, Commodities
	Technology and Feasibility Studies III (2630042)	1978-1986		43,000	Irrigation, Groundwater Development, Energy, Water Resources Planning, Policy Analysis, Research/Studies	Technical Assistance, Training, Construction, Commodities
	Alexandria Wastewater System Expansion (2630100)	1979-1994	Urban	380,000	Water Supply, Sanitation, Water Treatment	Technical Assistance, Training, Construction, Commodities
	Mineral, Petroleum, and Groundwater Assessment Program (2630105)	1980-1990	Rural	37,200	Groundwater Development, Water Resources Development, Research/Studies	Technical Assistance, Training, Commodities
	Irrigation Management Systems (2630132)	1981-1995	Rural	340,000	Irrigation, Water Resources Development, Institutional Development	Technical Assistance, Training, Construction, Commodities

Country	Project	Fiscal Year	Rural/Urban	Funding (US$ 000s)	Focus	Assistance
Egypt (cont.)	Utility Management and Energy Policy (2630123)	1982-1992	Rural	32,600	Water Supply, Energy, Water Resources Planning	Technical Assistance, Training
	Science and Technology for Development: Schistosomiasis Research (26301402)	1986-1998	Rural	39,650	Planning, Research/Studies	Technical Assistance, Training, Commodities
	High Dam Rehabilitation/ Modernization (2630160)	1982-1992		140,000	Water Supply, Energy	Technical Assistance, Commodities
	Provincial Cities Development (263016103)	1982-1994	Urban	110,000	Water Supply, Sanitation, Water Treatment, Planning, Institutional Development	Technical Assistance, Construction
	Cairo Sewerage II (2630173)	1984-1994	Urban	816,000	Sanitation, Water Treatment	Technical Assistance, Training, Construction, Commodities
	Canal Cities Water and Wastewater (2630174)	1987-1997	Urban	380,000	Water Supply, Sanitation, Water Treatment, Institutional Development	Technical Assistance, Construction
	Water/Wastewater Institutional Support (2630176)	1985-1994	Urban	15,000	Sanitation, Institutional Development	Technical Assistance, Training, Construction, Commodities
	Cairo Water Supply II (2630193)	1988-1996	Urban	145,000	Water Supply, Sanitation, Water Resources Planning, Institutional Development	Technical Assistance, Training, Construction, Commodities
	Subtotal			2,872,975		
Israel	Desalting Plant (2710005)	1975-1985	Rural	20,000	Water Supply, Water Treatment, Energy, Research/Studies	Technical Assistance, Construction
	Subtotal			20,000		

Country	Project	Fiscal Year	Rural/Urban	Funding (US$ 000s)	Focus	Assistance
Jordan	East Ghor Extension (2780175)	1974-1978	Urban	10,000	Irrigation, Water Resources Planning	Construction, Commodities
	Zarqa Triangle Irrigation (2780179)	1975-1979	Rural	4,500	Irrigation, Water Resources Planning	Construction, Commodities
	Maqarin Pre-Investment Studies (2780188)	1975-1978	Rural	1,000	Irrigation	Technical Assistance, Construction
	Sprinkler Irrigation Equipment (2780195)	1976-1980	Rural	4,500	Irrigation	Technical Assistance, Training, Commodities
	Maqarin Dam Design (2780200)	1977-1982	Rural	19,000	Irrigation, Energy, Research/Studies	Technical Assistance, Commodities
	Amman Water and Sewage (2780220)	1978-1989	Urban	67,500	Water Supply, Sanitation, Water Treatment, Irrigation, Water Resources Planning	Technical Assistance, Training, Construction, Commodities
	Water Management Technology (2780192)	1978-1984	Rural	1,320	Irrigation, Research/Studies	Technical Assistance, Training
	Community Development (2780228)	1978-1981	Rural	350	Water Supply, Irrigation, Water Resources Planning	Technical Assistance, Construction
	Rift Valley Water Resources Study (2780229)	1978-1982	Rural	5,000	Groundwater Development, Research/Studies	Technical Assistance, Construction, Commodities
	Irbid Water and Sewerage (2780233)	1980-1989	Urban	23,500	Water Supply, Sanitation, Water Treatment	Technical Assistance, Commodities
	Groundwater Resources Investigation (2780234)	1980-1987	Rural	5,000	Water Supply, Irrigation, Groundwater Development	Technical Assistance, Training
	Aqaba Water and Wastewater (2780206)	1982-1986	Urban	7,500	Water Treatment, Irrigation	Construction, Commodities

Country	Project	Fiscal Year	Rural/Urban	Funding (US$ 000s)	Focus	Assistance
Jordan (cont.)	Water System Services Management (2780259)	1982-1990	Urban	2,100	Water Supply, Sanitation, Water Treatment, Water Resources Planning	Technical Assistance, Construction
	Zarqa-Ruseifa Water and Wastewater (2780234)	1985-1989	Urban	21,000	Water Supply, Sanitation, Water Treatment	Construction, Commodities
	Water Quality Improvement and Conservation (2780288)	1992-1998	Urban/Rural	25,000	Sanitation, Water Treatment, Irrigation, Planning	Technical Assistance, Training, Construction, Commodities
	Subtotal			197,270		
Lebanon	Rehabilitation of Potable Water Systems (2680306)	1978-1988	Rural	6,500	Water Supply, Water Treatment, Water Resources Planning	Technical Assistance, Training, Construction, Commodities
	Potable Water and Environmental Sanitation (2680330)	1985-1986	Urban	7,680	Water Supply, Sanitation, Water Resources Planning	Technical Assistance, Construction, Commodities
	Subtotal			14,180		
Syria	Damascus Water Supply I (2760008)	1975-1984	Rural	96,000	Water Supply, Sanitation, Water Treatment, Water Resources Planning	Technical Assistance, Construction
	Damascus Water Supply II (2760010)	1976-1986	Rural	14,000	Water Supply, Water Resources Planning	Technical Assistance, Construction, Commodities
	Euphrates Basin Maintenance Amendment (2760011)	1976-1983	Rural	17,600	Irrigation	Technical Assistance, Training, Construction, Commodities
	Provincial Water Supply (2760024)	1979-1983	Rural	35,200	Water Supply, Water Treatment, Policy Analysis, Institutional Development	Technical Assistance, Training, Commodities

Country	Project	Fiscal Year	Rural/Urban	Funding (US$ 000s)	Focus	Assistance
Syria (cont.)	Subtotal			162,800		
Oman	Omani-U.S. Joint Commission: Fisheries Development Project (2720101)	1980-1990	Rural	50,000	Aquaculture	Technical Assistance, Training
	Wadi Al Khawd Aquifer Recharge (2720102)	1982-1987	Rural	7,500	Water Supply, Groundwater Development	Technical Assistance, Construction
	Water Resource Development (2720104)	1986-1996	Rural	62,491	Water Supply, Sanitation, Water Resources Planning, Institutional Development	Technical Assistance, Training, Construction
	Omani-U.S. Joint Commission: Fisheries Development and Management Program (2720106)	1990-1995	Rural	20,000	Aquaculture	Technical Assistance, Training
	Subtotal			139,991		
Yemen	Taiz Water and Sewerage Design (2790027)	1975-1978	Urban	1,535	Sanitation, Water Resources Planning, Research/Studies	Technical Assistance, Training, Construction
	Special Development Fund (2790033)	1975-1979	Rural	44	Irrigation	Technical Assistance
	Water Supply Systems Management (2790028)	1977-1986	Urban	8,100	Sanitation, Groundwater Development, Water Resources Planning, Institutional Development	Technical Assistance, Training
	Taiz Water/Sewerage Construction (2790039)	1977-1986	Urban	16,200	Sanitation, Water Treatment, Groundwater Development, Water Resources Planning	Technical Assistance, Training, Construction, Commodities

Country	Project	Fiscal Year	Rural/Urban	Funding (US$ 000s)	Focus	Assistance
Yemen (cont.)	Water Resources Planning and Management (2790043)	1979-1984		3,134	Water Resources Planning, Research/Studies	Technical Assistance, Training, Commodities
	Small Rural Water Systems (2790044)	1979-1989	Rural	21,487	Water Supply, Water Resources Planning	Technical Assistance, Training, Commodities
	Farming Practices for Productivity (2790084)	1989-1997	Rural	3,900	Irrigation, Policy Analysis, Research/Studies	Technical Assistance, Training, Commodities
	Subtotal			54,400		
Near East Regional	CRS West Bank Rural Development II, Health Sector (2980155)	1979-1984	Rural	1,581	Water Supply	Technical Assistance, Construction
	Cooperative Marine Technology II (298015801)	1983-1986		2,669	Aquaculture, Oceanography, Policy Analysis, Research/Studies	Technical Assistance
	Cooperative Arid Lands II (298015803)	1986-1992	Rural	4,250	Irrigation	Technical Assistance
	Cooperative Marine Technology III (298015808)	1986-1992		6,362	Aquaculture, Oceanography, Research/Studies	Technical Assistance
	Wastewater Reuse (289015824)	1990-1993	Urban	1,075	Wastewater Treatment, Research/Studies	Technical Assistance, Construction
	Cooperative Marine Technology IV (298015826)	1992-1997		3,000	Aquaculture, Oceanography, Research/Studies	Technical Assistance
	Cooperative Marine Technology (2980160)	1979-1984		4,238	Aquaculture, Oceanography, Research/Studies	Technical Assistance

