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REVIEW OF THE IMPACT OF PRICING POLICY ON WATER DEMAND IN THE ESCWA REGION WITH A CASE STUDY ON JORDAN

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ABBREVIATIONS AND EXPLANATORY NOTES

ACSAD	Arab Centre for the Study of Arid Zones and Dry Lands
Aquifer	A water-bearing stratum of permeable rock or soil able to hold or transmit water
Assessment	An examination of the aspects of the supply and demand for water and of the factors affecting the management of water resources
Average cost	Total costs divided by quantity of total output
bcm	Billion cubic metres; a measure of volume
Cost recovery	Fee structures that cover the cost of providing the service or investment
Demand management	The use of price, quantitative restrictions and other devices to limit the demand for water
Dublin Statement	The Dublin Statement on Water and Sustainable Development, adopted at the International Conference on Water and the Environment
Elasticity	Ratio of the percentage of change in quantity divided by the percentage change in price
ESCAP	Economic and Social Commission for Asia and the Pacific
ESCWA	Economic and Social Commission for Western Asia
FAO	Food and Agriculture Organization of the United Nations.
GCC	Gulf Cooperation Council
GDP	Gross domestic product
hectare	10 dunums = 10,000 m^2
IMF	International Monetary Fund
Marginal cost	Change in total cost per unit change in quantity
Marginal price	Pricing rate set equal to the cost of producing the last unit of water supply
MBTU	Million British thermal units
mcm	Million cubic metres
O & M	Operation and maintenance

ABBREVIATIONS AND EXPLANATORY NOTES *(continued)*

Opportunity cost	The value of goods or services foregone, including environmental goods and services, when a scarce resource is used for one purpose instead of for its next best alternative use
Policy	A declared intention and course of action adopted by Government, party, etc., for the achievement of a goal.
Strategy	A set of chosen short, medium, and long-term actions to support the achievement of development goals and to implement water-related policies
TDS	Total dissolved solids
Total cost	Total sum of variable and fixed costs
UNCED	United Nations Conference on Environment and Development (Rio de Janeiro, Brazil 1992). Also known as the Earth Summit.
WHO	World Health Organization

Notes: References to dollars ($) are to United States dollars, unless otherwise stated.

Two dots (..) indicate that data are not available or are not separately reported.

An em dash (—) indicates that the amount is nil or negligible.

A hyphen (-) indicates:

(1) The item is not applicable;
(2) Between years or months (for example, 1990-1992 or January-June), the years or months covered, including the beginning and ending of years or months.

An oblique (/) between years (i.e., 1993/1994) indicates fiscal (financial) years.

PART ONE
REVIEW OF THE IMPACT OF PRICING POLICY ON WATER DEMAND

Introduction

1. *Background*

Water consumption worldwide is on the rise. While the world's population doubled during the twentieth century, exploitation of freshwater resources increased sixfold. The ESCWA region is no exception; in fact, the member States are faced with increased water demand and fixed availability. Water scarcity is attributed to the region's extremely arid climate. Some countries have adequate water supplies and are able to meet their water requirements from river flows. However, water deficits are expected in the immediate future. Other countries are faced with chronic water shortages and have been relying heavily on the mining of groundwater sources. Water shortages in the ESCWA region are the result of high population growth, economic development activities, urbanization, and the need to provide adequate food supplies. All these factors are contributing to decreases in water availability in relation to per capita consumption from renewable water sources. Water supply limitations are further complicated by the fact that substantial volumes of surfacewater and groundwater are being exploited from sources that are shared between countries both within and outside the ESCWA region. In addition, the public at large perceive water resources as abundant and infinite. Water is generally provided at a rate substantially below its production costs, and some sectors receive water free of charge.

In the past, the most common approach to meeting water requirements has been to increase water exploration and development, and expand water infrastructure systems. During the last two decades, most of the ESCWA member countries have focused their efforts on the provision of safe and adequate water and food supplies to meet the requirements of increasing populations. This contributed to increasing water demand in all sectors, and to the depletion of scarce water resources. Little effort has been made to achieve integrated development and management of water sources, especially through demand management.

Recently, some countries initiated limited programmes to manage their water supplies through system rehabilitation, water impoundment, artificial recharge, water reuse, and development of desalinated sea water and brackish water. In addition, some demand management measures have focused on public education, leakage detection and control, and limited use of water-saving technology. Fragmented implementation of both supply and demand management measures has resulted in less than optimal development and utilization of water resources. In addition, the absence of effective regulations and water pricing policies also contributes to inefficient water use and depletion of water resources.

To meet future challenges and avert water shortages, water policy and strategies must emphasize a holistic and integrated approach to achieve simultaneous management of supply and demand, including economic criteria for water allocation and conservation. In the future, countries must recognize the critical role of water and its value in sustainable economic and social development, as well as the need to use water efficiently, equitably and soundly. Thus, each country in the region needs to evaluate the merits of attaching an economic value to water, as has been done in many parts of the world, and particularly in the developed nations. As a result, water could be treated as a scarce economic resource and protected accordingly.

At the United Nations Water Conference, held at Mar del Plata in 1977, and the International Conference on Water and the Environment, held at Dublin in 1992, the importance of attaching economic value to water was recognized as a means of increasing efficient utilization and conservation. The Dublin Statement adopted at the 1992 Conference established Guiding Principles: Principle No. 4 stated that "water has an economic value in all its competing uses and should be recognized as an economic good". The Guiding Principles contain valid provisions for recognizing the basic rights of all human beings to have access to clean water at an affordable price. The value of water as an important element in the management of water resources was also addressed at the United Nations Conference on Environment and Development, held at Rio de Janeiro in 1992. The Conference issued Agenda 21, chapter 18 of which deals with water issues. The Programme of Action of Agenda 21 encourages integrated schemes for water development and utilization, with emphasis on demand management measures which include water pricing, in order to promote efficient use and conservation of water sources.

Chapter 18 of Agenda 21 states that prerequisite for the sustainable management of water as a scarce vulnerable resource is the obligation to acknowledge its full costs. Planning considerations should reflect investment opportunities, environmental protection and operating and maintenance costs, as well as the opportunity costs reflecting the most valuable alternative use of water. The role of water as a social, economic and life-sustaining good should be reflected in demand management mechanisms.

There are two emerging economic practices that are being experimented with in different parts of the world through the implementation of pricing policy aimed at improved water use efficiency or cost recovery, as well as market criteria to transfer water from low to high value uses (United Nations, 1996). These approaches are based on the perception that water is a marketable commodity, with a value set by the law of supply and demand. The attachment of economic value to water would promote conservation and encourage privatization in the development, treatment and distribution of water resources. The economic value of water can be used as a criterion to improve water allocation and to set the administrative price level for water. The association of water directly with its production costs should be considered in the context of the social conditions within a country. The poor must be recognized as having an equal claim to potable water, as do the more affluent, at an equitable price. Under certain circumstances, subsidies may be used to provide for minimum water requirements. The economic viability of water pricing schemes to be implemented depends, at the very least, on the recovery of costs associated with the provision of water and water-related services. The modification of water consumption behaviour on the part of consumers may be influenced by price incentives as well as conservation tools and regulations, and implemented through a variety of methods including effective water pricing schemes. The public must be informed of the importance of pricing policies as a means of water resource management, and its preservation for future generations.

In the ESCWA region, the perception of water as an economic good is met with scepticism by decision makers and by the public because of socio-economic hardships in some countries, and by the knowledge that water has traditionally been provided free of charge or at prices substantially below production costs through different forms of subsidies. Socio-economic and political considerations in all countries of the region call for a gradual move towards the implementation of a pricing policy that equals the marginal and opportunity costs for water.

