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PROGRESS ACHIEVED IN THE IMPLEMENTATION OF THE MAR DEL PLATA ACTION PLAN IN THE ESCWA REGION

"WATER-RESOURCES MANAGEMENT: INSTITUTIONAL AND LEGISLATIVE ASPECTS"

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EXECUTIVE SUMMARY

It is well known that most of the ESCWA region is comprised of arid or semi-arid zones characterized by scarce or limited water resources. Overdraft conditions such as ground-water depletion, resulting in quality deterioration in the inland aquifers or sea-water intrusion in the coastal aquifers, are common features prevailing in the region. Likewise, surface water is increasingly vulnerable to pollution from agricultural practices or waste disposal.

When present and projected water requirements for all purposes are compared with the available ground- and surface-water resources, serious questions arise concerning the long-term economic, environmental and political sustainability of existing water-resources development and water-use patterns. Under existing patterns of water use, it is unlikely that the expansion of irrigated agriculture can proceed without water-shortage problems. Additionally, increasing water scarcity in the region is likely to impose significant constraints upon meeting growing domestic and industrial demand. Some of the Gulf States of ESCWA have met demand by securing water supplies through desalination of sea and brackish ground-water resources.

Many member countries have recognized the need for concurrent development, conservation and management of their vital water resources. Water assessment and planning to determine the most appropriate resources allocation to various water users, as well as to formulate medium- and long-term policies and guidelines for the exploitation, utilization and subsequent management of the water resources, were the objectives and targets considered during the last decade in some member countries of the ESCWA region.

The progress achieved in the primary areas of specific concern relative to water-resources management activities in the region is briefly described below:

A. Water-resources assessment database

In many countries of the region, the available water sector data are scattered and generally inadequate to establish a comprehensive database for planning purposes. In some countries, programmes designed to measure basic water data from meteorological, hydrological and hydrogeological station networks, as well as to collect, process, store and periodically disseminate these data, have been undertaken in recent years. Plans to strengthen and modify the existing networks are being considered in member countries such as Iraq, Jordan, the Syrian Arab Republic, the Gulf States and Yemen.

To facilitate better planning, the most recently developed techniques have been employed in some countries of the region to analyse water data and to assess the quality and quantity of their water resources. Remote sensing, airborne geophysics, simulation modelling and the computerization of water-sector data using programming, micro-computer networks and the latest software packages are common practices in many member countries.

B. Institutional arrangements

Serious efforts have been made at the national level in some countries to inventory and administer available and potential water resources. Despite all the work thus far carried out, however, the countries are far from achieving an integrated management of their total water resources. ESCWA member countries such as Jordan, Oman, Bahrain and Qatar have taken steps to unify and centralize their national water institutions; various water-related institutions still exist in the other member countries, with fragmented responsibilities pertaining to water-sector affairs still prevailing. Moreover, the executive organs within the centralized water institutions lack coordination and perform most of their functions in isolation.

C. Water legislation

Water legislation in the region is generally complex and obsolete vis-à-vis modern water-management practices and techniques, and has resulted in the fragmentation of administrative responsibilities. Provisions which regulate water-resources development and management are often contained in different laws and regulations, or have originated from traditional and customary uses which relate to the prevailing social structure of some member countries.

Recently, countries such as Jordan, the Syrian Arab Republic, Iraq and the Gulf States have more critically examined water legislation, rules, regulations, customs, decrees, ordinances and other measures of control in the water-resources field.

D. Water-resources planning

National master planning of water resources is practised by many countries in the region. Jordan established an overall national water master plan as early as 1977, aimed at encouraging efficient utilization of the available water, funds, manpower and other relevant means, the most suitable methods and operations, and as far as possible the reuse and renewal of water resources. Kuwait, Egypt, Iraq, Saudi Arabia and Oman have also been active in water planning and national water-policy formulation, while other countries have this subject under consideration. These national water policies and plans are expected to encompass many aspects of water resources that aim at the wise management, conservation and development of vital resources. Surface-water impounding, artificial ground-water recharge, rain-water harvesting, reuse of drainage water and treated sewage effluents, and sea-water and brackish ground-water desalination have been commonly practised in many countries of the region over the last decade to optimize water utilization and to manage and develop available water resources at national levels.

E. Environmental protection measures

Serious efforts have been made in some countries of the region to ensure a safe and adequate water supply in both urban and rural areas; these undertakings have been substantive in the Gulf States and Jordan. In Iraq, several water-supply projects and treatment plants are under way, while only the main cities are partially covered by such projects in Yemen. In the Syrian Arab Republic, plans to construct waste-water treatment plants in five major cities are progressing well.

Water legislation to control and monitor the environment is being applied in the Gulf States, Jordan and, Iraq and to a certain extent, in Egypt.

F. Main findings

The main findings during the mission[1/] to five member states may be briefly described as follows:

1. Jordan

Efforts have been made to institutionalize Jordan's water sector. Water-resources planning was initiated in 1977, and updating of the national water master plan is being considered. Much is still required to assess and manage the country's limited water resources more comprehensively. Efficient water legislation pertaining to surface- and ground-water resources, conservation and management is being applied.

2. North Yemen

Responsibility for the resources, supply, maintenance and operations of Yemen's water sector and related projects is very fragmented.

It was noted that the concerned officials in Yemen are very much in favour of centralizing their national water-institution arrangements, particularly for unified Yemen.

A major, substantive water project funded by the United Nations Development Programme (UNDP) and executed by the United Nations Department of Technical Cooperation for Development (DTCD) is being implemented. Its immediate objectives are establishing a comprehensive water database, drafting a water law assessing the country's water resources and drawing up a national water master plan.

Water legislation in Yemen is non-existent, with traditional water practices, customary uses and tribal water rights dominating.

1/ The mission (18 January to 25 February 1990) was set up as part of an Inter-Agency Activity (Department of International Economic and Social Affairs [DIESA]/DTCD/ESCWA) to assess the progress achieved in the implementation of the Mar del Plata Action Plan and the formulation of a strategy for its implementation during the 1990s.

3. Syrian Arab Republic

Overdraft conditions and water-quality deterioration prevail in some major basins in the Syrian Arab Republic. Outdated water legislation to conserve and manage the country's water resources is being applied, but not very well observed. New water legislation to control water quality as well as environmental protection measures have recently been proposed.

Vital national water master planning and water-use strategies are expected to commence in 1992. Shared watershed management of the Euphrates, Tigris, Orentis and Yarmouk rivers are subjects of major interest to the Syrian Arab Republic and the other concerned riparians interested in developing and maintaining sustainable agricultural.

4. Republic of Iraq

A substantive plan for major, country-wide agricultural development projects was considered and is currently being implemented. New land reclamation efforts, particularly in the South Euphrates River Basin, have been made.

The concerned Iraqi authorities have paid a great deal of attention to controlling floods and lessening their hazards. Appreciable efforts have been made to develop the country's surface-water resources; a number of surface-water reservoirs have been constructed, and other new projects are being undertaken.

Land and water legislation and regulations are being enforced for better management and conservation of both land and water resources.

Environmental protection measures to maintain good water quality in the Tigris and Euphrates rivers are being considered.

Iraq's surface-water resources and agricultural development projects may be hampered by the water-related activities being practised in neighbouring countries. In this sense, shared water-resources management plans have to be agreed upon for the benefit of all concerned countries, as is true for the Syrian Arab Republic.

5. Arab Republic of Egypt

The Ministry of Public Works and Water Resources and its Water Research Centre, the Ministry of Agriculture and Land Reclamation, and the Ministry of Reconstruction and New Communities are the government agencies responsible for water-sector affairs in Egypt. Tremendous efforts have been exerted over the last decade for land and water-resources management all over the country -- primarily surface-water irrigation schemes. Ground-water development projects are being implemented at the peripheries of the Nile Delta, Wadi al-Jadid, and the North Coastal Plain; to the east near the Suez Canal; and in Sinai.

Conjunctive use of surface- and ground-water resources and reuse of drainage water are common practices in most of the irrigation projects in Egypt.

Land and water legislation to control water quality and to conserve and manage the country's water resources are enforced in the country.

G. Conclusion and recommendations

In general, good progress in water-resources management, institutionalization and legislation has been achieved in the region.

In addition to the national and subregional recommendations stated in chapter IV of this report, the United Nations system may consider the following as major areas of concern during the 1990s, relative to water-resources management in the ESCWA region:

1. Enhancing activities pertaining to the establishment of a comprehensive water-sector database at national and regional levels. The use of computers and the latest software packages to upgrade the knowledge of national water resources should be promoted. Because the water data for national water-resources assessment are inadequate in many countries of the ESCWA region, research to apply limited water data to tentative assessments should be enhanced.

2. Focusing on shared water-resources issues and considering them a priority. The development and utilization of surface- and ground-water resources at national levels could result in serious tensions among riparian countries; those concerned should therefore be encouraged to develop those resources in cooperation with one another.

3. Improving manpower capabilities for multi-disciplinary planners and those at managerial levels in the field of water resources.

The region in general lacks efficient institutional organization and skilled manpower capable of formulating coherent water policies and plans for developing national water resources, taking into account the economic and social goals vis-à-vis the other financing and planning bodies within the country. Water-demand management through applying appropriate conservation techniques and water-pricing policies, implementing cost recovery projects, and applying incentives and penalty measures to enhance water-use optimization should be promoted.

4. Implementing water projects based on social gain as well as on economic feasibility. The social structure prevailing in some member States of ESCWA may dictate the necessity of implementing projects where social consideration outweigh economic feasibility, due to political and strategic considerations, and the necessity for equal distribution of national water-development projects.

5. Enhancing public awareness at national levels by promoting incentives designed to encourage people to abide by the drafted water legislation. Efficient water-use policies cannot be implemented unless they are supported by appropriate water legislation which defines the ownership of water, regulates its uses, and controls the environmental impacts resulting from water-resources use, waste and reuse.

6. Promoting the application of new technologies in the major areas of concern to augment available water resources within ESCWA region. These are:

(a) The use of non-conventional energy resources to desalinate brackish ground-water resources occurring in the non-oil-producing countries. In the meantime, further research should be carried out to reduce the cost of desalination methods currently being applied in the oil-producing countries, as desalinated sea and/or brackish ground water is a major element of the national water resources of many member States of ESCWA.

(b) The use of treated sewage and industrial waste. This type of water resource has become one of the most important elements augmenting regional water supplies, especially countries like Jordan; the usage of such resources must be carefully monitored, in view of health considerations.

(c) Improving water-use efficiency in irrigation and the reuse of the resultant drainage water. Because this offers the greatest potential for augmenting the available water resources in the region, projects that consider improving such efficiencies must be given priority in the region, particularly in countries where misuse of irrigation water prevails.

(d) Rehabilitation of water-supply networks and water-storage facilities. A good deal of water loss is reported to occur in many countries of the region from dam reservoirs, water-supply networks or conventional irrigation projects.

7. Giving priority to projects pertaining to better management of sea-water encroachment, as most of the major coastal aquifers in the region have been endangered -- particularly in the Gulf States.

8. Considering water-resources management as integral to regional security and stability. This would dictate designing water-resources policies and institutions within the region in compliance with plans for integrated economic development.

9. Requiring that lending agencies and donors substantially increase funds allocated to the water sector, particularly to execute water-resources projects in countries with financial constraints.

INTRODUCTION

A. Basic considerations

During the last decade, water-resources management and administration has established itself as a relatively self-contained activity concerned with finding solutions to problems resulting from increasing water demand on the one hand, and the availability of water as a natural resource on the other. These two components comprise the basics of water-resources management and planning.

In the past, in the ESCWA region and in others, water-resources managers and developers applied ad hoc solutions to major water supply-demand problems as they emerged by initiating engineering projects related to irrigation, road construction, town planning, health care, etc.; the problem was generally viewed as being remediable by engineering measures. With the increased scope and number of water conservation projects in the region, conflict resulting from supply-demand problems began to occur. Having now recognized the complexity of water issues, the old view of water-resources management and planning has been changed from one which seeks only engineering solutions to one with a more comprehensive and integrated view of water problems, to provide optimal solutions and to satisfy, as far as possible, the various water demands which will most benefit society, in line with the overall socio-economic national development plans.

This broad concept of water resources management and planning has resulted in initiating significant efforts at national levels within the region towards establishing efficient water institutions and training centres, executing major water projects, and adopting and applying modern techniques and methodologies such as systems analysis using high-speed computers, simulation modelling, statistical hydrology, isotope analysis, remote sensing and detailed hydrogeological mapping.

Population growth, agricultural and industrial development and improved living standards in most countries of the region have resulted in increasing demand for water, and subsequent increased amounts of waste water, causing a degradation in water quality. This increase in demand has produced problems related to water-resources availability and the progressive reduction of national resources due to water-quality deterioration and/or depletion. The failure to strike a balance between water-resources availability and demand through efficient water-resources management will likely limit socio-economic development in most of these countries.

B. Scope and objective of the report

This report has been prepared at the request of the Inter-Agency Working Group Preparatory Meeting on Water and Sustainable Agricultural Development held at the Food and Agriculture Organization of the United Nations (FAO) in Rome from 21 to 23 February 1990. The meeting was convened as per the resolution of the Committee on Natural Resources (CNR) 1987/7 operative paragraph 5, which requested the Secretary-General, in consultation with the regional commissions and organizations of the United Nations system, to report to the CNR at its eleventh session on progress made in formulating proposals

for a comprehensive strategy to implement the Mar del Plata Action Plan during the decade 1991-2000, and to include an assessment of these proposals as they relate to the activities of the United Nations system.

The Mar del Plata Action Plan called upon the regional commissions to play a major role in implementing its recommendations; they were therefore asked to be involved in an inter-agency activity to assess the progress made in the implementation of the Mar del Plata Action Plan and to formulate a strategy for its implementation in the 1990s.

The report has mainly dealt with the "Assessment of water resources management in the ESCWA region", as agreed in the Preparatory Meeting mentioned earlier.

After touring five countries of the region, the mission collected and analysed relevant information on the institutional and legislative infrastructures for the planning and management of water resources within the ESCWA region. A regional assessment was then carried out, based on available data, describing the progress achieved and constraints existing with regard to water-resources assessment and availability and water-resources management, including aspects such as policy formulation, planning, legislation, database development, and institutional arrangements. It also addresses issues related to the efficient utilization of water and its various aspects, including water-supply and irrigation conservation techniques and waste-water reuse in some countries of the region in case-studies. Progress made in the implementation of the Action Plan in some member States is outlined in this report, which concludes with the major priority areas in the ESCWA region to be considered in the formulation of regional, interregional and global strategies in the 1990s.

I. ASSESSMENT OF WATER-RESOURCES MANAGEMENT IN THE ESCWA REGION

It is well known that most of the ESCWA region is comprised of arid or semi-arid zones characterized by scarce or limited water resources. Many member countries have recognized the need for parallel development, conservation and management of their vital water resources. Water assessment and planning to determine the most appropriate allocation of water resources to the various consumers, as well as to formulate medium- and long-term water policies and guidelines for the exploitation, utilization and subsequent management of water resources, were the objectives and targets considered during the last decade in some member countries of the ESCWA region.

The progress achieved in the primary areas of specific concern relative to water-resources management in the region is identified through the activities undertaken at national levels during the last decade in the following areas:

Water-resources assessment
Institutional arrangements
Water legislation
Master planning
Environmental protection measures
Water-resources development activities

What follows is a brief assessment of the activities carried out in the region with respect to the above-mentioned areas:

A. Water-resources assessment

1. General overview

The United Nations Water Conference (UNWC), held in Mar Del Plata, Argentina in March 1977, recognized that a proper assessment of water resources at national levels should be undertaken in all countries of the world, particularly in developing countries.

The first resolution of the United Nations Water Conference stressed the need for water-resources assessment at the national level. It recommended that member States should give high priority to the initiation of programmes for the collection, processing, storage and dissemination of hydrological and hydrogeological data and to the formulation of long-term monitoring and follow-up programmes in order to realistically assess the available water resources and the means of developing them.1/

1/ Report of the United Nations Water Conference, Mar del Plata, 14-25 March 1977 (E/CONF. 70/29 Res I, p. 66).

Extensive hydrological and hydrogeological investigations were carried out during the last decade in most parts of the region. More and comprehensive studies are under way in some member States of ESCWA to reassess the water-resources situation, to conduct relevant investigations, even in areas where studies have never been carried out.

In Egypt, Iraq, Lebanon and the Syrian Arab Republic, extensive hydrological studies have been carried out. Ground-water studies in countries such as Egypt and Iraq are few and far between, or, in the case of the Syrian Arab Republic and Lebanon are limited to major basins. In Jordan and Gulf Cooperation Council (GCC) States, relatively reliable water-resources assessment has been conducted. In Yemen, no water-resources assessments on a country-wide scale have yet been made, although local water-resources investigations have been undertaken, with consideration given to socio-economic constraints.

Investigation and production of non-conventional water-resources (including treated sewage effluent) were topics given a great deal of attention during the last decade in the GCC States, Jordan, Egypt and Iraq.

Based on the water-resources studies carried out at national and subregional levels, regional water-resources availability can be briefly described as follows:2/

(a) The Arabian Peninsula subregion encompasses the Gulf States and Yemen.

Rainfall in the subregion is generally low and scarce, and is of a Mediterranean type in the north and monsoonal in the south. It is more arid than semi-arid. Rainfall volume over the Arabian Peninsula is estimated at 214 billion cubic metres (BCM)/year.3/ Zones of high rainfall exist over the mountains along the Red Sea coast, the Gulf of Aden, the Arabian Sea and the Gulf of Oman. The climate is generally hot, tropical and dry in summer and moderate to cold in the inland areas in winter, with high daily temperature variations in most of the subregion.

In the Arabian Peninsula subregion, surface-water resources are limited and rely on irregular, sporadic and un-predictable flood occurrences. The potential for making use of these floods is high in areas such as Tehama and the Batinah coastal plains in Oman and the United Arab Emirates.

Ground water and non-conventional water resources (desalinated water and treated sewage effluent) are the major components of the water supply in the subregion. The main producing aquifers are composed of: Palaeozoic sands; Mesozoic sands and carbonate rocks; and Tertiary carbonate rocks and Quaternary alluvium. Ground-water quality generally deteriorates as one moves from the mountain ranges towards the inland basins or sea coasts.

2/ Economic and Social Commission for Western Asia, "Assessment of the water resources situation in the ECWA region", 1981 (E/ECWA/NR/L/1/Rev.1).

3/ Ibid., p. 16.

The major aquifers in the subregion are grouped into the following:

(i) The volcanic rock group occurs predominantly in the Yemen platea and contributes greatly to the ground-water resources of the Yeme Republic;

(ii) The sandstone group occurs widely in the eastern part of th subregion and is characterized by its uniform distribution, artesia conditions and by the fact that it contains good ground-wate potential and is of relatively good quality;

(iii) The carbonate rock group also occurs widely in the same area, but with less uniformity vis-à-vis its ground-water potential and quality. It is generally artesian.

The limited water resources of the subregion have not been able to meet the increased water demands caused by rapid socio-economic developments which have occurred in the countries of the Arabian Peninsula in recent years. This situation led concerned authorities, particularly in the Gulf States, to initiate the production of additional water resources to meet their water demand through the desalination of sea and brackish ground water. At present, the total estimated desalinated sea-water production in the subregion is about 953 million cubic metres (MCM), of which 165 MCM is being produced in Kuwait, 508 MCM in Saudi Arabia, 65 MCM in Qatar, 45 MCM in Bahrain and 7 MCM in Oman.4/

(b) The northern and north-east subregion encompasses Jordan, Lebanon, the Syrian Arab Republic, Iraq and Egypt.

In this subregion, surface-water resources predominate, though ground-water resources do occur and are well developed in Jordan, the Syrian Arab Republic, and to a lesser extent, in Lebanon and Egypt.

In Iraq, surface-water resources development is well under way, while ground-water resources are neither developed nor identified.

The maritime zones of the subregion are somewhat humid to semi-arid, while the inland areas are arid to semi-arid. The climate is predominantly Mediterranean, producing hot dry summers and rainy winters with daily temperature variations which are reported to be high in Iraq and in the inland areas of the Syrian Arab Republic and Jordan.

Surface-water resources in the subregion are appreciable and are represented by the following main rivers: Nile, Euphrates, Tigris and tributaries, Yarmouk, Orentis, Barada, Litani, Hasbani, Jordan, Lebanon and others.

4/ Economic and Social Commission for Western Asia, GCC paper, "The water resources situation in the GCC States", (in Arabic), Proceedings of the Ad Hoc Expert Group Meeting on Water Security in the ESCWA Region, Damascus, 13-16 November 1989 (E/ESCWA/NR/89/WG.3/WP.2). (hereinafter referred to as Meeting on Water Security).

Ground-water resources occur in Palaeozoic sandstones, Jurassic-Cretaceous-Palaeogenic carbonate rock aquifers, Tertiary volcanic rocks and Quaternary alluvium. The quality ranges from excellent to brackish. Water quality is good in the foothills of the active recharging zones, but deteriorates generally eastward, in the inland basins in the Syrian Arab Republic and Jordan, and westward from the Zagros mountains in Iraq. There are appreciable potential ground-water resources in Lebanon and, to a lesser extent, in the Syrian Arab Republic. In Iraq, further investigation is needed before the potential is known.

Efforts to regulate flood waters and develop surface-water resources have been remarkable in the subregion, as represented by Al-Tabaka Dam in the Syrian Arab Republic, Qaroun Lake in Lebanon, and other projects in Jordan, Iraq, and Egypt.

The estimated available water resources, based on the various hydrological and hydrogeological investigations carried out in the region, may be summarized as follows below in table 1.

Table 1 provides an idea of the importance of the close relationship that exists between water-resources availability and present and future water demand. Many member States of the region will reach their development limits by the year 2000, due to acute water shortages which are even now a reality in countries such as Bahrain, Kuwait, Yemen, Jordan and Qatar. In other cases, the estimated demand for agricultural water will not be met at all, preventing some countries from achieving food self-sufficiency, if present regional water-use practices continue.5/

It is worth mentioning here that the available surface-water resources figures shown in table 1 for both the Syrian Arab Republic and Iraq, and to a certain extent for Egypt and Jordan, may not apply in future, due to water-resources development activities being practised in the neighbouring upstream countries sharing the same sources and the absence of registered riparian rights.

The volumes of the available ground-water resources shown in table 1 may not be accurate, as they are based mostly on reconnaissance investigations. Ground-water over-exploitation due to excessive and uncontrolled pumping, as well as deterioration in water quality, are common features observed in many regional basins such as those in Jordan, the Syrian Arab Republic, Saudi Arabia, and Yemen. Ground-water quality is deteriorating due to sea-water intrusion into the coastal plains aquifers in Yemen, Oman, Bahrain, the United Arab Emirates and Qatar. All these factors have resulted in a progressive reduction in available ground-water resources in the ESCWA region, to the extent that sustainable agricultural development may be hindered in the future.

5/ Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD), Arab Fund for Economic and Social Development (AFESD), and Kuwait Fund for Arab Economic Development (KFAED), paper submitted at the Symposium on Water Resources and Their Utilization in the Arab World, Kuwait, 17-20 February 1986, (in Arabic).

Table 1. Estimated water-resources supply, demand and balance in the ESCWA region
(Million cubic metres)

Country	Estimated Water resources 1985	Water use 1985	Water demand 2000	Tentative water balance 1985	Tentative water balance 2000	Non-conventional water resources 1985	Non-conventional water resources 2000	Total available water resources 1985	Total available water resources 2000	Estimated total water balance 1985	Estimated total water balance 2000
Bahrain	153	223	302	(70)	(149)	87	186	240	339	17	37
Kuwait	247	329	675	(82)	(428)	356	547	603	794	274	119
Oman	1 483	580	1 255	903	(288)	10	39	1 493	1 522	913	267
Qatar	100	145	235	(45)	(135)	198	274	298	374	153	139
Saudi Arabia	5 546	8 670	14 627	(3 124)	(9 081)	1 160	1 534	6 706	7 080	(1 964)	(7 547)
United Arab Emirates	487	829	1 700	(342)	(1 213)	277	370	764	857	(65)	(843)
Yemen	4 177	916	2 560			9	12				
Iraq	43 500	42 350	60 639	1 150	(17 139)	0	0	43 500	43 500	1 150	(17 139)
Jordan	1 086	893	1 160	190	(74)	35	116	1 121	1 202	225	42
Lebanon	7 300	1 036	2 010	6 264	5 290	0	0	7 300	7 300	6 264	5 290
Syrian Arab Republic	25 035	8 095	17 262	16 940	7 773	74	140	25 109	25 175	17 014	7 913
Palestine	–	–	–	–	–	–	–	–	–	–	–
Egypt	61 350	60 700	66 000	650	(4 650)	1 400	2 200	62 750	63 550	2 050	(2 450)
Region total	150 464	124 769	168 425	22 434	(19 578)	3 606	5 418	149 884	151 693	26 031	(14 172)

Sources: Economic and Social Commission for Western Asia, "Assessment of the Water Resources Situation in the ECWA Region", 1981 (E/ECWA/NR/L/1/Rev.1). Arab Centre for the Studies of Arid Zones and Dry Lands (ACSAD), Arab Fund for Economic and Social Development (AFESD), and Kuwait Fund for Arab Economic Development (KFAED), national papers on the water sector presented at the Symposium on Water Resources and Their Utilization in the Arab World, Kuwait, 17-20 February 1986. (in Arabic). Economic and Social Commission for Western Asia, various national papers presented at the Ad Hoc Expert Group Meeting on Water Security in the ESCWA Region, Damascus, 13-16 November 1989 (E/ESCWA/NR/1990/3).

Notes: Brackish ground water predominates in the Arabian Peninsula. The flows of the Tigris and Euphrates rivers will be reduced by upstream abstraction in Turkey. Some figures on water resources and water demand are not confirmed, but are based on reconnaissance surveys.

2. Establishment of a database

The United Nations Water Conference, in recommendation A of the Mar del Plata Action Plan, stressed the importance of acquiring greater information about the quantity and quality of water resources, in order to improve their management. To this effect, it states that the "regular and systematic collection of hydrometeorological, hydrological and hydrogeological data needs to be promoted and to be accompanied by a system for processing quantitative and qualitative information for various types of water bodies."