Country	Project	Fiscal Year	Rural/Urban	Funding (US$ 000s)	Focus	Assistance
Near East Regional (cont.)	Gaza Strip and West Bank Program (2980166)	1981-1986	Urban	6,434	Water Supply, Sanitation, Water Resources Planning	Technical Assistance
	Arid Lands Research Program (2980170)	1982-1985	Rural	5,000	Irrigation, Research/Studies	Technical Assistance
	Irrigation Support Project for Asia and the Near East (7631510)	1987-1994	Rural	20,100	Irrigation, Water Resources Planning, Policy Analysis, Research/Studies	Technical Assistance, Training
	Project in Development and the Environment (2980365)	1991-1996	Rural	19,000	Water Resources Planning, Policy Analysis, Research/Studies	Technical Assistance, Training
	Subtotal			73,709		
	Grand Total			3,616,812		

THE FULL VALUE OF WATER AND WATER-RELATED INVESTMENTS

Appendix E

Long-term welfare of a country, and perhaps even its survival, requires that economic rationality play a part in the decisionmaking process surrounding the development and use of water resources. Both water itself and the capital to develop and use water efficiently are in short supply. In addition, compared with most commodities, water use is more likely to affect persons other than the direct beneficiaries, sometimes through the physical environment and sometimes through market-exchange processes. An effective water management action plan in the Near East must address these issues of scarcity and interdependence as they relate to water and its use.

This appendix outlines the issues pertaining to water management and provides a framework to help decision makers balance the beneficial and adverse effects of water resource development in the complex, often politicized process of selecting specific water-related programs and projects. This appendix is not a handbook for analyzing economic feasibility of projects; in fact, A.I.D. already has handbooks for that purpose. Instead, this material highlights the special characteristics of water and water-related projects, explains why water projects need special analysis, and describes some of the technical, socio-political, and economic considerations of such analysis.

Critical Issues

Shortages

Water. Despite mounting evidence that the availability of water is becoming more and more limited, in many countries in the region it is still treated as a free good. No charge is imposed on users for extracting water from either surface or groundwater sources, and property institutions practically never vest an exchangeable right in users. Although users may pay for the treatment, transport, and even disposal of water, the price paid rarely reflects the true value of water to society. Equally important, the value of water in terms of its opportunity cost or foregone benefits is too rarely considered in water development planning.

Capital. That water-development capital is scarce is a theme that needs little elaboration. In the coming decades, A.I.D. and its host countries in the Near East will have to attempt to accomplish water development and management goals with extremely limited budgets. Accordingly, planners must scrutinize proposed expenditures to ensure that the resulting benefits will exceed the

direct and indirect costs incurred, thus yielding a satisfactory return on investment.

Interdependencies and Water Use

Water exhibits important economic and physical interdependencies that distinguish it from most other resources and commodities. Economic interdependencies of the water resource exist in the form of linkages between water-based economic activities and the rest of the economy. Purchases in the local economy by water users add employment and income. For example, irrigators receiving new water supplies purchase services and goods locally, thereby boosting the economy in that area.

Physical interdependencies arise from the physical characteristics of water itself. Being liquid, water tends to flow, seep, evaporate, and transpire. This mobility causes a unique, unpredictable interrelationship among its users. For example, in many cases diversionary uses of water from streams and aquifers return up to one-half of the original water diverted. Users who are downstream, or interconnected through an aquifer, are directly affected (positively or negatively) by the quantity, quality, and timing of releases, leaks, or return flows by the upstream users. Such characteristics make it difficult to identify and measure the use of water, thus making it relatively difficult to establish and enforce the exclusive property rights of an exchange economy. Physical interdependencies such as these cause what are known to economists as technological externalities.

Approaches to Classifying and Defining Economic Effects

Comparative evaluation of water-related projects or proposals is based on balancing the positive and negative effects: the desirable or positive effects are called benefits, while the undesirable or negative effects are called costs. All proposed decisions entail some costs since, at the very least, a choice of one course of action implies a decision not to do something else. In general, a commitment of some resources (labor and capital) is also necessary to derive benefits.

Classifying According to Type of Effect

Program evaluation needs to address all the effects, or consequences, of a proposed policy. In addition to the basic distinction between benefits and costs, it is useful to specifically define and classify the range of potential effects.

Real and pecuniary effects. One major type of impact is the distinction between real and pecuniary effects. Real effects are the changes in the actual quantities of goods and services available to the affected parties. In the case

of benefits, real effects are additions that in some way aid the final consumers. In the case of costs, they represent the actual value of the resources that have been diverted from alternative uses.

Pecuniary effects result from changes in demand and, hence, from changes in price for various goods and services in the economy. Pecuniary effects are usually regarded as mere income transfers since increased incomes for some are balanced by increased outlays for others.

Real effects are regarded as the key issue by most economists. At the national level, positive and negative pecuniary effects are usually ignored since they are assumed more or less to offset each other. At the local level, however, pecuniary benefits, even though offset by diffuse national costs, may have a significant effect. Unfortunately, it is not always easy to distinguish between real and pecuniary effects.

Direct and indirect effects. It is also important to distinguish between direct (or primary) and indirect (or secondary) impacts. Direct effects, which can be either benefits or costs, are those that would immediately result once the proposed development project was implemented. Direct benefits represent the value of project goods and services, which is often measured by the willingness of the beneficiary to pay for the project benefits. The value of the resources and services sacrificed to accomplish an investment or program is the direct (opportunity) cost. They are measured by the benefits foregone when a scarce resource is used for one specific purpose rather than for another purpose.

Indirect effects (usually referred to in the economic literature as external spillover costs or benefits) affect third parties and can be beneficial or adverse. In the past, such effects have not been quantified; they have either been ignored or treated lightly. For example, discharge of municipal, industrial, and agricultural waste and effluent into area streams, the effects of which were neither quantified nor well understood, has been a major factor in the deteriorating quality of the region's water resources.

Indirect effects can be classified as either technological or pecuniary. Technological indirect (or external) effects result from interactions among individuals through a physical medium. In the case of water systems, indirect technological effects are often registered as changes in the quantity or quality of water available to third parties. By definition, technological indirect effects are not priced in market exchanges, so some process of imputing values is necessary; this is typically accomplished through shadow pricing.

Pecuniary effects, on the other hand, are uncompensated side effects transmitted through the price system. Backward-linked (or induced) pecuniary effects are those experienced by suppliers of inputs to project beneficiaries. In the case of irrigation, these might be fertilizer, machinery, or fuel suppliers.

Forward-linked (or stemming-from) effects accrue to those who process, store, or transport project outputs.

Economists disagree as to whether indirect pecuniary effects are real—which would require measuring and including them in program appraisals—or merely offsets to indirect costs incurred elsewhere in the economic system. The latter view is typically held in the United States and is currently being applied to cost-recovery studies in Egypt.

Water resources analysts in both the public and private sectors may choose from among a number of dollar-denominated measures to appraise investments. Corporate financial specialists might employ gross revenues, cash flow, net profits, or a number of similar concepts to help them assess the desirability of an investment. In the private sector, profitability is the most appropriate measure. For public water program analysis, monetary measures include gross revenues, value added (payments to primary-factor owners—land, labor, capital, and managements), and net economic benefits (benefits above costs). For the public sector, net benefits, which correspond to profits in the private sector, provide the most rigorous measure of investment desirability and suitability.

Classifying According to Degree of Measurability

Quantitative measurement of positive and negative effects obviously simplifies program appraisal. Unfortunately it is often quite difficult to quantify impacts in the context of water resources planning. One fruitful approach is to consider benefits and costs according to the degree to which they can be measured in monetary terms. The following four categories—free market, market intervention, nonmarket, and nonmonetary—range from the most readily monetized benefits and costs to those which it is impractical to value in monetary terms.

Free market. Market prices exist and the observed prices correctly reflect the values society places on the resources. These are limited to extensively traded commodities whose prices are not influenced by explicit government policies.

Market intervention. Prices can be observed but do not reflect appropriate social values. These include goods and services for which the government intervenes in the marketplace such as the important farm crops of wheat and rice. Examples of inputs include labor or imported capital equipment.

Nonmarket. Market prices do not exist, but the user's willingness to pay can be inferred from one of several recently developed analytic techniques. For example, the quantities of water diverted for irrigation water are typically not priced, but the willingness to pay can be estimated by analyzing farm budgets. In turn, the benefits of improvements in water quality might be estimated in terms of cost savings from the least-cost treatment alternative.

- *Shadow pricing water quantity and quality.* Shadow prices are often employed to estimate the value of specific applications of water that preclude other productive uses. The shadow price reflects the value to others of that fraction of the water used whose use is precluded elsewhere. For example, the diversion of one acre-foot of water to an upstream project may only preclude downstream users from using one half of an acre-foot because much of the water is again available downstream through return flows. If the downstream cost of an acre-foot of water is $1.00, then $.50 (the shadow price) would need to be subtracted from the output value of the upstream project when calculating its net benefits.