However, prior to the formulation and implementation of pricing schemes, there is a need to evaluate both conventional and non-conventional water sources, as well as the characteristics of water demand and socio-economic conditions. Special consideration must be given to the nature of water resources, particularly in arid environments that exhibit spacial and temporal water variability, as well as the socio-economic characteristics of the concerned country.

2. *Regional water resources*

The availability of water resources varies between the ESCWA members according to their physiographical and hydrogeological settings. Among the ESCWA members, Egypt, Iraq, Lebanon, and the Syrian Arab Republic have relatively dependable surface water resources in the form of major rivers and springs. River flow in these countries originates both from within and outside regional boundaries. In addition to available surface water, water supply is supplemented through extraction from groundwater reserves of in Egypt, Jordan, Lebanon, the Syrian Arab Republic, and the West Bank and the Gaza Strip.

Surface water and groundwater reserves are frequently renewed through rainfall, perennial river flow and through flooding.

(a) *Surface water*

For the major rivers, namely the Nile in Egypt, the Euphrates and the Tigris in the Syrian Arab Republic and Iraq, the Orontes and Litani in Lebanon and the Syrian Arab Republic, and the Litani in Lebanon. These rivers represent major water sources for domestic, industrial and agricultural requirements within these countries. Jordan, the West Bank and the Gaza Strip have limited surface water and rely mainly on renewable groundwater sources. Allocation from the Nile in Egypt is estimated at 55.8 billion cubic metres (bcm) per year, while the estimates for the Euphrates and Tigris in the Syrian Arab Republic and Iraq are 16.4 and 60.5 bcm respectively. The average surface water flow in Lebanon is estimated at 4.8 bcm, while for Jordan it is 0.692 bcm. A number of large dams have been constructed on these rivers to regulate flow. Water stored behind the dams is the main source for domestic, industrial and irrigation purposes in Egypt, Iraq and the Syrian Arab Republic.

In contrast, Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, the United Arab Emirates, and Yemen are characterized by a harsh desert environment and are devoid of rivers and lakes. The water resources in this region consist of limited quantities of run-off resulting from flash floods, groundwater in the alluvial aquifers, and extensive groundwater reserves in the deep sedimentary formations. This region also relies on non-conventional water sources such as desalination of sea and brackish water, and limited use of renovated wastewater.

Surface water in these extremely arid countries along the Arabian Peninsula consists of run-off generated mainly from flash floods. The average annual volume of water generated from flooding is estimated at 5.3 bcm. The intermittent nature of flow renders it unreliable as a water source. The national totals for Saudi Arabia and Yemen are estimated at 2.2 bcm and 2 bcm respectively. The amount of surface water available in Oman and the United Arab Emirates was estimated at 0.92 bcm and 0.18 bcm respectively. The remaining countries have only negligible amounts of surface run-off.

In general, utilization of surface run-off has been directed towards traditional flood irrigation, especially in the south-western region of Saudi Arabia, and most of Yemen. Regulated and unregulated flood flow is the main source of groundwater recharge to the shallow alluvial aquifers. More than 300 small dams have been constructed, mainly in Saudi Arabia, for the purpose of flood protection and groundwater recharge, with a combined storage capacity exceeding 0.5 bcm. Fifty-two dams have been or are being constructed in Oman, the United Arab Emirates, and Yemen for the same purposes.

(b) *Groundwater*

Groundwater resources in the ESCWA region consist of water stored in both shallow and deep aquifers. Carbonate aquifers are predominant in Jordan, Lebanon and the Syrian Arab Republic, while sandstone is prominent in southern Iraq and northern Egypt, and the Gulf countries. Shallow quaternary wadi deposits located in the coastal plains and inland basins, as well as the alluviums of river flood plains, contain groundwater of good quality that is frequently recharged by perennial river flow. The shallow aquifers in Egypt's Nile delta, and in Iraq, Jordan, Lebanon, the Syrian Arab Republic, and the West Bank hold groundwater reserves adequate to meet partially the water requirements. The Arabian Peninsula also contains deep non-renewable aquifers that extend over large areas and in which significant reserves of groundwater, with varying degrees of salinity, are stored. Water quality in relation to salinity, as well as location at considerable depths, may limit the development of these aquifers and restrict the ways in which the water can be utilized. These deep aquifers represent the main source of water for agriculture.

Groundwater reserves in the shallow alluvial aquifers also represent one of the main sources of water for many of the Gulf countries. Alluvial deposits along the main wadi channels and flood plains of drainage basins make up the shallow groundwater system in Kuwait, Oman, Saudi Arabia, Yemen, and the United Arab Emirates. Groundwater in the shallow aquifers is the only renewable water source for these countries, and it is used for domestic and irrigation purposes.

(c) *Desalination*

Non-conventional water resources are being utilized to supplement natural sources in order to satisfy water requirements in many of the ESCWA member countries. Brackish and sea water desalination has also become a viable alternative to meet the rising demand. The Gulf States rely largely on desalination to help to satisfy domestic water demand, and during the last 20 years these countries, with the exception of Yemen, have become increasingly dependent on desalination to meet their water supply requirements. They have become, by necessity, world leaders in desalination of sea water and brackish groundwater for domestic consumption. The high salinity of groundwater in most of the Gulf countries has compelled them to rely on desalination plants. Combined plant capacity in Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, the United Arab Emirates, and Yemen has reached 1.75 bcm, compared with a worldwide capacity of 5.7 bcm. Limited amounts of desalinated water from small plants, estimated at 43.6 million cubic metres (mcm), are being produced in Egypt, Iraq, Jordan, and the Syrian Arab Republic, mainly through the private sector, in comparison with the Gulf Cooperation Council (GCC) countries, where desalination is relatively more common.

(d) *Wastewater*

It is difficult for the existing wastewater treatment facilities in many of the ESCWA member countries to handle the ever-increasing volumes of wastewater generated by increased water consumption and urbanization. Urbanization and industrialization are exerting additional pressure on water resources, and increasing water requirements. At the regional level, urban populations increased from 47% in 1980 to 55.8% in 1995, and the region is expected to become predominantly urban in the next 25 years. Large cities and capitals have grown steadily. The number of large cities with populations of over 1 million inhabitants in the ESCWA region increased from five in 1970 to nine in 1995. The increasing rate of urbanization will require investment in water and sewerage infrastructure, improved water quality, and increased per capita water consumption. High water production costs are expected in the near future.

Wastewater discharge from major urban centres is polluting shallow alluvial aquifers and coastlines, as well as causing urban water tables to rise. The most common manner of dealing with this problem has been simply to dispose of wastewater rather than treat and reuse it, owing to the extensive capital investment required for water treatment systems. Planning for full utilization of treated effluent remains in the early stages, and the regional treatment capacity is sufficient to handle only 40% of the domestic wastewater generated. However, reuse of renovated wastewater is being practised in varying degrees for urban landscaping and irrigation. The regional total volume of reused renovated wastewater and drainage water is estimated at about 6 bcm, which is far less than the treated and untreated volume usually available from domestic water consumption. Reuse of treated effluent and irrigation drainage water is estimated at 11 bcm in Egypt, 1.3 bcm in the Syrian Arab Republic, and 52 mcm in Jordan. The use of wastewater ranges between 6 mcm in Yemen and 107 mcm in Saudi Arabia. The ratio of reuse to domestic and industrial water requirements ranges between 27.7% and 30%. In the region as a whole, renovated wastewater meets only a small fraction of water demand. Water resource estimates based on various hydrological and hydrogeological investigations carried out in the ESCWA region are shown in table 1.