The conference made a number of recommendations for action at the national level; those within the scope of this report are listed below:

(a) Establish a national body with comprehensive responsibilities for water-resources data, or allocate existing functions in a more coordinated way, and establish data banks for the systematic collection, processing, storage and dissemination of data in agreed formats and at specified intervals of time;

(b) Expand and extend the network of hydrological and meteorological stations, taking a long-term view of future needs, following as far as possible the recommendations of the United Nations specialized agencies on standardization of instruments and techniques and comparability of data, and use existing meteorological and hydrological data series for the study of seasonal and annual fluctuations in climate and water resources. Such analysis could also be used in the planning and design of networks;

(c) Establish observation networks and strengthen existing systems and facilities for measurements and recording fluctuations in ground-water quality and level; organize the collection of all existing data on ground water (borehole logs, geological structure, and hydrogeological characteristics, etc.), systematically index such data, and attempt a quantitative assessment to determine the present status of and gaps in knowledge; increase the search for, and determination of, the variables of aquifers, with an evaluation of their potential and the possibilities of recharge;

(d) Standardize and organize as far as possible the processing and publication of data so as to keep the statistics up to date and take advantage of the observations made in stations operated by different institutions.

In many countries of the region, the available water-sector data are scattered and generally inadequate to establish a comprehensive database for planning purposes. In some countries, programmes pertaining to the measurement of basic water data from networks of meteorological, hydrological and hydrogeological stations, as well as the collection, processing, storage and periodic dissemination of these data, have been undertaken in recent years. Plans to strengthen and modify the existing networks are being considered in most countries in the region, including Jordan, the Syrian Arab Republic, Iraq, the Gulf States and Yemen.

The newest and latest techniques have been employed in some countries in the region to analyse water data and to assess the quality and quantity of their water resources, to facilitate better planning. Remote sensing, airborne geophysics, simulation modelling and computerization of water-sector data using programming, micro-computer networks and the latest software packages are common practices in many member countries.

The 1987 INFOHYDRO information, indicates that six countries in the region (Egypt, Bahrain, Jordan, Lebanon, Oman and Qatar), were known to have established computerized systems (data banks) at least for partial use. However, it appears that as of 1987 the amount of basic information stored remained relatively low, and that the amount of data analysed is even lower. For the most part, it appears that much of the available information is in the form of primary data (field observations) and in laboratories (in the case of water quality), rather than in the form of analysed data -- especially statistics related to averages, duration curves, unit hydrographs, etc. Existing data is (generally) stored manually, in files, and are not easily accessible. As a result, this data remains relatively useless for planning and management purposes.[6/]

Two examples of achievements pertaining to water data-bank development briefly described below:

(a) Good progress has been made in the development of Jordan's comprehensive water-sector database established in 1983. It includes data on hydrology, hydrogeology, meteorology, water supply, water treatment, graphics, maps, report writing, production and administrative support. The water data bank of Jordan utilizes five types of computer systems supported by a good scientific and administrative software library:

(i) Digital Equipment Cooperation (DEC) PDP 11/44 Mini-computer for data storage, retrieval, analysis and dissemination;

(ii) DEC VAX 8200 Mainframe Computer System to facilitate the activities of the Water Authority of Jordan (WAJ) in the field of water-resources assessment. It has more storage capacity and is more powerful than the PDP 11/44;

(iii) WANG Computer System and Data General 2000;

(iv) Personal computers;

(v) There are a total of 27 PCs at WAJ. Because they are more flexible than the mainframe computers mentioned above, they are used by all WAJ departments for spread-sheets, word-processing, graphics, simulation modelling, mapping and other engineering applications.

6/ Economic and Social Commission for Western Asia, "Issues related to the availability of water resources assessment data in the ESCWA region" Meeting on Water Security, Damascus, 13-16 November 1989 (E/ESCWA/NR/89/WG.3/WP.6).

As part of Jordan's established comprehensive water database, several technical papers have been published since 1977:

(i) TP 50 contains daily, monthly and yearly rainfall data for 1976-1980;

(ii) TP 51 contains spring-flow data up to 1985;

(iii) TP 52 contains rainfall data for 1980-1985;

(iv) TP 53 contains the monitoring of ground-water quality up to 1985.

A technical paper recording stream-flow data for the main wadis and streams in Jordan up to the year 1985 is being prepared.

(b) In Yemen, plans to establish a comprehensive water database are being implemented in the country as part of the High Water Council Project YEM/88/001 funded by UNDP and executed by DTCD. A micro-computer network system has been designed to provide the required database for North Yemen.

This micro-computer network system (NOVEL), supported by a very specialized software package, was installed in late 1989. This will provide water data-bank facilities which will provide all relevant water-sector information pertaining to water resources, water use and demand, water projects and studies, skilled manpower, maps, reports, landsat imagery, and any other necessary water-related data. This proposed data-bank structure is intended to form a database which is simple to use and powerful in its facilities for data manipulation and retrieval and the presentation of a broad range of hydrological and hydrogeological data.

3. Monitoring networks

Good progress has been made in establishing water-resources (ground-water and surface-water) observational networks in many countries of the region (Jordan, Saudi Arabia, Egypt, Iraq and the Syrian Arab Republic) as a tool for achieving better realistic water-resources assessments. Tables 2 and 3 show the monitoring-network systems established in the ESCWA region. As the tables indicate, none of the member States have networks covering the whole country in accordance with the World Meteorological Organization (WMO) standards. Countries with generally adequate networks are Qatar, Lebanon, Egypt and Jordan, while poor networks exist in Bahrain, Oman, and Yemen. Fair-to-acceptable networks exist in Iraq, Kuwait, Saudi Arabia, the Syrian Arab Republic and the United Arab Emirates.

Table 2. Water-resources monitoring network*

Member country	Total area (square km)	Hydrological observation stations: Precipitation Rec.	Precipitation Non-rec.	Evaporation	Discharge Rec.	Discharge Non-rec.	Stage (WL) Rec.	Stage (WL) Non-rec	Sedimentation	Water quality	Ground water Rec.	Ground water Non-rec.
Bahrain	622	2	2	..	..	..	..	..	..	..	..	72
Egypt	1 001 449	45	37	15	70	160	111	316	6	20	..	800
Iraq	446 000	84	19	17	9	120	9	120	40	72	..	..
Jordan	98 060	101	195	66	3	880*	31	32	33	38	72	78
Kuwait	16 000	10	..	..	..	..	..	..	..	..	..	..
Lebanon	10 400	..	..	10	..	..	..	..	..	..	..	..
Oman	300 000	32	24	3	..	..	..	..	..	..	24	230
Qatar	11 000	3	26	..	..	..	..	..	..	8	8	152
Saudi Arabia	2 149 690	426	273	61	205	209	..	..	41	..	240	269
Syrian Arab Republic	185 180	227	45	62		29	18	33	..	..	..	74
United Arab Emirates	77 600	..	..	..	..	..	..	..	..	..	..	..
North Yemen	195 000	..	..	..	..	..	..	..	..	..	..	..
South Yemen	287 683	..	..	..	..	..	..	..	..	..	..	..
Total station		950	619	236	287	1 398	169	501	120	138	344	2 377

Source: Economic and Social Commission for Western Asia, "The role of the WMO in water resource assessment and monitoring in Western Asia", Amman, 5-8 June 1989 (E/ESCWA/NR/89/WG.1/4).

Notes: .. Indicates data not available.
* Including spring-flow measurement.

Table 3. Precipitation observation stations in the ESCWA region

Country	Total area (Square km)	Date	Number of stations	
			Non-recording	Recording
Bahrain	622	..	..	..
Egypt	1 001 000	..	..	..
Iraq	446 000	1 975	84	19
Jordan	98 060	1 984	364	59
Kuwait	16 000	1 983	10	0
Lebanon	10 400	1 973	145	58
Oman	300 000	1 983	52	24
Qatar	11 000	1 983	3	26
Saudi Arabia	2 149 690	1 984	426	273
Syrian Arab Republic	185 180	1 973	227	45
United Arab Emirates	77 600	..	..	..
North Yemen	195 000	..	..	..
South Yemen	287 683	..	..	..

Source: World Meteorological Organization, Operational Hydrology Report 28, (WMO, No. 683) 1987 edition.

B. Institutional arrangements

Serious efforts have been made by some countries to inventory and administer their available and potential water resources. However, despite all the work thus far carried out, the countries are far from achieving integrated management of their total water resources. Some countries of the region have taken steps to unify and centralize their national water institutional arrangements, while in the other member States, various independent water-related institutions still exist.

Only Jordan and Lebanon have established national water authorities which are responsible for the central management, planning and administration of national water resources.

In Iraq, a Central Advisory Board for Water Management and Planning has been established, to assist the other existing specialized organizations in facilitating the implementation of waterworks throughout the country.

In South Yemen a National Committee for Water Management and Policy on Utilization of Water Resources has been established. The Ministry of Agriculture and Agrarian Reform carries out water studies and land reclamation projects.

Egypt plans to establish a permanent body responsible for water planning at the national level. The Ministry of Public Works and Water Resources, with its Water Research Centre, the Ministry of Reconstruction and New Communities and the Ministry of Agriculture and Land Reclamation are the responsible government agencies for water-sector affairs in Egypt.

In Jordan, the Ministry of Water and Irrigation is responsible for the development, management and conservation of national water resources, and was established in 1988.

The Syrian Arab Republic has taken steps to further unify the different water institutions in the country. The recently established Ministry of Irrigation is supposed to deal with water affairs on a country-wide scale, replacing the water-related departments in the Ministry of Public Works and Water Resources and the Ministry of the Euphrates Dam. The Ministry of Housing and Public Utilities is responsible for water-supply activities, excluding those in the main cities, which administer their own projects. The Ministry of Planning plays an important role in determining water policies through planning and coordination.

The other countries must better coordinate their efforts, to improve efficiency in the water sector. In Oman, Yemen, and the United Arab Emirates, water development is carried out by a fairly large number of departments within a number of ministries and other governmental and non-governmental bodies. This kind of fragmented administration has resulted in conflict and poor management, as well as in appreciable difficulties vis-à-vis national water-resources development.

Water-sector responsibility in Yemen is very fragmented in all aspects: resources, supply, maintenance and operations of water projects; concerned Yemeni officials are, however, very much in favour of centralizing their national water institutions, particularly for unified Yemen.

Water-sector responsibilities in North Yemen have been allocated to the following institutions:7/

(a) Ministry of Electricity and Water:

The National Water and Sewerage Authority provides the water supply and sewerage to major cities and towns;

The Rural Water Supply Department plans, designs and constructs water-supply projects for small towns and villages, but does not operate or maintain them. The operation and maintenance components are entrusted to local development associations, assisted by the Confederation of Yemeni Development Authorities. The Department has a unit of hydrology which sites and constructs wells and collects data;

(b) Ministry of Oil and Minerals:

The General Department of Water Resources Studies is responsible for the collection and dissemination of data, and undertakes water-resources investigations within the country at local levels;

7/ Department of Technical Cooperation for Development (work plan for a joint UNDP/DTCD/Yemen Arab Republic project), "Assistance to the High Water Council in the preparation of a water master plan" (YEM/88/001).

(c) Ministry of Agriculture and Fisheries:

This Ministry handles irrigation projects, which normally have a rural water-supply component; local authorities are usually responsible for their maintenance and operations;

The Ministry manages a number of development units, including the Tehama Development Authority, the General Administration for Irrigation and Rural Development, the Northern Regional Agricultural Development Authority, the Eastern Regional Agricultural Development Authority, and the Regional Projects Units;

Some of the Ministry projects incorporate water-resources studies;

(d) Local Development Associations:

These are responsible for the operation and maintenance of rural water-supply projects;

(e) Civil Aviation and Meteorology Unit:

This Unit collects, processes, and disseminates meteorological data through its Meteorological Department;

(f) Ministry of Municipalities and Housing:

It monitors the quality of drinking-water supplies relative to health considerations through its Environmental Health Department.

In order to remedy this problem of scattered water-sector responsibility, the Government established the High Water Council (HWC) in 1981, chaired by the Prime Minister, who presides over seven Ministers. The Council is expected to prepare policies and plans -- and is also entrusted with the coordination, monitoring and control -- of the water-resources sector.

A proposal for the reorganization of the High Water Resources Council is presently with the Shura Council. According to the proposal, the HWC would be chaired by the Prime Minister, and membership would include the Chairman of the Central Planning Organization and the Ministers of Water and Electricity; Public Works, Oil and Minerals; Economy; Supply and Commerce; Agriculture and Fisheries; Housing and Municipalities; and Cooperatives.

The Development Authority representatives also sit on the HWC. The Minister of Electricity and Water has been delegated authority by the Council to act as liaison through a Technical Secretariat (TS), which is supposed to serve as an advisory organ to help the Council implement its programme.

The aims of the High Water Resources Council are:

(a) Implementing comprehensive policies and plans, allocating budgetary resources, and the development and conservation of water quantity and quality in accordance with water plans;

(b) Coordinating the activities of water-related entities.

In order to develop an efficient TS for the Council, a major project funded by UNDP and executed by DTCD was being implemented in 1988. Its immediate objectives were establishing a comprehensive water database, drafting a water law, assessing the country's water resources and drawing up a national water master plan. The implementation of this project will allow the TS to develop its capabilities, giving it greater responsibilities so that it may better assist the HWC in carrying out its nation-wide water-sector management responsibilities.

In conclusion, although serious efforts have been made to centralize water-sector responsibilities in some member States, the executive organs or departments forming the central water authorities still perform their functions in isolation and lack coordination.

C. Water legislation

Water legislation in the region is generally complex and outdated vis-à-vis modern water-management practices and techniques, and has resulted in the fragmentation of administrative responsibilities. Provisions which regulate water-resources development and management are often contained in different laws and regulations, or have originated from traditional and customary uses which relate to the prevailing social structure of some member countries.

Recently, countries such as Jordan, the Syrian Arab Republic, Iraq and the Gulf States have critically examined their water legislation, rules, regulations, customs, decrees, ordinances and other measures of control in the water-resources field.

Land and water legislation and regulations are enforced in Iraq for better management and conservation of both of these resources. Legislative measures were issued as early as 1962, and were reviewed in 1971, 1981, 1983, 1986 and 1988.

In Jordan, all water resources are government property; the Ministry of Water and Irrigation (MWI) controls these resources as per the articles 25 of the Water Authority of Jordan (WAJ) Law, and 18 and 24 of the Jordan Valley Authority (JVA) Law. Protection of water quality in Jordan is observed in accordance with Article 6 of the WAJ Law and Article 38 of the JVA Law. Other articles of the JVA and WAJ laws deal with water-resources development, conservation and management on a country-wide scale (more details given in the section on case-studies).

The Gulf Cooperation Council Charter considers national water resources worthy of special concern. Article 4 of the Charter obliges the member countries to undertake measures to pursue technical and scientific development in all fields, including water resources. The Ministerial Committee for Agriculture and Water Resources is responsible for coordination and cooperation in the field of agriculture and water resources among the GCC States, and has formed several technical committees. The Permanent Committee for Land and Water Uses is responsible for:

(a) Drafting unified water legislation;

(b) Coordinating ground-water research and investigation on the major shared aquifers;

(c) Proposing and convening symposiums related to water-resources development and conservation.

One of the main achievements of this Permanent Committee was the development of the Water-Resources Conservation Regulation, which was adopted and enforced by the Higher Ministerial Committee in 1985.

Another group, composed of the Ministers of Water and Electricity in the GCC States, has formed a number of specialized committees for:

Optimum use of water and electricity
Unification of water and electricity specifications
Exchange of information
Standardization of maintenance and operations methodologies

These four committees have drawn up common guidelines and legislative measures for water desalination, water supply and water-quality standards to be applied in the GCC states.

In the Syrian Arab Republic many water ordinances, decrees, regulations and other legislative measures have been issued based on the main Water Law number 165 of 1958. They are continually being revised to better control and conserve national ground-water and surface-water resources, and to regulate irrigation and drainage. In July 1987, a draft proposal for "Water quality protection in Syria" was submitted to the concerned legal authorities for review and approval.

In Egypt, Law number 48 -- "Protection of the Nile River and Water Courses from Pollution" -- was enforced as of June 1982. Another Law number 12 of 1984 and its relevant executive charter number 14717 of 1987 was implemented in Egypt to control, manage and monitor irrigation and drainage activities.

In Yemen, the legal situation is at best confusing. While some reports refer to the existence of only very basic and ineffecive water regulations, other reports detail sets of quite sophisticated legal and administrative arrangements, albeit at the local level and of a customary and traditional nature. The irrigation and communal settlement water-supply rules and regulations are related to religious norms, and apply to irrigation, domestic supply and, to a certain extent, environmental problems. Operative rules and legal measures seem to be based on ad hoc situations, particular cases and pragmatic interpretations.

D. Water-resources planning

National master planning of water resources is practised by many countries in the region. Jordan established an overall national water master plan as early as 1977, aimed at encouraging the most efficient use of the available water, funds, manpower and other relevant means, the most suitable methods and operations, and as far as possible the reuse and renewal of water resources. Kuwait, Egypt, Iraq, Saudi Arabia and Oman have also been active in water planning and national water-policy formulation, while other countries have this subject under consideration. These national water policies and plans are expected to encompass many aspects of water resources that aim at the wise management, conservation and development of their vital resources. Surface-water impounding, artificial ground-water recharge, rain-water harvesting, reuse of drainage water and treated sewage effluents, and sea-water and brackish ground-water desalination have been commonly practised in many countries of the region over the last decade to optimize water utilization and to manage and develop the available water resources at national levels.

Jordan and the UNDP started a cost-sharing project in 1989 to update the national water master plan for the major basins in the country.

Another master plan for rural water supply was completed in Iraq and a strategy was formulated accordingly. The plan evaluates the country's water resources vis-à-vis water demand in the inhabited rural areas of Iraq.

In Saudi Arabia, national water plan preparation was initiated during the second Five-Year National Development Plan (1975-1980), and completed in 1984, after the ongoing and planned socio-economic development projects in Saudi Arabia were incorporated. The plan identified water supply-demand projections up to the year 2020 for the whole Kingdom.

In Egypt a Water Master Plan project (UNDP/EGY-73/024) was launched in January 1977. The project was financed by UNDP and executed by the International Bank for Reconstruction and Development (IBRD), with the Ministry of Irrigation acting as a cooperating agency. Work on the project started in October 1977; the first phase was completed in December 1981, while the second phase commenced in 1982 and was completed in 1986. The first phase of the project involved the preparation and evaluation of development plans in which water supply and the needs of various users were matched, while the second part carried out supporting studies and analysis. The plan in general provided a very comprehensive evaluation of water supply and demand country-wide, and considered aspects such as effective use of the available water resources, economic performance in the agricultural sector, social and environmental impacts, and capital investment and energy requirements.[8/]

8/ International Bank for Reconstruction and Development (a joint IBRD/UNDP/Egypt Ministry of Irrigation Project), "Water master plan, executive summary of main report", 1981 (UNDP/EGY-71024), pp. 1-31.

In the other member States of ESCWA, national water master planning is lacking; subregional water master plans to develop and manage shared water basins do not exist. Only one activity at the interregional level has been agreed upon since 1959, involving Egypt (ESCWA and ECA member State) and Sudan (ECA member State) in a project to develop the Nile River waters. Work related to this project is still under way.

E. Environmental protection measures

Many regional water-resources projects have positive environmental impact when implemented. Such projects are related to flood control (Iraq, the Syrian Arab Republic, Jordan) soil preservation and reduced salination (Jordan, Yemen), pollution control (the Syrian Arab Republic, Iraq, Egypt) providing adequate sanitary services and minimizing health hazards (the Syrian Arab Republic, Iraq, Egypt, Jordan), enhancing artificial ground-water recharge and augmenting potential surface-water resources (Jordan), and providing recreational facilities (Iraq).

Some other water-resources development projects carried out in the region resulted in adverse environmental effects, often because they are decided upon without due consideration given to their potential impact on the eco-systems prior to their implementation. Such effects relate to health hazards, destruction of the resources, waterlogging and soil salinity, and wildlife disturbances, to name just a few.

From the national development plans of some of the ESCWA member States, it is clear that environmentally sound water-resources development and management have been seriously considered during the last decade. Serious efforts have been made in Iraq, the Syrian Arab Republic and Egypt to overcome waterlogging and soil salinity by installing drainage networks, and to improve water-application efficiency through better management practices. In Iraq, several small regulating dams have been constructed upstream and downstream of the major dams to lessen flood hazards, to reduce the rate of sedimentation, and for recreational purposes.

Forestation of the Zarqa River Basin to prevent soil erosion and reduce the rate of salination in the King Talal Dam reservoir is considered a major environmental issue in Jordan. Also in Jordan, the Azraq springs and swamps, formed by natural flooding, were substantially reduced or even completely depleted as a result of ground-water over-exploitation in the area. The overdraft conditions in the Azraq area became more serious in 1981, when the Government of Jordan implemented a domestic water-supply project which involved piping about 15 MCM/year from the Azraq well field to Amman, 100 km distant. There also existed local irrigation-water demand, estimated at 20 MCM/year. In order to compensate for the loss of natural flooding, ground-water pumping was rescheduled and rationalized among public and private beneficiaries in Azraq so as to secure minimum spring flows of about 3 MCM/year, (the original spring flow was in the order of 15 MCM/year) and to maintain as far as possible the eco-system prevailing in the Azraq Oasis prior to the implementation of the Amman water-supply project.

Another example from Jordan is the recently constructed Khirbet Samra natural treatment plant (about 35 km north-east of Amman) which is considered an environmentally sound water-resources management project. The treated sewage effluent presently produced (about 20 MCM/year) is feeding the King Talal Dam (about 85 MCM capacity), downstream from the treatment plant. The stored waters are being used for restricted agriculture in the Jordan Valley. The effluent is also contributing to the artificial ground-water recharge downstream of the plant.

Regarding health hazards, sewerage networks constructed without adequate treatment facilities in some member countries have resulted in ground-water contamination and pollution problems, though plans to overcome them are under way.

Serious efforts towards minimizing health hazards have been made in some countries of the region to ensure adequate and safe water supply in both urban and rural areas. These undertakings have been substantive in the Gulf States and Jordan, while in Iraq several water-supply projects and treatment plants are under way. Only the main cities are partially covered by such projects in Yemen, while waste-water treatment plant construction in five major Syrian cities is progressing well.

Due to extensive agricultural development projects in the coastal areas within the region, ground-water over-exploitation has occurred, resulting in sea-water intrusion and depletion of the resources in some of the GCC member States.

Water legislation to control and monitor the environmental and water pollution are being applied in the Gulf States, Jordan (articles 6 of WAJ Law and 38 of JVA Law), Egypt (Law 48 of 1982 and Ministerial resolution 8 of 1983), and in Iraq (Presidential letters: number M/2/12618, dated 3/10/83, and number 5/33463).

F. Regional water-resources cooperation

In general, it can be concluded that good regional progress has been made in water-resources management, institutional arrangements and water legislation at the national level, though very limited progress vis-à-vis managing and developing shared water resources at the regional level has been made. Moreover, the national water resources and major sanitation projects have been hampered because of the increased regional and political stability and the resultant general trends of diverting technical and financial aid to more pressing needs.

The lack of regional cooperation for managing and developing the major shared water resources has been common in the region. Despite years of efforts, no formal protocols yet exist among riparians of the Nile, Yarmouk, Orentes, Al-Kabir, Tigris and Euphrates rivers. If current circumstances continue, most of the downstream riparians will experience a severe quantity and/or quality deficit in water resources. Under even the best circumstances, most of the end-user countries will be unable to generate sufficient capital to finance feasible and critically needed water-storage and management projects without massive assistance from donor nations and lending institutions.

The existing shared water commissions in the region (The Undugu Group for the Nile, the Technical Committee for Yarmouk, the Trilateral Commission for the Euphrates and Tigris rivers) proved unable to meet periodically and defuse the water conflicts among the riparians.

Such conflict resolution cannot be attained without the formulation of joint comprehensive water-resources management plans. The plans should include explicit agreements on water allocation among the concerned riparians for each river basin and/or exploitation rights for the major aquifers within the region.

II. ASSESSMENT OF WATER-RESOURCES DEVELOPMENT ACTIVITIES

A. Water activities at the national level

In general, the region has experienced rapid socio-economic development at all levels during the last decade, and the available water supply has not been able to meet the resulting increased demand for water in various sectors. This situation has led the member States of ESCWA to make tremendous efforts to develop their natural water resources (including non-conventional sources) to meet as much of the increasing demand as possible.

What follows is a brief summary of the progress made in the water sector by member States of ESCWA; information was obtained through available literature and direct contact with concerned officials. Tables in the annex show the number of projects completed in each member country and describe the major water-related activities carried out in the region since the Water Conference.

1. Hydrological and hydrogeological surveys

Because the region is generally arid, hydrogeological surveys assume a special significance. Semi-detailed and detailed studies in this field have been carried out in the last decade in most of the member countries. Although many (more than 45) ground-water surveys have been implemented, total ground-water potential has not yet been identified; there is still a need for more detailed and accurate information on the quantity and quality of available and potential regional ground-water resources.

It is noteworthy that most of the hydrogeological investigations completed in many countries of the region were carried out by foreign engineering consulting firms. There have also been other projects carried out by the specialized United Nations agencies. National experts in some countries undertook case-studies or cooperated with the consulting firms as official government counterparts, either for supervision and guidance or for on-the-job training aimed at allowing local staff to take over at later stages. Foreign consultants are probably needed for two main reasons: compliance with the financial and/or technical support conditions of the donating agencies (governmental or non-governmental); and the lack of competent manpower to undertake such investigations in some member countries.

A review of available literature revealed that many of the studies carried out were redundant. In many countries, the same area was often studied by more than one investigator; the same conclusion was often reached without any substantive amendments resulting, including those carried out in the Tehama Plain of Yemen, Batinah Plain of Oman, Azraq Basin of Jordan, the Eastern Province of Saudi Arabia and others.

A few national hydrogeological surveys were undertaken (Jordan, Qatar, Bahrain and the Syrian Arab Republic); other studies each dealt with one particular basin (Yemen and Oman). Some of these studies are very detailed, while others are superficial. Surface-water resources investigations and development have focused on some important river systems in the region, such as the Nile, Euphrates, Tigris, Jordan, Yarmouk, Litani and others. Water resources have been developed to some extent in some of these river basins (Tigris, Euphrates and Nile), but the potential for development for various purposes is still great. Dam construction is progressing remarkably well; a good number of small and large dams for various purposes (hydropower, flood control, irrigation, domestic water supply and livestock) have been constructed or are under way in Saudi Arabia, the Syrian Arab Republic, Jordan, Iraq, Oman and Yemen (see II.6).