  Water quality degradation effects should also be included as costs. These can often be estimated as the cost of cleaning up the water so that downstream users can make effective use of it.

- *Environmental effects.* The framework for extending traditional feasibility-analysis procedures to allow for external effects exists as a result of the increasing concern over the past two decades with valuing environmental effects. Quantitative environmental values are used almost routinely at U.S. federal and state levels in evaluating environmental measures. In fact, the U.S. federal government has developed regulatory impact analyses that consider many environmental values in great detail.

  Some of these values could be used appropriately by other countries. In any case, they provide examples of approaches that could be adapted by Missions to address the unique local conditions in each host country.

- *Displacement.* Displacement of people caused by water investments is another indirect effect of increasing concern. It is now generally recognized that these costs entail far more than the values of properties seized by eminent domain. Since the properties of people in their own cultures and milieu are likely to be worth more to them than to those who purchase them, the actual monetary costs of the property and transportation probably understate the negative values of resettlement. Nevertheless, it is possible to quantify the other resettlement values by estimating the varying levels of these negative values.

Nonmonetary. For many impacts, meaningful monetary evaluation is often impractical. Typical examples include maintenance of important ecosystems and preservation of endangered species or archeological treasures. Even in this category, however, guidelines such as the following are available:

- *Ecology.* Ecological effects present perhaps the most complex valuation problems since they are not only difficult to estimate accurately in physical terms, but they are also difficult to value monetarily. However, ecological effects can be described in physical terms and values can be estimated. In fact, over the past decade abundant evidence has been

amassed on people's willingness to pay for the preservation of unique vegetative and animal species and other aesthetic values, and this can be used in evaluation.

- *Human health.* Life and health risks can be valued fairly readily when the established dollar value pertains to a statistical life and not to the life of any individual. Expenditures must be limited by the dictates of reasonable prudence. By definition, a well-developed procedure determines the sacrifice, in terms of consumption denied, that people will make to gain an increase in the probability of survival. This determines the prudent level of safety measures or justified expenditure to save a statistical life. In the West, such procedures have led to statistical values being applied in the range of $2 to $5 million per life. Similar approaches have been developed and are rapidly being refined for valuing morbidity effects.

Effects on free market benefits and costs generally present few measurement problems for economic appraisal. For market intervention and nonmarket situations, some special analytical approaches are necessary to measure and quantify the benefits and costs. In the economic appraisal literature, these approaches—which attempt to replicate the market exchange value that would occur in a hypothetical free market—are usually called shadow pricing. Such nonmarket techniques have been used extensively to value water in streams for uses such as recreation and fishing.

Data Development

The degree of quantification required by the classification system demands large amounts of data and extensive analytical capabilities; naturally, available data and analytical capability vary from country to country. For those host countries in which the amount of data appears inadequate, innovative techniques such as the following are required. The various elements of the proposed intervention can be initially framed using standard USAID feasibility-analysis techniques; each will have a specific set of effects including some that can be readily quantified and some that cannot.

Much of the data can then be collected from available sources. For example, farm budgets essential to valuing such effects as irrigation, flood control, drainage, water-logging, and salt intrusion exist or can be readily created for any country. Most Missions with agricultural programs also have some useful data as do previous A.I.D. project papers, World Bank appraisal reports, and other studies. These can serve as sources of data for hydroelectric plants, sewer and wastewater facilities, and municipal and industrial water supplies, as well as for irrigation. Recent World Bank water resources projects, in particular, have required countries to quantify many of these effects.

After gathering the available data, apply the collective judgments of experienced and knowledgeable professionals to close the data gaps. These experts can estimate the values needed in ranges that reflect the confidence one should place in the estimates to quantify the remaining effects of various choices for decisionmaking purposes.

The With-Without Principle

The basic purpose of project evaluation is to contrast the situation where the proposed program is in place and operating with the situation that would prevail without the program. When all incremental impacts—positive benefits and negative costs—on the relevant populations have been addressed, this process reflects the with-without principle.

Proper with-without evaluation is not accomplished by merely contrasting conditions before and after the project since many changes in the affected area would have occurred without the project. Such effects need to be identified and eliminated from the project justification.

Area Covered by the Analysis

A project may create benefits, costs, and other impacts on a local area or a larger region; they may even extend nationwide or worldwide. For reasons of simplicity or of political jurisdiction, decision makers limit their recognition of benefits and costs to a specific area. The geographical area or political subdivision within which the decision maker decides to quantify impacts also defines the area for analysis. In order for an appraisal to be valid, all relevant impacts must be addressed. In particular, all significant external costs need to be scrupulously included in the analysis.

Off-Stream Versus In-Stream Benefits of Water Use

Water development is most often defined as capturing and transporting water from natural watercourses to serve some human activity elsewhere: agricultural irrigation, industrial and manufacturing uses, and household consumption and sanitation are prime examples of off-stream usage. Increasingly, however, water is valuable while still in the stream for such purposes as electricity generation, dilution to improve water quality, preservation of wildlife and fishery habitats, and water-based outdoor recreation.

Off-stream uses are consumptive, especially irrigation and water for household and public uses. By contrast, in-stream uses are most often nonconsumptive, meaning that water is not lost to evaporation or transpiration during its usage. Many categories of in-stream use present special difficulties for estimating value both because of the nonconsumptive character of the benefits and because consumers do not compete for their use.

Applying Feasibility Testing

An investment represents the commitment of resources or inputs that have alternative productive uses to a project from which the returns accrue over some future planning period. Applying a feasibility test to water resources projects or programs provides a specific example of the problems encountered when evaluating public programs.

Net Benefit Principle

The general strategy of evaluation is defined by one fundamental principle, supplemented by certain concepts and definitions that should be applied consistently across proposed programs. The basic axiom is this: in any situation requiring choice, select the policy alternative that produces the greatest net benefit. The net benefit principle, as applied in economic evaluation, is based on Paretian welfare economics which is, in turn, rooted in the Utilitarian principle of selecting the greatest good for the greatest number. An investment is thus said to be economically feasible if its anticipated benefits (B) exceed its anticipated costs (C): a B/C ratio greater than one. The degree of feasibility required can be obtained by setting a cutoff B/C ratio greater than one.

A crucial issue in feasibility appraisal is how to make benefit and cost streams commensurate in time. Typically, benefits occur at different times than costs, with the benefits accruing late in the project's life and costs concentrated in the early years. Benefits accruing early are valued more highly than those received later. Some form of weighting system is needed to make streams of benefits and costs commensurate over the project's life. This task is achieved by the use of a specially defined interest rate, usually called the discount rate; it is selected to reflect the public's assumed time preference between present and future benefits and costs. The term economists use for the process of applying the weighting system is discounting to present value.

Feasibility Formula for Water Resources

A feasibility formula for water resources analysis rests on the axiom of choice just introduced and on the concepts of scarcity and interdependency discussed earlier. It requires that scarcity of capital and water and the prevalence of interdependencies inherent in water management be fully taken into account.

If all benefit and cost expressions are assumed to be in discounted present value terms, employing a consistent planning horizon, interest rate, and price level, the full conditions for economic feasibility of a water project or plan can be expressed as follows: a project is feasible if the willingness to pay of the direct beneficiaries, plus in-direct benefits to off-stream and in-stream water users as well as any pecuniary external benefits to non-water-users exceeds

construction costs plus foregone direct benefits plus foregone indirect benefits (opportunity costs) imposed on off-stream and in-stream users as well as foregone external benefits to non-water-users and operation and maintenance costs.

The feasibility test therefore addresses these issues:

- The scarcity of capital is measured by the cutoff rate of interest used to discount benefit and cost streams to present value:
- The value of water in alternative uses is measured by the foregone-benefits terms.
- The interdependencies, both the technological and pecuniary externalities, are reflected in the foregone indirect user and nonuser benefits expressions.

Measuring Effects in Monetary Terms

The basic principle of measuring the real economic impact of water policies, projects, and programs is the willingness of those receiving benefits to pay for them. To be incorporated into economic analysis, beneficial and adverse effects must be expressed in monetary terms. Since project inputs and outputs are generally expressed in physical terms such as tons, kilowatt hours, and cubic meters, these physical measures must be transformed into commensurate value terms by applying the appropriate prices to each input and product.

Whether the prices used in the evaluation are market prices or shadow prices, they must represent willingness to pay for a particular good or service by consumers, producers, or units of government. This approach assumes that individual preferences should form the basis for public policy. If so, individual valuations as reflected by willingness to pay would constitute the measure of value for policy analysis. Willingness to pay is measured by the individual's best offer to obtain a particular good or service.

Intermediate or producer goods. Incremental profitability added by an intermediate good to the business enterprise is the usual basis for valuing intermediate goods. The following approaches are commonly used to estimated this value:

- *Change in net income.* This method equates willingness to pay with the increment in profit attributable to an increment in water supply. Budgets are developed that forecast the project's profit and subtract forecasted profit without the investment. The increment between the profits with the project compared to those expected without the investment is defined as the willingness to pay for the investment.