TABLE 1. WATER RESOURCES IN THE ESCWA REGION, 1996
(*Million cubic metres*)

Country/area	Population (in millions) 1996[a]	Conventional water resources[b/c/d]			Non-conventional water resources		Water consumption 1996[c]
		Surface water	GW recharge	GW use	Desalination	Wastewater reuse and drainage	
Bahrain	0.6	0.2	100.0	166.0	75.0	11.0	272.0
Egypt	63 271.0	55 750.0	400.0	4 562.0	31.7	4 400.0	63 100.0
Iraq	20 607.0	60 480.0	2 000.0	1 500.0	7.4	N.A.	42 800.0
Jordan	5 664.0	692.0	275.0	418.0	2.5	52.0	895.0
Kuwait	1 687.0	0.1	160.0	80.0	350.0	42.0	538.0
Lebanon	3 084.0	4 800.0	600.0	240.0	1.7	2.0	1 225.0
Oman	2 302.0	918.0	550.0	645.0	47.3	5.5	1 235.0
Qatar	0.6	1.4	50.0	190.0	98.6	35.4	298.0
Saudi Arabia	18 836.0	2 230.0	3 850.0	14 430.0	795.0	107.0	16 300.0
Syrian Arab Republic	14 574.0	16 375.0	3 400.0	3 500.0	2.0	1 270.0	9 810.0
United Arab Emirates	2 260.0	185.0	125.0	900.0	385.0	108.0	1 223.0
West Bank and Gaza Strip	2 238[e]	30.0	185.0	N.A.	N.A.	N.A.	440.0
Yemen	15 678.0	2 000.0	1 525.0	1 200.0	9.0	6.0	2 715.0
Total	**147 964.1**	**143 461.7**	**13 220.0**	**27 831.0**	**1 805.2**	**6 038.9**	**140 851.0**

Source: Compiled by the ESCWA secretariat from country papers and international sources, 1994, 1995 and 1996.

Notes: N.A. = information is not available; GW = groundwater.

a/ United Nations. Department for Economic and Social Information and Policy Analysis.
b/ The flow of the Tigris and Euphrates rivers will be reduced by upstream abstraction in Turkey.
c/ ACSAD paper submitted to the 2nd Symposium on Water Resources Development and Uses in the Arab World, Kuwait, 8-10 March 1997.
d/ Water supply availability may be limited by economic and geographic development constraints.
e/ *Demographic and Related Socio-Economic Data Sheets for the Countries of the Economic and Social Commission for Western Asia*, No. 8, 1995.

3. *Regional water demand*

Imbalances between the increasing water demand and the limited water resources available are being experienced by most of the ESCWA member countries. Most countries have water deficits of varying degrees. During the last decade, water demand in all sectors increased dramatically as a result of high population growth, improvement in the living standards, and efforts to establish self-sufficiency in food and industrial development. Currently, agriculture is the primary water consumer. Industrial water demand varies among the nations in the region, but is roughly equivalent to domestic water requirements.

Total water demand for agricultural, industrial and domestic purposes in the ESCWA region reached 140.1 bcm in 1990, with the major consumers being Egypt, Iraq and the Syrian Arab Republic, as a result of high population concentrations, food requirements, and agro-industrial activities. Water requirements are expected to reach 165.5 bcm by the end of the century, and 233.4 bcm by the year 2025, as shown in table 2. Agriculture accounts for the majority of water use, followed by the industrial sector. Agricultural water requirements account for the majority of water use in the ESCWA region as a whole, with demand estimated at 123.1 bcm in 1990, and a demand of 103.4 bcm in Egypt, Iraq, Jordan, Lebanon, the Syrian Arab Republic, and the West Bank and Gaza Strip, and 19.7 bcm in Bahrain, Kuwait, Oman, Qatar, the United Arab Emirates, and Yemen. The percentage of each demand sector (domestic, industrial or agricultural), in relation to total demand for the years 1990, 2000 and 2025, is shown in table 3 and figure I. In 1990, the percentage of agricultural demand ranged from 28% to 90% of the total water demand in the northern ESCWA region (Egypt, Iraq, Jordan, Lebanon, the Syrian Arab Republic, and the West Bank), while in the south (the Arabian Peninsula) the range was from 21% to 93%, as shown in table 3. Agricultural water demand in the ESCWA region is expected to reach 142.1 bcm and 186.4 bcm in the years 2000 and 2025, as shown in table 2.

Industrial activities in most of the ESCWA member countries and area have also contributed to increases in total water requirements, although not as dramatically as the agricultural sector. Industrial water demand reached 6.3 bcm as of 1990 in Egypt, Iraq, Jordan, Lebanon, the Syrian Arab Republic, and the West Bank and Gaza Strip, and only 0.3 bcm in the GCC countries and Yemen. The percentage of industrial water demand ranged between 0.4% and 11.3%, with the smaller percentages being reported for the GCC countries. Countries with relatively well-established industrial infrastructures are Egypt, Iraq, and the Syrian Arab Republic. Industry is still fairly limited in the southern region. Industrial demand is projected to reach 9.3 bcm and 19.7 bcm in the years 2000 and 2025 respectively, with the highest demands in Egypt, Iraq, and the Syrian Arab Republic.

Industrial production structure in most of the ESCWA member countries is geared towards consumer goods and petroleum refinement. Many industries in the region, especially in Egypt, Iraq, Jordan, the Syrian Arab Republic and Saudi Arabia, rely on raw materials derived from agricultural products. Major industries in Egypt, Iraq and the Syrian Arab Republic include: mining, cement, basic metals, textiles, and food and beverage production, while the industries in Oman, Saudi Arabia, and the United Arab Emirates consist of petrochemicals, cement and limited food and beverage production. Most industrial activities are confined close to major urban centres, requiring competition with the domestic sector to satisfy water requirements. In urban areas with concentrated industrial activities, industrial water requirements represent the major water consumer in relation to domestic requirements. In most of the GCC countries, field development and petrochemical industries are considered to be water-use intensive. Industries in Egypt and Iraq utilize surface water from major rivers, while the remaining countries rely on groundwater supplemented with surface water, desalinization, and a limited amount of recycled water.

TABLE 2. PAST AND PROJECTED WATER DEMAND FOR THE ESCWA REGION, 1990, 2000 AND 2025
(Million cubic metres)

Country/area	1990			2000			2025			Total demand		
	Domestic	Agriculture	Industrial	Domestic	Agriculture	Industrial	Domestic	Agriculture	Industrial	1990	2000	2025
Bahrain	86	120	17	169	124	26	230	271	73	223	319	574
Egypt	2 700	49 700	4 600	2 950	59 900	5 693	6 300	69 100	10 900	57 000	68 543	86 300
Iraq	3 800	45 200	1 450	4 600	48 142	2 230	4 750	66 000	3 560	50 450	54 972	74 310
Jordan	190	650	43	340	1 090	78	750	1 090	175	883	1 508	2 015
Kuwait	295	80	8	375	110	105	1 100	140	160	383	590	1 400
Lebanon	310	750	60	550	1 299	150	1 100	2 581	450	1 120	1 999	4 131
Oman	81	1 150	5	170	1 270	85	630	1 500	350	1 236	1 525	2 480
Qatar	76	109	9	90	185	15	230	205	50	194	290	485
Saudi Arabia	1 508	14 600	192	2 350	15 000	415	6 450	16 300	1 450	16 300	17 765	24 200
Syrian Arab Republic	650	6 930	146	1 150	10 300	375	3 070	22 900	2 300	7 726	11 825	28 270
United Arab Emirates	513	950	27	750	1 400	30	1 100	2 050	50	1 490	2 180	3 200
West Bank and Gaza Strip	78	140	7	260	217	18	800	420	70	225	495	1 290
Yemen	168	2 700	31	360	3 100	60	840	3 800	137	2 899	3 520	4 777
Total	**10 455**	**123 079**	**6 595**	**14 114**	**142 137**	**9 280**	**27 350**	**186 357**	**19 725**	**140 129**	**165 531**	**233 432**