2. Irrigation projects

In general, irrigation and agricultural water-use projects have received a lot of attention in member States of ESCWA in recent years, particularly in Iraq, Egypt, the Syrian Arab Republic, Jordan, Saudi Arabia and Oman; about 60 projects were completed or are ongoing in the region. Modern irrigation projects have been executed extensively in Jordan and Saudi Arabia, while rehabilitation of the existing irrigation-drainage networks in Iraq and Egypt is progressing well. In the Syrian Arab Republic, several irrigation projects and parallel dam construction activities are also in progress. Studies to use treated drainage water are being considered in Iraq and Egypt, where the reused drainage water reached 12.168 km^3/year in 1989.[9/]

Subregional irrigation and water-resources development projects are being studied in Egypt, in cooperation with the other countries sharing the Nile River. Modern technology (computers and remote-control equipment) is employed in large-scale irrigation projects in Egypt.

The oil-producing countries -- particularly Oman, Saudi Arabia and Iraq-- are proceeding with plans to increase agricultural production through the implementation of modern and efficient irrigation-drainage projects, to become as self-sufficient in food production as the available water resources will allow.

3. Drinking-water supply projects

All member countries of ESCWA have vigorously undertaken drinking water supply projects aimed at improving the living standards of their populations, as a follow up to the Mar del Plata Action Plan (MAP). It was reported that in 1980 about 92 per cent of the urban population in the ESCWA region and about 51 per cent of the rural population were supplied with safe drinking water. Most of the member States' national development plans have include a target date of the year 2000 to secure a safe, adequate water supply for the total population within the region, as shown in the attached annex.

9/ Economic and Social Commission for Western Asia, "Water resources planning in Egypt: issues ahead to the year 2020", Meeting on Water Security, Damascus, 13-16 November 1989 (E/ESCWA/NR/89/WG.3/WP.8).

In recent years, the oil-producing countries have carried out several drinking-water supply and sanitation projects aimed at raising the standards of these utilities and at making them compatible with the newly achieved economically developed status and improved living conditions. The problem of securing safe and adequate water supply in the shortest possible time has become a basic social goal and one of the main political targets of the respective governments. In Bahrain, Kuwait, the United Arab Emirates and Qatar, 100 per cent of the urban areas are supplied with piped water.

More than 500 large and small water-supply projects in urban and rural areas were completed and/or are ongoing in the region.

The water-supply projects vary from one country to another according to the water-supply source, relying on surface-water resources in Egypt (Nile River), in Iraq (Tigris and Euphrates rivers) and equally on surface and ground water in the Syrian Arab Republic (Euphrates, Orentis, and Al-Kabir rivers). The rest of the member States of ESCWA depend largely on ground water for their water supply. This source is not reliable, as it is a depletable source which deteriorates in quality when over-pumped, as a result of the increased water demand in large cities like Amman, Aden, Riyadh and Sana'a. Sources are also frequently distant from inhabited areas. Poor-quality ground water occurs in the United Arab Emirates, Bahrain, Qatar and Kuwait; brackish ground water is blended with desalinated water to provide adequate water supplies to these Gulf States.

Given these situations, water-supply projects are dictated by supply sources, then to fit individual needs. Examples include piping water from remote areas to distribution areas like Amman, Riyadh and Aden; or, in other countries using surface-water resources, the construction of large and small treatment plants for the big cities in Jordan, Iraq and Egypt, and the rural areas in Iraq, respectively.

In the other oil-producing member countries (Kuwait, Saudi Arabia, the United Arab Emirates, Oman, Qatar and Bahrain) desalination projects have been undertaken to secure the countries' water supplies.

4. Desalination projects

Because of their limited water resources and the rapidly decreasing quantity and quality of the water, many oil-producing countries of the region have turned to the sea for their fresh-water supply; considerable progress in desalination activities has been achieved in recent years.

In Bahrain, additional desalination units designed to produce 45 million gallons per day (MGD), and in Kuwait, more desalination plants were constructed at the Doha East and Doha West stations, raising the total production capacity to 65 MCM/year. Six new plants were constructed in Saudi Arabia bringing the total installed capacity of the Kingdom to 508 MCM/year. In Oman, additional units were installed at the Ghabrah Station to increase the fresh-water production capacity to 20 MCM/year. In Qatar, the expansion of Ras Abu Aboud and Ras Abu Fontas stations, with a designed capacity of 65

MCM/year was completed in 1986. Finally, total production of desalination water in the United Arab Emirates has reached 165 MCM/year.10/

5. Reuse of treated sewage effluent

Due to the limited and scarce water resources available in most of the member States of ESCWA, non-conventional water-supply augmentation has become an important developmental activity in the region. Waste-water reuse has been practised by some member States of ESCWA for a considerable period of time; however, its application has been limited, and plans have only recently been formulated for large-scale development of this non-conventional supply source. Lack of knowledge about the long-term effects of treated sewage effluent use for various purposes and the availability of other water resources have prevented the reuse of treated waste-water on a wider scale; however, the development of new technologies and the rising cost of desalinating water have led to a higher, more substantial rate of waste-water reuse in the ESCWA region during the last decade. Water reuse, whether in agriculture or for other purposes, still entails certain risks to human beings; it must therefore be monitored carefully, with consideration given to the overall cost of sewage treatment.

Jordan, the Gulf Cooperation Council States and Egypt have practised waste-water reuse in agriculture and public gardening. The following table shows the present and future treated sewage effluent use in these countries.

Table 4. Treated sewage effluent use

Country	Volume of waste-water reuse (Million cubic metres) Present	Future	Use
Bahrain	65	..	Gardening
Kuwait	40	..	"
Oman	9	..	"
Qatar	120	..	Irrigation
Saudi Arabia	400	..	"
United Arab Emirates	62	..	Gardening
Egypt	600	1 000	Irrigation
Jordan	35	116	"
Total	1 331	1 116	

Source: Economic and Social Commission for Western Asia, "The water resources situation in the GCC States", (in Arabic), Meeting on Water Security, Damascus, 13-16 November 1989, (E/ESCWA/NR/89/WG.3/WP.1).

10/ Economic and Social Commission for Western Asia, "The water resources situation in the GCC States", (in Arabic), Meeting on Water Security, Damascus, 13-16 November 1989, (E/ESCWA/NR/89/WG.3/WP.1).

6. Surface-water impounding

Surface-water impounding activities were carried out in the region as early as the 1950s.

Some member countries of ESCWA have paid a great deal of attention to controlling floods and lessening their hazards. Appreciable efforts have been made to develop surface-water resources at national levels. A number of surface-water reservoirs have been built, while work on new projects is being carried out. Iraq, the Syrian Arab Republic, Jordan, Yemen and Saudi Arabia have been the active member States in this respect during the last two decades.

The Iraqi Government plans to achieve a total live storage capacity of 55,000 MCM, an amount that does not include water from the Tharthar Lake and existing marshes. The total storage capacity of the existing and future reservoirs when completed is estimated to be 95,000 MCM/year (table 5).

In Jordan, most of the flood waters flow into the Dead Sea or evaporate in the desert mud-flats. About 15 reservoirs had been constructed in Jordan by 1988, the total capacity of these dams is about 126 MCM (table 6). A number of dam sites with a potential total storage capacity of about 387 MCM were identified in different localities in the country; studies and construction of some of these structures are under way.

Table 5. Dams and reservoirs in Iraq

Structure name	Designed Storage (MCM) Normal storage	Live storage	Reserve storage	Remarks
Structures at the Tigris River				
Dokan	6 800	5 500	400	Existing (1959) (for power and irrigation, or P+I)
Tharthar	77 600	38 500	7 800	Existing (1956) Rehabilitated (1976) (for regulation)
Fatha	23 300	19 300	2 700	Planned
Mosul (Saddam)	10 700	9 700	1 800	Existing (1986) (P+I)
Bakhma	8 300	7 800	600	Existing (P+I)
Badouch #1 and #2	..	..	..	Under construction (P+I)
Structures at the Diyala River (Tigris tributary)				
Darbandi Khan	3 000	2 500	1 100	Existing (P+I) (1961)
Himrin	3 950	2 300	1 400	Existing (P+I)

Table 5. (continued)

Structure name	Designed Storage (MCM) Normal storage	Live storage	Reserve storage	Remarks
Structures at the Euphrates River				
Hadithah (Qadisiya)	8 200	7 500	2 200	Existing (for irrigation)
Habbaniyah	3 300	2 700	..	Existing (1956) Rehabilitated (1970)
Total	145 150	95 800	1 800	

Source: Economic and Social Commission for Western Asia, "Assessment of the water resources situation in the ECWA region", January 1981 (E/ECWA/NR/L/1/Rev.1) (updated).

Table 6. Water structures in Jordan

Dam name	River or Wadi	Year completed	Capacity (MCM)	Purpose
King Talal	Zarqa	1986	82	Irrigation, power
Wadi Arab	W. Arab	1984	20	Storage, power
Kafrein	Kufrein	1967	4.8	Irrigation
Shueib	Shueib	1964	2.3	Ground-water recharge
Sharhabeil	Ziglab	1964	4.3	Irrigation
Sultani	Mujib	1962	0.3-1.2	Irrigation, livestock watering
Qatrana	Mujib	1962	2.3	Ground-water recharge, livestock watering
Lahfi	Dhuleil	..	0.7	" "
Buweida	Yarmouk	1967	0.7	" "
Ghadeir Al-Abyad	Yarmouk	1967	0.7	" "
Samma Sirhan	Yarmouk	1965	1.7	" "
Agib	Dhuleil	1983	1.4	Ground-water recharge
Burgu'	Ruweishid	1950	1.5	Livestock watering
Sha'lan	Ruweishid	1970	1.0	Irrigation
Deir El-Kahf	Deir El-Kahf	1950	1.5	Livestock watering

Source: Economic and Social Commission for Western Asia, "The Jordanian experience in planning and development of water resources" Expert Group Meeting on Water Security in the ESCWA Region, Damascus, 13-16 November 1989 (E/ESCWA/NR/89/WG.3/WP.2).

In the Syrian Arab Republic details pertaining to small dam and reservoir construction are not available. By 1983, about 84 small- and medium-sized dams had been constructed with a total capacity of 313 MCM, in addition to the large Euphrates Dam, the storage capacity of which is 11,600 MCM.[11/]

About 199 small and large dams were constructed during the last decade in Saudi Arabia, with an estimated total storage capacity of 750 MCM. These dams are mainly for making use of flood waters for irrigation, livestock and/or artificial ground-water recharge. Table 7 shows the main dams of about 5 MCM storage capacity and above.

Table 7. Water structures in Saudi Arabia

Structure	Location	Capacity (MCM)	Use
Jizan	Jizan	51	Irrigation
Aqul	Al-Madinah	7	Compensation
Al-Madiq	Najran	86	Control and irrigation
Turbah	Taif	20	Compensation
Lava	Taif	10	"
Itud	Asir	6	Control
Far'a	Yenbu'	20	"
Tandahah	Asir	22	"
Abi Hisani	Mecca	20	Compensation
Far'a	Al-Madinah	20	Control
Total		262	

Source: Arab Center for the Studies of Arid Zones and Dry Lands, Arab Fund for Economic and Social Development, and the Kuwait Fund for Arab Economic Development, paper submitted at the Symposium on Water Resources and Their Utilization in the Arab World, Kuwait, 17-20 February 1986, (in Arabic).

Note: These exist in addition to about 189 small dams providing a total storage capacity of about 488 MCM.

11/ Syrian Arab Republic, Ministry of Irrigation, "Water resources in the Syrian Arab Republic", (Damascus, 1986) (in Arabic).

B. Subregional water activities

Water-related activities at the subregional and regional levels are very limited; few subregional water projects are known to have been implemented during the last decade.

There are other ongoing projects at the interregional level, however, such as the Nile River water conservation projects in which Egypt, Sudan and other concerned non-Arab countries are involved.

1. The Yarmouk River Basin project

An agreement was signed between Jordan and the Syrian Arab Republic in 1953 to utilize their share of the Yarmouk River waters for irrigation and hydropower generation. The project has undergone several modifications.

Feasibility studies, design and tender documents were prepared, though no progress has since been achieved. The site of the dam was relocated in 1987 as a result of the political situation in the area, and new design and relevant tender documents were reviewed accordingly.

2. The Hamad Basin project[12/]

Planning for the Hamad Basin project began in 1975. The four countries sharing the basin agreed to cooperate within the framework of a plan based on an integrated study of the available and potential natural resources of the basin; water-resources surveys were given special attention. In 1978, the concerned member countries agreed upon the project documents formulated by the Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD). The project was begun in 1979 and lasted for four years, in cooperation with ACSAD. National follow-up projects within the Hamad Basin are currently being implemented.

The project area indicated by the formulated plan was about 100,000 square kilometres, but was later increased to encompass entire areas belonging to the basin in the countries concerned.

Some of the projects' objectives include: acquiring the basic data and information necessary for the comprehensive socio-economic development of the basin; improving the living standard of the inhabitants; and evaluating the basin's natural resources, including surface, ground water, vegetation and animal resources.

The total estimated cost of the project is US$ 27,000,000; financed by the member countries concerned and from ACSAD funds.

12/ Economic and Social Commission for Western Asia, "Hamad Basin project investigations" (E/ESCWA/AGR/WG.12/28), p. 54.

The project includes the following activities:

(a) Topographical survey using available maps and interpretations of satellite imagery, plus the preparation of a base map of 1:500,000 scale (completed);

(b) Climatological studies using existing meteorological data and that collected during the course of the project;

(c) Surface- and ground-water points inventory, analysis and evaluation;

(d) Geological studies and hydrogeological correlations, as well as delineation of the main water-bearing formations and determination of their hydraulic parameters;

(e) Collecting, compiling, recording and storage of water data;

(f) Soil survey, plus wildlife and vegetal-cover studies.

3. Project for shared water resources in the Gulf States and the Arabian Peninsula[13/]

As per the request of the Secretariat of the Council of Ministers of Agriculture in the Gulf States and the Arabian Peninsula, FAO carried out a shared-water project during the period April 1977 to May 1979.

The aim of the project, as agreed upon between FAO (the executing agency) and the Council of Ministers, was to undertake the following:

(a) Gather all documents which deal with the water resources of the region (project area) and evaluate them thoroughly;

(b) Develop a conceptual hydrogeological model for the Eastern Arabian Basin, based on all available data;

(c) Fit each country into the developed model and determine how each shares its water resources;

(d) Draw up a programme for future investigations aimed at better quantification of the shared resources, and prepare a pumping programme to ensure equitable sharing by the countries concerned.

To achieve the above, the FAO technical team reviewed and evaluated the available water sector data and documents relevant to the project area (1.7 million square kilometres), including information pertaining to geological setting, geophysical surveys, hydraulic and hydro-chemical parameters, and hydrogeological conditions prevailing in the project area.

13/ Food and Agriculture Organization, Survey and Evaluation of Available Data on Shared Water Resources in the Gulf States and the Arabian Peninsula, vols. I-III (Rome, FAO, 1979).

Data on piezometry, water quality and well inventory are also presented on maps, and geological cross-sections were drawn. A summary of all significant hydrogeological data and the results of previous studies carried out in the area were included as well.

In the course of their studies, the FAO team described the aquifer systems in the Eastern Arabian Basin as:

(a) System A: the main aquifer system which recharges in inland Saudi Arabia and underflows to the east, to its eventual discharge into the Gulf;

(b) System B: composed of discontinuous fresh-water lenses which extend from coastal Saudi Arabia across Bahrain and Qatar, and into central Abu Dhabi. This system also includes the shallow, unconsolidated aquifers of the eastern United Arab Emirates and inland Oman, and the fresh-water aquifer in northern Kuwait and areas in south-eastern Iraq.

A ground-water simulation model was developed, based on the data collected and a review of previous findings. The model simulated the main aquifer systems in the basin, the recharge sources and discharge areas in the different localities of the project area, water quality, etc. The project concluded by classifying the resources according to their source aquifers, determined the hydrogeological situation and each aquifer system's hydraulic model, and established the extent of sharing which is possible within the framework of the proposed hydraulic model; it also concluded that further studies are required in Kuwait, Bahrain and the United Arab Emirates, and recommended that a data bank and retrieval system for hydrological and hydro-meteorological data should be established. Further interpretation of the available and future data, records, and reports should be undertaken, and the interpretations should be of a more scientific nature.

The FAO team also studied and described the hydrogeological conditions prevailing in the Yemeni subregion of the project area, based on available data, records and previous investigations. It was concluded that the development of surface-water resources in Yemen is possible in the Tuban, Bana and Beihan basins. The largest area for the potential sharing of ground-water resources is that between Yemen and Saudi Arabia, where ground water, in the Cretaceous sandstone and in the Umm Al-Radhuma aquifers is recharged in Yemen and flows towards Saudi Arabia. The available data does not provide enough information for a precise statement on the extent of potential sharing in this area.

4. International Drinking Water Supply and Sanitation Decade[14/]

(a) A project was executed by ESCWA and funded by UNDP; an official report on the activity was issued in September 1982 (E/ECWA/NR/13/Rev.1). The cost of the project was estimated at US$ 0.04 million. The objectives were:

(i) Reviewing the national plans in ESCWA member States for the International Drinking Water Supply and Sanitation Decade;

14/ Economic and Social Commission for Western Asia, "Activities of governments and international agencies in the field of water resources within the ESCWA region", 1986, (E/ESCWA/NR/86/4), pp. 80-81.

(ii) Enabling ESCWA to report to the United Nations Economic and Social Council on the present status of the Decade activities in the region;

(iii) Identifying the constraints and needs of programmes so that the Decade goals may be achieved;

(iv) Drawing up a regional plan of action for Decade activities, to be undertaken by the Commission during the Decade.

(b) As per the work programme of 1988/89, ESCWA scheduled the implementation of a programme element entitled "International Drinking Water Supply and Sanitation Decade end-decade-review".

Contact was made with World Health Organization (WHO) and East Mediterranean Regional Office (EMRO) to jointly implement the programme element, whose objectives were:

(i) To survey the activities carried out in the region as a follow-up to the International Drinking Water Supply and Sanitation Decade (IDWSSD);

(ii) To describe and identify areas and indicators illustrating the successes and constraints experienced in the region during the implementation of the Water Decade activities.

WHO/EMRO independently implemented the jointly programmed activity and produced the relevant output.

5. Study and development of traditional waterworks[15/]

The project is being executed and funded by ACSAD. Expenditures on the project were US$ 0.08 million as of 1985. The project objectives are:

(a) Conducting an inventory and classifying all existing conventional waterworks in the Arab (Arab League member) countries;

(b) Studying promising development possibilities.

The project is designed to optimize the utilization of the rural water resources through development of the existing conventional waterworks.

6. ACSAD Water Resources Data Bank project[16/]

The project is executed by ACSAD and funded by both ACSAD and French Aid. Total estimated cost of the project is US$ 0.144 million. The project objectives are:

(a) Collecting data on water resources in Arab countries;

15/ Ibid.
16/ Ibid.

(b) Identifying specific gaps in the present database and conducting hydrological and hydrogeological studies required for future planning.

7. Regional development and application of components of the Hydrological Operational Multi-purpose System (HOMS)[17/]

The project is being executed and funded by ACSAD, UNDP and Arab countries. Total estimated cost is US$ 0.808 million. The objectives of the project, which covers all Arab countries, are:

(a) Improving qualitative and quantitative hydrological data needed for development planning assessment;

(b) Encouraging rational utilization of the available water resources.

8. Water-resources mapping of the Arab countries[18/]

ACSAD is executing the project. ACSAD and the concerned Arab countries are covering the cost, which is US$ 0.9 million. The aims of the project are:

(a) Water-resources inventory of the Arab countries;

(b) Cartographic representation of surface and ground water.

9. Yemeni Joint Project for Natural Resources[19/]

The DTCD is the executing agency for the project, which is funded by UNDP and the Arab Fund for Economic and Social Development (AFESD). The amount spent up to 1985 was US$ 5.2 million. The project objectives are:

(a) National exploration and management of mineral and water resources;

(b) Geological and hydrogeological surveys of mineral and water resources in Yemen.

10. Assessment of water resources by using remote-sensing techniques

During ESCWA's 1988/1989 work programme, a project entitled "Assessment of water resources by using remote-sensing techniques in the ESCWA region" was scheduled for implementation.

(a) The development objectives of the project are:

(i) To help ESCWA member States assess their national water resources;

17/ Ibid.
18/ Ibid.
19/ Ibid.

(ii) To improve the general state of knowledge regarding water resources of the ESCWA region as a basis for orderly programming and optimum use of these resources;

(iii) To assess the shared water resources, considering that there are several hydrological basins shared by two or more countries;

(iv) To help countries acquire the information necessary to formulate urgently needed water strategies and plans of action at natural and regional levels;

(v) To provide technical cooperation at subregional and regional levels among the countries sharing the water basins;

(vi) To strengthen the national and regional capabilities of ESCWA countries in water-resources management.

(b) The immediate objectives of the project are:

(i) To introduce new remote sensing techniques for water-resources assessment in the region;

(ii) To produce hydrological-hydrogeological maps on an acceptable scale;

(iii) To support and complement national water-resources surveys and establish a basis for continuing intraregional cooperation in the field of water resources;

(iv) To optimize water-resources utilization in the region with survey analysis through hydrological modelling.

ESCWA has implemented the first stage of the project in the shared water basins of Wadi Sirhan (Jordan/Saudi Arabia) and Wadi Bana (Yemen). The total cost of the first phase was in the order of US$ 15,000. The Islamic Development Bank (IDB) has allocated US$ 200,000 to provide financial support to help ESCWA to implement the latter stages of the project. An additional US$ 200,000 (in kind) has been allocated from United Nations Environmental Programme (UNEP) budget for participation in the implementation of the project as part of ESCWA/UNEP joint project.

11. River Nile water conservation projects

These were interregional projects involving one ESCWA member State, the Arab Republic of Egypt (also a member State of ECA) and the People's Democratic Republic of Sudan (also from the ECA region), as well as Ethiopia and Uganda.

These activities, comprised of several major water projects and works designed to regulate and conserve the Nile River flood waters, were located outside the Egyptian border. They were stopped as of November 1983 due to the political situation in South Sudan.

III. CASE-STUDIES

The information previously presented in this report provides evidence that good progress has generally been made in the ESCWA region in the implementation of the Mar del Plata Action Plan (MAP). Examples of success achieved in certain areas with respect to water-resources management were described earlier within the text.

In the forthcoming presentation, three examples illustrate the progress made in the implementation of the Action Plan since the United Nations Water Conference held in the region in 1977. These examples pertain to Jordan (ground water), Egypt (surface water) and the GCC States, where the non-conventional water resources are the major component of the total national water resources.

A. The Hashemite Kingdom of Jordan[1/]

The average annual volume of rainfall within Jordan is estimated at 8,500 million cubic metres (MCM). About 93.8 per cent of the country's total area is desert or marginal (for grazing), and receives less than 200 mm average annual rainfall. The total available water from surface- and ground-water sources is estimated at 1,198 MCM, of which 938 MCM is surface water and 260 MCM ground water. Approximately two thirds of Jordan's potential usable water resources is surface water. With the exception of spring water and King Abdullah Canal resources (Deir Alla Water Supply Scheme), surface-water resources are presently used exclusively for irrigation. About 66 MCM of surface water is being stored behind the existing dams. Most of the municipal water-supply system in Jordan as well as industry and irrigation, depends on ground water and springs. Treated waste-water effluent is being reused to increase water resources, with a contribution of 36 MCM in 1988; it is expected to reach about 116 and 165 in the years 2005 and 2015, respectively.

A great proportion of the replenishable surface- and ground-water resources has been utilized, reaching a stage between complete annual utilization and exhaustion. The resources remaining for future use are diminishing gradually. The development of all of these resources would seem insufficient for Jordan's demand after the year 2000. Ensuring safe and rational utilization of these resources has therefore been the main task of concerned government authorities.

1. Institutional arrangements for the water sector

The organizational framework of Jordan's water sector has evolved over the years to suit various requirements at different times. Before the establishment of the Water Authority of Jordan (WAJ), water affairs were managed by the following major institutions:

1/ Economic and Social Commission for Western Asia, "The Jordanian experience in planning and development of water resources", Meeting on Water Security, Damascus, 13-16 November 1989 (E/ESCWA/NR/89/WG.3/WP.2).

Natural Resources Authority (NRA)
Water Supply Corporation (WSC)
Jordan Valley Authority (JVA)
Amman Water and Sewerage Authority (AWSA)

In addition, many small municipalities and villages operated and maintained their own water-supply systems and sanitary services.