- *Alternative cost approach.* This technique can be applied in a number of cases where direct willingness to pay is difficult to estimate. Hydroelectric power valuation is its most common application in water resources planning, but the method is also applied to inland waterways transportation and industrial water use. Its name refers to the cost of the alternative method that appears most feasible for supplying project services or goods, but it is applicable only if the alternative is itself economically feasible. In other words, the services do not cost more than the individual is willing to pay.

Consumer goods. In the industrialized countries, techniques for valuing water as a final consumptive good have advanced rapidly during the past decade. The applicability of these techniques to developing nations, however, has not been frequently tested.

Willingness to pay for residential water supplies can sometimes be directly observed. In other cases, data on prices and quantities consumed can be subjected to statistical analysis, or regression analysis can be employed to derive the demand function for water in the sample communities. Residential water valuation is often achieved by the alternative cost test, an approach more likely to succeed in developing nations.

Assigning values for water treated as a public good has presented much more of a challenge for water planners. Such assessments are usually associated with water quality improvement, recreation, and aesthetic enjoyment of water in natural surroundings. Two lines of approach have been attempted, both based on user surveys. The first collects and statistically analyzes data on actual user expenditures and then mathematically derives a willingness-to-pay function from these data.

The other approach asks users directly about their willingness to pay for incremental levels of environmental services for hypothetical proposed policy interventions. This method is called the contingent valuation method (CVM) because it seeks users' valuations on contingent or hypothetical water supply or environmental supply situations. Although the method must overcome some skepticism regarding the reliability of interview responses, careful application of the technique in industrialized countries has yielded valuable information for planning purposes. Some investigation of the applicability of CVM to developing countries is warranted.

Conclusion

The case for assisting governments of cooperating countries in the Near East region to improve analysis of water use is compelling. Difficulties associated with doing meaningful and comprehensive benefit-cost studies of water use are greatly outweighed by the critical need to establish economically rational

priorities for water resource development. Scarcity of water and capital for water resource development as well as issues arising from the transboundary interdependencies inherent in water resources, all make an argument for A.I.D. to use its expertise and resources to help countries in the region maximize the use of their scarce water resources.

POLLUTION PREVENTION TECHNIQUES WITH APPLICATION TO WATER RESOURCES

Appendix F

The pollution prevention approach to solving environmental problems is broadly applicable to addressing both water use efficiency and water quality issues.

The following capsule summaries of successful industrial pollution prevention projects with documented economic benefits illustrate the enormous potential for Near East countries. The projects show that many different industries and industrial processes offer opportunities for pollution prevention interventions.

The economic benefits for these examples, mostly from U.S. companies, depend to some extent on a regulatory structure that offers avoidable costs. Such regulatory systems, including effective enforcement, generally do not exist in Near East countries.

A significant fraction of economic savings often results from other factors, including raw material and energy savings, improved productivity and output, and improved product quality because pollution prevention actions are within industrial and agricultural systems rather than at the end-of-the-pipe. Thus, in some of the examples, a payback period has been calculated on the assumption that the action is taken in a developing country without avoidable regulatory compliance costs.

Unfortunately, in many published case studies, there are either no detailed economic data or insufficient data to calculate economic benefits associated with nonregulatory factors.

SUCCESSFUL POLLUTION PREVENTION PROJECTS WITH WATER BENEFITS

Process	Description	Capital Cost	Payback
Electroplating	Replaced single-pass, water treatment system with closed-loop, batch system for rinse water. Water usage decreased from 12,000 gallons per day to 500 gallons per day (90% reduction). 20% reduction in sludge production resulting in a savings of $58,460 per year in waste disposal costs. Savings in pollution control costs of $29,400 per year and personnel/maintenance of $10,200 per year.	$210,000	3 years (I) >10 years (D)
Film developing	Installation of decanter system to provide gravity separation of organic solvent from water (1,1,1-trichloromethane). Savings: $12,000 in first year by reducing amount of new solvent and makeup water required for the film developing unit.	$4,000	0.25 year (D)
Metal parts remanufacturing and restoration	Metal parts cleaning system, which bakes metal parts to remove volatile oils and grease and sprays the parts with a high-velocity stream of aluminum shot to remove grime and rust and provide a rust-resistant coating, replaced system involving wet application of caustic soda, scrubbing and water rinse. Resulted in annual savings of 48,000 gallons of rinse water (100% reduction), $5,400 for caustic soda; $25,000 in labor costs (decrease from three employees to two employees), and $12,000 to $18,000 in caustic sludge waste management by recycling the aluminum dust by-product. Aluminum shot costs $1,500 per year.	$75,000	<2 years (I) <2.5 years(D)

Key: (I) Payback period dependent on regulatory structure in U.S., which provides avoidable costs.
(D) Payback period applicable to developing countries without costly regulatory compliance impacting economics.

Process	Description	Capital Cost	Payback
Food canning	Steam-jet vacuum compressor added to atmospheric cookers to prevent the escape of steam (wasted food-processing energy) through the can in-feed and discharge ports. This system compressed vapors into the cooker. Vapor exhaust hoods retained steam in the cookers. Resulted in a 100% reduction in water usage (3,600 gallons per cooker per year), and $45,000 in energy per 1,000-hour season.	$1,300 to $2,500 per cooker	<0.5 year (D)
Phosphate manufacture	Implemented closed-loop, process water system for inorganic fluoride removal. Lime added to process water to create calcium fluoride precipitate and then water passed through two gravity thickeners and filter press and recycled back to the venturi scrubbers for reuse. Resulted in approximate savings of 280,000 gallons of water per day ($870,000 per year) and $930,000 in water treatment per year.	$2,000,000	1 year (I) 2 years (D)
Manufacture and metal finishing of stationary power tools	Installation of automated, metal electroplating system to replace manual system. Increased annual productivity by $200,000. Chemical consumption decreased by 25% ($8,000). Water costs decreased by $1,100 per year. Plating wastes decreased from 450 to 360 pounds per day. Wastewater treatment costs reduced by 25%. Annual personnel and maintenance savings $35,000. Eliminated worker exposure to acids and caustics.		1 year (I)
	Ultrafiltration system and oil skimmer were installed allowing for recovery from process water of $8,000 worth of oil per year and $3,000 worth of alkaline cleaning solutions per year. Water costs reduced by $1,100 per year and process water treatment costs by $10,000 per year. Saved firm from having to expand their water treatment capacity.	$65,000	2 years (I) 5 years (D)

Key: (I) Payback period dependent on regulatory structure in U.S., which provides avoidable costs.
(D) Payback period applicable to developing countries without costly regulatory compliance impacting economics.

Process	Description	Capital Cost	Payback
Agricultural irrigation	Treated mixed municipal and industrial sewage applied onto 5,000 acre corn farm with sandy soil. Resulted in annual corn harvest of $1.1 million, providing over 20% of the facility's operating expenses. Wastewater aerated and storaged in lagoons for three or more months, then spray-irrigated onto fields through series of center-pivot irrigation rigs. Rapid infiltration used to inundate fields with 30-40 inches per week of wastewater, using retaining walls around the fields to hold excess water until infiltration. Resulted in increased crop yields and enlarged system capacity.		
Metal working	Disposal of water mineral oil emulsion machining coolant replaced by portable waste coolant recycling system. Metal chips removed in paper filter, with reuse possible, and oil recovered. Reduction of 80-90% in waste coolant. Annual reduction in virgin materials costs of $21,000 and disposal costs of $12,300.	$17,500	<0.5 year (I) <1 year (D)
Grey and Compacted Graphite Iron Casting	Wastewater treatment system modified from single-pass system to two interconnected closed-loops, eliminating 75% of total process water needed to be treated. Reduction in capital costs in pretreatment facility by 50-75%, annual energy costs by $744, annual water usage by $13,000, and annual personnel and maintenance costs of $18,000.		
Electronic equipment manufacturing	Cooper-etching rinse stream treatment system modified by installing electrolytic metal recovery cell downstream from rinse tank to recover cooper and allow for recirculation of rinse water back into rinse tank. Recovered $2,000 worth of copper during first year of operation. 50% reduction in water usage with installation of flow restrictors.		

Key: (I) Payback period dependent on regulatory structure in U.S., which provides avoidable costs.
(D) Payback period applicable to developing countries without costly regulatory compliance impacting economics.

Process	Description	Capital Cost	Payback
Acrylonitrile manufacture	Generation of hazardous blowdown (cooling tower water used to remove buildup of slime and solids that accumulate during recirculation) eliminated by replacing conventional water cooling system with closed-loop coolant refrigeration system. After coolant is used to cool the process, it is compressed to a higher temperature and pressure and then passed through a radiator that would reject the heat to the environment and then recycle back into the system. Savings: $20 per ton of product.		Few years (I)
Truck parts manufacturing	Installed wastewater ultrafiltration system, which included cyclone "grit" separator and floating oil skimmer, to filter approximately 111,000 gallons/year of spent coolant wastes, scrubber water, and mop water. Total of 88,0000 gallons/year of filtered permeate reused for mop and scrubber water and 22,000 gallons of concentrated oily waste is shipped offsite for fuel blending. Annual savings: $60,800 per year in water consumption and disposal costs.		0.5 year (I)
Leather finishing	Switched from oil-based paints to water-based paints for pre-coats and intermediate coats on 35%—40% of product line. Wastewater from water-based paint spraying operations treated and reused back in the spray booths. Annual disposal cost savings of $100,000.		<0.5 year (I)
Nickel plating	Used advanced reverse osmosis to separate rinse tank waste stream into two streams to recycle into plating line. Concentrate of 50% nickel in rinse water waste stream recycled to the plating tank. Permeate of deionized water recycled to clean rinse tank.	$75,000	4.5 years (I)
	Low temperature evaporative recovery system uses vacuum evaporation to concentrate rinse water waste streams, which then pass through carbon filter for organic contaminant removal prior to reuse as make-up rinse water. Reduces water use and chemical purchases. Annual capital and operating costs: $9,419. Net savings of $16,831 per year.		Approximately 1 year (I)

Key: (I) Payback period dependent on regulatory structure in U.S., which provides avoidable costs.
(D) Payback period applicable to developing countries without costly regulatory compliance impacting economics.