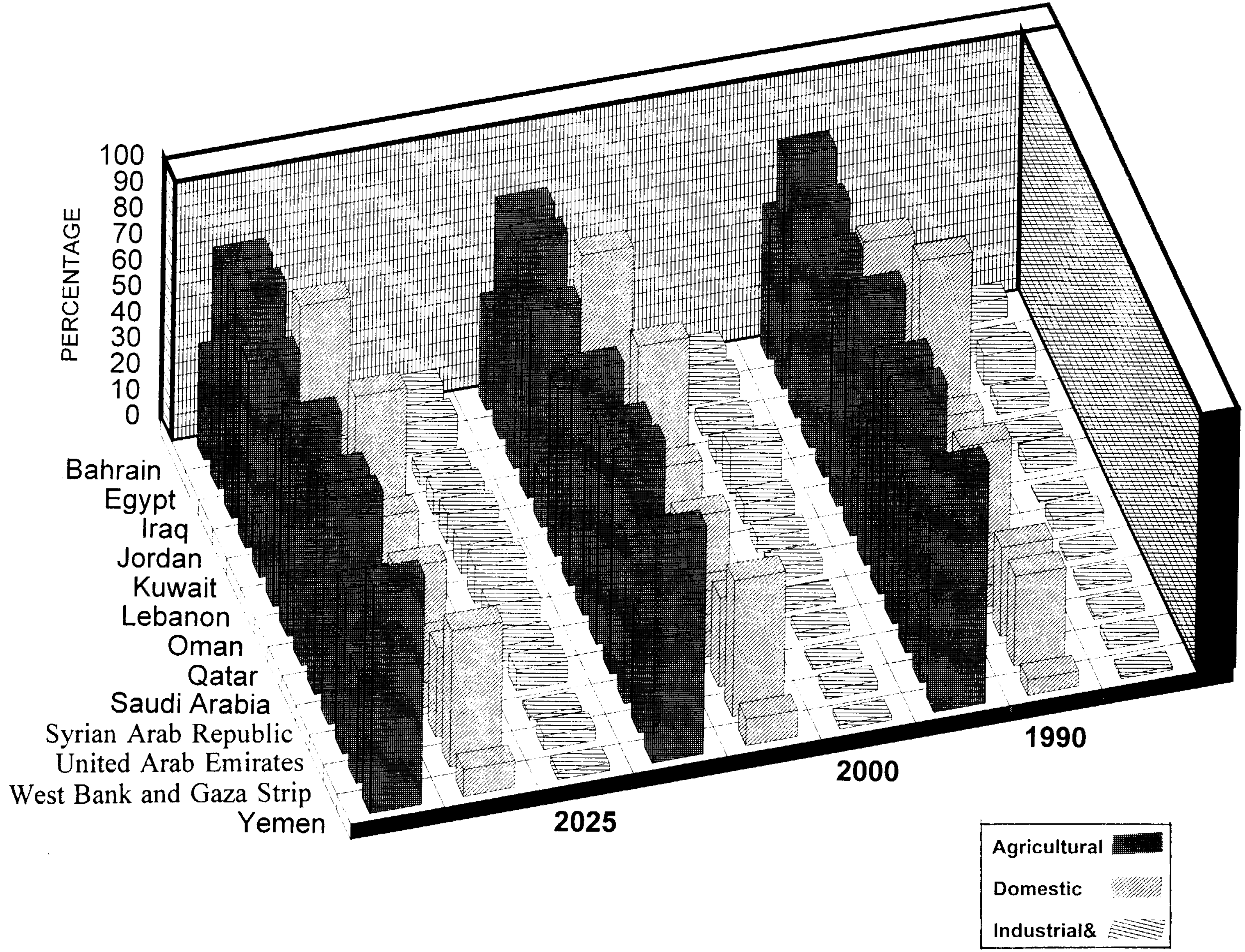
Source: Compiled by the ESCWA secretariat from country papers, regional and international sources, 1992, 1994, 1995, 1996 and 1997.

TABLE 3. PROPORTION OF WATER DEMAND BY SECTOR TO TOTAL DEMAND IN THE ESCWA REGION
(*Percentage*)

Country/area	1990			2000			2025		
	Domestic	Agriculture	Industrial	Domestic	Agriculture	Industrial	Domestic	Agriculture	Industrial
Bahrain	38.6	53.8	7.6	53.0	38.9	8.2	40.1	47.2	12.7
Egypt	7.5	89.6	2.9	4.3	87.4	8.3	7.3	80.1	12.6
Iraq	7.7	81.0	11.3	8.4	87.6	4.1	6.4	88.8	4.8
Jordan	21.5	73.6	4.9	22.5	72.3	5.2	37.2	54.1	8.7
Kuwait	77.0	20.9	2.1	63.6	18.6	17.8	78.6	10.0	11.4
Lebanon	27.7	67.0	5.4	27.5	65.0	7.5	26.6	62.5	10.9
Oman	6.6	93.0	0.4	11.1	83.3	5.6	25.4	60.5	14.1
Qatar	39.2	56.2	4.6	31.0	63.8	5.2	47.4	42.3	10.3
Saudi Arabia	9.3	89.6	1.2	13.2	84.4	2.3	26.7	67.4	6.0
Syrian Arab Republic	8.4	89.7	1.9	9.7	87.1	3.2	10.9	81.0	8.1
United Arab Emirates	34.4	63.8	1.8	34.4	64.2	1.4	34.4	64.1	1.6
West Bank and Gaza Strip	34.7	28.3	3.1	52.5	43.8	3.6	62.0	32.6	5.4
Yemen	5.8	93.1	1.1	10.2	88.1	1.7	17.6	79.5	2.9

Source: Compiled by the ESCWA secretariat from country papers, regional and international sources, 1992, 1994, 1995 and 1996.

Figure 1. Water demand projection in domestic, industrial and agricultural sectors



Domestic water requirements represent only a small fraction of total water requirements in the ESCWA member countries. In 1990, domestic requirements were estimated at 10.5 bcm, and are expected to reach 14.1 bcm and 27.4 bcm in the years 2000 and 2025 respectively, as a result of increased population growth and improved standards of living. Domestic demand has been estimated at 8.6 bcm for countries with large populations such as Egypt, Iraq, Saudi Arabia and the Syrian Arab Republic, which represent 7.5% to 9.3% of the total water demand. In comparison, domestic demand for the remaining countries was estimated at 1.8 bcm, accounting for a range of 5.8% to 77% of total demand, as shown in table 3.