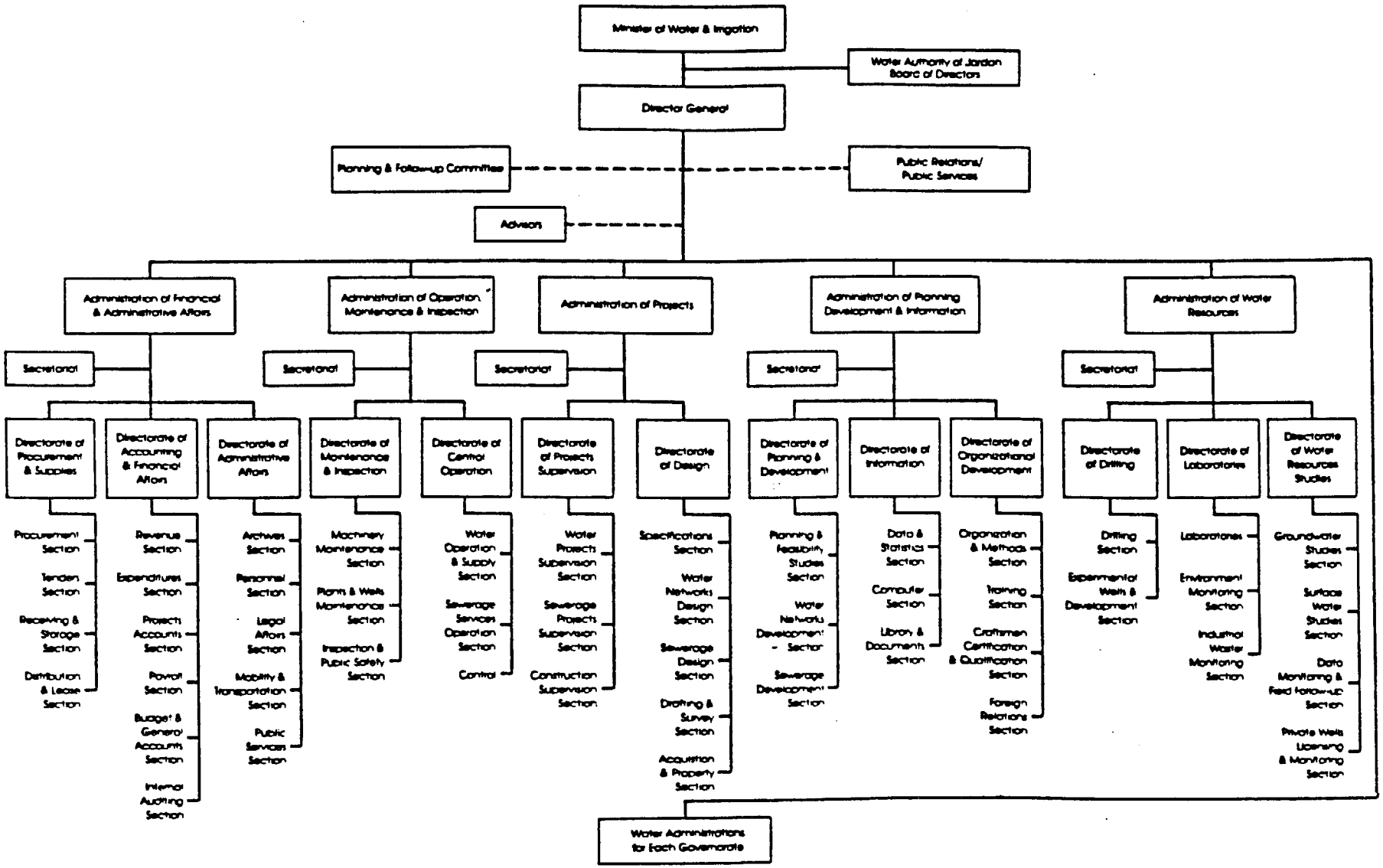
The scattered water responsibilities in Jordan, where serious water shortages and heavy competitive use exist, have given rise to problems of poor coordination and have in some cases led to a duplication of efforts among the various organizations involved. The need to create a single national water authority to set policies for the water sector was one of the main recommendations of the National Water Symposium held in Amman in 1978. This was realized in 1983 with the enactment of Law number 34 and the creation of the Water Authority, to be responsible for the planning, development, allocation and management of all water resources; and for assuming responsibility for the planning, development, and provision of water supply and sewerage services from all agencies and municipalities performing these functions prior to its creation.

Until July 1987, the water sector was managed by two independent authorities:

Water Authority of Jordan (WAJ)
Jordan Valley Authority

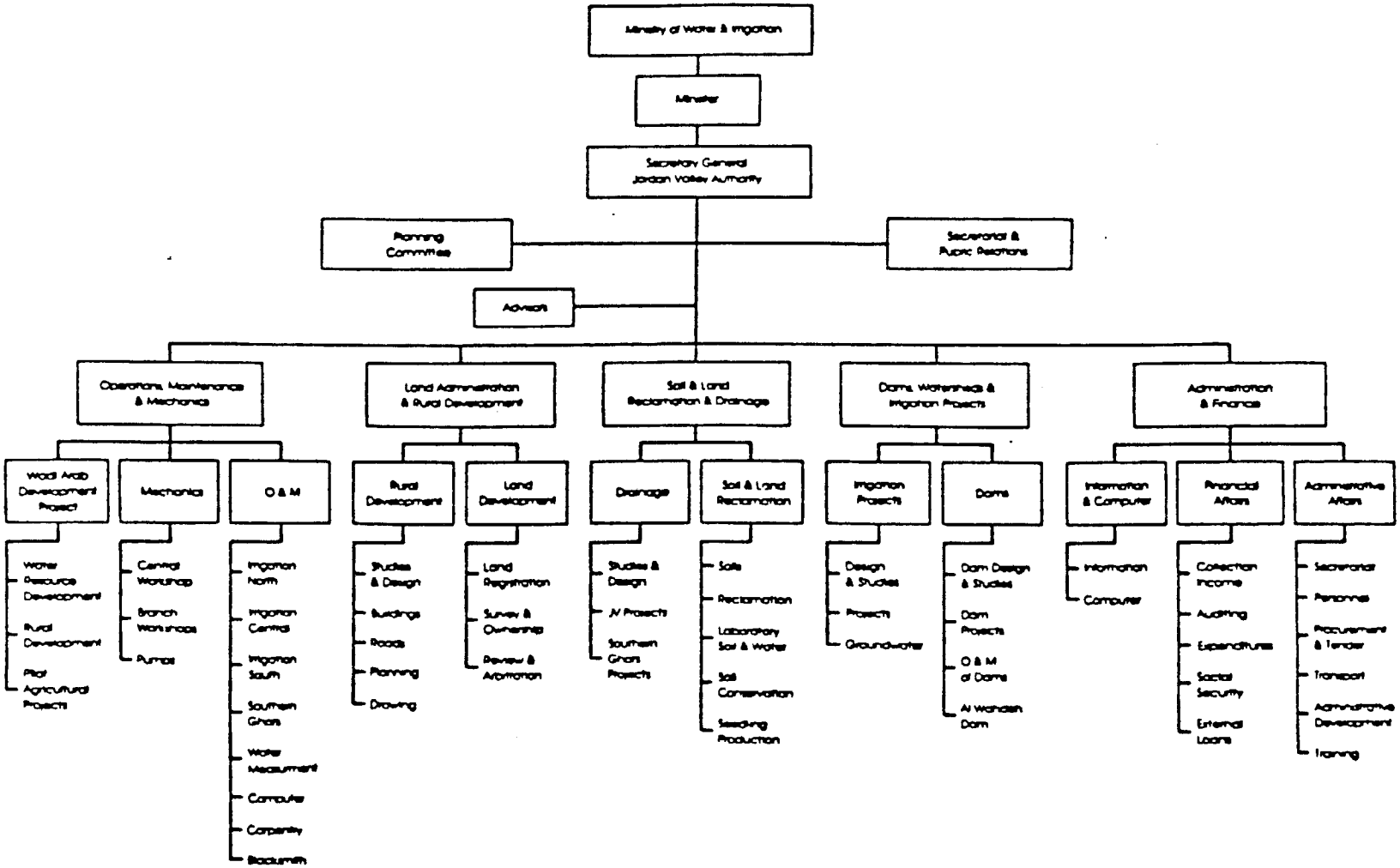
JVA was responsible for irrigation and development in the Jordan Valley, while WAJ was concerned with water supply, sewerage and water resources. The presidents of both organizations had ministerial rank. Figures I and II present the organizational structures of WAJ and JVA, respectively. In 1987, the two authorities were brought together under one Ministry of Water and Irrigation (MWI). The final organizational structure of the new Ministry is still under discussion. Figure III illustrates the recommended organization for the new Ministry; there would be two major Departments (Water Resources and Multi-Purpose departments) and two Authorities Irrigation and Water & Sewerage authorities responsible to the Minister.

Figure I. Jordan Water Resources study, Water Authority of Jordan organization chart



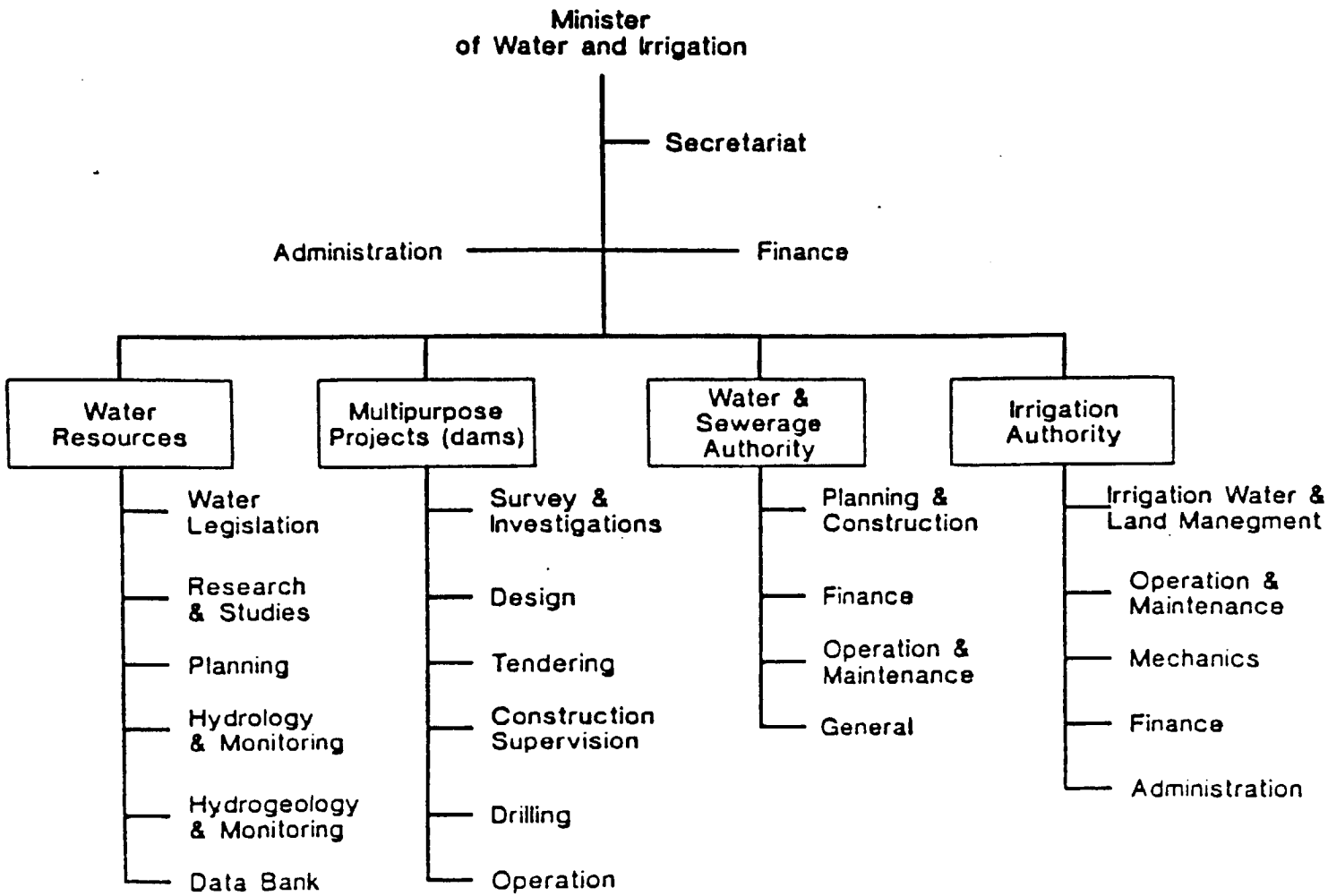
Source: Economic and Social Commission for Western Asia, "The Jordanian experience in the planning and development of water resources", Meeting on Water Security, Damascus, 13-16 November 1989, (E/ESCWA/NR/89/WG.3/WP.2).

Figure II. Jordan Water Resources study, Jordan Valley Authority organization chart



Source: Economic and Social Commission for Western Asia, "The Jordanian experience in the planning and development of water resources", Meeting on Water Security, Damascus, 13-16 November 1989, (E/ESCWA/NR/89/WG.3/WP.2).

Figure III. Jordan water sector organization proposed structure



Source: Economic and Social Commission for Western Asia, "The Jordanian experience in the planning and development of water resources", Meeting on Water Security, Damascus, 13-16 November 1989, (E/ESCWA/NR/89/WG.3/WP.2).

2. Legislation for water-resources organization and management

At present, the Ministry of Water and Irrigation (MWI) is the only official institution responsible for water-resources development, protection, and conservation (through WAJ Law number 18 of 1988 and JVA Law number 19 of 1988).

(a) Water conservation legislation and regulations

All water resources are government property and under the MWI control, according to articles 25 of WAJ Law number 18, and 18 and 24 of JVA Law number 19. These articles read as follows:

Article 25 WAJ Law 18

(i) All water resources available within the boundaries of the Kingdom, whether they are surface or ground waters, regional waters, rivers or internal seas are considered State-owned property and shall not be used or transported except in compliance with this law;

(ii) Any water resources that are not under the management, responsibility or supervision of the Authority shall not be used in excess of personal or domestic needs or other acceptable private usage; nor in excess of legal water rights in accordance with the law and regulations in effect including drinking and irrigation rights applicable to the area of land which contains that resource;

(iii) All natural and judicial bodies are prohibited from selling water from any source, or granting or transporting it, without obtaining in advance the written approval of the Authority and within the conditions and restrictions decided on or included in the contracts or agreements concluded between them and the Authority;

(iv) All persons on whom the provisions of paragraphs (b) and (c) of this article are applicable shall adjust their conditions to suit these provisions within a period of three months of the date this Law becomes effective. Otherwise, such persons will be subject to the legal and other penalties stated in these articles.

Article 18 of JVA Law 19

(i) The water acquired by means of projects constructed by the Authority and which were not used or exploited for irrigation purposes in any area prior to the declaration of a water settlement law in effect, shall be considered government property. Such water may be sold, leased or otherwise disposed of in the way as may be decided by the Authority;

(ii) The Authority shall have full authority in the allocation or usage of all surface or ground waters which are developed under the supervision of the Authority;

(iii) When the Authority constructs an irrigation project, it shall first consider the registered water rights, and any excess water shall be considered government property.

Article 24 of JVA Law 19

(i) The Authority has the right to fix the upper limit of the amount of water it supplies to the holders in accordance with water availability and with the crops planted in the farm units. It also has the right to supervise the water and its supply and distribution and to fix its price and to stop supplying water to the farm units.

The MWI adopted an extensive programme to develop public awareness and education for water conservation through television, newpapers, educational presentations and seminars. The effect of price on water demand was also examined; by increasing the price of water, demand was reduced.

In the agricultural sector, farmers were encouraged to use improved irrigation techniques such as sprinklers and drip-irrigation systems, which greatly reduce the water used by different plants. Because water is applied only to the exact point where it is needed, drip irrigation generally saves 25 to 50 per cent over conventional methods. This system is widely used in the Jordan Valley and in the uplands, while the sprinkler method is the only irrigation system used in the southern part of the country.

Well-drilling licences are issued only by WAJ for limited volumes of water to be extracted yearly. The number of the new licences issued has greatly decreased in the last five years; only 45 licences were issued in 1988, compared to 73 in 1985 and 198 in 1981. Most of these licences were given only for agricultural purposes. In addition, bans were imposed on drilling activities in northern and southern Jordan. Article 30 of the WAJ Law number 18, paragraph (a-4), deals with the sentencing of anyone who drills an unlicenced well or violates the conditions of the licence issued to him.

(b) Protection of water quality

In the last ten years, water pollution has become a very sensitive subject among local and international agencies because of the enivronmental problems it produces. In Jordan, several governmental organizations are responsible for the control of water pollution for surface-water bodies such as the King Talal Dam (KTD), and for ground-water basins which may have direct contact with sewage effluent or contaminated water.

Chemical and bacterial analyses are mainly carried out by the MWI, Ministry of Health, Royal Scientific Society, Jordan University and Municipality of Greater Amman laboratories. The MWI is responsible for the routine monitoring of water-resources quality, while the other agencies are responsible for ensuring that the water quality meets World Health Organization drinking water standards. Article 6 of WAJ Law number 18 outlines these responsibilities and tasks:

(i) Survey the different water resources, conserve them, and determine ways, means and priorities for their implementation and use;

(ii) Develop the potential water resources in the Kingdom, increase their capacity and improve their quality, protect them from pollution, supervise them and administer their affairs and put forth programmes and plans to meet future water needs by providing additional water resources from inside or outside the Kingdom and through the use of water treatment and desalination;

(iii) Regulate and advise on the construction of public and private wells; investigate ground-water resources; drill exploratory, reconnaissance, and production wells; and license well-drilling rigs and drillers;

(iv) Study, design, construct, operate, maintain, and administer water and public sewerage projects including collecting, purifying, treating, and disposing of water, and the use of any other methods dealing with water;

(v) Draw terms, specifications and special requirements in relation to the preservation of water and water basins. Protect them from pollution, and ascertain the safety of water and sewerage structures and public and private distribution and disposal networks, and take the necessary actions to ensure technical control and supervision, including all necessary tests;

(vi) Carry out theoretical and applied research and studies regarding water and public sewerage to achieve the Authority's objectives, including the preparation of approved water-quality standards for different uses and technical specifications concerning materials and construction, in order to apply the findings to the Authority's projects in coordination with other concerned departments; and publish the final findings and standards so as to generalize their application by all means available to the Authority;

(vii) Issue permits to engineers and licensed professionals to perform public water and sewerage works; and participate in organizing special training courses to qualify them in order to improve the standard of such works and to reduce water losses and pollution. All those involved in water and sewerage works are requested to adjust their practice in accordance with the provisions of this article and to obtain the specified permit accordingly;

(viii) Regulate the uses of water, prevent its waste, and monitor its consumption.

JVA has designed regulations for protecting the Jordan Valley and controlling polluted discharge, described in article 38 of the JVA Law: "No person is allowed to pollute the water resources of the Valley or discharge, without the Minister's written permission, to these waters any polluting materials declared in the Official Gazette by the Minister as materials causing pollution".

(c) Legislation regarding water-resources development

Water-resources development, planning, maintenance and operation are under the responsibility of MWI, through article 6 of WAJ Law and article 3 of JVA Law.

Article 3

Under this Law, an Authority known as the "Jordan Valley Authority" shall be established and shall undertake the following:

(i) The development of the water resources of the valley and utilizing them for purposes of irrigated farming, domestic and municipal uses, industry, generating hydroelectric power and for other beneficial uses; also their protection and conservation and the carrying out of all the works related to the development, utilization, protection and conservation of these resources, including:

- The carrying out of studies required for the evaluation of the water resources including hydrological, hydrogeological and geological studies, the drilling of exploratory wells and the establishment of observation stations.

- The planning, design, construction, operation and maintenance of irrigation projects and related structures and works of all types and purposes including dams and related works, hydropower stations and related works, wells, pumping stations, reservoirs and water-delivery and distribution networks; also surface and subsurface drainage works, flood-protection works, and roads and buildings, needed for operation and maintenance.

- Organizing and directing the construction of private and public wells.

3. Water-resources planning and utilization

Most of industry and municipal water-supply systems in Jordan depend on ground water and springs. Several aquifers are being over-pumped and water resources depleted. The distribution of water resources does not correspond to the areas of highest demand, particularly the densely populated urban areas. WAJ, under pressure to meet increasing municipal and industrial water requirements, has constructed a complex conveyance system. The feasibility of constructing pipelines linking the entire water system in northern Jordan to permit integrated resource management is under study. Pressure to develop new sources has sometimes led to the selection of costly solutions. One example is the Deir Alla pumping station, completed in 1985 and designed to pump, treat and convey 45 MCM per year to the Amman area. (From 75m to about 1,035m above sea level and from a distance of 65 kilometres).

The irrigated agriculture now covers more than 480,000 dunums; 288,000 is in the Jordan Valley and the remainder is in the highlands. Modern irrigation started in the Jordan Valley with the completion of the King Abdullah Canal (KAC) in 1965 and the construction of the King Talal Dam (KTD) on the Zarqa River in 1979. Great progress has been achieved in many parts of the country in modernizing irrigation techniques designed to conserve the country's water resources. In general, non-conventional and limited conventional irrigation methods are applied in Jordan.

Because the Government has been well aware of the need for rational water-resources planning, many developments have taken place since the implementation of the national water master plan in 1977: the KTD has been used only for irrigation; additional limited ground-water resources have been identified; and sewage network and treatment activities are under way, with about 9 MCM per year of sewage return flows currently used for irrigation in the Jordan Valley; finally, storage dams were built and about 1,270 wells were drilled for ground-water exploration and extraction.

(a) Surface-water utilization

Surface-water resources originate from the Yarmouk and Zarqa rivers, which provide most of the irrigation water for the Jordan Valley. Present surface-water consumption is currently estimated at 336 MCM. Plans to make use of desert flash-flood water through small dams (for aquifer recharge, local irrigation and livestock) have been implemented. The main potential for further surface-water development is through the construction of new water storage facilities on the Yarmouk River (Al-Wahdah Dam), and in the Jordan Valley (Karameh) and rift side wadis (Kufranja and Yabis dams). Jordan has had a lot of experience in the planning and utilization of surface water, to a degree that irrigated agriculture has developed and expanded from a few scattered, seasonally irrigated farms in the 1950s to about 550,000 dunums in 1988, of which 320,000 dunums are in the Jordan Valley and 230,000 dunums are in the highlands.

Surface-water impounding activities are progressing well in Jordan. There are plans to make use of storm run-off water, and of flood water available during the rainy season. Water impounded by dams or retention reservoirs is used for domestic, industrial, irrigation and livestock purposes. By 1986, about 15 reservoirs had been constructed, with a total capacity of about 126 MCM (table 5).

A number of impounding reservoirs with a total storage capacity of about 387 MCM were identified in different areas of the Kingdom; the capacity of each dam varies between 2 MCM and 220 MCM.

The Government of Jordan has also begun to develop rain-water harvesting practices. Desert pools have been rehabilitated or constructed, and flood-water spreading has been undertaken. Artificial ground-water recharge using flood water was being practised in different localities (Shueib and Khalidiya dams) and, as of 1989, was under way in others (Siwaqe, Al-Abyed, Jurdaneh, and the Azraq and Jafer basins).

(b) Ground-water utilization

Ground-water sources close to population centres in Jordan have been extensively exploited for municipal and industrial purposes. Most of these sources are currently being extracted to or beyond the limits of reliable aquifer yields. Data show that some unexploited ground water still exists in areas which are remote from population centres. It is estimated that 12,000 MCM of stored ground water can be found within the country, though most of this is fossil water. Further studies are required to verify this resource in terms of quality, quantity and the economic viability of extraction.

Ground-water resources can be classified as replenishable, fossil or brackish.

Replenishable ground water is presently used for municipal, industrial and agricultural purposes. It is estimated that about 354 MCM of this water is currently being utilized in different localities in Jordan, resulting in the over-pumping or depletion of Jordan's main aquifers at a rate of about 94 MCM (1989 estimates).

Fossil ground water forms the major stored quantities of available ground water in Jordan. The main potential for increased production lies with the fossil aquifer of the Disi Basin in southern Jordan. The last study, carried out in 1986, showed that the safe yield of this aquifer is about 110 MCM per year over a 100-year period. The salinity of this water ranges between 500 and 2,000 parts per million (ppm).

Abundant amounts of brackish ground water are available in Jordan, particularly in the Rift Valley and desert areas. Brackish or slightly-to-moderately salty ground water exists in different aquifer systems in Jordan.

Currently, three brackish-water well fields are being explored; water from them could be pumped and diluted in the King Abdullah Canal (KAC) to increase the available surface water utilized for irrigation. These well fields include:

(i) Adasiya well field, which consists of 19 wells producing 25 MCM, with salinity ranging between 2,000 and 4,000 ppm;

(ii) Hisban well field (flowing wells), with a total productivity of about 10 MCM and salinity levels of about 3,000 ppm;

(iii) Ghor Safi well field, with a total productivity of about 7 MCM and salinity levels of about 2,250 ppm. Brackish water will likely be used for industrial purposes, to protect the fresh shallow aquifer at Safi from depletion due to present over-pumping.

Brackish water in Jordan is currently only used for the irrigation of palm trees in Aqaba.

(c) Treated sewage effluent reuse

The construction of sewerage facilities has rapidly increased since 1984, with the creation of WAJ. Eleven treatment plants were constructed and another 22 plants were planned and designed for urban and rural areas. Sewerage networks will likely serve 84 per cent of the population in 1990 and 88 per cent by 2015.

The production of treated effluent which can be used for irrigation is estimated to reach 116 MCM in the year 2005 and 165 MCM in 2015. Experimental irrigation using treated effluent has been applied in some areas of Jordan; the scheme is described below.

The stabilization ponds at Khirbet Samra, 42 kilometres north-east of Amman, have a present capacity of about 0.1 MCM/day. About 3 per cent of treated effluent from the ponds is presently used for irrigation around the ponds. The irrigated area is about 3,000 dunums, planted with 3,000 fruit and olive trees and about 1,600,000 other, different forest trees. The effluent from the Jerash plant is discharged into the Amman-Zarqa Basin, stored in the KTD, and used for irrigation in the Jordan Valley. WAJ, in collaboration with FAO, is involved in a regional project on Samra waste-water reuse, the main objective of which is to assess the impact of waste water on soil, crops and workers in the irrigation area.

(d) Other measures, such as improving skilled-manpower capabilities, applying computers in water science, establishing a comprehensive water-sector database, and establishing a regional centre for isotope analysis and interpretation in cooperation with the International Atomic Energy Agency (IAEA), have been undertaken by the water-related institutions in Jordan.

B. The Arab Republic of Egypt[2/]

1. Water resources

The main components of Egypt's available water resources are:

	MCM/year
Egypt's share of the River Nile Waters	55 500
Usable drainage water	10 000
Usable ground water from the Delta aquifers and Upper Egypt	2 200
Total available water resources	67 700

For its surface water, Egypt relies primarily on the annual flow of the Nile River, which is dependent on annual climatological conditions prevailing in the headwater regions beyond the Egyptian borders.

2/ Economic and Social Commission for Western Asia, "Water-resources planning in Egypt: issues ahead to the year 2020", Meeting on Water Security, Damascus, 13-16 November 1989 (E/ESCWA/NR/89/WG.3/WP.8).

During the drought that lasted from 1979/1980 to 1987/1988, experienced by the entire eastern African region, Egypt's surface-water resources were taken from the High Dam Lake; the live storage in the lake was reduced from 81,250 MCM in 1979 to about 8,000 MCM in 1989.

As per the Upper Nile water conservation projects, Egypt's share would have increased by 7,500 MCM/year at the High Dam, but these projects were stopped in November 1983 due to the political situation in South Sudan.

In addition, there is the possibility of reusing treated sewage effluent (from an estimated 600 MCM by 1992 to 1,000 MCM in the year 2000). About 4,900 MCM/year of ground-water resources may be developed in promising localities within the country by the year 2000.

2. Institutional arrangements

The Ministry of Public Works and Water Resources (MPWWR), formerly the Ministry of Irrigation, is the main organ responsible for water affairs in Egypt. The Ministry of Housing and Reconstruction, the Ministry of Planning and the Ministry of Health also deal with the water sector, but on an ad hoc basis.