Process	Description	Capital Cost	Payback
Copper Cyanide Plating	Advanced reverse osmosis technology used to recover and recycle/reuse copper cyanide contaminated rinse water. 98% recovery of copper cyanide allowing direct reuse in plating line.		
Printed circuit board manufacturing	Decreased withdrawal rate of plating bath. Intermediate withdrawal rate of plating bath combined with a longer drain time. Each modification resulted in 55% reduction in drag out for electroless bath and 40% reduction for etchant bath, and prevented 200 grams/day of copper from entering the waste stream. Annual savings for each modification: $3,300. ($2,600 saved from extended resin life in ion exchange treatment system). $700 per year saved in water and sewer charges if rinse water flow rates are reduced proportionally to reduction in drag out.	none	Immediate (D)
Flexible circuits manufacturing	Soft absorbent polyvinyl alcohol rollers replace hard rubber squeegees to reduce drag out in cleaning operation. Sponge rollers compress to return solution to concentrated cleaning bath, reducing the amount of acid and other contaminants carried into rinse. With the conservation of cleaning solutions, less ends up in rinse tanks. Rinse water volumes proportional reduced with reduction in dragout.		<1 year (I)
	Conductivity activated flow controller reduces rinse water flow in tin lead plating line. Rinse water flow turned off to rinse tanks when conductivity falls below set point. Conservation of water and volume reduction in rinse water treatment.		Approximately 1 year (I)

Key: (I) Payback period dependent on regulatory structure in U.S., which provides avoidable costs.
(D) Payback period applicable to developing countries without costly regulatory compliance impacting economics.

Process	Description	Capital Cost	Payback
Petroleum refining	Reduction in coke-cutting water fines generated from the coke-cutting operation, which normally enters in-ground sump where the solids and water separated by gravity (>25 tons a year of coke fines enters the sewer system). Sump retrofitted with inclined plate separator to increase separation efficiency. Increased recovery of coke and reduced oil/water separation solids. Annual savings: $250,000 (I).		
	Reused acidic water from off gas scrubber for make-up water in crude desalting units instead of discharging to wastewater treatment unit. Reduced water consumption and hydraulic loading to treatment unit. Annual cost savings: $450,000.		0.5 year (I)
Aluminum, carbon, and stainless steel machining	Used a deionized water system, a mixing and proportioning system, and a high-speed centrifuge to decrease coolant usage. Increased useful life and performance of coolant by replacing tap water with deionized water (reduced levels of metals, metal salts, bacteria, and other compounds). Mixing system installed to deliver proper coolant-to-water ratio to the machining equipment. High-speed centrifuge removes unwanted tramp oil and debris and breaks tight tramp oil emulsion from coolant. Within one year: 80% reduction in waste disposal and reduced operator's time. Increased value of waste-oil for recycling (energy use).		
Stainless steel processing	Oil skimmers installed on all machine coolant reservoirs to remove free oil resulting in increased life of coolant by biological activity reduction (26% reduction in coolant generation). Separated waste streams into waste oil and coolant (water) resulting in the recovery of 30,000 gallons of high-BTU oil for fuel blending and disposal cost savings of $0.24 per gallon. Reduced number of different coolants used from 15 to 6 allowing for increased recycling. Installation of fluid evaporators eliminated water portion of coolant mixture and resulted in a high BTU waste for fuel blending. Achieved 90% reduction in waste coolant. Annual operating cost savings: $290,000.	$140,000	0.5 year (I)

Key: (I) Payback period dependent on regulatory structure in U.S., which provides avoidable costs.
(D) Payback period applicable to developing countries without costly regulatory compliance impacting economics.

Process	Description	Capital Cost	Payback
Citrus packing	Discharge of wash water to wastewater treatment plant replaced by water pretreatment and reuse system, which reclaimed and reused water 20 to 40 times. System included a 1,100 gallon polypropylene reservoir, two HP recirculation pumps, a canister filter with removable micro-mesh cartridge element, and a chlorinator. Daily water savings: 19,000 gallons (95% reduction). Waste wash water generated from detergent washing, disinfection, waxing, and coloring containing cleaning chemicals, wax and oil, sand, sooty mold, and fruit debris. Annual operating cost: $8,000. Savings in sewer and water charges: $2-$5 per thousand gallons. Reduction of total water usage and sewer disposal costs from $750/month to $25/month. Added chemical purchase costs: $150/month.	Pre-treatment: $5,000 Reuse: $5,000	2-3 growing seasons (I)
Milk and ice cream processing	Installed system to recover product-water mixtures from the High-Temperature-Short Time Pasteurizing System and recover raw rinse water for the Raw Cleaning-In-Place System. In the HTST Pasteurization System, reused 90% of rinse water and recovered and reused 75,000 pounds ($42,357) of dairy solids and butterfat annually. Annual total reuse value of recovered materials: $87,185. Prevented loss of 170,000 lbs. of milk, decreased biological oxygen demand by 17,000 lbs. over four-month period (14.7% reduction per day), and decreased total suspended solids by 22.8% in one-month period. Monthly savings: $24,000 per month. Annual savings: $350,000. Reduced chemical usage, sludge production, and power requirements for treatment plant.		

Key: (I) Payback period dependent on regulatory structure in U.S., which provides avoidable costs.
(D) Payback period applicable to developing countries without costly regulatory compliance impacting economics.

Process	Description	Capital Cost	Payback
Aluminum radiator manufacturing	Switched from conventional chromium chromate and chromium phosphate coating process, which contained cyanides to cyanide-free and no rinse chromate coating process. Resulted in volume reduction of generated filter cake sludge from 20 yards per month to < 1 yard per month; elimination of all forms of cyanide from process and resulting waste sludge; and 80% reduction in water usage (from 14,000-17,000 gallons per day to 3,000 gallons per day). Coating chemicals recycled back into the system. Minimized amount of product used by adding controls for automatic sampling and replenishment of precise water chemical mixture. Avoided cost of cyanide waste management offset increase in chemical coating costs.		
Acrylic yarn manufacturing	Reused non-contact cooling water and contact production water in dyeing process. Placed three 5,000-gallon, salvaged, stainless steel tanks adjacent to dye vessels. Piped the circulated water from the cooling coils to the three tanks through a temperature-activated diverter valve for reuse. Used hot water from tanks for dyeing process steam needs during generation of heat. Water used in dye house. Contact water reused by transferring the water from the process tanks back into preparation tanks. Expended chemicals replenished for batch reuse. Savings in water usage and disposal costs: $13,000 per month. Process water usage reduced from 320,000 gallons per day for 12 dye batches to 102,000 gallons per day for 20 dye batches. Resulted in water use and waste generation reduction of 60%, with an increase in batches produced. Savings from water reuse system: Chemical savings of $45 per batch. Reduced fuel usage by 440 gallons per day by reducing heat-up time by 8-10 minutes per cycle Reduced water usage by 3,000 gallons per batch recycled. Minimized chemical usage by automating dye bath flow and temperature. Resulted in clean final dye bath exhaust. Eliminated need for rinsing after dyeing. Replaced vertical configuration dyeing machine with machine that has packages in horizontal configuration. Resulted in 50% reduction in both water and chemicals utilization.	Reuse system: $5,600	<30 days (I)

Key: (I) Payback period dependent on regulatory structure in U.S., which provides avoidable costs.
(D) Payback period applicable to developing countries without costly regulatory compliance impacting economics.

Process	Description	Capital Cost	Payback
Polystyrene and barrier film manufacturing	Reduced water usage by 3 million gallons per year by recycling cooling water. Cooling water used to cool extruded molten recycled polymer is recooled in heat exchangers and reused in system.		
Lumber products manufacturing	Replaced liquid glues with dry glues. Used the wastewater from the glue washdown water as make-up water for liquid glues. System required two barrels to hold the wastewater, pumps, and fiberglass settling tank. Lined 3-gallon glue mixing pots with plastic trash compactor bags to eliminate rinsing. Annual savings: $1,000 on annual permit fees, $300 per month in sewer fees, and $10,000 per year in pre-treatment costs. Reduced landfill disposal fees. Conserved water.	$1,500	

Key: (I) Payback period dependent on regulatory structure in U.S., which provides avoidable costs.
(D) Payback period applicable to developing countries without costly regulatory compliance impacting economics.