Based on current trends and projections, and the availability of supplies, water shortages are now being experienced in the ESCWA member countries, and are expected to increase in the future. Water resources, such as perennial surface water, renewable groundwater, desalinization, and reclaimed wastewater, are already insufficient to meet expected demand. It is expected that in order to offset the imbalance between supply and demand, mining of groundwater, especially from the deep aquifers, may be required to meet agricultural and other demands unless some conservation strategies are implemented. Expected domestic and industrial demand increases in the next 30 years may also necessitate the construction of additional desalinization and treatment plants to produce water and treat wastewater for most of the countries in the region, especially the GCC countries, unless strict demand management measures, including appropriate water pricing methods, water conservation measures, and effective schemes, are implemented, and good quality groundwater is used solely for domestic and industrial use.

If present domestic consumption patterns continue unaltered, most countries in the ESCWA region will be required to allocate financial resources towards the construction of hydraulic structures, distribution systems, and the construction of new desalinization plants and support facilities with capacities capable of handling increasing demands. A large number of waste treatment plants will also be required to handle the resulting wastes. This huge investment may result in considerable economic strain, especially in those countries with limited financial resources. However, proper logistics, including supply/demand management planning and integrated development and management of water resources, along with just allocation of shared water sources through equitable agreements, will contribute significantly to alleviating water deficits. Many countries in the region have already taken steps to implement demand management programmes, including the application of proper economic criteria that emphasize appropriate pricing schemes to help reduce the imbalance between supply and demand, and promote effective conservation.

4. *Justification of the study*

Socio-economic development in the ESCWA region is dependent on the availability of adequate water resources. The most accessible sources have already been developed to meet rising water demand. The cost of water resource development is rapidly increasing as many countries have been forced to depend on costly desalination, and harness sources located far away from where water is needed. Furthermore, pollution from discharge of effluent is contributing to the reduction of available supplies.

Evidence from various ESCWA member countries indicates that the cost of investment in augmenting water supplies from both conventional and non-conventional sources has been rising over the past few decades. The cost of water production and providing services is much higher than water charges in most of the ESCWA member countries. Water charging schemes in all sectors are not conducive to improving water use efficiency nor do they promote conservation. In the domestic sector, most of the countries apply a progressive tariff structure, while in the agricultural sector which is the main water consumer, there is an absence of tariffs or regulations to control and monitor consumption. Water tariffs in the domestic and industrial sectors generate revenues substantially lower than the cost of operation and maintenance. Water prices are heavily subsidized through governmental budgeting. Revenues from the provision of water to the domestic sector are very small compared with the cost of water development, and considerably less than the capital investments required to expand existing water facilities. In the irrigation sector, water provided free or at minimal cost contributes to overconsumption, especially from groundwater sources. In addition, low cost irrigation water is neither conducive to efficient use, nor does it encourage the use of water saving technology.

In order to decrease future water shortages, effective water management practices must be implemented, including water pricing incentives that limit consumption and encourage conservation in all sectors. Effective water pricing policy can be used as an instrument to generate revenues, which in turn will help with the recovery of capital costs for existing and planned facilities, and operation and maintenance costs. Thus, formulation and implementation of appropriate water pricing policy can contribute significantly towards the management of water resources in the ESCWA region through enhancement of water use efficiency, and also act as a deterrent to help curb water consumption.

The present technical publication reviews the impact of pricing policy on water demand in the ESCWA region. It is a direct response to the recommendation of the Dublin and Rio de Janeiro declarations concerning water management and sustainable development. The study focuses on examining the concept of water pricing as an effective management tool for regions with scarce water resources. The study also examines the characteristics of the cost of water supply from different sources, and the types of tariffs being applied in different sectors. The study assesses the influence of major factors that may influence water pricing policy, especially in the agricultural sector. The feasibility of various water pricing schemes that have been implemented in different parts of the world is assessed: some may be suitable for application in selected countries in the ESCWA region. The range of options included water user associations, trading, and privatization. In conclusion, the study suggests some general guidelines that can be used to formulate strategies for water pricing policy.

I. PRINCIPLES OF WATER RESOURCES ECONOMICS

A. BASIC CONCEPTS

1. *Background*

Water, like other scarce resources, is often subjected to conflicting demands to satisfy the needs of society. There are a variety of tools that can be used to resolve these conflicting demands, including economic principles and postulates. In economic terms, the collective consumption of water by society can lead to its classification as a public good. Thus, the association of demand management through the adoption of a pricing mechanism assists in the efficient distribution of scarce resources and services to achieve optimal allocation of water resources to different sectors, as well as its conservation. Effective pricing policy thus represents an important aspect of water management with regard to efficient use and conservation of water resources. The efficient use of water, in this context, refers to minimizing use while achieving a given level of output or satisfaction. Conservation implies that in addition to efficient use, some changes in the pattern or structure of output itself are put into effect to reduce water demand (Brook, 1996).

The consideration that water has an economic value lends itself to the principle of a quantity-pricing relationship. Thus, pricing policy will influence the quantity of water to be used. Evidence of the inverse relation between pricing and water demand, in which increases in price lead to declines in demand and vice versa, has been documented in the literature on the subject. However, the formulation of effective pricing policy must be based on the evaluation of influencing factors such as the characteristics of water demand, the depletion of resources, cost recovery, obligation, legal and administrative requirements and consumer acceptance.

A convenient way to evaluate the impact of pricing policy on water demand is the application of economic principles including price elasticity and marginal and opportunity cost concepts. However, prior to evaluating water from an economic standpoint, it is important to describe some of its natural and marketable characteristics.

2. *Water characteristics*

Water as a natural resource must be recognized for being indispensable and irreplaceable for life, as well as for its contribution to social and economic development. Water as a commodity can be utilized directly from the water sector by the consumer, or may be used in an indirect manner to produce refined goods from the agricultural and/or industrial sectors (Sadik and Barghothi, 1997). Water is differentiated from other natural resources with regard to its temporal and spatial renewability. Its variability sometimes leads to drought or flood, which may result in substantial damage and economic loss.

Accordingly, supply and demand principles with regard to water as an economic resource must take into consideration the absence of mobility of both surface and groundwater sources, as well as the need for large investments to provide supplies in order to take advantage of economy of scale. Because of water's natural monopoly characteristics, there are few water supply producers. Governments are usually the only water producers and providers, and are also responsible for deciding what the price of water will be. Governments usually fix tariffs over long periods of time (Sadik and Barghothi, 1997), and often they do not reflect the actual costs involved in water production and delivery.

Multiple use of water in different sectors and production processes sometimes results in both positive and negative effects with regard to water quality and environmental degradation, groundwater mining, and surface- and groundwater interaction. There are difficulties in economic quantification of the costs and benefits of these consequences that result from water development and use.

According to Sadik and Barghothi (1997), these characteristics are the main reasons for the lack of implementation of market-oriented principles to water as a marketable commodity. However, because of its varying characteristics, there are options in considering water as a public or private commodity, and its management requires consideration of political, social and legal factors in the evaluation of pricing policies.

Several tools are usually involved in managing the demand for water, especially through different cost recovery schemes, including water trading among users in a water market, changing the patterns of water consumption, and training and educational programmes for users to promote water efficiency. However, what tops the list of water management measures are the formulation and implementation of water pricing policy, and enforcement. Water pricing schemes represent the most effective measure to achieve efficient water use and conservation.

B. WATER PRICING POLICY

Effective pricing policy has been recognized as an important demand management measure. It encourages water use efficiency, and discourages waste in all sectors. Water pricing policy objectives on a national level include the achievement of economic efficiency and income distribution. In developing countries, policy goals have been oriented towards distributing income among certain segments of the society through the principle of water pricing subsidies. However, recent trends have emphasized both income distribution and water pricing policy. A policy based on realistic pricing schemes that meet public acceptance and that is properly administered can achieve efficient use of water resources as well as cost recovery of capital investment and services.