The Water Research Centre (WRC) of the Ministry of Public Works and Water Resources was established after Presidential Decree 830 of 1976. It enjoys its own jurisdiction and is responsible for all aspects of waste-resources development. The objectives of the Centre are to investigate possibilities and undertake measures for long-term water planning, to secure a safe and adequate water supply, and to satisfy the needs of various users in the country. It also provides solutions for various problems resulting from irrigation and drainage schemes. It undertakes water-resources investigations and research in connection with the High Dam Project, evaluates the country's surface- and ground-water resources, and proposes measures and actions for the wise utilization and management of these resources.

The Centre is composed of eleven institutions:[3/]

1. Water Distribution and Irrigation Systems Research Institute
2. Drainage Research Institute
3. Hydraulics and Sediment Research Institute
4. Water Resources Development Research Institute
5. Weed Control and Channel Maintenance Research Institute
6. Ground-Water Research Institute
7. High Aswan Dam Side Effects Research Institute
8. Mechanical and Electrical Research Institute
9. Survey Research Institute
10. Soil Mechanics and Foundations Research Institute
11. Coastal Protection Research Institute

3/ Egypt, Ministry of Irrigation Water Research Centre, "Specialization and accomplishment of the centre and its institutes up to 1979", memo, no date, p. 14. (in Arabic).

The Centre also has four general departments:

1. Planning and Follow-Up Department
2. Research Services Department
3. Administrative and Financial Department
4. Training and Manpower Development Department

With regard to domestic water supply, the country is divided into several service regions: Greater Cairo, Alexandria, the Suez Canal cities (Port Said, Ismailia and Port Suez) and provincial Egypt, which comprises the rest of the country.

The Executive Authority for Water Planning was established in 1972 under the auspices of the Ministry of Irrigation, in view of the need for long-term planning for efficient water utilization. The preparation of a master plan for water-resources development and use is among the immediate objectives of the Authority.

In addition to local governorates, the General Organization for Greater Cairo Water Supply, the Alexandria Water General Authority, the General Organization for Water Supply and the Suez Canal Authority are the organs responsible for the design, construction, operation and maintenance of the domestic water-supply sector projects.

3. Water legislation

Available information about water-sector regulations and legislation is very limited. However, Law number 12 of 1984 and its executive regulations issued as per Ministerial Decree number 14717 of 1987 comprises comprehensive legislative measures to control and monitor the irrigation and drainage activities in the country.

(a) Law number 12 includes legislation pertinent to:

(i) Public ownership related to irrigation and drainage;
(ii) Private activities on public property with respect to irrigation and drainage facilities;
(iii) Private irrigation and drainage networks;
(iv) Field drainage networks;
(v) Ground water;
(vi) Drainage waters;
(vii) Pumpage and pumping units;
(viii) Measures to protect coastal plains.

(b) Law number 48 was issued in 1982 (and its executive regulations passed by Ministerial Decree number 8 in 1983) to protect the River Nile and other water courses from pollution. The law is very comprehensive; if applied thoroughly by the private and government sectors, it will be satisfactory for the environmental protection of Nile River water and the control of drainage water inflow.

4. Water-resources utilization and planning in Egypt

A Water Master Plan project (UNDP/EGY-73/024) was launched in January 1977. The project was executed by IBRD and financed by the UNDP, with the Ministry of Irrigation acting as cooperating agency. The project was begun in October 1977 and the first phase was completed in December 1981;[4/] the second phase commenced in January 1982 and was completed in 1987.

The first part of the project involved the preparation and evaluation of development plans in which the water supply and consumer needs were matched, while the second was concerned with supporting studies and analysis.

Part 1: Planning methodology

(a) Develop the agricultural sector. Three alternative planning methodologies were studied:

(i) Evaluate the available water supply, as well as present and new projects. Compute the water requirements for other users and deduct these figures from the available water resources totals. The remainder was for agricultural development to the year 2000, distributed at five-year intervals;

(ii) Determine the water requirements for all users including the agricultural sector (with an annual growth rate of 4.9 per cent, including 1.9 per cent for new-lands development);

(iii) Determine the staging of new water-supply development projects (including the Upper Nile conservation projects) to satisfy water demand;

(iv) Determine water requirements, as in (ii) but with a 3 per cent rate of growth in the agricultural sector, 0.5 per cent of which must be for new-lands development.

(b) Supply the growing demand for municipal, industrial and all other users.

(c) Evaluate and compare plans on the basis of the effective use of available water, economic performance in the agricultural sector, capital investment required, social and environmental impacts and energy requirements.

Part 2: Supporting studies

These studies are related to the following: cost analysis of the water supply and land-development projects, and cash-flow expenditure during the planning period; water requirements to support agricultural development and economic evaluation for these projects; water demand and cost analysis for municipal and industrial uses, as well as waste-water quality investigations

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4/ International Bank for Reconstruction and Ministry of Irrigation Project (a joint IBRD/UNDP/Egypt Ministry of Irrigation Project), "Water master plan, executive summary of main report", 1981 (UNDP/EGY-71024), pp. 1-31.

and treatment for possible reuse in agriculture; determination of the operation, maintenance and replacement costs for Nile River regulation, irrigation and drainage systems; and finally, the establishment of a database and development of an agro-economic model.

The Water Master Plan concluded that if the Upper Nile conservation project were completed, about 11.5 BCM of additional water would be available after 20 years (first alternative). This amount would be enough for developing an additional 2.7 million feddan, and there would be a remainder of 1.8 BCM available for land development after the year 2000. As per the second alternative, and if new lands served by Nile waters were developed at the rate of 180,000 feddan/year, the developed water supply would be fully committed after 1997, and no further development would be possible unless additional water supplies were mobilized. If land development continued at the rate of 50,000 feddan/year, the increased water supply would exceed demand during the planning period. In this case, only the Jonjuli Project (part of the Upper Nile conservation project) would be required up to 1997.

The Water Master Plan project guarantees that there will be significant amounts of water used for agriculture independent of the supply-demand balance for the Nile. These will be drawn from the ground-water resources of the New Valley in the oasis areas, the shore lands along Lake Nasser, and treated waste water in the Greater Cairo area.

The drought conditions prevailing in the eastern coastal regions of Africa, the halted Upper Nile water-conservation projects and government plans to increase the cultivated areas in Egypt at a rate of 150,000 feddan annually, have all led the Egyptian Government to reconsider its water-use policy. Much progress has been made in Egypt's use of its national water resources. Conjunctive use of surface, ground, drainage and treated waste waters has been successfully practised to cope with both the drought conditions which lasted from 1979/80 to 1987/88 and the halted water-conservation projects. These projects are expected to feed the High Dam Lake at a rate of 7,500 MCM/year in their first phase, rising to 8,900 MCM/year upon completion.

The ground-water resources available in the eastern and western deserts and in Sinai provide about 2,700 MCM/year, expected to increase to 4,900 MCM/year after development.

Treated sewage and industrial waste water currently contributes a total volume of about 1,400 MCM/year, and is expected to reach 2,200 MCM/year by the year 2000. Drainage-water reuse is likely to be available at a rate of about 3,470 MCM/year for the five-year period 1987-1992; and should reach 6,500 MCM/year by the year 2000. A digital model was created in 1983 which simulates the changes that may occur in the quantity and quality of drainage waters over time after improving the drainage networks, increasing the volume of reusable drainage water for irrigation, changing the crop pattern and cultivating short-span crops. This model was intended to be used as a tool to make appropriate decisions for future development and to optimize reuse of the available drainage water and record its limitations, taking all necessary precautions so as not to negatively impact soil and crop productivity.

The strategy to utilize the potential ground-water resources in the Nile Delta and Valley, eastern and western deserts and in Sinai is mainly designed to:

(a) Provide domestic water supplies;

(b) Irrigate newly reclaimed lands at the peripheries of the Nile Delta and Valley;

(c) Improve the efficiency of agricultural production and the existing irrigation networks.

The concerned government authorities have adopted a short-term water-use policy to overcome the Nile water shortage. The policy relies on:

(a) Using the largest possible quantity of ground-water, agricultural drainage water and sewage drainage for irrigation;

(b) Rationalizing water in all fields and reducing withdrawal discharges from the High Dam Lake;

(c) To consider consecutive years with continuous shortage in the Nile supply. Then the withdrawal will be as follows:

(i) When the lake storage is 60-65 BCM by the end of July, withdrawal is to be reduced by 10 per cent.

(ii) When the lake storage is 50 BCM or less by the end of July, withdrawal is to be reduced by 20 per cent.

In the light of the above water policy, table 8 shows planned water used in Egypt, vis-à-vis the above-mentioned water policy, up to the year 2020.

Table 8. Expected available water resources in Egypt balanced with water requirements
(BCM)

Year	Available water resources (expected)			Total (BCM)	Requirements (projected)		Total (BCM)	Irrigated land (feddan)
	Nile	Drainage	Ground		Municipal and industrial	Irrigation		
1992	53.5[a/]	7.0	3.5	64.0	10.4	52.8	63.2	600 000 New Land
2000	55.5+2.2[b/]	7.5	4.9	70.1	10.7	58.3	69.0	Additional 1 000 000
2010	55.5+4.0	8.2	4.9	72.6	10.9	61.3	72.2	Additional 750 000
2020	55.5+8.2	8.6	4.9	77.2	12.6	64.2	76.8	Additional 650 000

Source: Economic and Social Commission for Western Asia, "Water resources planning in Egypt: issues ahead to the year 2020" Meeting on Water Security, Damascus, 13-16 November 1989 (E/ESCWA/NR/89/WG.3/WP.8).

a/ Represents Egypt's share in Nile River water at Aswan High Dam.
b/ Represents Egypt's share in the Upper Nile water conservation projects upon implementation.

C. The Gulf Cooperation Council (GCC) member States

The GCC States are Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates. The total population in 1986 was estimated at 17,795,773.[5/]

Rainfall in the area is generally scanty, sporadic, irregular and ranges from 200-600 mm/year in the Asir Mountains of Saudi Arabia to 50-100 mm/year over the rest of the GCC States, except in Oman, where it ranges from 100-300 mm/year.

Fresh and brackish ground water provide the major component of conventional water resources in the subregion. Overdraft conditions and ground-water quality deterioration due to both aquifer depletion and sea-water intrusion have been common during the last decade in these member States. Surface-water resources are available when flash floods occur along the major wadis debouching from the mountainous areas in Saudi Arabia, Oman and the United Arab Emirates. Surface water impounding activities are well established in Saudi Arabia and, to a certain extent, in Oman (see section II.6).

The region's limited water resources, ground-water depletion and progressive water-quality deterioration have prevented the member countries from meeting water demand which has increased due to rapid socio-economic development in the GCC States over the last two decades. This situation has led concerned authorities in the GCC States to develop additional water resources by desalinating sea water to meet their demands, to an extent that they are considered the world's leaders in delineated water production (about 953 MCM in 1987 (see table 4).

1. Institutional arrangements

A variety of institutions responsible for water-sector affairs exist in some of the Gulf States, and are involved in functions related to water planning, policy formulation, and the operation and maintenance of waterworks at the national level. This situation has led to conflicting interests, unnecessary budget allocations, the overlapping or dispersal of responsibilities, and even diversified technical specifications and designs of national waterworks. In some States, centralized water institutions such as water-resources councils or general water commissions were established to oversee and integrate water-sector affairs. Table 9 shows the institutional arrangements in the Gulf States and their mandates.

5/ Economic and Social Commission for Western Asia, "Water situation in the GCC States", Meeting on Water Security, Damascus, 13-16 November 1989 (E/ESCWA/NR/89/WG.3/WP.1), (in Arabic).

Table 9. Institutional arrangements in the GCC States

State	Institution	Legislation	Mandate
Bahrain	Water Resources Council	Law 7, 1982 Law 12, 1980	Water planning, policy formulation, coordination of water activities, ground-water conservation and development.
Kuwait	Ministry of Electricity and Water		Construction, maintenance and operation of water-supply projects including desalination plants, ground-water exploration and licencing, and applied research.
	General Commission for Agriculture and Fisheries	Law 94, 1983	Land and water utilization for agriculture and fisheries.
	Kuwait Institute for Scientific Research (KISR)	1981	Applied water-resources research and development in cooperation with concerned authorities.
Oman	Water Resources Council and General Commission for Water Resources	Sultanate Decree 45/85, 1985; 63/79, 1979	Water planning and policy formulation. Assessment and approval of water projects, coordinating water activities. Approving water legislation and regulations and budget allocations for water studies and works. Manpower training and water data banking.
	Ministry of Electricity		Domestic water supply maintenance and operation, including desalination activities.
Qatar	Ministry of Electricity and Water		Domestic water supply maintenance, operation and the construction of relevant networks, including desalination facilities.
	Ministry of Municipal Affairs and Agriculture		Irrigation-water supply, well-drilling permits and ground-water monitoring and development.
Saudi Arabia	Ministry of Planning		Socio-economic development planning vis-à-vis water issues.
	Ministry of Agriculture and Water		Ground-water and surface-water exploration, development and conservation.
	General Corporation for Desalination		Water master planning and implementation, policy formulation, and waste-water treatment and distribution for agriculture. Construction, maintenance and operation of desalination plants.
United Arab Emirates	General Water Resources Commission	Law 21, 1981	Water planning, policy formulation, coordination of water activities and water-data collection.
	Ministry of Electricity and Water		Domestic water supply maintenance and operation and desalination activities.
	Ministry of Agriculture and Fisheries		Irrigation-water supply, and ground-water development, monitoring and investigation.

2. Non-conventional water resources

Because of their limited water resources and an overdraft situation which has resulted in reduced quantity and quality, many of the oil-producing countries have turned to the sea for their fresh-water supply. Considerable progress in desalination activities has been made in recent years.

The Gulf States are generally considered world leaders in non-conventional water-resources production, particularly in desalinating sea water and/or brackish ground water. Since the United Nations Water Conference, substantial progress has been made in desalination techniques, improving skilled manpower capabilities to maintain and operate desalination plants, and the progressive cost reduction of desalination per unit volume of water produced.

In Bahrain a long-term water-resources development policy is to produce distilled sea water and blend it with brackish ground water to bring the quality up to acceptable drinking water standards. At Sitra multi-stage-flash (MSF) desalination plant, water production was increased from 5 MCM in 1975 to 35 MCM in 1985. Brackish ground-water desalination using reverse osmosis (RO) also increased from 14 MCM in 1975 to 28 MCM in 1988. Figure IV shows Bahrain's development of desalinated water production as of 1980, and as projected up to the year 2000.

In Kuwait, about one million cubic metres are produced daily from five MSF desalination plants. Figure V shows the distilled and fresh-water production in Kuwait during the period 1954-1984.

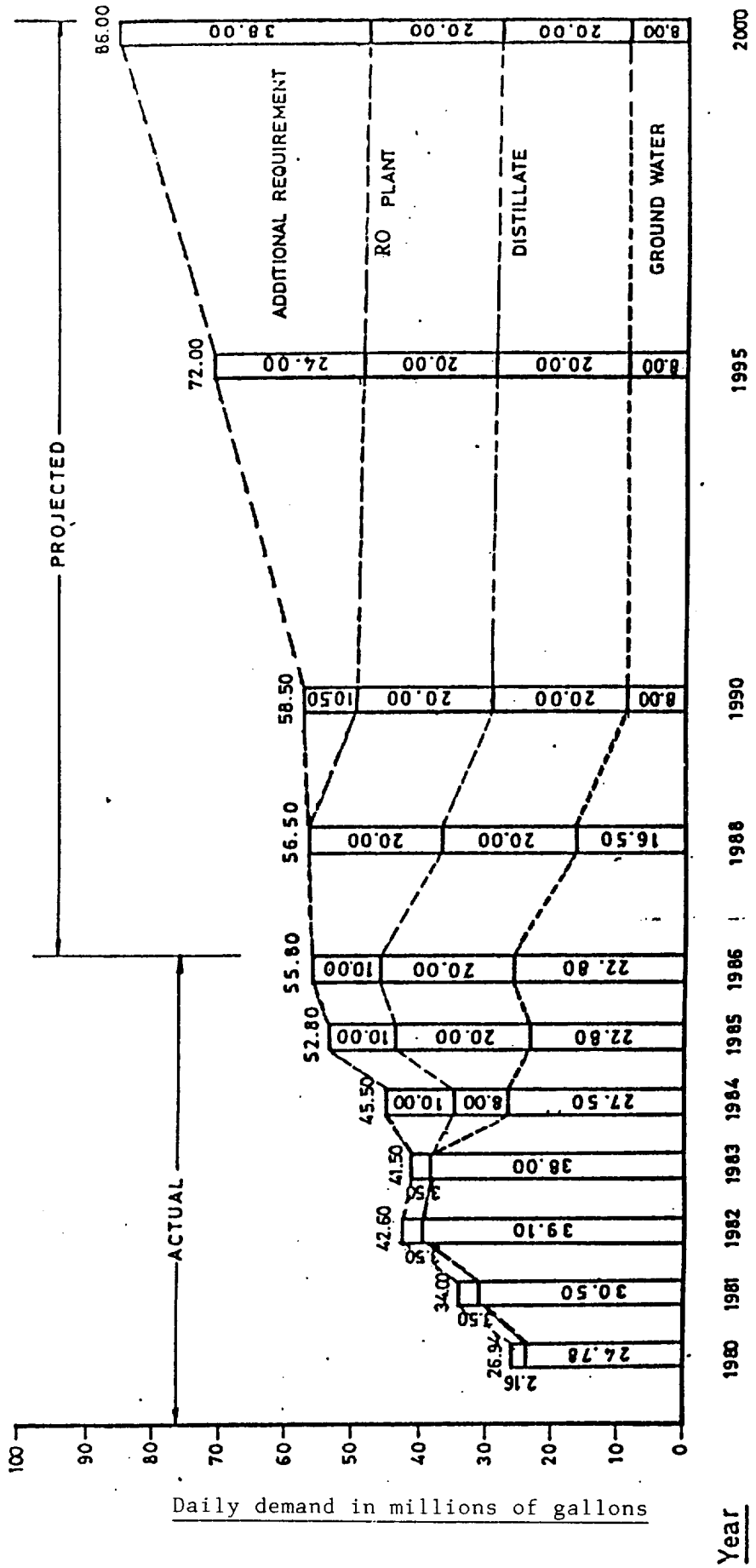
In Qatar, desalinated water production was estimated at 96 MCM in 1986.

In 1976, an MSF desalination plant with a capacity of 4.8-7.2 million gallons/day (Mgd) was constructed in the area of Oman's capital, Muscat. In 1982, a second MSF facility with the same capacity went into operation. In addition, two small brackish-water reverse-osmosis desalination plants have been constructed in Oman, bringing total current desalinated water production to about 20 MCM/year.

Because of the limited conventional supplies available, Saudi Arabia came to rely heavily upon desalinated water production to meet its increasing domestic water demand. Since the creation of the Saline Water Conversion Corporation in 1965, several MSF and RO desalination plants have been set up in the country. Saudi Arabia is considered first in world desalinated-water production (sea water and brackish ground water). The production rate is reported to be 930 MCM/year. Some of the water produced is piped 485 kilometres inland to the capital, Riyadh.

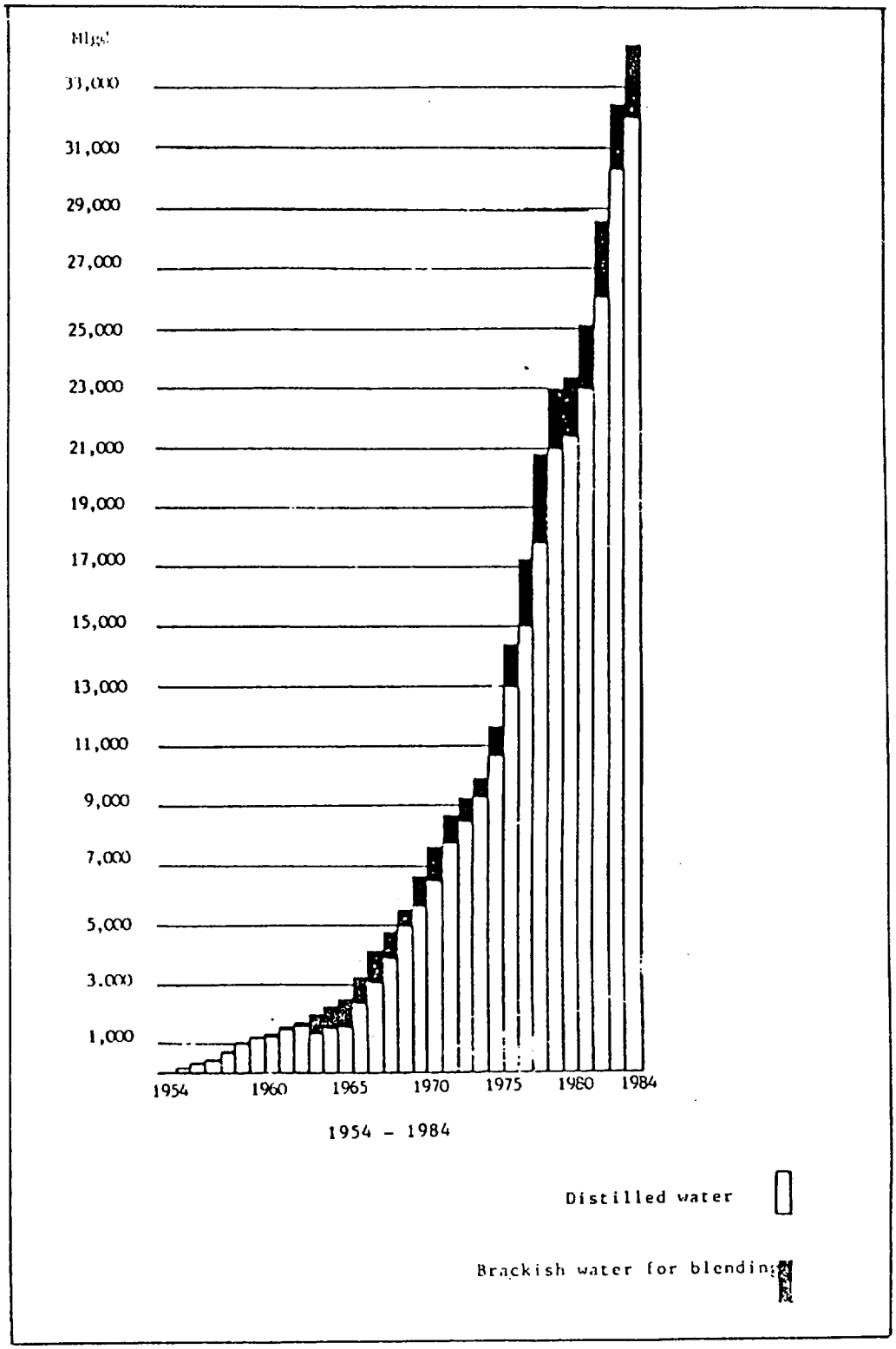
Sea and brackish ground-water desalination is considered a major water-supply component providing most of the domestic water requirements in the United Arab Emirates. Total desalinated-water production capacity is reported to be about 163 MCM/year at present.

Figure IV. Resources supply and demand in Bahrain, 1981-2000



Source: Data supplied by the Bahrain Ministry of Electricity and Water, 1986.

Figure V. Distilled and fresh-water production in Kuwait, 1954-1984



Source: Data supplied by the Kuwait Ministry of Electricity and Water.

In addition, treated sewage effluent reuse is widely practised in the Gulf States for restricted irrigation or public gardening.

In conclusion, non-conventional water-resources production in the GCC States has contributed substantially to meeting the countries' domestic, industrial and, to a certain extent, irrigation-water requirements. The national water resources (primarily ground water) in some member States are no longer potable and can hardly even be used to irrigate certain saline-water tolerant crops, due to excessive water-quality deterioration and sea-water intrusion into the coastal aquifers. Treated sewage effluent, which normally provides about 60 to 70 per cent of domestic water supply, has helped maintain agricultural production in some areas in the Gulf States.

IV. ACTIONS AND RECOMMENDATIONS

A. Recommendations at national levels

1. The State of Bahrain

(a) Expanding country-wide ground-water observation networks;

(b) Updating detailed hydrogeological investigations and drawing up a national water master plan; these should aim at meeting increased demand by developing potential usable ground water and increasing desalinated-water production, thus preserving the hydraulic state of equilibrium and alleviating sea-water intrusion.

2. The Arab Republic of Egypt

(a) Carrying out studies for the assessment of national ground-water resources, particularly in the eastern and western deserts and in Sinai;

(b) Improving agricultural water-use efficiency, presently reported to be low;

(c) Promoting irrigation projects that use ground water, surface water and drainage waters conjunctively in newly reclaimed lands;

(d) Considering measures to execute the Upper Nile water-conservation projects in cooperation with the countries sharing the Nile waters.

3. The Republic of Iraq

(a) Carrying out country-wide hydrogeological investigations to identify and develop potential ground-water resources, particularly in east, west and south-west Iraq;

(b) Giving priority to projects where the integrated use of surface and ground water is possible;

(c) Carrying out long-term hydrochemical investigations on the river waters to keep track of changes in water quality and behaviour. In particular, the objective should be to arrive at the optimum application of water in various sectors in order to alleviate salt accumulation in soils, ground water and river water, especially in southern Iraq.

4. The Hashemite Kingdom of Jordan

(a) Investigating the most economic and feasible ways and means for better allocation of the country's water resources, with consideration given to prioritizing and ranking purposes;

(b) Investigating the potential for desalinating the brackish ground water which exists on a considerable scale in the Jordan Valley and at depth in the eastern plateau using low-cost methods, for domestic and industrial purposes;

(c) Promoting the utilization of flood waters occurring in the desert areas through artificial ground-water recharge, diversion to other areas, or through local utilization in dry-farming projects;

(d) Executing additional projects where surface- and ground-water resources may be utilized in an integrated manner, in areas like the southern ghors and Wadi Araba.

5. The State of Kuwait

Making use of the sporadic floods to artificially recharge the Kuwait aquifers and improve the ground-water quality; because desalination plants would then start with better quality water, the cost of producing desalinated water out of brackish water would be reduced.

6. The Lebanese Republic

(a) Conducting detailed hydrogeological investigations to achieve a realistic understanding of the country's ground-water resources;

(b) Giving priority to integrated surface- and ground-water resources projects, particularly in the Beka'a area and the coastal plain;

(c) Developing and applying appropriate water regulations and legislation to conserve and administer the national water resources;

(d) Making use of the considerable quantity of flood waters and subsurface flows which are being lost annually into the Mediterranean.