A.I.D. CENTRALLY FUNDED ENVIRONMENTAL AND NATURAL RESOURCES RELATED PROJECTS

Appendix G

Acronym	Project Name	A.I.D. Office Phone/Fax	Contractors	Project Address	Phone/Fax
ASSET	A.I.D. Staff Strengthening through Environmental Training	HRDM/ PM/TD/PCT tel. 703-875-1112 fax. 703-875-1402	Institute for International Research (Prime), Coverdale Organization, KBN Engineering & Applied Sciences, Resources for the Future, Winrock International	1815 N. Ft. Myer Dr. Suite 600 Arlington, VA 22209	tel. 703-527-5546 fax. 703-527-4661
BEST	Biomass Energy Systems & Technology	R&D/EI tel. 703-875-4052 fax. 703-875-4053	Winrock International	1611 N. Kent St. Suite 600 Arlington, VA 22209	tel. 703-525-9430 fax. 703-243-1175
BSP	Biodiversity Support Program	R&D/ENR tel. 703-875-4669 fax. 703-875-4639	World Wildlife Fund, The Nature Conservancy, World Resources Institute	1250 24th St., NW Washington, DC 20037	tel. 202-293-4800 fax. 202-293-9211
DESFIL	Development Strategies for Fragile Lands	R&D/EID/ RAD tel. 703-875-4532 fax. 703-875-4949	Chemonics International (Prime); Rodale Institute; Abt Associates; Datex, Inc.	1133 21st St., NW Suite 610 Washington, DC 20036	tel. 202-331-1860 fax. 202-331-1871

Acronym	Project Name	A.I.D. Office Phone/Fax	Contractors	Project Address	Phone/Fax
ENRIC	Environment & Natural Resources Information Center	R&D/ENR tel. 703-875-4019 fax. 703-875-4639	Datex, Inc.	1400 I St., NW Washington, DC 20005	tel. 202-789-1525 fax. 202-789-1520
EPAT/ MUCIA	Environmental and Natural Resources Policy and Training Project	R&D/ENR tel. 703-875-4046 fax. 703-875-4639	Midwest Universities Consortium for International Activities (MUCIA) (Prime), Abt. Associates, DAI, Development Assistants, WRI	1611 N. Kent St. Suite 807 Arlington, VA 22209	tel. 703-481-0699 fax. 703-481-0026
EPAT/TA	Environmental and Natural Resources Policy & Training Project / Technical Assistance Component	R&D/ENR tel. 703-875-4046 fax. 703-875-4639	Winrock International (Prime), Center for Policy Negotiation, Development Assistance Corp., The Futures Group, Inst. for Int'l Research, Iowa S.U., Johns Hopkins, KBN Engineering, The Keystone Center, Management Systems Int'l, NYU, The RAND Corp., Resources for the Future, Tellus Institute, Tropical Research and Development Inc., Tufts U., Tuskegee U., U. of Maryland, U. of Rhode Island, Yale U.	1611 N. Kent St. Suite 801 Arlington, VA 22209	tel. 703-525-9430 fax. 703-516-0481
EPM	Environmental Planning & Management Project	R&D/ENR tel. 703-875-4539 fax. 703-875-4639	World Resources Institute's Center for International Development & Environment	1703 N.Y. Ave., NW Suite 700 Washington, DC 20007	tel. 202-638-6300 fax. 202-638-0036
ETS	Evaluation Technical Services	POL/E/POA tel. 703-875-4902 fax. 703-875-5269	Development Alternatives, Inc. (Prime), Development Associates, MSI, RTI	7250 Woodmont Ave. Suite 200 Bethesda, MD 20814	tel. 301-718-8699 fax. 301-718-7968

Acronym	Project Name	A.I.D. Office Phone/Fax	Contractors	Project Address	Phone/Fax
F/FRED	Forestry/Fuelwood Research & Development Project	R&D/ENR tel. 703-875-4669 fax. 703-875-4639	Winrock International Institute for Agricultural Development	1611 N. Kent St. Suite 600 Arlington, VA 22209	tel. 703-525-9430 fax. 703-522-8758
IPC	Implementing Policy Change	R&D/EID tel. 703-875-4587 fax. 703-875-4949	Management Systems International (Prime), International Development Management Center, DAI, Abt.	600 Water St., NW Washington, DC 20024	tel. 202-484-7170 fax. 202-484-0754
ISPAN	Irrigation Support Project for Asia and the Near East	ASIA/DR/TR tel. 202-647-0915 fax. 202-647-7368	Camp Dresser & McKee International (Prime), DAI, TRG, Harza, CARE, Cornell University, University of Arizona, ISTI	1611 N. Kent St. Suite 1001 Arlington, VA 22209	tel. 703-243-7911 fax. 703-525-9137
PRIDE	Project in Development and the Environment	NE/DR/ENR tel. 202-663-2493 fax. 202-663-2494	Chemonics International Consulting Division (Prime), RCG/Hagler Bailly, Science Applications International Corp., Capital Systems Group, Environomics, Industrial Economics, Lincoln University, Resource Management International	2000 M St., NW Suite 200 Washington, DC 20036	tel. 202-331-1860 fax. 202-331-1871
PRISM	Program Performance Information for Strategic Management	CDIE/SDS tel. 703-875-5810 fax. 703-875-5269	Management Systems International (Prime), Labat Anderson, Inc., Research Triangle Inst.	600 Water St., SW Washington, DC 20004	tel. 202-484-7170 fax. 202-488-0754
VBC	Vector Biology and Control Project II	R&D/H/CD tel. 703-875-4480 fax. 703-875-4686	Medical Service Corporation International (Prime), Harvard University, Tulane University, Henry M. Jackson Foundation	1901 N. Ft. Myer Dr. Suite 400 Arlington, VA 22209	tel. 703-527-6500 fax. 703-243-0013

Acronym	Project Name	A.I.D. Office Phone/Fax	Contractors	Project Address	Phone/Fax
WASH	Water and Sanitation for Health Project	R&D/H/CD tel. 703-875-4726 fax. 703-875-4686	Camp Dresser & McKee International (Prime), ARD, ISTI, RTI, TRG, UNC, URC	1611 N. Kent St. Suite 1001 Arlington, VA 22209	tel. 703-243-8200 fax. 703-243-9004

Acronym	Areas of Expertise	Services Performed	Illustrative Assignments	Contract Period	Access
ASSET	■ Training courses ■ Short-term training	■ Environmentally sustainable development planning ■ Environmental impact assessment ■ Environmental economics ■ Mission director training in environmentally sustainable development ■ Presentations on a variety of environmental issues at USAID seminars, conferences, and other training activities.	■ One- to three-week Environmental Impact Assessment (EIA) courses ■ Two-week Environmentally Sound Development Planning (ESDP) courses ■ One-week environmental economics for sustainable development courses ■ Mission director seminar series	1990-1992	Core for workshop expenses Mission OE funds for travel and per diem
BEST	■ Sugarcane, rice, and wood energy systems ■ Advanced biomass conversion technologies ■ Carbon sequestration ■ Support for rural electrification through distributed generation ■ Technology adaptation and transfer ■ Feasibility analysis ■ Agro-industry waste management	■ Technical assistance ■ Resource assessments ■ Policy studies ■ Applied research and development ■ Cost-sharing of preinvestment studies ■ Seminars, workshops, conferences ■ Project evaluation	■ Assessment of waste management options for the citrus industry in Belize ■ Sugarcane field trash recovery trials at a sugar mill in Thailand ■ Workshop on biomass energy pricing and power contracts in Costa Rica ■ Design for cane trash processing system ■ Wood energy technology trade exhibit and tour for Central American mill owners ■ Assessment of the potential for recovering cane trash in Egypt ■ Prefeasibility support for rice husk power project in India	1989-1994	Core/mission buy-ins

Acronym	Areas of Expertise	Services Performed	Illustrative Assignments	Contract Period	Access
BSP	■ Conservation of biological diversity and promotion of sustainable economic growth ■ Design and implementation of conservation and development projects ■ Protected area and buffer zone planning and management	■ Develop local leadership and institutional capacities for conservation ■ Research and development of monitoring and assessment systems ■ Identify and support economic, and other non-economic incentives for conservation of biodiversity ■ Develop mechanisms to encourage local participation in conservation ■ Manage small research grants program on biodiversity conservation	■ Conservation needs assessments for Papua New Guinea and Bulgaria ■ Research Grants Program that funds approximately 34 applied research projects per year from applicants in AID-assisted countries ■ Establishing agricultural alternatives for local farmers in order to decrease the degradation of forests in five wildland buffer zones in Mexico ■ A workshop that enables community participation in planning a marine park in Mafia Island, Tanzania ■ A Global Climate Change study—built on the technical capabilities of BSP, NASA, and the Univ. of Maryland—that determined the impacts of deforestation in Central Africa on climate change ■ Provided funding and technical support to Wildlife Fund Thailand to manage smaller, grass-roots groups' conservation activities in Thailand ■ Conducted mid-term evaluation of an integrated conservation and development project, Boscosa, Costa Rica	1988-1994	Core/bureau and mission add-ons
DESFIL	■ NRM policy ■ Incentives and property rights ■ Technology development ■ Gender	■ Research on forest management, sustainable agriculture, indigenous people, policy taxonomy, soil conservation, and fertility enhancement taxonomy ■ Technical assistance ■ Networking ■ Dissemination	■ Fielded one member of concept design team for NRM project in Guatemala ■ Environmental Trust Project design in Honduras	1991-1996	Core/mission buy-ins