The essence of such a pricing policy should be geared towards achieving one or a combination of the following objectives (ESCWA/FAO, 1994):

(a) Improve overall efficiency of water use and conservation of water resources;

(b) Achieve efficient allocation of water resources among and within sectors;

(c) Raise enough revenues to satisfy financial requirements of water supply and development, as well as infrastructure;

(d) Subsidize, if possible, special areas and/or users to accommodate minimum requirements;

(e) Achieve equity objectives or certain patterns of income redistribution;

(f) Protect the aquatic environment.

Accomplishing the efficiency and conservation objectives requires full comprehension of the pricing techniques that would assist in conserving water resources, while at the same time providing sufficient revenues for future investment plans. The efficient use and conservation of water imply its association with a level of output, as well as changes in the pattern of output itself.

On theoretical grounds, economists always think that efficient utilization of water resources, like any other commodity that has economic value, can be optimally achieved through appropriate cost-recovery approaches. Cost recovery concepts represent an important tool in water conservation, as well as in reducing the burden on government budgets. However, the design of water charges is based on the goal of either partial or complete cost recovery, depending on the socio-economic situation of the country concerned. Cost recovery aspects involve accounting for capital investment, operation, maintenance, administration, and financial interests.

There are several types of cost recovery approaches, including service which incorporates operation and maintenance costs, marginal costs, opportunity costs, average costs, and market-oriented costs. The selection of a particular pricing scheme depends on the sector in which it will be applied, the level of subsidies, equity, the ability to pay, promotion of conservation, and poverty alleviation (Sadik and Barghothi, 1992). The best concept of pricing cost is through equating the price of water (P) with its marginal cost (MC) of production (Saunders and Warford, 1980). Thus, marginal price concept is efficiency- and conservation-oriented.

1. *Marginal costs*

Marginal costs represent the incremental cost of water supply, which is the added expense involved in increasing water production by one additional unit; this could be measured by the present value of the cost of providing an extra unit (one cubic metre) of water from the next alternative source of water. For example, the marginal cost of using one cubic metre of underground water to irrigate a parcel of land would be the discounted projected cost of increasing, or replacing, one cubic metre of irrigation water supply from the next available source of water, which could be another water well or any other alternative source of water of the same quality.

There are two components of marginal cost: (a) those associated with changes in operating costs that result from changes in rate structure for existing capacity; and (b) the costs associated with expanding the capacity of supplies. The aspect of marginal cost pricing can be used simultaneously to serve two objectives. It can reflect the approximate order of cost magnitude of the water system expansion to determine changes according to the magnitude of water consumption from that system (Warford, 1976). In addition, application of this principle can contribute towards propelling the existing allocated water closer to its ideal use. This allocation helps to reduce waste and confines water use at its appropriate value.

In considering the concept of using marginal costs to achieve efficient resource use, careful attention should be given to the short-and long-term implications, referred to as short-run marginal cost (SRMC), and long-run marginal cost (LRMC). The short-run concept refers to the cases in which the water supply system has unused or excess water production capacity, i.e. when capacity is less than fully utilized. Under such circumstances the marginal cost of production (extra supply cost) is likely to consist only of the extra expenses of water treatment and pumping. Eventually, as demand grows, the marginal costs take hold when the existing capacity becomes fully utilized and the need to create new capacity for augmenting water supply emerges. Adding the capital cost of installing supplementary or new capacity to the regular short-run cost of operation, maintenance, water treatment and pumping would create the difference between the short-run and long-run marginal costs.

Normally, the long-run marginal cost exceeds short-run marginal costs as a result of the inclusion of the cost of environmental damage and resource depletion. Hence, the efficiency of water utilization could be best served when water prices reflect long-run marginal costs, even in periods of excess supply. Marginal pricing can contribute to efficient utilization of water resources.

The application of a marginal pricing tool may be advantageous for situations in which water demand is increasing and the long-run marginal cost can be recovered, where present capacities are already being fully utilized, or where new facilities are being added. Increasing demand and full utilization of existing capacities are situations that have been experienced in all of the ESCWA member States, and therefore the long-run marginal cost of providing water is rising. Under such circumstances, efficient water pricing schemes for the ESCWA region are now required. Setting water price equal to long-run marginal costs, with the possibility of generating a revenue surplus, is a necessary option at this point. This financial surplus can be used to eliminate subsidies granted to water supply agencies. The excess revenue may also be used to subsidize poverty stricken areas or groups.

The use of long-run marginal cost pricing mechanisms may become an economic burden in some countries with low income-generating sectors, or where it is politically unacceptable. In some cases, it may be appropriate to use short-run marginal pricing instead of long-run marginal cost, which reflects operation and maintenance costs rather than the cost of capacity expansion. Such pricing schemes would also be easier to develop and administer, as a first step towards promoting efficient use of scarce water resources. The objective of achieving marginal opportunity cost recovery is not promising, owing to its political sensitivity.

2. *Opportunity costs*

The other aspect of water management is optimal allocation among competing sectors. Economic theory with regard to optimal allocation of scarce water resources among users suggests the application of the principle of "equi-marginal value in use". This is realized when, in any given circumstance, the value of the last marginal unit of water utilized is equal in all uses and for all users (Schramm and Gonzales, 1977; Winpenny, 1994). The marginal value of water in this situation refers to its "opportunity cost", which measures the net value of a resource in the next best alternative use.

In the case of irrigation use, the opportunity cost of one cubic metre of water would be measured by the value of that water if it were used for such purposes as residential consumption. Under perfect market conditions, the "economic price" or the "marginal return of water" should reflect its opportunity cost in the short run. Moreover, efficiency requires that the marginal cost of supplying water be equated with the marginal benefit of water to users. High opportunity costs are associated with water allocated to the agricultural sector to produce output that usually has low international market value. In these situations, either crop or livestock values are less than the cost of water used in producing them.

The calculation of the value of water for an irrigated crop would be estimated by dividing the net income generated by the crop by the cost of the irrigation water required for the crop. The net income of the crop can be estimated by subtracting the total cost of crop production from the gross income generated. However, in reality, equalization of marginal return of water to its price is not feasible owing to the underdeveloped water market and distortions of prices in most of the other sectors of the economy (FAO, 1994). Therefore, water charges should be based on recovering marginal costs. The opportunity-cost concept is appropriate for situations where water is scarce and there is a critical shortage.

Determination of marginal or opportunity cost estimates usually requires detailed information on the market value of future expected demand, investment alternatives, and pollution costs. Where this type of information is lacking, particularly in developing countries including the ESCWA region, the task becomes problematic.

Marginal cost calculations involve the projection of capacity as well as operating costs for a given time period pertaining to a particular water demand. This calculation procedure is a very difficult task and is usually based on rough estimates. Approximate long-term marginal cost estimates would be represented by the average total cost of water supply from the newest sources or project (United Nations, 1980). This can be calculated by dividing the discounted value of future supply costs by the expected amount of additional water to be produced (Saunders and Warford, 1980).

3. *User costs*

In addition to marginal and opportunity cost principles, there are other pricing tools such as user cost, full cost, and average pricing cost, which deal with depletable resources such as groundwater. When water is provided from an aquifer being mined in excess of the magnitude of recharge, the true cost of the water should represent the future cost of providing new water sources when the aquifer is depleted or contaminated (Winpenny, 1994). The concept of user cost refers to the opportunity forgone of using a current resource, rather than in the future. The true cost of water is the future cost of replacing it with another source when the aquifer is exhausted or contaminated. The cost represents the price of exhaustible groundwater sources.