7. The Sultanate of Oman

(a) Establishing hydrological and hydrometeorological networks as an initial step for a country-wide water-resources assessment programme;

(b) Conducting detailed hydrogeological investigations covering the whole of Oman for a better understanding of the country's water resources;

(c) Implementing artificial ground-water recharge projects and constructing dams to make use of the potential floods which often occur in the Batinah, Dhahira and Sharqiya areas, particularly to slow the rate of increasing overdraft conditions and flood hazards, as well as minimizing ground-water quality deterioration due to sea-water intrusion.

8. The State of Qatar

(a) Continuous monitoring of the ground-water level and water quality changes;

(b) Studying additional possibilities for making use of the sporadic floods to artificially recharge usable aquifers to help in overcoming overdraft conditions and sea-water intrusion in some peninsula localities;

(c) Updating and calibrating the constructed hydrogeological model to simulate aquifer conditions of the Peninsula to determine optimal ground-water withdrawal on a long-term basis and to show how much of the growing demand must be met by desalination.

9. The Kingdom of Saudi Arabia

(a) Establishing one central water authority to deal with all aspects related to water-resources exploration, development and management;

(b) Continuing to establish hydrological, hydrometeorological and ground-water observation networks for recording and observing water-related basic data;

(c) Undertaking periodic hydrochemical investigations to keep track of water-quality modifications in the major well fields in the country;

(d) Using sporadic floods in the Tehama Plain to recharge the alluvial aquifer in order to alleviate overdraft conditions.

10. The Syrian Arab Republic

(a) Drawing up a national water master plan to streamline and integrate the use of the country's water resources. The plan should involve detailed hydrological and hydrogeological investigations on a national scale so as to determine the optimum safe yield of the potential ground-water resources, to make use of all possible floods as presently planned, and for the better allocation and most economical use of water resources for various sectors;

(b) Centralizing and/or unifying the responsibilities of the existing water-related institutions into one body responsible for all aspects of the country's water-resources conservation, development and management;

(c) Reviewing the existing water legislation and widening its scope to include aspects pertaining to well drilling, ground-water extraction, protecting quality in areas such as the Euphrates Basin within the Syrian Arab Republic, and preventing the pollution of Barada River waters and others.

11. The United Arab Emirates

(a) Conducting detailed or updated hydrogeological investigations to arrive at a realistic understanding of the country's ground-water resources and the optimum safe yield;

(b) Establishing a ground-water-monitoring programme to define the water-level and quality variations to gauge the resources' response to exploitation.

12. The Yemen Republic

(a) Initiating a water-resources assessment programme as soon as possible in order to identify the quantity and quality of the country's water resources;

(b) Assisting the ongoing UNDP/DTCD High Water Council Project for the preparation of a national water master plan including:

(i) Establishing a comprehensive water-sector database, drafting appropriate water legislation and water laws, and establishing a country-wide monitoring system for water-data collection;

(ii) Establishing efficient institutional arrangements to implement the plan;

(c) Controlling ground-water abstraction in areas experiencing serious depletion and quality deterioration;

(d) Developing skilled-manpower capabilities in all water fields;

(e) Taking measures to protect the ground-water reservoirs from pollution, particularly in Sana'a Basin;

(f) Updating previous water-resources investigations carried out in some localities to arrive at a more realistic understanding of the country's water resources;

(g) Investigating the possibility of carrying out artificial ground-water-recharge projects to make use of the sporadic flood waters in major valleys such as Tuban, Abyan, Hajor and others, to alleviate the overdraft conditions in these areas. If these overdraft conditions are not dealt with, conditions will steadily worsen, so these projects should be given priority.

B. Proposed subregional and regional actions and recommendations

Some of the major surface- and ground-water basins in the region extend beyond national boundaries. Actual knowledge regarding national water resources, including the shared resources, varies from one country to another. Many investment projects and other efforts can be more effectively undertaken if the concerned countries develop these shared resources more cooperatively. The major shared basins are described below.

1. Ground-water basins

The following are the major shared aquifers occurring in the region.

(a) The Palaeozoic-Mesozoic sandstone aquifer is best represented in Saudi Arabia, Jordan, Kuwait, Bahrain, Qatar, the United Arab Emirates, Oman and Yemen. In Saudi Arabia there are several known members of this sandy aquifer, including Saq, Tabuk, Wajid, Minjur and Wasia-Biyadh. The last member is the most important aquifer member in the Eastern Province of the country.

In Yemen the aquifer is known as Mukalla, and extends to Rub-Al-Khali (the Empty Quarter) and Ramlet Al-Sabatyn.

(b) Carbonate rock aquifer comprises three different groups:

(i) The Dammam/Um Al-Radhuma limestone complex (Palaeocene-Eocene Tertiary) occurs in Saudi Arabia, Kuwait, Bahrain, Qatar, the United Arab Emirates, Oman and Yemen.

(ii) Carbonate rock aquifers belong to Upper Cretaceous-Palaeocene time period and occur in the Hamad Basin in Jordan, Saudi Arabia, Iraq and the Syrian Arab Republic. This group is also represented by the Aruma and Um Al-Radhuma aquifers in eastern Saudi Arabia.

(iii) Jurassic-Cretaceous-karstic limestone and dolomite aquifers occur mainly in Lebanon, the Syrian Arab Republic and Jordan, in the highlands (the uplifted blocks) that border the Rift Valley system on both sides. The aquifer is of great importance in all sharing member countries as it feeds most of the large springs occurring in the area, with generally regular flows.

The primary reasons for investigating the above-mentioned shared major aquifers are:

(a) To delineate each aquifer's areal extent, potential, storage capacity and its dependability vis-à-vis space, time and quality;

(b) To study the possibility of trapping or capturing the water flowing to the sea, to waste, from some of the aquifers mentioned above. The Dammam/Um Al-Radhuma aquifer complex is experiencing a high rate of waste and quality deterioration through submarine flow into the Gulf area in Bahrain, Qatar, the United Arab Emirates and to the east and west of Saudi Arabia. Mesozoic karstic carbonate in Lebanon and the Syrian Arab Republic aquifer have proven to have similar wasted, submarine flows into the Mediterranean Sea. The same aquifer is experiencing quality deterioration and/or drainage by subsurface flow into the brackish ground-water reservoir in the Jordan Valley depression;

(c) To formulate and execute plans of action to develop potential water resources in the shared aquifers, from which more than one member country can benefit through fairly planned joint development schemes;

(d) To make consistent the status of hydrogeological investigations carried out on those aquifers and to fill in the gaps in these studies;

(e) To initiate plans and programmes for joint future monitoring, data updating and development of these aquifers.

2. Surface-water basins

The following are the major shared water-basins.

(a) The Euphrates and Tigris river basins are international river basins which Iraq and the Syrian Arab Republic share with Turkey, in the case of Euphrates River, and with Turkey and Iran in the case of the Tigris. The Euphrates River has a catchment area of about 444,000 km^2 within Iraq, Syrian Arab Republic and Turkey, while the Tigris River has a catchment area of about 471,606 km^2 within Iraq, the Syrian Arab Republic, Iran and Turkey. The mountain regions within the neighbouring non-ESCWA member countries contribute substantially to the river flows. The four sharing countries have already constructed several hydraulic structures on the rivers to regulate floods, for power production or to implement irrigation schemes. These projects were executed at national levels to satisfy each country's objectives. Comprehensive river basin development may not be achieved without effective cooperation between the sharing countries;

(b) The Yarmouk River Basin has a catchment area of about 7,250 km^2 in the Syrian Arab Republic and Jordan. The average annual flow is in the order of 425 MCM/year. Jordan and the Syrian Arab Republic are actively engaged at present in executing a joint project to construct the Maqarin Dam on the Yarmouk River to make use of the river flows for irrigation and power production.1/ A joint commission composed of government experts was recently appointed to supervise the execution of the project;

(c) The Orentis and south Al-Kabir river basins are shared by the Syrian Arab Republic and Lebanon. The Orentis River (about 512 MCM/year) flows into the Mediterranean Sea after crossing the fertile areas in northern Beka'a (Lebanon) and the Ghab Plain (the Syrian Arab Republic).2/ Several hydraulic structures, such as Homs Lake and the Rostan and Muharradah dams, have been constructed to regulate the flow of the Orentis River in the Syrian Arab Republic.

Al-Kabir River has an average annual flow of 190 MCM/year;3/ a joint project is being investigated between the Syrian Arab Republic and Lebanon to make use of southern Al-Kabir River waters to irrigate the Akkar Plain in both countries.4/

1/ Syrian Arab Republic, Ministry of Irrigation, "Water resources of the Syrian Arab Republic", (in Arabic) by S. Safadi (Syrian Arab Republic, 1979) pp. 31, 32.

2/ Lebanon, Ministry of Water and Electricity, "The water situation in Lebanon", by J. Sharaf-Eddin (Lebanon, 1971), table 5 (in Arabic).

3/ Lebanon, Ministry of Water and Electricity, "The water situation in Lebanon", by J. Sharaf-Eddin (Lebanon, 1971), table 2 (in Arabic).

4/ Syrian Arab Republic, Ministry of Irrigation, "Water resources of the Syrian Arab Republic", (in Arabic), by S. Safadi (Syrian Arab Republic, 1979) p. 37.

(d) The Wadi Tuban, Wadi Bana and Wadi Beihan watersheds are non-perennial streams originating from the high-rainfall zones in Yemen, from where they debouch into the Gulf of Aden. Neither the available nor the potential surface- and ground-water resources are well defined or developed. Developing these basins might be best attained through integrated joint development plans. The ongoing AFESD/UNDP/DTCD Joint Yemen Project on Natural Resources is presently involved in formulating such plans.

Cooperation and coordination in the development and management of the above-mentioned shared watersheds and river basins would be extremely beneficial. The ultimate goal of shared basin development is the execution of a comprehensive and multi-faceted plan dealing with measures to ensure rational development, utilization and conservation of the water resources, taking into account the socio-economic factors prevailing in the concerned member countries.

In order to reach agreement on joint actions for shared basin development, negotiations should be conducted. In these discussions, the upstream country might seem to be in a very strong negotiating position, but one must consider the whole field of relations among the countries involved; if one country abuses its water position, it may well suffer in its relations with the neighbouring countries in another field such as trade affairs. It is clearly vital that the negotiations should be conducted in a spirit of regional cooperation, possibly resorting a neutral country and/or a knowledgeable team of experts to suggest what would be equitable and beneficial for all countries concerned.

Considering the previous points, it is recommended that the following actions be considered by the involved member countries to develop their shared surface- and/or ground-water resources:

(a) Setting up joint advisory steering committees responsible for the coordination, follow-up and exchange of information regarding watershed investigations. These committees would be composed of representatives of the Governments concerned;

(b) Forming national teams of experts to operate collectively, where possible, to standardize and establish basic technical data on all relevant watershed parameters. Representatives of these national teams delegated by their Governments should be members in the steering committees mentioned above;

(c) Formulating joint programmes for the following: basic data collection, inventory and publication; required mapping; appraisal of existing projects; training requirements and facilities; research and its execution, basin development and management; and the design and execution of relevant pilot projects of common interest;

(d) Sponsoring necessary studies and research, with the help of international agencies and other bodies as appropriate, to compare and analyse the institutions currently managing and developing the shared basins;

(e) Formulating subregional plans and designs, including alternative water-resources development schemes and allocation policies;

(f) Undertaking efforts at the subregional level, under the leadership of oil-producing countries and other interested member or non-member countries, to initiate research programmes dealing with a wide spectrum of topics related to the use and production of non-conventional water resources, in order to make these techniques available to those with financial constraints and limited water resources. Such topics (among others) are:

(i) Exploration of non-conventional energy sources to be used in desalination plants, especially in non-oil producing countries;

(ii) Continued research to reduce the cost of tertiary and advanced waste-water treatment processes;

(iii) Continued research to develop new techniques to reduce the cost of present desalination techniques, with particular reference to the treatment of brackish ground water;

(g) Offering aid (possibly from international organizations) to countries with financial constraints for schemes to develop non-conventional water resources;

(h) Directing efforts towards the establishment of a joint river basin for the major river basins in the region as appropriate and in full agreement with the concerned member Governments. This kind of authority has proven to be very efficient in other regions. It would provide the basis for cooperation, coordination and monitoring of all areas related to water-resources development in a sound and comprehensive manner for the benefit of all countries involved;

(i) Carrying out the main duties of this proposed authority, which at least at the initial stages, would be concerned with all basic data collection, processing, analysis, interpretation, evaluation and fact-finding.

Annex I

QUESTIONNAIRE FOLLOWED DURING THE MISSION

The questions mentioned below will provide guidelines and pertinent information on the recent developments and activities undertaken within the ESCWA region towards the implementation of the Mar del Plata Action Plan, particularly with respect to the building and arrangement of institutions, long-term water planning, water-legislation and environmental protection measures. Case-studies may then be described to reflect water-resources development, management and conservation.

1. Information regarding water-related agencies and institutions in the region.

(a) Name of the water institution (governmental or non-governmental);

(b) Organizational chart;

(c) Mandate and territorial coverage;

(d) Linkage with other water institutions and economic and financing organizations;

(e) Number of staff (high- and medium-level) engaged in water-resources programmes.

2. Major projects implemented or being implemented in the country.

(a) Brief description of the project;

(b) Beneficiaries (urban, rural) and percentages;

(c) Socio-economic impacts of the project(s):

Rural and/or urban areas
Agriculture and food production
Industrial water use
Others

(d) Technical activities and/or methodologies or techniques encompassed in the projects executed:

Water-resources evaluation
Project formulation
Project execution
Operation and maintenance
Management and planning
Others

(e) Management activities are encompassed by the project(s):

Definition of policies and legislation
Water-resources planning
Technological development
Technical assistance and training
Information systems and database
Coordination of and cooperation in activities
Others

3. Criteria or factors dictating priorities of water-resources projects among various development sectors in each country in the region;

4. Legislative measures and regulations to improve water resources management, administration and conservation;

5. Measures to control environmental impacts on national surface and/or ground-water resources;

6. Training facilities existing in the country to improve manpower capabilities, particularly for multi-disciplinary water-resources planning;

7. Information regarding the existing water database or data banking (hardware and software packages and skilled manpower involved);

8. Information regarding any activities carried out or planned for multi-purpose water-resources development for the shared surface- and/or ground-water basins.

Annex II

PROGRESS ACHIEVED IN WATER-RESOURCES DEVELOPMENT PROJECTS SINCE THE UNITED NATIONS WATER CONFERENCE (ESCWA REGION)

1. The forthcoming annex presents brief accounts of the progress made in water-resources development projects in the ESCWA region, on a country-by-country basis, since the United Nations Water Conference. The sources of information are:

(a) Replies to questionnaires sent to ESCWA member States, from 1982 to 1985;

(b) ESCWA, "Major water related activities in the ESCWA region as of 1975";

(c) ESCWA, "Activities of governments and international agencies in the field of water resources within the ESCWA region", E/ESCWA/NR/86/4;

(d) UNDP, Compendium of Approved Projects, serial issues from 1979 to 1988;

(e) World Water, issues from 1980 to 1985;

(f) Middle East Economic Digest (MEED), issues from 1980 to 1989;

(g) Arab Fund for Economic and Social Development (AFESD), Annual reports from 1980 to 1984.

2. The projects listed in tables 1 to 13 are not necessarily the only projects implemented or ongoing in the region; others may have been implemented in the region but not shown in the tables due to the lack of adequate data.

(a) In Bahrain, water-resources development projects aim at providing safe water and sanitation to all the inhabitants of the island. In recent years, as ground-water resources have been over-exploited, emphasis has been placed on providing potable water through desalination; numerous such projects have been executed to provide safe water for all. Sewerage projects have also been executed, an example of which is the master plan for Bahrain sewerage, which aims to provide safe sewage disposal and treatment for the entire population by the year 2000. Finally, treated effluent is being used for agriculture in order to conserve ground water;

(b) Egypt's main water resource is the Nile, the flow of which is regulated by the Aswan High Dam. The rapidly growing population puts a strain on the available water resources, as well as on the provision of sanitation services. Therefore, quite a number of water-resources project in Egypt concentrate on providing safe water and sanitation to an ever-growing population. As water becomes even more scarce, attention is also being placed on conserving water through, for instance, better irrigation techniques such as reusing drainage water to increase the irrigated area.

An example of a typical project for Egypt is the Master Plan for Water Resources Development and Use, Phase III, which is being executed by several cooperating agencies such as, in this case, UNDP, the United States Agency for International Development (USAID) and the Government. The project aims at optimizing the development and utilization of Egypt's water resources for irrigation, municipal and industrial uses, hydro-power production and flood control on a national scale;

(c) The Tigris and Euphrates rivers are Iraq's major sources of water, and together provide 67,500 MCM/year. Ground-water resources exist but are not fully developed.

Iraq's major water projects have concentrated on providing drinking water and sanitation to all urban and rural areas. Emphasis has also been placed on water-conservation projects such as constructing dams which are also used to generate hydroelectricity and improve agricultural land through better management, drainage and irrigation practices;

(d) Ground and surface water are the main sources of water in Jordan. A total of 220 MCM of ground water and 480 MCM of surface water is available annually. Water-resources projects have concentrated on ground-water development, water-supply and sanitation projects for urban and rural areas, and waste-water reuse and irrigation;

(e) Kuwait has both conventional and non-conventional water resources. The ground-water potential of Kuwait is estimated at 150 MCM/year. Kuwait also has a highly developed sea-water and brackish ground-water desalination system which provides the main source of water supply in Kuwait. Recycling of sewage water is also used, though mainly for irrigation.

Kuwait's water-resources projects concentrate mainly on the construction of desalination plants and distribution systems for sanitation and to ensure safe water.

Kuwait has been a pioneer among the Gulf States in the use of desalinated water;

(f) Lebanon has abundant water resources amounting to 3,375 MCM/year of surface water and 400 MCM/year of usable ground water. Due to the prevailing instability in Lebanon, projects have been limited;

(g) Ground water is the major source of water in Oman; surface water contributes to ground-water recharge. The estimated volume of ground water available is 650 MCM/year. Non-conventional water resources in the form of desalinated water are also used.

Most of the water-sector projects focus on water-resources development, ground-water conservation, and water-supply and sanitation schemes;

(h) Ground water is the major water resource in Yemen, especially for domestic and agricultural uses.

Most of the water-resources projects to date have concentrated on providing potable water to both urban and rural areas; integrated development projects for various water resources in the country have also been designed to improve agricultural production and conserve water through improved irrigation practices;

(i) Qatar's main water resource is ground water; surface-water resource amounts are insignificant. Most of Qatar's drinking water is supplied through desalination. Ground-water resources are fully utilized, and treated sewage effluent is used mainly for irrigation.

Most of the major water-resources projects have concentrated on desalination, ground-water development and conservation, and supplying drinking water and sanitation to all of Qatar's population;

(j) Ground- and surface-water resources in Saudi Arabia are limited and do not meet the demand; numerous desalination plants were therefore installed to meet the demand for drinking water. Some ground water and surface water is utilized for agricultural purposes.

Projects in the Kingdom have concentrated on evaluating the ground-water potential, implementing water-supply and sanitation projects (including desalination plants), providing safe water for the entire population and executing several dam projects;

(k) The Syrian Arab Republic has large surface-water resources from rivers such as the Euphrates and Al-Assi, and from springs; the total is estimated at around 33.7 MCM. Most of the water used in the Syrian Arab Republic is derived from surface water.

The country's potential for ground-water resources development is still being studied.

Because the Government gives high priority to the water sector, numerous projects have concentrated on developing and conserving surface water through constructing dams and reservoirs, water-supply projects which aim to provide safe water to the greatest number of people, and ground-water development projects, as well as strengthening manpower in the water sector;

(l) There are limited surface-water resources in the United Arab Emirates. Ground water is found in the top carbonate aquifer but is not sufficient for the country's needs. The ground-water storage volume is 5,200 MCM, with an estimated annual recharge of 100 MCM.

Desalinated sea water is extensively used to augment ground-water supplies; it is also mixed with ground water to meet WHO standards for domestic consumption.

Most of the projects in the country have concentrated on the construction of desalination plants and on providing safe water and sanitation facilities;

(m) Ground water is the main water resource in Yemen; however, reliable data are not available to judge exactly how extensive these resources are.

Over-use in certain areas has resulted in quality deterioration. There is little or no legislation controlling the use of ground water.

There is a need, therefore, for water-resources management, particularly in the area of conjunctive use of ground- and surface-water resources. One of the more important projects in Yemen at the moment is one involving United Nations assistance to the High Water Council for establishing a technical secretariat and preparing a water master plan.

Annex table 1. Bahrain's water-resources development projects executed between 1980 and 1985

No.	Project name and objectives	Start and end dates	Executing agency	Funding source	Funds (Millions of dollars)	Socio-economic impact	Remarks
Non-Conventional							
1.	Developing water resources by constructing desalination plants						
	Construction of desalination plants, at 45 MGD capacity, undertaken as Bahrain ground-water resources deteriorated	1982-1986	Governmental	Governmental Abu Dhabi Saudi Arabia	217.5 39.8 45.1	Providing 436,000 people in Bahrain with adequate water supply	
2.	Tubli sewage treatment plant						
	Construction of treatment plant	1978-1984	Governmental	Governmental	30.0	Better health conditions	
	Sewerage network					Sparing ground water by using treated effluent for agriculture	
3.	Master plan for Bahrain sewerage						
	Sewerage design to cater for projected population in the year 2000	Started in 1982	Governmental	..	..	Better health conditions	
4.	Providing seven-expert team on irrigation projects for six months	..	Governmental	ADFAED[a/]	..	Strengthening manpower	
5.	Extension of the Sitra power and water station						
	To increase capacity from 5 MGD to 20 MGD	Expected completion by 1985	Governmental	Governmental	133	Providing adequate drinking water to meet excessive demand	
6.	Urgent village water works programme	June 1977-1982	Governmental	..	..	Providing water distribution systems out of distillate production for twelve groups of villages	

a/ Abu Dhabi Fund for Arab Economic Development.

Annex table 2. Egypt's water-resources development projects executed between 1980 and 1985

No.	Project name and objectives	Start and end dates	Executing agency	Funding source	Funds (Millions of dollars)	Socio-economic impact	Remarks
Conventional							
1.	Master plan for water-resources development and use, Phase III; and implementation of planning and management system						
	The first two phases of this master water planning project helped establish a database, mathematical models, planning procedure on national water use and development plans, and established the function of water planning as a permanent and important governmental function	Completed in 1987	UNDP Governmental	UNDP USAID Governmental	0.35 4.3 0.513	Optimizing development and utilization of Egypt's water resources for irrigation, municipal and industrial uses, hydro-power production and flood control in the whole country	
2.	Egypt water-use and management project						
	Data collection Farm management surveys Comparative analysis and feasibility studies Economic studies for different irrigation improvements	Completed 31 December 1984	Governmental USAID	Governmental USAID	2.07 2.3	Improving social and economic conditions of small farmers in Egypt through development of improved irrigation, water management and associated practices which increase agricultural production, promote efficient water use, and decrease drainage problems	
3.	Damietta earthfill dam						
	Construction of earthfill dam for storage and irrigation	..	Governmental	Governmental Italy	16.8 9.6	Irrigation and drainage Improving river transport	
4.	Support to IDWSSD[a/]	Until 1985	Governmental WHO UNICEF[b/]	UNDP WHO	0.183 0.100 0.100	Improving health conditions	
5.	Hydraulic institute	1985	UNDP Governmental	UNDP	0.81	Strengthening manpower by providing training on hydraulic structuring	

Annex table 2. (continued)

No.	Project name and objectives	Start and end dates	Executing agency	Funding source	Funds (Millions of dollars)	Socio-economic impact	Remarks
6.	Flood protection in Upper Egypt	1985	UNDP Governmental	UNDP	0.016	Preventing drainage problems by flood control	
7.	Watershed management (Al-Kasr)	Until 1985	Governmental	UNDP	0.542	Watershed management	
8.	Irrigation schemes						
	Constructing irrigation schemes in Ismailiya, Qattarn Sharkiya	..	..	World Bank	68.0	Irrigation	
9.	Fifth drainage project						
	Carrying out agricultural drainage work on 190,000 hectares, mostly in the drainage basins around the Nile Delta	..	Governmental	Governmental	130.0	Improving agricultural conditions	
10.	Al-Adia agricultural project in the Delta						
	Installation of a series of eight pumps with a flow rate of 1,000 litres/second	Completed in 1985	Local	..	..	Irrigation of 60 hectares	
Non-Conventional							
1.	Sanitary drainage system						
	Installation of potable-water waste-water system	..	Governmental	USAID	79.4	Improving health conditions	
2.	Beheira water-supply project						
	Installation of potable-water treatment plant for removal of manganese and iron from ground water	..	Governmental	World Bank	..	Improving water quality	
3.	Greater Cairo Waste-Water Project (Phase I)						
	Construction of waste-treatment plant	1986	Governmental United Kingdom	USAID ..	1.214 ..	Providing sanitation services in Cairo	
	Construction of pumping stations for water reuse		Governmental	..	..		

Annex table 2. (continued)

No.	Project name and objectives	Start and end dates	Executing agency	Funding source	Funds (Millions of dollars)	Socio-economic impact	Remarks
4.	Waste-water facility construction in the canal cities						
	Installation of waste-water systems in the Canal cities	..	Governmental	USAID Governmental	40.0	Improving health conditions by providing adequate sanitation	
5.	Helwan waste-water project						
	Construction of waste-water plant	..	Governmental	EEC[c/]	41.0	Improving health conditions	
	Sanitation services to south Cairo towns, from Maadi to Al-Tabin			Netherlands	..		
	Irrigation of 9,500 hectares						
6.	Ground-water survey and assessment of drainability and reclamability of south Hussaniya-lake Manrole area	1985-1986	Governmental	UNDP Governmental	0.255 0.047	South Hussaniya ground-water survey	
7.	Rehabilitation and improvement of water-delivery systems in old lands	1986-1989	Governmental	World Bank Governmental	1.93 0.27	Irrigation	
8.	Assistance to the Water Research Centre umbrella project	1987-1991	Governmental	UNDP Governmental	1.03 0.52	Improving water management	
9.	Technical assistance for the maintenance and operation of electro-mechanical systems in irrigation schemes	1988-1992	Governmental	World Bank Governmental	0.15 0.45	Improving irrigation	
10.	Greater Cairo drinking water project	1978	General Organization for Greater Cairo Water Supply	FRG[d/] USAID Japan	.. .. ..	Providing safe drinking water	

a/ International Drinking Water Supply and Sanitation Decade.
b/ United Nations Children's Fund.
c/ European Economic Community.
d/ Federal Republic of Germany.