Acronym	Areas of Expertise	Services Performed	Illustrative Assignments	Contract Period	Access
ENRIC	■ Environment and natural resource program data management and analysis ■ Database management ■ Information management including GIS use	■ Program analyses ■ Tracking of USAID environment strategy ■ Examination and quality control of AC/SI codes used for project in the environment strategy ■ Reports, publications, newsletter	■ Prepare USAID Administration Report to Congress on Conservation of Tropical Forests and Biodiversity ■ Develop AC/SI code formula and compute programs for tracking the Environment Strategy ■ Review ways to analyze AID; portfolio contribution to UNCED; Agenda 21 ■ Information dissemination to FAO on USAID forestry projects	1991-1993	No formal mechanism
EPAT/ MUCIA	■ Energy, industry, and urban environment ■ Macroeconomics policy and environment ■ Resource pricing and institutions ■ Forestry and watershed management ■ Population and migration ■ Training	■ University-based research ■ Collaborative in-country research ■ Policy training ■ Environmental publications	■ Synthesis paper on "Forestry for Sustainable Development" ■ "Water, Sewerage and Solid Waste: Public and Private Policy in Developing Countries" ■ Training course on environmental policy analysis and implementation	1991-1996	Core/mission buy-ins

Acronym	Areas of Expertise	Services Performed	Illustrative Assignments	Contract Period	Access
EPAT/ TA	■ Natural resource and environmental policy ■ Economic policy ■ Urban and rural pollution control and management ■ Sustainable agriculture ■ Environmental economics ■ Water resource management ■ Institutional strengthening	■ Applied in-country research ■ Institutional strengthening ■ Human resource development ■ Policy dialogue ■ Policy analysis and formulation ■ Project design and evaluation ■ Economic analysis and modeling	■ "Guidelines for the Use of Economic Instruments for Environmental Protection in Developing Countries" for the Development Assistance and Environment Working Party of the DAC/OECD ■ Seminar on "Agricultural Transformation in Africa" for the Africa Bureau ■ Study on establishing endowments for environmental NGOs in Africa ■ Assessment of economic analysis in African non-project assistance programs and natural resource management project ■ Desktop study of delegation of authority to missions for environmental review of non-project assistance, Africa Bureau ■ Strategic Planning workshop for the Jamaica Natural Resources Conservation Authority ■ Recommendations for the use of natural resource accounting in Africa for Africa Bureau	1991-1996	Core/mission buy-ins
EPM	■ Natural resource management ■ Sustainable agriculture ■ Forestry and land use ■ NGO support and policy ■ NRM data systems	■ Multidisciplinary technical assistance ■ Studies and lessons learned ■ Policy development and support ■ Institutional capacity building	■ Agroecosystems analysis in the Philippines ■ Agroecosystem management policy seminar workshop Bicol River Basin Development Project ■ Rapid Rural Appraisal training/publications ■ Case studies of NGOs ■ Country Environmental Profiles in Pakistan, Africa, Latin America/Caribbean, Asia, and the Near East	1985-1994	Core/mission buy-ins
ETS	■ Technical assistance for a program evaluation of USAID-funded environment and natural resources projects	■ Evaluation design ■ Data collection and analysis ■ Synthesis of evaluation findings	■ Literature review of USAID-funded E/NRM projects from 1980-1990 ■ Data collection on the impact of USAID-financed E/NRM projects in Pakistan	1991-1994	No buy-ins

Acronym	Areas of Expertise	Services Performed	Illustrative Assignments	Contract Period	Access
F/FRED	■ Multi-purpose tree species (MPTS) research ■ Scientific and collaborative networking ■ Integrating biological and social sciences ■ National networks ■ Training ■ Research grants ■ Information dissemination through publications	■ Networking ■ Facilitating MPTS field research ■ Improving availability of genetic resources ■ Interdisciplinary research for community-based tree improvement ■ Gender analysis as an integral part of MPTS research ■ Linking with and strengthening national networks ■ Information dissemination	■ Developed Multipurpose Tree Research System 3, an integrated microcomputer information and decision support system ■ Award annual small research grants ■ Establish and maintain seed orchards of psyllid-resistant Leucaena in five Asian countries ■ Developed jackfruit subnetwork and related pilot project ■ Develop women's focus groups within community-based tree improvement activities of the jackfruit network ■ Sponsor PhD and Master training and course ■ Distribute Farm Forestry News (quarterly newsletter)	Phase I: 1985-1990 Phase II: 1990-1995	Core
IPC	■ Policy analysis ■ Management ■ Implementation ■ Strategic planning ■ Applied research ■ Institution building ■ Monitoring systems	■ Multidisciplinary technical assistance ■ Implementation assistance ■ Stakeholder analysis ■ Environmental mapping ■ Institutional assessment ■ Strategic planning for policy change ■ Applications of strategic management technology ■ Implementation issues in project design and evaluation	■ Implementation issues in the management of natural resources policy in Africa ■ Assessment of alternatives for regulation of restrictive business practices in Zimbabwe ■ Development of case studies on management of natural resources in Africa ■ Implementation of national forum on strategic management of private investment and export growth in Uganda ■ Assistance in start-up and implementation of policy analysis unit in Jamaica ■ Assessment of SPAP funded activities on policy selection and implementation at the national and regional level in the Sahel.	1990-1995	Core/mission buy-ins

Acronym	Areas of Expertise	Services Performed	Illustrative Assignments	Contract Period	Access
ISPAN	■ Water resource management ■ Water quality ■ Flood control ■ Irrigation ■ End user participation	■ Interdisciplinary technical assistance ■ Studies, lessons learned ■ Human Resource Development ■ Policy development ■ Planning and management ■ Project design and evaluation ■ Newsletter	■ Water resources action plan document for the Near East Bureau ■ Water resources perspectives paper on Asia for the Asia Bureau ■ Environmental baseline study and literature survey on the Gulf of Aqaba for the Middle East Peace Talks ■ Under the Eastern Waters Initiative, long-term on-site services to support the Bangladesh Flood Action Plan ■ Applied study on the sustainable use of water resources in Morocco, Egypt, Pakistan, and Indonesia ■ Irrigation management policy support in Sri Lanka ■ Water quality laboratory design concepts and layouts, equipment procurement documents and training plans, in Oman ■ Draft material for a water and soil resources conservation project paper in Morocco ■ Series of project coordination workshops for the Irrigation Management Systems Project in Egypt	1987-1994	Core/mission and bureau buy-ins

Acronym	Areas of Expertise	Services Performed	Illustrative Assignments	Contract Period	Access
PRIDE	■ Environmental economics ■ Private sector programs ■ Incentive-base pollution control ■ Environmental education and training ■ Public awareness ■ Policy and planning ■ Institutional development	■ Strategic planning ■ Technical studies ■ Training assessments ■ Environmental awareness campaign designs ■ Institutional analysis ■ Project design ■ Private sector business profiles ■ Environmental assessment ■ Pollution prevention/waste minimization analysis ■ Policy analysis ■ Newsletter	■ Water Management Study in Jordan ■ Water Conservation and Management Project Paper in Jordan ■ Water Quality Assessment and Management Plan in Egypt ■ Environmental legislative review in Jordan ■ Small Scale Wastewater treatment assessment in Tunisia ■ Private sector environmental management project design for World Bank and USAID in Morocco ■ Private Sector Environmental Business Survey	1991-1996	Core/mission buy-ins
PRISM	■ Strategic planning and management ■ Monitoring and evaluation ■ Design and managment	■ Workshops ■ Technical assistance ■ Assistance to missions in integrating project and program level data	■ By mid-1992, PRISM had provided technical assistance to over 30 USAID missions as well asto offices in regional and central bureaus ■ By September 1992, 75% of AID resources were to be covered by program performance information systems ■ By June 1993 100% of all resources should be covered	1991-94	Core/mission buy-ins

Acronym	Areas of Expertise	Services Performed	Illustrative Assignments	Contract Period	Access
VBC	■ Vector borne disease control ■ Country and regional planning ■ Technical assistance in epidemiology, entomology, HRD, information ■ Coordination with institutions	■ Technical assistance in planning, management, operational research, epidemiology, entomology and vector control, information ■ ID/HRD in training and TOT, institutional development, community participation ■ Environmental studies, intersectoral planning and research on environmental health, integrated disease control	■ Economic impact of malaria in Africa ■ Alternate water resources/utilization in Senegal) ■ Data management in Pakistan, Nepal, Honduras, and El Salvador ■ Ivermectin Distribution Program coordinating AFRICARE and LAC ■ Chagas' disease programs in Bolivia ■ Contingency plans for dengue outbreaks in Latin America ■ Niger malaria strategy development ■ Environmental guidelines and assessments in Pakistan, Bolivia, El Salvador ■ KAP and other malaria studies in Malawi ■ National Malaria Control Action Plan in Kenya	1989-1994	Core/mission and regional office buy-ins
WASH	■ Engineering for water supply and sanitation ■ Institutional and human resources development ■ Environmental health ■ Financial management and cost recovery ■ Community participation and hygiene education ■ Environmental management	■ Interdisciplinary technical assistance ■ Risk assessments ■ Project design and evaluation ■ Training ■ Institution strengthening ■ Prefeasibility studies	■ Explored methods to increase private sector participation in urban water supply in Indonesia ■ Strengthened the Ecuadoran agency in charge of rural water and sanitation ■ Developed a decision-making system to manage point-source pollution in the Danube River Basin ■ Assessed the total cost to Peru of the 1991 cholera epidemic ■ Prepared a manual of affordable options for managing wastewater and solid waste	Phase I: 1980-1984 Phase II: 1984-1989 Phase III: 1988-1993	Core/mission and bureau buy-ins

AN INNOVATIVE APPROACH TO ACTION PLAN IMPLEMENTATION

Appendix H

Implementing the action plan and directly addressing issues of water shortages, water quality degradation, and resource mismanagement will be challenging, particularly because controversial interministerial concerns are certain to emerge. An innovative policy formulation program in Sri Lanka is a potential guideline for implementing the water resources strategy under similar circumstances.