The current extraction of a unit of water from an exhaustible source brings forward the date at which it will be depleted. This depletion factor must be included as part of the price of water. In other words, the price level that promises an efficient rate of extraction from groundwater sources should be equated to the social marginal cost, which combined both user costs and the marginal cost of extraction, as follows:

$$\text{water price} = \text{marginal cost} + \text{user cost}$$

To determine the full user cost, all external costs of resource extraction, including pollution, damage or quality losses, should be included in the user price. When dealing with groundwater, it has been suggested that the price should be raised to the point at which the actual withdrawal rate coincides with the sustainable rate (Winpenny, 1994). Such an option has the disadvantage of raising the short-run price of water supply, but it pays off in the long run in terms of significant cost savings, when compared with the alternative of depletion.

4. *Full costs*

Full cost pricing represents variable and fixed costs. Full cost pricing calls for the setting of a price rate that reflects the full cost of supplying water, including all outlays such as capital depreciation and social and environmental costs associated with water supply projects. Full cost water rate bases are usually higher than those based on other pricing methods, thus making water prices more difficult for the public to accept. However, like the marginal cost pricing rate, full cost pricing is an economically efficient method to achieve efficient optimal allocation of water.

5. *Average costs*

This concept is based on the idea of equating the price of water to the average cost of operating and maintaining water facilities. It is estimated by dividing the total cost by the demanded quantity. It is easy to implement. However, it is sometimes inefficient in situations where high and increasing marginal replacement costs for current capacity. Its application can lead to excessive use of existing water supply, shortages, and costly supplemented water projects (Collinge, 1992).

The recovery of full costs (capital investment, operation and maintenance, administrative and financial) for providing water and services is seldom achieved in developing countries. A recent World Bank study of the Bank's financial projects in different parts of the world attributed the problem of low cost recovery to poor maintenance, low quality services, and the reluctance of Governments to collect fees (Sadik and Barghothi, 1992). In light of the low cost recovery achieved through specific rate structures, the preferred option is to consider the use of a water pricing scheme that would ensure financial autonomy, as a good starting point for recovery of operation and maintenance costs and partial recovery of capital expenditures.

C. Factors affecting water pricing

The water supply costs, especially marginal costs, are affected by the distance between the water users and the source of water. It also depends on the time of the day or the season of consumption (Dandy and others, 1997). To promote better use of the production facilities and avoid unnecessary investment to meet peak demand, it is often useful to structure prices to vary with the cost of serving:

(a) Different geographic areas (distance from water source);
(b) Different seasons (summer rates versus winter rates);
(c) Different hours of the day (daytime versus evening hours).

Moreover, practical pricing systems should vary according to a number of other factors, in addition to production costs, such as:

(a) Identification of the water consumer sector (domestic, industrial, or agricultural). Pricing water for domestic use should account for factors such as the type of service, subsistence level of consumption, and the purpose for which the water is used. Agricultural water prices should reflect the intensity of water use per crop, the number of water applications, and the size of the irrigated area. Industrial water pricing should take into consideration differences among industries in terms of intensity of use, size, and the type and quality of effluent;

(b) The type of water source (surface, groundwater, renewable or non-renewable, or non-conventional sources);

(c) Differences in water quality (treated, non-treated, brackish, saline, or recycled).

The above considerations require some knowledge of the range of pricing structures from which choices can be made.

D. Water rate-setting criteria

A well-designed rate structure can lead to better management of supplies and provide incentives for water conservation. Criteria for establishing water rate configuration can be based on elements of cost recovery, equity, economic efficiency and local acceptability. The most important factor is user acceptability, represented by the ability to pay. Economic efficiency focuses on achieving water services at minimum cost. Rate setting usually accounts for cost recovery of operation, maintenance and expenses of the water supply system. The second most important criterion is effective rate design in order to achieve equity. This criterion is based on sharing the costs of the water delivery system among customers in a fair manner. The fixed costs charged by a municipality include the total costs represented by administrative overhead and billing costs, and must be borne by all customers. These costs should be covered in either first or second block rates. Consideration must be given to the existence of large industrial or agricultural water users where municipalities may be compelled to maintain larger delivery systems to accommodate their requirements. In such situations the majority of small users will actually compensate for the few larger users. Economic efficiency, theoretically, means achieving a given objective at the least cost. It can be achieved when the price of water is equal to the marginal cost. System repair and expansion costs are adequately covered, and the rate reflects the true cost of water. Public acceptance can be decided by the local authorities to guarantee income distribution. Efficient rate structuring includes mechanisms for recovering the true cost of water services, without resulting in underpricing, overpricing, or subsidizing some consumers at the expense of others.

E. Water price elasticity

Prior to the setting of water rates, it is useful to evaluate the impact of alternative pricing schemes on water demand. Water price elasticity provides a convenient way to evaluate the impact of a pricing scheme on water demand in varying degrees in the domestic, industrial and agricultural sectors. Elasticity measures the sensitivity of goods or services to change in prices, or in the case of water the quantity demanded, while maintaining other factors at a constant level. Mathematically, price elasticity represents the ratio of the percentage of change in the quantity of water demanded to the percentage of change in price. An elastic demand curve represents a larger price change than proportional change in demand. In general, in an unregulated market environment, elastic demand represents the condition where an increase in water price results in increased consumption as reflected in lost revenues: otherwise, the price-demand relation is inelastic. However, in a regulated market situation, revenue effects are evaluated in respect of monetary requirements.

In the water sector, demand is generally price inelastic, meaning there is an inverse relation between water consumption and the price charged for water services. The elasticity coefficient has a negative value for inelastic demand. For example, an elasticity of -0.4 indicates that a 10% increase in price is associated with a 4% reduction in water demand, and revenues would increase by 5.6%. In the long run, this theory suggests that consumers will decrease their water consumption in response to price increases.

Price elasticity is an essential tool for estimating the effect of rate structure changes (tariffs) on water demand and revenues, especially for water utility regulators. Total revenue is estimated as the price times the water quantity. Thus, elasticity of demand for water must be estimated in order to determine the overall effect on revenues. It should be pointed out that revenue instability may be created when price elasticity is ignored during the design of water rate structure. This implies that the formulation of a rate structure is a dynamic process in which water demand affects the cost of providing needed volumes of water. In turn, the cost of providing water determines the price of water, which consequently affects water usage.

In general, municipal water demand is price inelastic owing to the nature of water services and the lack of reasonable substitutes. It should be pointed out that sometimes the price impact can be minimized when other climatic and income factors become dominant. Studies on residential water demand indicate that price elasticity may range between -0.20 and -0.40, while for commercial and industrial demand the coefficient may range between -0.50 and -0.80. A lower price elasticity indicates that the implementation of appropriate pricing schemes in the commercial and industrial sectors can lead to higher reduction in water consumption, in comparison with the residential sector. However, large price increases may force a particular sector to seek alternative water supplies. Indoor water use for domestic purposes is generally less price elastic than water used outdoors for landscaping and irrigation, because of uncontrolled outdoor consumption. Price elasticity is also influenced by peak and off-peak water demand. In addition, water rate increases in excess of inflation rates can have a significant impact on water consumption. Rate structure changes in higher price ranges are usually more effective at reducing water consumption than rate changes in the lower price ranges. The sensitivity of price in relation to water demand may also increase over time as a result of implementation of water conservation programmes.