Annex table 3. Iraq's water-resources development projects executed between 1980 and 1985

No.	Project name and objectives	Start and end dates	Executing agency	Funding source	Funds (Millions of dollars)	Socio-economic impact	Remarks
	Conventional						
1.	**Karkh water-supply project, 1st stage**						
	Installation of head works with 300 MGD capacity	15 July 1981-15 May 1985	Governmental	Governmental	410.0	Supplying water to 2.5 million people in Karkh; this project is considered part of the complete water-supply system of Baghdad	
	Installation of twin 2-3 m diameter ductile pipe						
	Construction of four ground-storage tanks and installation of 200 km of ductile pipes of 1,600-3,000 mm diameter						
2.	Baghdad networks						
	Transportation and distribution of treated water from the treatment works to the proposed ground storage	1 May 1981-1 December 1984	Governmental	Governmental	1123.0	Delivering water to 5.5-6 million people in Baghdad by the year 2000	Part of the overall Baghdad water supply plan to the year 2000
3.	Abu-Ghreeb agricultural project, Phases 3 and 4						
	Irrigation of 273,000 ha by six canals taking water from the Euphrates	..	Governmental	Governmental	111.7	Providing agricultural products to Baghdad	One of Iraq's largest food-production schemes under implementation
	Regional plan covering farm development, electrification, domestic water supply, and village construction						
4.	Mosul Dam						
	Dam construction 3,000 m long, 100 m high, with 13 BCM reservoir storage capacity	April 1981-1985	Governmental	Governmental	2500.0	Flood control and water storage; providing water for irrigation for Jazira project	One of the largest dams in Iraq
	Construction of three hydroelectric-power stations					Providing electrical power of 1,010 MW for tourism and fisheries	

Annex table 3. (continued)

No.	Project name and objectives	Start and end dates	Executing agency	Funding source	Funds (Millions of dollars)	Socio-economic impact	Remarks
5.	Haditha Dam project						
	Reservoir with 8.2 BCM storage capacity Generating 660 MW of electric power	June 1981-end of 1985 (expected)	Governmental	Governmental	35.0	Flood control storage, electricity and tourism	
6.	Bakeme Dam (design)						
	A multi-purpose dam with power generation of 2,500 MW, impounding 8.3 BCM	..	Governmental	Governmental	3,000.0		Expected to be completed within six to seven years
7.	Saddam irrigation project, Phase I						
	Irrigating 350,000 dunums by installation of 67-km lined main canal and 265-km sub-mains of asbestos pipes	Completed 4 November 1983	Governmental	Governmental	..	Seven new villages each comprising 577 houses, a new road network, four experimental research farms, and remote control of operation system	
8.	Northern Jezira irrigation project						
	Irrigating 240,000 dunums Installating underground pumping station Providing sprinkler irrigation system for 400 dunums	Completed April 1985	Governmental	Governmental	74.0	Expanding agricultural land and providing new incomes to more families	North Jazira is one of three linked irrigation areas around Mosul in the north
9.	East Jazira irrigation project, Phase II						
	Irrigating 74,000 ha Constructing 220 km of water channels and several pumping stations	..	Governmental	Governmental	..	Increasing agricultural production and national income	First phase has been completed
10.	Khazim Gonnel irrigation hydroelectricity project, Phase II						
	Designing project to irrigate 25,000 ha Generating electricity	..	Governmental	Governmental	..	Expanding agricultural land and increasing national income	

Annex table 3. (continued)

No.	Project name and objectives	Start and end dates	Executing agency	Funding source	Funds (Millions of dollars)	Socio-economic impact	Remarks
11.	Amara irrigation scheme						
	Developing an integrated agricultural system over a total area of 284,000 ha	Completed December 1981	Governmental	Governmental	..	Increasing agricultural land and national income	
12.	Sulaimaniya irrigation scheme	..	Governmental	Governmental	2.0	Increasing national income	
13.	New Rumaitha irrigation drainage scheme						
	Irrigation scheme for 37,500 ha Planning a farm and cropping programme Livestock, dairy and agro-industry	Started 1981	Governmental	Governmental	650.0	Increasing national income	
14.	Kirkuk water-supply system						
	Supplying and installing 330,000 ton/day water-treatment plant	..	Governmental	Governmental	110.0	Better health conditions by providing adequate water supply	
15.	Baiji water-supply system						
	Constructing a 15 MGD treatment plant to meet Baiji's requirements until the year 2000	..	Governmental	Governmental	19.5	Providing adequate water supply	
16.	Ramadi water-supply scheme						
	New water supply network scheme to cover Ramadi province	..	Governmental	Governmental	33.0	Improving and renewing water-supply network	
17.	Basrah water-supply scheme						
	Suspended due to war conditions	..	Governmental	Governmental	..	Providing potable-water supply	
18.	Hilla water-supply scheme	..	Governmental	Governmental	33.0	Providing drinking-water supply	
19.	Tel Afar water-supply scheme						
	New water-supply network scheme to cover Tel Afar area	..	Governmental	Governmental	44.0	Improving and renewing water-supply networks	

Annex table 3. (continued)

No.	Project name and objectives	Start and end dates	Executing agency	Funding source	Funds (Millions of dollars)	Socio-economic impact	Remarks
20.	Sulaimaniya water-supply scheme						
	Pumping water from lesser Zab River some 70 km to town	..	Governmental	Governmental	..	Providing drinking-water supply	
21.	Dohouk water-supply scheme	..	Governmental	Governmental	30.5	Providing drinking-water supply	
22.	New Hindiya barrage						
	Replacement of old Hindiya Barrage to ensure flow of water through irrigation canal	..	Governmental	Governmental	..	Economic impact on the middle and southern provinces along the Euphrates	
23.	Falluja barrage						
	Ensuring the flow of water through irrigation canals by gravity	1 September 1977-11 February 1985	Governmental	Governmental	..	Broad economic impact expected	
24.	Construction of four barrages on Kufa and Suleimaniya canals						
	Constructing control structures for irrigation	Started January 1984	Governmental	Governmental	..	Broad economic impact expected	
Non-Conventional							
1.	Tigris-Euphrates main outfall drain (MOD), second stage						
	Collects the drainage water from the middle and southern regions of the country and releases it into the Arabian Gulf; will act as the main collection for about 1.5 million ha	First stage completed (date not available); second stage expected to be completed in 1986	Governmental	Governmental	670.0	Immense impact on agricultural products is expected from this project; fresh-water fish and shipping are also expected to benefit from the scheme; a series of navigation locks has also been planned to allow ships of up to 2,000 tons to travel as far as Nasiriya	MOD is know as the country's third river

Annex table 3. (continued)

No.	Project name and objectives	Start and end dates	Executing agency	Funding source	Funds (Millions of dollars)	Socio-economic impact	Remarks
2.	Basrah sewerage scheme, Phase III Extending treatment plant to serve an additional 600,000 people Installing pipe networks for over 2,000 ha	Started 16 January 1984	Governmental	Governmental	120.0	Better health conditions	The first two phases have been completed. The first phase included the main treatment plant: 6.1 km trunk, four large pumping stations and a pipe network. The second phase consists of four pumping stations, rain-water drainage and a network of pipes from two other districts in Basrah

Annex table 4. Jordan's water-resources development projects executed between 1980 and 1985

No.	Project name and objectives	Start and end dates	Executing agency	Funding source	Funds (Millions of dollars)	Socio-economic impact	Remarks
Conventional							
1.	Water supply from Azraq to Amman						
	Drilling wells in Azraq area	Completed 1982	Governmental	Governmental	31.415	Providing adequate water supply to 560,000 people in Amman	
	Constructing water reservoirs and required pumps						
	Installing 110-km length of 24 in. pipline						
2.	Southern Ghor water-resources project, Phase II						
	Agricultural development of the Southern Ghor by: Diversion weir construction in Wadi Al-Mujib	Completed 1985	Governmental	Governmental	17.3	Increasing agricultural land and national income	
	Irrigation of 4,000 ha through 3,500 m-long canal				26.0		
3.	Desert dams						
	Recharge of ground water by: Constructing two earthfill dams in the north-east desert	Completed 1985	Governmental	Governmental	1.5	Providing scattered villages with adequate water and better health conditions; serving bedouin and encouraging them to settle	
	Maintenance of old dams						
4.	Sultana and Qatrana dam maintenance						
	Improving storage capacity by maintenance of the two dams	Completed 1985	Governmental	Governmental	0.605	Recharge of ground water (used by nomadic bedouin for their drinking water and cattle)	
5.	Ground-water development project in the Jordan Valley						
	Drilling exploration and production of 11 deep-water wells (300-1,200 m depth) in Jordan Valley to provide adequate water supply and surplus water for irrigation	Completed 1983	Governmental	Governmental USAID	7.4 2.44	Providing adequate water supply and better health conditions to different villages in the Jordan Valley; surplus water is pumped to East Irrigation Canal to irrigate additional agricultural land	

Annex table 4. (continued)

No.	Project name and objectives	Start and end dates	Executing agency	Funding source	Funds (Millions of dollars)	Socio-economic impact	Remarks
6.	Wadi Araba irrigation project						
	Increasing agricultural land by installing irrigation network to irrigate 180,000 dunums	Completed in 1985	Governmental	Governmental USAID	6.0 15.0	Increasing agricultural land, improving irrigation practices and increasing national income	
7.	Ground-water drainage project						
	Drainage system construction for salty land in the Jordan Valley and Wadi Araba	Completed in 1985	Governmental	Governmental USAID	4.375 4.375	Improving soil and agricultural conditions	
8.	Water-transfer scheme from the East Ghor Canal to Amman						
	Increasing the availability of the water supply to Amman by conveying 45 MCM of water from Deir Alla to Amman by pumping canal water through a 1,200 m head	Phase I completed in 1985	Governmental	Governmental USAID AFESD Saudi Fund for Development	52.2 24.5 25.0 31.3	Providing a permanent source of water to Amman/Zarqa and Ruseifa from the East Ghor Canal	
9.	Euphrates pipeline project						
	160 MCM of water conveyance from the Euphrates to Al-Zaatary area in north Jordan to increase the available water supply for Amman	..	Governmental	Governmental	100.0	Providing Amman with additional water supply	
10.	Wadi Al-Arab irrigation system-Shuna						
	Conveying water from the dam to irrigate 1,250 ha in north Shuna using drip and sprinkler irrigation systems	..	Governmental	Governmental Japan	18.0	Increasing cultivated land and national income; improving irrigation practices	
11.	Raising the height of King Talal Dam						
	Increasing amount of cultivated land by raising the height of the dam to increase reservoir storage from 56 to 76 MCM	Completed in 1985	Governmental	Governmental USAID Kuwait	1.97 18.28 39.10	Increasing cultivated land in the Jordan Valley by adding 8,200 ha	
	Installation of a four MW hydro-electric power station						

Annex table 4. (continued)

No.	Project name and objectives	Start and end dates	Executing agency	Funding source	Funds (Millions of dollars)	Socio-economic impact	Remarks
12.	Sultani water-well supply to Karak						
	Improving water supply in Karak by pumping ground water of 15,000 M^3/day from Sultani well field with a 16 in. diameter pipeline	Completed in 1985	Governmental	Governmental	3.25	Improving the water supply situation for 50,000 people of the Karak districts	
13.	Improvement of water-supply network in the District of Irbid						
	Improving water supply Maintaining water pipe network and pumps Constructing reservoirs	Completed in 1985	Governmental	Governmental USAID	4.525 1.725	Providing the 3/4 million inhabitants of Irbid with permanent, potable water	Water source is from four flowing wells drilled in Wadi Al-Arab
14.	Development of water resources						
	Ground-water studies by drilling exploratory wells all over the country to test availability of ground water	..	Governmental	Governmental USAID	1.5 11.0	Providing more available ground-water resources	
15.	Wadi Al-Arab Dam project						
	Studying ground-water by drilling exploratory wells Irrigating additional land in Jordan Valley by storage of water flows (17 MCM) through Wadi Al-Arab	1981-1985	Governmental	Governmental Japan	27.5 27.5	Irrigating additional agricultural land (about 12,500 dunums in the Jordan Valley); increasing national income by developing recreational area around the dam	
16.	Raising the height of Wadi Al-Arab Dam						
	To increase the capacity of the dam from 20 MCM to 39.6 MCM	..	Governmental	Governmental	..	Irrigating additional agricultural land (about 12,500 dunums) in the Jordan Valley; increasing national income by developing recreational area around the dam	

Annex table 4. (continued)

No.	Project name and objectives	Start and end dates	Executing agency	Funding source	Funds (Millions of dollars)	Socio-economic impact	Remarks
17.	Irrigation scheme in Central Jordan Valley						
	Installing pipes to provide 6,000 ha with drip irrigation	..	Governmental	AFESD	18.0	Providing better irrigation system to conserve water and energy and to increase agricultural production	
18.	North desert villages water-supply project						
	Providing adequate potable water supply	Completed in 1985	Governmental	Governmental USAID Loans	0.65 0.6 ..	Improving the living conditions of 16,000 inhabitants dwelling in 16 scattered villages by providing on adequate potable water supply and bettering health conditions	
19.	Ajlun villages water-supply project						
	Providing 20 villages of the Ajlun area with an adequate potable water supply	Completed in 1985	Governmental	Governmental USAID	1.42 0.25	Providing better health and living conditions for 30,000 people in 20 villages of the Ajlun District and Kora	
20.	Al-Zaatary water-supply development project						
	To provide a permanent water supply to the Irbid district by drilling water wells in Al-Zaatary area	Completed in 1985	Governmental	Governmental	4.725	Providing additional new ground-water resources to the Irbid district	
21.	Jarash village water-supply project						
	Providing 15 villages in the Jarash area with an adequate water supply	Completed (date unavailable)	Governmental	Governmental	0.825 0.400	Providing better living and health conditions for 30,000 people in 15 villages in Jarash area by providing an adequate water supply	

Annex table 4. (continued)

No.	Project name and objectives	Start and end dates	Executing agency	Funding source	Funds (Millions of dollars)	Socio-economic impact	Remarks
22.	17-Village water supply project in Karak District						
	Providing 17 villages in the Karak area with an adequate water supply	Completed in 1985	Governmental	Governmental USAID Loans	3.5 0.5 ..	Providing better health and living conditions for 10,000 people in 17 villages	
23.	Improvement of water-supply network in Karak District						
	Expanding and improving the water supply network in the Karak District	..	Governmental	Governmental USAID Loans	1.86 0.250	Providing 94,000 people with an adequate water supply	
24.	Disi water-supply project-Aqaba						
	Installation of water pipes of different diameter to Aqaba with reservoir construction and pump installation	Completed before 1985	Governmental	Governmental Loans	2.01 3.64	Providing adequate water supply to Aqaba	
25.	Water supply to villages in Ma'an District						
	Pumping-station installation Connecting pipeline networks to villages	Completed in 1985	Governmental	Governmental	1.85	Providing 75,000 people with an adequate water supply	
26.	Water supply and house connections for limited-salary employees in Aqaba						
	Installing water-supply network and house connections to limited-salary employees in Aqaba	Completed in 1985	Governmental	Governmental	1.53	Providing better health and living conditions for limited-salary employees in Aqaba	
27.	Improving Water Supply Network in Ma'an District						
	Developing and expanding the water network Water reservoir construction Installing pumping stations	Completed in 1985	Governmental	Governmental USAID Loans	1.25 0.125 ..	Providing adequate water to 39,000 people in Ma'an District	

Annex table 4. (continued)

No.	Project name and objectives	Start and end dates	Executing agency	Funding source	Funds (Millions of dollars)	Socio-economic impact	Remarks
28.	Improving the water network and drilling new wells within Balqa and Amman districts						
	Constructing water networks and drilling water wells for Wadi Al-Sir, Ardha, Tla Al-Ali	Completed in 1985	Governmental	Governmental USAID Loans	6.75 7.625 ..	Providing adequate water supply for six towns around Amman (about 900,000 people)	
29.	Water network in the Amman region						
	Constructing water network and main reservoirs in Amman	Completed in 1985	Governmental	Governmental	15.0 16.25	Providing Amman (1,180,000 people) with permanent (24 hr/day) potable water supply	
	Drilling wells						
Non-Conventional							
1.	Greater Amman water-supply and sewerage project						
	The project will improve the water supply and sewerage services in the Greater Amman Area and includes:	Completed in 1987	Governmental	Governmental World Bank	26.4 30.0	The project will serve 300,000 people in (150,000 are classified as poor), and will improve health conditions, protect ground water from pollution and provide treated effluent for irrigation, thus contributing to agricultural development	
	Extension and rehabilition of 100 km of water mains						
	Construction of two sewage-treatment plants						
2.	Amman sewerage-collection system						
	Increase Ain Al-Ghazal treatment plant efficiency to treat 68,000 m^3/day	..	Governmental	Governmental Loans	18.0 27.0	Improving general health conditions in Amman by increasing sewerage services to 300,000 people	
	Constructing a new collection system						
3.	Aqaba sewerage project						
	Improving health conditions by construction of a new sewer system and treatment plant	Completed in 1988	Governmental	Governmenal Loans	4.125 6.1875	Providing 30,000 inhabitants of Aqaba with an adequate sewerage system and improving health conditions in the city	
	Renewing the old sewerage system						
	Installing a new pumping station						

Annex table 4. (continued)

No.	Project name and objectives	Start and end dates	Executing agency	Funding source	Funds (Millions of dollars)	Socio-economic impact	Remarks
4.	Zarqa and Ruseifa water-supply and sewerage project						
	Establishing a modern water system in Zarqa/Ruseifa, the main components of which are: 133-km water-main 12,000 water metres 364 km of primary and secondary sewers 30,000 house laterals Sewage treatment plant 14 km of storm water drains	Completed in 1988	Governmental	Governmental USAID KFW[a/] World Bank IDB West Germany	21.0 15.0 14.4 17.0 7.8 14.0	Providing 300,000 people with potable water and an adequate sewerage system to improve health conditions; water reuse in agriculture	
5.	Irbid water, sewerage and treatment plant						
	Providing Irbid with an adequate water supply and installing a water-distribution and sewerage system and treatment plant (12,000 m^3/day capacity)	Completed in 1986	Governmental	Governmental USAID World Bank	8.75 18.75	Improving health conditions in Irbid (113,000 people) by providing adequate water supply and sewerage network; water reuse in agriculture	
6.	Eight-city water-supply and sewerage project						
	Providing improvements to water-supply and distribution systems and eliminating problems associated with inadequate cesspools in eight cities The project includes: Installation of about 110-km water-distribution main, 8,000 m^3 of water reuse 117 km of sewers Five sewage-treatment plants Procurement of operating equipment Consultant services	40 per cent completed in 1985	Governmental	Governmental World Bank European Investment	28.2 30.0 7.5	Improving health conditions for 136,000 people by constructing water distribution and sewerage system	

a/ Kreditanstalt fur Wiederaufbau.

Annex table 4. (continued)

No.	Project name and objectives	Start and end dates	Executing agency	Funding source	Funds (Millions of dollars)	Socio-economic impact	Remarks
7.	Madaba, Karak, Tafila and Ma'an water and sewerage project						
	Constructing water and sewer systems, terminals, storm water and water networks	45 per cent completed in 1985	Governmental	Governmental USAID and Loans	7.5 17.5 ..	Improving health conditions and providing adequate water supply for 64,000 inhabitants in Karak, Ma'an, Tafila and Madaba; water reuse in agriculture	

Annex table 5. Kuwait's water-resources development projects executed between 1980 and 1985

No.	Project name and objectives	Start and end dates	Executing agency	Funding source	Funds (Millions of dollars)	Socio-economic impact	Remarks
Conventional							
1.	Exploitation of new ground-water resources at Umm Qudeir						
	Developing brackish-water resources for blending with desalinated water by drilling 41 wells	Started in 1984; 80 per cent will be completed in 1985	Governmental	Governmental	80.1	Supplying 25 MGD of brackish water to be blended with desalinated water to meet water demand in agriculture and industry	
2.	Utilization of new water resources at Wafra						
	Providing 15 MGD of brackish water for blending with the desalinated water from Al-Zour plant by drilling underground wells	1984	Governmental	Governmental	..	Meeting water demand in agriculture and industry	
3.	Three concrete water reservoirs at Sulaibi Khat and Sulaibiya						
	Construction of three reservoirs for fresh-water storage	..	Governmental	Governmental	34.0	Increasing water-distribution coverage	
Non-Conventional							
1.	Distillation plant at Doha West, Stages I and II						
	Construction of 16 distillation units to provide six MGD each for domestic water supply	Started 8 June 1981	Governmental	Governmental	92.6 (Phase I) 372.0 (Phase II)	Providing 96 MGD	
2.	Construction of new distillation complex						
	Providing 96 MGD for domestic water supply	..	Governmental	Governmental	..	Meeting excessive water supply demand	
3.	Al-Zour West distribution complex						
	Covering works between the Al-Zour desalination plant and distribution complex	1984	Governmental	Governmental	77.4	Providing water-supply network to the country	

Annex table 5. (continued)

No.	Project name and objectives	Start and end dates	Executing agency	Funding source	Funds (Millions of dollars)	Socio-economic impact	Remarks
4.	Sea-water desalination by reverse osmosis						
	Research and development programme for experimentation purposes	1985 (88 per cent)	Governmental (Fed. Rep. of Germany)	Governmental	33.0	For research and development programme	
5.	Shuwaikh distillation plant, Units No. D1, D2 and D3						
	Erecting three distillation plants	26 June 1978-20 May 1982	Governmental	Governmental	55.8	Providing adequate drinking water supply	
6.	Concrete reservoir at Abraq Khaitan						
	Water storage	..	Governmental	Governmental	182.0	For water storage to meet the increased water consumption	
7.	Al-Zour Pipes						
	160 km of pipes to link Al-Zour station to Kuwait City	..	Governmental	Governmental	80.5	Improving the water-supply network	
8.	Effluent Utilization Project (KEUP), Phase I						
	Entails the use of effluent from three sewage-treatment plants to produce 350,000 m^3 to irrigate 30,130 ha of agricultural land and 12,000 ha of windbreak forests	..	Governmental	Governmental	180.0	Increasing agricultural land and recreation zones	

Annex table 6. Lebanon's water-resources development projects executed between 1980 and 1985

No.	Project name and objectives	Start and end dates	Executing agency	Funding source	Funds (Millions of dollars)	Socio-economic impact	Remarks
Conventional							
1.	Chabrouh Dam						
	Geological reconnaissance feasibility study completed	Started in 1979	FAO	UNDP(1980) Governmental (1981) UNDP Governmental (1982) Governmental (1983) UNDP Governmental	0.102 2.78 0.105 2.681 0.225 0.099 0.1915	Water storage to irrigate and expand agricultural land	
2.	Hydro-agricultural project	..	FAO	UNDP	0.143	Operation and maintenance	$0.143 million is UNDP expenditure from 1980 to 1982
3.	Koura Zagharta irrigation project	Started January 1978	FAO	Governmental UNDP	1.387 0.106	Expanding agricultural land	
4.	Water-supply projects	..	UNICEF	Governmental UNICEF	..	Supplying adequate water country-wide	
5.	National waste-management plan, Phase I	Started September 1982	WHO	UNDP (1982) Governmental (1982) Governmental (1983)	2.15 1.014 0.850	Improving health conditions	
6.	Waste-management plan, Phase II	Started January 1984	WHO Governmental	..	..	Improving health conditions	

Annex table 7. Oman's water-resources development projects executed between 1980 and 1985

No.	Project name and objectives	Start and end dates	Executing agency	Funding source	Funds (Millions of dollars)	Socio-economic impact	Remarks
Conventional							
1.	Rusail and Seeb Airport water-supply project						
	Provide water-supply system to Rusail areas and adjacent villages	Completed January 1985	Governmental	Governmental	7.124	Providing 90 per cent of the population in these areas with an adequate water supply	
	Improve the water supply storage and distribution facilities in Seeb Airport						
	Pumping station, reservoir						
2.	Nizwa water-supply scheme						
	Supplying water to Nizwa town	1 July 1982-20 May 1984	Governmental	Governmental	1.54	Providing 75 per cent of Nizwa town with potable water	
	Well field, transmission pipeline						
3.	Wadi Kabir Water Supply						
	Providing water supply to Wadi Kabir area	..	Governmental	Governmental	1.54	Providing 75 per cent of the Wadi Kabir area with water supply	
	Pipeline network distribution						
4.	Improvement of underground water-resources in the capital area						
	Improving the western and eastern well fields of the capital area	..	Governmental	Governmental	9.747	Providing the capital area with potable water	
	Constructing new wells						
5.	Six-town water-supply project						
	Providing water supply to the following six towns: Qurrant, Musana, Ibri, Rustaq, Bilad-Bani Abu Ali, Adam	Project for two towns completed in 1985	Governmental	Governmental	9.637	Each system will provide for 60 per cent of population	
6.	Seeb water-supply project						
	Water supply to Seeb town	23 February 1983-2 May 1984	Governmental	Governmental	12.4	Providing 75 per cent of the population of Seeb Town with adequate water supplies	
	Storage reservoir, pumping station						

Annex table 7. (continued)

No.	Project name and objectives	Start and end dates	Executing agency	Funding source	Funds (Millions of dollars)	Socio-economic impact	Remarks
7.	Gubrah and Wadi Aday pump stations, reservoirs and associated works						
	Providing capital area with blended desalinated sea water and ground water	..	Governmental	Governmental	13.88	Providing whole population of the capital area with an adequate water supply	
	Two reservoirs, two pumping stations						
8.	Experimental dam at Wadi Al-Kodh						
	Storage and recharge	Completed March 1985	Governmental	Governmental	14.5	Recharging dam	
9.	Feasibility study for sewage treatment plant						
	Construction of treatment plant	..	Governmental	..	..	Serving 51,000 people with adequate sanitation; improving health conditions	
	Installation of 13 pumping stations						
10.	Sewerage master plan for Muscat/Seeb	Completed July 1985	Governmental	Governmental	..	Providing better health conditions	
Non-conventional							
1.	Expansion of the two desalination plants at Ghubrah	Completed in 1986	Governmental	Governmental	89.9	Providing 12 MGD and increasing water supply services in the capital	
2.	Salalah sewerage project						
	Designing sewerage scheme for Salalah	..	Governmental	Governmental	..	Serving 50,000 people of Salalah by providing adequate sanitation, thus improving health conditions; water reuse will be for irrigation	

Annex table 8. Democratic Yemen's (South) water-resources development projects executed between 1980 and 1985

No.	Project name and objectives	Start and end dates	Executing agency	Funding source	Funds (Millions of dollars)	Socio-economic impact	Remarks
Conventional							
1.	Water supply project for Socotra Island						
	Design of drinking-water supply system on the island	1985	Governmental	Governmental UNCDF[a/]	0.731 0.575	Increasing productivity and improving health conditions of the island population	
2.	Seiyun regional water-supply project						
	Construction project to provide Seiyun and adjacent villages with potable water	1987	Governmental	AFESD IDA[b/]	13.0 2.0	Providing adequate water supply to the rural community	
3.	Rural water-supply project						
	Construction of 17 water-supply projects for 17 rural communities	..	Governmental	AFESD Governmental	5.5 5.0	Improving health conditions; providing 100,000 people in 17 rural communities with potable water	
4.	Aden water-supply project						
	Construction project to increase and improve Aden's water supply until 1990	1984	Governmental	AFESD OPEC Islamic Bank	.. .. 11.0	Serving a larger portion of Aden's population with adequate water supply	
5.	Greater Aden water-supply project						
	Securing water supply until the year 2000	60 per cent will be completed in 1985	Governmental	Governmental Foreign	4.5 4.7	Rehabilitating the existing water supply of Aden and improving health conditions	

a/ United Nations Capital Development Fund.
b/ International Development Association.