The Irrigation Management Policy Support Activity (IMPSA) in Sri Lanka successfully addressed these issues by emphasizing the participation of government officials at all levels. The program, which lasted from 1990-92, was jointly carried out by the Government of Sri Lanka and USAID. It was managed by the Irrigation Support Project for Asia and the Near East (ISPAN), with technical assistance from the International Irrigation Management Institute.

There were three key elements in the IMPSA process:

- Full-time staff and effective leadership by local experts provided through the IMPSA Secretariat.
- Good analytical work, prepared by the Secretariat, assisted by local and expatriate consultants provided by ISPAN and International Irrigation Management Institute (IIMI). A system of *staff working papers* was based on secondary data and extensive interviews with government officials and others rather than on primary data collection. Informal groups of government officers worked with consultants to generate specific staff working papers which were then merged into a single *policy paper* that focused the attention of senior officials on the issues and options.
- The workshop context, which brought interaction, coordination, and agreement. The workshops, which reviewed staff working papers and policy papers, were in a series that was highly participatory and moved progressively upward through the GSL bureaucracy.

The process was iterative, relying on workshops where ideas were floated early, permitting them to be examined politically and bureaucratically from all sides. As a result, adjustments in various technical and bureaucratic positions were made. The ideas were then re-examined in succeeding workshops, with further adjustments made at each stage, until the participants reached consensus. At that point, the policy papers were submitted to the Cabinet for approval.

The process brought eventual agreement on policies, programs, actions to be taken, and, more importantly, who would be responsible for implementing them. It can be readily adapted for other technical areas.

SUGGESTED READINGS ON WATER RESOURCES

Appendix I

General Background on Water Resources

Clarke, Robin

1991 Water: The International Crisis. London: Earthscan Publications Ltd.

A popularly written text which describes the world's freshwater shortage and reviews the political and economic conditions that led to it.

Postel, Sandra

1992 Last Oasis: Facing Water Scarcity. The Worldwatch Environmental Alert Series. New York: W.W. Norton and Company.

An interesting overview of water scarcity that stresses the need for conservation, reuse, and increased efficiency.

World Resources Institute

1992 World Resources: A Guide to the Global Environment. New York: Oxford University Press.

An excellent yearly review of environmental conditions and trends. The chapters on freshwater, oceans, and coasts provide a particularly good background on water resources to the uninitiated.

Near East Perspectives

Blake, Gerald, John Dewdney, and Jonathan Mitchell

1987 The Cambridge Atlas of the Middle East and North Africa. Cambridge: Cambridge University Press.

An excellent compendium of maps and descriptive text on diverse topics, including the physical environment, demography, economics, and communication in the region.

Caponera, Dante

1973 Water Laws in Moslem Countries. FAO Irrigation and Drainage Paper 20/1.

Although it is somewhat dated and has occasional inaccuracies, this work remains the standard text on Islamic water laws.

Gischler, Christiann
1979 Water Resources in the Arab Middle East and North Africa. Cambridge: Middle East & North African Press Ltd.

Slightly dated, but still the best technical reference for water resources in the Near East.

Shahin, Mamdouh
1989 "Review and Assessment of Water Resources in the Arab Region." Water International 14:206-19.

An informative overview of water resources in the Near East.

Swearingen, Will
1987 Moroccan Mirages: Agrarian Dreams and Deceptions, 1912-1986. Princeton University Press.

A fascinating account of the historical roots of and political context for water resources planning in contemporary Morocco.

Waterbury, John
1979 Hydropolitics of the Nile Valley. Syracuse University Press.

A seminal study of water politics in the region that has served as a model for others examining the relationship between political processes and water resources.

Water Shortages

Naff, Thomas, and Ruth Matson
1984 Water in the Middle East: Conflict or Cooperation. Boulder: Westview Press.

A standard treatment of water shortages in the region.

Schiller, Eric
1992 Sustainable Water Resources Management in Arid Countries. A special issue of the Canadian Journal of Development Studies.

Includes particularly good articles on regional water scarcity and case studies of Jordan, Egypt, and Morocco.

Sexton, Richard
1990 Perspectives on the Middle East Water Crisis: Analyzing Water Scarcity Problems in Jordan and Israel. ODI/IIMI Irrigation Management Network Paper 90/3f.

Challenges those who focus only on water scarcity as the cause of future conflicts.

Starr, Joyce, and Daniel Stoll (eds.)
1988 The Politics of Scarcity: Water in the Middle East. Boulder: Westview Press.

Representative of the narrowly conceived, but still influential, position that water resources scarcity could lead to war in the Near East.

Management Issues

El Katsha, Samiha, and Anne White
1989 "Women, Water, and Sanitation: Household Behavioral Patterns in Two Egyptian Villages." Water International 14:103-11.

An excellent examination of women's attitudes toward water use, making a persuasive argument for increased education and public awareness.

Okun, Daniel, and Donald Lauria
1991 "Capacity Building for Water Resources Management. An International Initiative for the 1990s." Background Paper for the UNDP Symposium on a Strategy for Water Resources Capacity Building. IHE, Delft, the Netherlands.

An overview of management issues in the water sector.

Ostrom, Elinor
1992 Crafting Institutions for Self-Governing Irrigation Systems. San Francisco: Institute for Contemporary Studies Press.

An interesting perspective on water users association efforts by a political scientist. A short video is based on the text.

Rogers, Peter
1992 "Comprehensive Water Resources Management. A Concept Paper." Policy Research Working Paper on Water and Sanitation. Infrastructure and Urban Development. The World Bank.

A thought-provoking overview of the new approaches needed to integrate water resource use among different users and across different economic sectors.

Small, Leslie, and Ian Carruthers
1991 Farmer-Managed Irrigation: The Economics of Reform. Cambridge: Cambridge University Press.

A broad assessment of irrigation financing policies that should be a basic resource for those considering instituting cost recovery programs.

Tang, Shui Yan
1992 Self-Governance in Irrigation. San Francisco: Institute for Contemporary Studies Press.

Because it focuses on small-scale irrigation systems, this is a companion piece to Ostrom's work

Pollution Prevention

Higgins, T.
1989 Hazardous Waste Minimization Handbook. Chelsea, Michigan: Lewis Publishers.

Useful descriptions of several types of industrial waste reduction.

Hirschhorn, Joel, and Oldenburg, K.
1990 Prosperity Without Pollution: The Prevention Strategy for Industry and Consumers. New York: Van Nostrand Reinhold.

A comprehensive treatise on the principles and applications of pollution prevention to different types of environmental issues and problems.

Office of Technology Assessment, U.S. Congress
1986 Serious Reduction of Hazardous Waste: For Pollution Prevention and Industrial Efficiency. Washington, DC: Superintendent of Documents, Government Printing Office.

A pioneering analysis of the pollution prevention strategy and its economic and environmental advantages over the traditional end-of-pipe approach.

ACRONYMS

ABS	Annual Budget Submission
ADB	Asian Development Bank
A.I.D.	U. S. Agency for International Development (Washington)
AMER	Associates for Middle East Research
bcm	billion cubic meters
BOO	build-operate-own
BOT	build-operate-transfer
CVM	contingent valuation method
ESF	Economic Support Fund
FAO	Food and Agriculture Organization
gpd	gallons per day
IIMI	International Irrigation Management Institute
IMPSA	Irrigation Management Policy Support Activity
ISPAN	Irrigation Support Project for Asia and the Near East
LEPA	low-energy precision application
LOP	life of project
mcm	million cubic meters
MERC	Middle East Regional Cooperation Program
NGO	nongovernmental organization
ODI	Overseas Development Institute
OECF	Overseas Economic Cooperation Fund
ppm	parts per million
PRIDE	Project in Development and the Environment
PVC	polyvinyl chloride
UN	United Nations

UNESCWA	United Nations Economic and Social Commission for Western Asia
USAID	U. S. Agency for International Development (Overseas Mission)
WASH	Water and Sanitation for Health Project
WUA	water users association