Annex table 8. (continued)

No.	Project name and objectives	Start and end dates	Executing agency	Funding source	Funds (Millions of dollars)	Socio-economic impact	Remarks
6.	Wadi Hadhramout agricultural-development project, Phase II						
	Follow-up and floor-erosion study and construction of 56 deep water wells	By 1985, 50 per cent of the project will be completed	Governmental	Governmental KFAED[c/] AFESD IDA UNDP	4.0 9.0 0.2 10.6 1.2	Increasing and improving the agricultural area (2,950 ha), directly benefiting; 900 families benefits will extend to 200,000 people	
	Survey and design of irrigation works using well water						
	Improving 130 existing water wells and drilling 56 wells						
7.	Wadi Tuban agricultural-development project						
	Providing drinking water to six villages	..	Governmental	Governmental IDA AFESD	4.901 4.502 6.1	Improving health conditions; expanding agriculture and improving irrigation practices; strengthening manpower; improving water management (coverage: 500,000 people)	
	Training local manpower						
	Constructing lined canals						
	Water management						
	Studying ground-water potential						
8.	Wadi Beihan development project						
	Assessment of surface and ground water	60 per cent will be completed in 1985	Governmental	Governmental IDA IFAD[d/]	4.12 .. 14.0	Around 6,000 will benefit by increased income	
	Increasing agricultural production						
9.	Bedouin development programme	1980-1981	UNDP	Governmental UNDP	3.315 2.016	Improving living conditions	
10.	Mukalla sewerage scheme						
	Installation of sewerage network in Sharef District (Phase I)	..	Denmark IDA Governmental	Denmark IDA Governmental	27.7	Improving health conditions by providing 80 per cent of Sharef District with an adequate sewerage system (30,000 people)	

c/ Kuwait Fund for Arab Economic Development.
d/ International Fund for Agricultural Development.

Annex table 8. (continued)

No.	Project name and objectives	Start and end dates	Executing agency	Funding source	Funds (Millions of dollars)	Socio-economic impact	Remarks
11.	Rural water supply project						
	Equipping 18 boreholes and constructing 2 water-supply schemes	1978-1981	UNDP UNICEF WFP[e/]	Governmental	3.87	Improving living and health conditions	
Non-Conventional							
12.	Desalination plant	..	USSR	USSR	..	Providing adequate drinking water supply	

e/ World Food Programme.

Annex table 9. Qatar's water-resources development projects executed between 1980 and 1985

No.	Project name and objectives	Start and end dates	Executing agency	Funding source	Funds (Millions of dollars)	Socio-economic impact	Remarks
Conventional							
1.	Sub-surface geology and its relation to hydrogeological conditions						
	Intensifying geological studies on the subsurface Tertiary formations in the country	Started in 1983	Governmental	..	..	Study for possible new ground-water resources	
2.	Assistance in ground-water development and conservation						
	Development of the ground-water investigation section of the water department	1982-December 1985	UNDP/DTCD Governmental	UNDP/DTCD Governmental	.. 0.388	Impact on the country's future if ground-water investigations prove the existence of appropriate new sources	
3.	Artificial ground-water recharge						
	Keeping ground-water reservoirs in permanent equilibrium	April 1984-April 1987	Governmental	Governmental	1.42	Increasing agricultural and national income	
4.	Ground-water modelling						
	Operating the previous ground-water model of northern Qatar and feeding the input data with recently available information for formulating generalized hydrological and ground-water models	..	..	Governmental	..	Country water budget	
Non-Conventional							
1.	Doha West sewage-treatment plant						
	Providing 120,000 m^3/day	Started in 1985	Governmental	Governmental	6.9	Serving 100,000 people with proper sanitation; reused water is used for irrigation	
2.	Doha South sewage-treatment plant						
	Construction of the treatment plant and network	Started in 1985	Governmental	Governmental	16.5	Improving health conditions; reused water is used for recharge	

Annex table 9. (continued)

No.	Project name and objectives	Start and end dates	Executing agency	Funding source	Funds (Millions of dollars)	Socio-economic impact	Remarks
3.	Naijah sewage-treatment plant						
	Tertiary treatment plant to purify water for municipal irrigation (55,000 m^3/day)	Completed in 1985	Governmental	Governmental	42.2	Improving health conditions by serving 210,000 people; reusing water for irrigation	
4.	Extending sewerage networks						
	Doha/Rayyan network	Completed in 1986	Governmental	Governmental	13.1	Improving health conditions by sewer connections to the main sewage system	
	Connect Wakra and Wukair to main sewerage network				2.7		
	Khor and West Bay				4.8		
	Umm Said				2.5		
5.	Desalination plants						
	Ras Abu Aboud Station, Phase III	1977	Governmental	Governmental	..	Producing 4 MGD	
	Ras Abu Fontas Station, Phase II and III	1979-1981	Governmental	Governmental	..	Producing 32 MGD	

Annex table 10. Saudi Arabia's water-resources development projects executed between 1980 and 1985

No.	Project name and objectives	Start and end dates	Executing agency	Funding source	Funds (Millions of dollars)	Socio-economic impact	Remarks
	Conventional						
1.	**Mekka water supply**						
	Two-pipeline network 300-km long	..	Governmental	Governmental	57.5	Improving potable water distribution in the Mekka area	
	Building seven water reservoirs with a capacity range from 7,000 to 15,000 m^3						
	Installing a pumping station and 17-km pipe						
2.	**Uneiza water scheme**						
	Providing Uneiza with potable water by drilling 10 wells and installing a water pipe	..	Governmental	Governmental	27.0	Providing 100,000 people with potable water	
3.	**Riyadh's secondary water-distribution system**						
	Improving water distribution by installing a 309-km water pipe		Governmental	Governmental	27.0	Improving and increasing the water-distribution system in Riyadh, the capital	
	Installing 380-km main water pipe						
4.	**Irrigation development in the Wadi Jizan**	Completed January 1983	FAO	UNDP Governmental	0.928 4.025	Meeting demand for irrigation	
5.	**Primary drainage system in Jubail**						
	Constructing a primary drainage system in Jubail	..	Governmental	Governmental	10.4	Improving cultivation conditions benefiting 37,500 people	
6.	**Operation and maintenance of Jeddah sewage network**	..	Governmental	Governmental	8.85	Improving health conditions	
	Non-conventional						
1.	**Al-Khobar Plant, Phase II**						
	Producing 50 MGD and 500 MW power to provide additional water supply and power to Al-Khobar, Dammam, Qatif, Sihat, Safwa, and Raheemah	Completed in 1983	Governmental	Governmental	1 053.7	Meeting water demand in Al-Khobar, Dammam, Qatif, Sihat, Safwa, and Raheemah	

Annex table 10. (continued)

No.	Project name and objectives	Start and end dates	Executing agency	Funding source	Funds (Millions of dollars)	Socio-economic impact	Remarks
2.	Jeddah plant, Phase VI						
	Providing Jeddah with 50 MGD desalinated water	Completed in 1981	Governmental	Governmental	717.7	Meeting increasing demand for water and electricity due to the increase in population	
	Generating 500 MW of electric						
3.	Asir desalination plants, Phase I						
	Providing additional water supply to towns and villages in Asir	Started in 1985	Governmental	Governmental	643.4	Providing potable water to mountainous villages and towns in Asir as well as to coastal towns around Shugaig	
4.	Jubail plant, Phase I						
	Providing 30 MGD of desalinated water	Completed in 1981	Governmental	Governmental	..	Meeting water demand in Jubail, including the naval base	
	Generating 300 MW of electric power						
5.	Jubail plant, Phase II						
	Providing Riyadh with 210 MGD of desalinated water	Completed 22 February 1983	Governmental	Governmental	1 872.0	Meeting water demand in the capital city of Riyadh	Integrated project with its networks and internal and external services
	Generating 1,295 MW of electric power						
6.	Rabigh plant, Phase I						
	Providing Rabigh with 0.24 MGD of desalinated water	Completed in 1981	Governmental	Governmental	..	Meeting water demand in Rabigh	
7.	Reverse osmosis desalination plant in Al-Birk						
	Providing 0.5 MGD desalinated water to Al-Birk	Completed in 1983	Governmental	Governmental	21.7	Providing water supply to Al-Birk	
8.	Haql plant, Phase I						
	Providing Haql with 0.120 MGD of desalinated water	Completed in 1980	Governmental	Governmental	..	Providing Haql and surrounding villages with potable water	

Annex table 10. (continued)

No.	Project name and objectives	Start and end dates	Executing agency	Funding source	Funds (Millions of dollars)	Socio-economic impact	Remarks
9.	Medina/Yanbu plant, Phase I						
	Providing 25.0 MGD of desalinated water	Completed in 1981	Governmental	Governmental	510.6	Meeting water demand due to an increase in population and pilgrims' needs; the total capacity of water and electricity is being increased by 80 per cent to Medina and 20 per cent to Yanbu	Water is pumped from Yanbu in two pipelines, one 170-km long, which feeds Medina, and a 50-km line which feeds Yanbu
	Generating 250 MW of electric power						
10.	Water-transmission pipeline to Riyadh						
	Conveying 210 MGD of potable water to Riyadh by installing 60-in.-diameter pipe 466-km long	Completed in 1983	Governmental	Governmental	1 743.7	Water transfer will serve the capital (Riyadh)	
11.	Operation and maintenance of sewerage and water network						
	Building a sewage treatment plant and network in Hasa	..	Governmental	Governmental	71.0	Improving sewage network and sewage treatment plants; water reuse wil be used for irrigation	
	Installing new house connections and a new distribution network						
12.	Water plant and sewage-treatment plant						
	Supplying water and providing sewage treatment in Riyadh	Started in 1985	Governmental	Governmental	5.41	Providing additional water supply for irrigation and improving health conditions	

Annex table 11. The Syrian Arab Republic's water-resources development projects executed between 1980 and 1985

No.	Project name and objectives	Start and end dates	Executing agency	Funding source	Funds (Millions of dollars)	Socio-economic impact	Remarks
Conventional							
1.	Amelioration of Figeh Spring exploration						
	Determining maximum reliable yield that can be withdrawn by pumpage from Figeh aquifer	45 per cent completed in 1985	Governmental	Governmental USAID	6.0 9.0	Providing low-cost supplemental drinking water for Damascus; improving health conditions	
2.	Protecting Figeh source from pollution over its catchment area and protection of wells, delivery galleries and reservoirs						
	Protective measures for Figeh source water Maintaining all existing sewer installations in the villages	..	Governmental	Governmental	..	Providing water supply to the populations of Figeh, Hreira and Ifra villages (3,000-5,000 inhabitants)	
3.	Sheikh Maskene Dam and irrigation network						
	Storing 15 MCM of water Irrigation of 1,100 ha	9 June 1980-1 August 1985	Governmental	Governmental	6.0	Increasing agricultural land and national income	
4.	New water-resources development project for the city of Damascus						
	Proposals to provide the city of Damascus with adequate water supplies until the year 2010	..	Governmental	Governmental	..	Study to find additional water resources for Damascus and Wadi Baracka villages	
5.	Tasil's Dam and irrigation network						
	Storing 6.628 MCM of water Construction of earthfill dam	1 April 1979-1 August 1985	Governmental	Governmental	4.6	Increasing agricultural land by 700 ha, resulting in an increase in national income	

Annex table 11. (continued)

No.	Project name and objectives	Start and end dates	Executing agency	Funding source	Funds (Millions of dollars)	Socio-economic impact	Remarks
6.	Tashreen Dam project						
	Construction of earthfill dam to produce 400 MW of electricity	..	Governmental	Governmental	382.65	The project will result in the production of electricity, which will contribute to the national, electrical network and improve living conditions	
7.	Al-Ba'ath Dam						
	Construction of an earthfill dam	December 1981-1986	Governmental	Governmental Others	197.4	Regulating the Euphrates	
8.	Zif Dam						
	To store 9.6 MCM of water	Started 15 May 1985	Governmental	Governmental	7.8	Increasing agricultural land and providing drinking water	
9.	Maskene East irrigation project						
	Construction of irrigation and drainage works	1985-1988 (expected)	Governmental	Governmental Japan	275.0 12.5	Increasing agricultural land and national income	
	Reclamation of 18,000 ha						
10.	Maskena West irrigation project						
	Construction of irrigation and drainage works	Started in 1984	Governmental	Governmental USSR	266.0 ..	Reclaiming 50,000 ha and expanding agricultural land and national income	
	Reclamation of 18,000 ha						
11.	Kashieh Dam						
	Construction of earthfill dam to store 9.6 MCM	Completed December 1985	Governmental	Governmental	15.0	Additional agricultural land; new settling conditions	
12.	Middle Euphrates project						
	Execution of irrigation and drainage network	1976-1984	Governmental	Governmental Japan	118.0 52.5	Increasing the national income and expanding agricultural land	
	Developing 27,000 ha for agriculture						
	Construction of main pumping station						

Annex table 11. (continued)

No.	Project name and objectives	Start and end dates	Executing agency	Funding source	Funds (Millions of dollars)	Socio-economic impact	Remarks
13.	Lower Euphrates project (zones 1, 2 and 3)						
	Decrease spreading of soil salinity and reform and irrigate 67,000 ha in zone 1, and 77,000 ha in zones 2 and 3	Zone 1 completed 31 December 1984; only 70 per cent of zones 2 and 3 will be finished by 1 December 1985	Governmental World Bank	Governmental (Zone 1) World Bank (Zone 1) Governmental (Zones 2 and 3)	92.0 0.76 25.6	Decreasing salinity, providing additional agricultural land and increasing national income	
14.	Reconstruction of Upper Al-Salhabiya Canal						
	Reconstruction of the old canal due to unforeseen geological conditions, e.g. karstic cavities, gypsum layers	Completed in 1984	Governmental	Governmental	..	Increase in agricultural land and GNP	
15.	Al-Khaboor irrigation project						
	Irrigating 150,000 ha Optimum use of surface and ground water Social development and improvement of the local communities Contribution to industrial foods Hydroelectric power generation Construction of three storage dams	.. Planned completion by 2000	Governmental	Governmental	1,622.0	Increase in agricultural products and national income; development of the adopted agricultural methods; decrease in irrigation costs	
16.	April 17 Dam						
	Storage and use of Afreen River water Flood protection Electricity generation	..	Governmental	Governmental	..	Irrigating 30,000 ha by sprinklers, generating 10,000 kilowatts, improving living conditions, and increasing national income	

Annex table 11. (continued)

No.	Project name and objectives	Start and end dates	Executing agency	Funding source	Funds (Millions of dollars)	Socio-economic impact	Remarks
17.	Tashreen 16 Dam						
	Storage and irrigation dam Flood protection	Completed in 1985	Governmental	Governmental	..	Irrigation of 14,000 ha	
18.	Al-Thawra Irrigation Dam on the Al-Sanoober River						
	Storage and irrigation dam Irrigating 10,540 ha Hydroelectrical power generation	June 1984-1989 (expected)	Governmental	Governmental	166.6	Expansion of agricultural land in or around the North River, areas located between Al-Sanoober River and Banias City, and areas located between Banias and Tartoos	
19.	Jarrehi Dam						
	Rockfill dam to store 19.5 MCM Irrigating 1,900 ha	November 1977-1982	Governmental	Governmental	72.0	Increasing agricultural land and national income	
20.	Al-Sin development project						
	Installation of irrigation networks using Al-Sin Spring	..	Governmental	Governmental	..	Expanding agricultural land in the coastal region and increasing national income in the area	
21.	Soreet Spring area development project						
	Irrigating 1,200 ha Improvement of irrigation and drainage methods	Completed in 1985	Governmental	Governmental	..	Expanding agricultural land	
22.	Saffan Dam						
	Construction of earthfill dam to store 50 MCM	Expected completion in 1985	Governmental	Governmental	..	Expanding agricultural land and increasing national income	

Annex table 11. (continued)

No.	Project name and objectives	Start and end dates	Executing agency	Funding source	Funds (Millions of dollars)	Socio-economic impact	Remarks
23.	Akkar Plain development project						
	Irrigation and drainage of 21,000 ha	..	Governmental	Governmental	..	Expanding agricultural land	
	Protection of lowlands from flooding						
	Dam construction at Khalifa River						
24.	Buquaa' Plain project						
	Irrigating 4,000 ha	Phase I completed April 1984	Governmental	Governmental	..	Increasing agricultural land and national income	
	Storage dam construction on Al-Muzaina River						
	Drainage network in the low-land of the plain						
	Flood-protection structure construction						
25.	Wadi Al-Yarmouk project						
	Integrated irrigation system for 1,400 ha	1983-1988 (expected)	Governmental	Governmental	..	Increasing agricultural products	
	Dam construction between Abdee and Al-Shejarah						
	Establishing experimental agricultural farm						
26.	Barada and Al-Awaj project						
	Water budget evaluation in Barada and Al-Awaj	..	Governmental	Governmental	..	Providing water resources for domestic water supply	

Annex table 11. (continued)

No.	Project name and objectives	Start and end dates	Executing agency	Funding source	Funds (Millions of dollars)	Socio-economic impact	Remarks
27.	Al-Balikh Basin project, (1-A)						
	Construction of irrigation pipe 18-km long Reclaiming 10,000 ha Construction of main pump station Six new villages established for settlement from other regions	10 July 1976-31 December 1984	Governmental	Governmental World Bank	57.0 24.0	Increasing national income, new settlement in rural areas, and improving standard of living	
28.	Improvement of fisheries and agricultural production						
	Consultancy and training	..	Governmental	FAO	0.85	Training manpower	
29.	Euphrates multi-purpose training centre						
	Providing experts and equipment	Started in 1982	FAO	FAO	0.603	Strengthening manpower working on irrigation	
30.	Development and management of water resources for agricultural use	1986-1992	FAO Governmental	UNDP Governmental	0.85 0.80	Developing water resources for agricultural	
Non-Conventional							
1.	Aleppo sewerage project						
	Enhance health and environmental conditions downstream of Aleppo Install an appropriate institutional structure in Aleppo for providing sewerage	..	Governmental	Governmental World Bank	112.0 70.0	Serving 1.3 million people of Aleppo by providing sanitation and water reuse for irrigation; improving health conditions	
2.	Homs and Hamah sewerage project						
	Installing sewer system in Homs and Hamah	..	Governmental	Governmental World Bank AFESD	104.0 17.0 30.0	Improving health and environmental conditions in Homs and Hamah (148,000 people); water will be reused in agricultural	

Annex table 12. United Arab Emirates water-resources development projects executed between 1980 and 1985

No.	Project name and objectives	Start and end dates	Executing agency	Funding source	Funds (Millions of dollars)	Socio-economic impact	Remarks
Conventional							
1.	Drilling of wells at various places in the northern Emirates						
	Developing additional water-supply sources in parts of the northern Emirates Providing additional 5.7 MGD of ground water	20 March 1980-19 March 1981	Governmental	Governmental	16.18	Providing 81,000 people with potable drinking water	
2.	Drilling of boreholes in the northern Emirates						
	Developing additional ground-water resources with a potential capacity of 4.632 MGD	10 May 1981-20 November 1982	Governmental	Governmental	15.33	Providing 52,000 people with adequate water supply	
3.	Drilling of production boreholes in different areas of the northern Emirates						
	Providing an additional water supply of 4.32 MGD from ground-water resources	29 November 1981-10 January 1983	Governmental	Governmental	19.3	Providing 62,000 people with adequate water supply	
4.	Drilling of production boreholes in the northern Emirates						
	Developing additional ground-water resources of 5.172 MGD	28 March 1982-2 February 1983	Governmental	Governmental	19.0	Water supply for 26,000 people	
Non-Conventional							
1.	Umm Al-Nar (West) extension						
	Construction of 4 MPS distillers (5 MGD each) to provide potable water to the city of Abu Dhabi	23 per cent completed in 1985	Governmental	Governmental	19.0	Supplying potable water to 450,000 people	

Annex table 12. (continued)

No.	Project name and objectives	Start and end dates	Executing agency	Funding source	Funds (Millions of dollars)	Socio-economic impact	Remarks
2.	Al-Toweelah						
	Construction of 3 MSF distillers (6 MGD each) to provide Abu Dhabi with potable water	70 per cent completed in 1985	Governmental	Governmental	154.8	Supplying 450,000 people with potable water	
3.	Umm Al-Nar (East) extension						
	Construction of MSF distillers (6 MGD each) to provide additional potable water	45 per cent completed in 1985	Governmental	Governmental	150.4	Providing potable water to the Abu Dhabi area	
4.	Institutional support to the Ministry of Electiricty	Completed by 1985	UNDP	Governmental	0.96	Institutional support to the Ministry of Electricity and Water for the whole country	
5.	Al-Aweer sewage-treatment plant						
	Construction of sewage treatment plant (DS51)	Completed in 1987	Governmental	Governmental	209.0	Serving 500,000 people by reusing effluent of 130,000 m^3	
	Installation of five main networks (DS52)						
6.	Turnkey project for brackish water reserve-osmosis plant at Umm Al-Quwain						
	Providing 1.5 MGD of additional water to Umm Al-Quwain town	Completed in 1985	Governmental	Governmental	39.0	Providing 13,000 people with adequate water supply	

Annex table 13. Yemen Arab Republic's (North Yemen's) water-resources development projects executed between 1980 and 1985

No.	Project name and objectives	Start and end dates	Executing agency	Funding source	Funds (Millions of dollars)	Socio-economic impact	Remarks
Conventional							
1.	Rural water supply	Completed January 1980	WHO	Governmental UNDP	0.261 0.7873	Strengthening manpower in the water sector	
2.	Yemen flood-relief action	1977-1981	UNDP UNDP/OPE[a/]	UNDP UNDP/OPE Governmental	0.020 0.014 0.0022	Flood control	
3.	Establishment of meteorological services	Started January 1980	WHO	UNDP Governmental	0.0886 0.008	Providing necessary basic data for hydrological studies	
4.	Establishment of meteorological services	Started November 1981	WHO	UNDP(1981) UNDP(1982) UNDP(1983) Governmental	2.811 3.139 3.139 0.786	Providing necessary basic data for hydrological studies	
5.	Strengthening of the rural Water-Supply Department of the Ministry of Public Works II	1976-1985	WHO	UNDP	0.350	Providing adequate water supply and improving health conditions	
6.	Rural development in the central highlands	Started December 1983	..	AFESD IDA IFAD	10.2 20.0 ..	Irrigation development	
7.	Wadi Maur development III	Started June 1979	..	KFAED Others	10.0 70.0	Developing irrigation to increase production; providing potable water	
8.	Wadi Siham study	Started in 1978	..	KFAED	18.0	Aiming at conducting a survey for available water resources	
9.	Wadi Rima development	Started in 1979	Governmental	KFAED Others	10.0 25.0	Increasing agricultural projects; support manpower	
10.	Development of the Irrigation Department in the Ministry of Agriculture	Started in 1979	Governmental	AFESD	1.0	Supporting manpower	
11.	Rural water supply for 92 Villages	1985	Governmental	AFESD Governmental	2.3 1.3	Improving health conditions for 44,000 people	

a/ UNDP/Office for Projects Execution.

Annex table 13. (continued)

No.	Project name and objectives	Start and end dates	Executing agency	Funding source	Funds (Millions of dollars)	Socio-economic impact	Remarks
12.	Ma'rib Dam						
	Storing run-off to irrigate 10,000 ha Recharging to ground water	Started October 1984	Governmental	ADFAED	9.0	Expansion of agricultural land in the YAR	
13.	Rural water-supply project related to primary health care units in YAR						
	50 water-supply projects to provide drinking water	25 projects out of 50 were expected to be completed in 1985	UNICEF Governmental	UNICEF Governmental	1.92 ..	Improving the living conditions of 50,000 (rural population) by providing safe drinking water and relieving women of the burden of carrying water	
14.	Engineering Services for Confederation of Yemeni Development Associations						
	Planning, design and construction of feeder road Development of water resources for drinking and irrigation purposes	Started March 1979	Governmental	Governmental	0.28	Improving living conditions of rural areas all over the country	
15.	Rural water-supply project						
	52 projects to provide adequate potable drinking-water supply for rural areas	31 December 1985	UNICEF UNCDF	UNICEF UNCDF Governmental	0.40 2.087 1.20	Improving living and health conditions	
16.	Water-supply and sewerage systems for Sana'a and Hudaida	1973-1984	WHO	UNDP Governmental WHO Netherlands	0.726 0.367	Strengthening skilled manpower in the water sector	Activities ended by the end of 1973; fellowship components extended to 1984 with reduced allocation under cost sharing with the Netherlands

Annex table 13. (continued)

No.	Project name and objectives	Start and end dates	Executing agency	Funding source	Funds (Millions of dollars)	Socio-economic impact	Remarks
17.	Dhamar water supply and sewerage						
	Improving water and sewage systems to meet Dhamar demand until 1995	Started in 1984	Governmental	AFESD IDA Netherlands Governmental	10.5 60.0	Improving and providing water supply for Dhamar's agriculture; improving health conditions by providing adequate sanitation	
18.	Introduction of appropriate irrigation systems and technologies in the Sana'a Governorate	1988-1982	FAO Governmental	UNDP Governmental	1.30 1.17	Improving irrigation	
19.	Establishment of a secretariat and national plan for the High Council for Water	1987-1989	UNDP	UNDP	0.01	Institutional improvement	
20.	Assistance to the High Council for Water in establishment of a technical secretariat/preparation of a master water plan	1988-1993	UNDP Governmental	UNDP Governmental	2.38 1.16	Institutional improvement	

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