F. Pricing configurations

Revenues for water production and services are usually recovered using appropriate water tariff schemes. The degree of cost recovery usually depends on the tariff configuration and enforcement. Water tariffs represent the charges that are usually levied on the portion of the public that receives water services. Most of the time, tariffs are assessed for both the provision of water and the wastewater system. Originally, tariffs, which could be considered an early form of water pricing, consisted of fees and assessment charges to collect funds for operation of the water supply system. Tariff revenues can either partially or fully cover all costs associated with system operation, maintenance, capital expenses, and financial costs, depending on the implementation policy. Tariff objectives in developed countries have largely been geared to cover all costs (United Nations, 1996), while in developing countries goals have been to achieve income distribution and partial cost recovery. In developing countries, revenues usually fall short of providing full cost recovery, especially in the agricultural sector. The remaining costs are met through proper taxes, government subsidies, and debts. Sometimes a fixed fee is levied per month to cover billing and meter reading.

In agriculture, in both developed and developing countries, water charges are small and revenues frequently fail to recover full costs. Tariff structures are designed to achieve income distribution through different subsidy levels. Most tariff structures usually take into consideration the need to ensure that low income groups are not prevented from acquiring the minimum amount of water necessary to sustain a healthful and productive existence.

The present tariffs for all sectors in the ESCWA region fall short of the actual production, operation and maintenance costs. Water charges do not generate enough revenue to cover the cost of services, nor do they encourage water conservation. The Government usually owns and operates the water supply system for the domestic sector, and some irrigation projects provide water at prices much lower than marginal costs. In the municipal sector, Governments have been pursuing a policy of subsidizing the water rate. Industrial water is usually supplied directly from the water source, through the water supply system, or through privately owned facilities.

Current water prices, in most countries, cover only a very small portion of the cost of water supply and distribution, and are unrealistic as a tool for motivating water conservation in the face of water scarcity and increasing demand. Efficient pricing patterns would involve a gradual decrease in government subsidies, until the charging price is equivalent to marginal cost pricing. It can be argued that marginal pricing is relatively high and would be an additional burden on farmers and consumers in countries such as Egypt, Jordan, the Syrian Arab Republic and Yemen. However, a solution must be found to curb inefficient use of scarce water resources.

1. *Domestic and industrial tariffs*

There are several types of tariffs (water charges) used in the domestic, industrial and agricultural sectors throughout the world. The tariff structure is influenced by the availability of water, consumer income, and socio-economic factors. Pricing systems which could be applicable to municipal water consumption may not always be appropriate for pricing irrigation water, because unlike municipal water supplies, a considerable proportion of water used in agriculture is not subjected to volumetric metering. There are several commonly used water pricing rates, employed mainly in the domestic sector.

(a) **Flat or uniform rates**. Regardless of consumer class, a flat rate is charged for unlimited volumes of water, while a uniform rate is charged at a constant price per unit of water consumed. These types of pricing are usually practical in countries with abundant water sources. The method is simple to design and administer, and is the most popular with consumers. However, since the monetary rate is constant, the marginal cost of water to the consumer is zero, and there is no incentive to conserve or reduce consumption. The flat rate usually includes installation charges and a fixed service charge per billing period, regardless of the amount of water consumed, especially in unmetered urban areas or for providing surface irrigation. The uniform rate is based on the average cost concept where total cost is divided by the number of units of water consumed. The cost of service is not the primary reason for adopting a uniform rate structure. Under such a pricing scheme, the same price is charged for a given area over a given time period, and for a given user group (ESCAP, 1996).

(b) **Block rates**. Block rates can either decline or increase, according to consumption. Water consumption is divided into blocks, and rates vary from one consumption block to the next, with respect to the volume sold. The rate charged is lowered for each ascending block, and the opposite is true for a declining block rate. Block rates favour small water consumers (the poor). Increasing rates can be used to recover the full marginal costs of a new water source. Increasing block rates can be justified when identifiable customer groups exist. In the case of declining block rates, the marginal price of water is reduced by moving to the next higher block of consumption, whereas the opposite is true with regard to marginal costs in the case of a progressive block rate. Declining block rates provide no incentive to conserve water, and the increasing block rate is only minimally effective as a conservation tool.

Marginal cost pricing is best achieved with the implementation of a progressive tariff structure. The rate of the tariff can be designed to discourage off-peak consumption. Since the marginal price is higher than the average price for an increasing rate structure, the progressive block rate structure would be more effective in discouraging water consumption than either a uniform or decreasing block rate. None the less, the use of progressive block tariffs does not in itself imply anything about the marginal cost of water. In some countries, particularly some of the ESCWA member States, even the highest block is priced well below the incremental cost of supply.

Declining block rates have been common in regions and countries with substantial excess supplies of water; however, they are not appropriate when water utilities are operating close to or at full capacity, because this does not induce water conservation with the aim of avoiding extra investment outlays to expand capacity. In developing countries, including some of the ESCWA member countries, progressive block rates are commonly used for pricing municipal water. They are often used when there is a shortage of supply, and for water conservation.

Another form of water charge has been established based on the size of the water supply pipe or meter. The fixed monthly fee could be used to reflect economics of size of the delivery system capacity. In addition, sometimes peak demand changes, and this can be used to overcome the difficulties associated with water system capacity. Peak demand tariffs have the effect of limiting usage during critical times.

(c) **Seasonal and peak rates**. Seasonal rate structure differs from peak and off-season periods by the introduction of higher rates during certain seasons. The same rate structure can be applied for hours in a day rather than on a seasonal basis, known as peak rate. Customers are charged premium rates for using water during peak periods. Peak rates provide one method of sending price signals to consumers. Seasonal and peak rates can consist of two basic types: one is to delineate the peak and off-peak hours or seasons, and the other is by adding a surcharge for high level usage during peak periods.

For situations where demand for water exceeds capacity at the prevailing rates, the price scale could be revised upwards to lower demand to the level of existing capacity. In this case, a capacity duty would be levied on all users to restrain consumption and postpone capacity expansion. A similar idea could be applied in periods of drought in order to ration the limited supply of water.

(d) **Conservation rates**. Several rate structures could be combined to bring about greater efficiency and conservation. Examples of conservation rate structure include a combination of progressive block rates, peak season rates, and excess use surcharges. These rates would directly influence water use patterns in order to delay the need for developing additional facilities for water supply and distribution (Duke and Montoya, 1993).

(e) **Capacity rates**. This water pricing charge is based on the size of the house connection pipe, or the size of the water meter. Under this rate structure, the consumer pays for delivery system capacity in proportion to the capacity available to them. Another form involves fixture and appliance charges. Customers are charged according to the number of water-using appliances they own.

The different types of water-charging structures have been used mainly in the domestic sector, and to a limited extent in the industrial sector. In the domestic sector, a minimum charge is often added in the case of municipally metered water use, regardless of consumption volume or the applied price structure. However, minimum charges are considered inequitable from the economic standpoint, since they penalize low volume consumers by charging for water that is not consumed. Therefore, in many countries, this pricing mechanism is being replaced with a service charge that covers all administrative and maintenance costs with regard to water services (Goldstein, 1986).

2. *Irrigation tariffs*

(a) **Volume based rate**. In the agricultural sector, the rate structure has not evolved enough to be used as an effective tool to improve water allocation and achieve conservation. Water-charging schemes have not been implemented, owing to the farming community's opposition and the reluctance of decision makers to implement effective water pricing policy. However, some form of rate structure has been practised in the irrigation sector. Volumetric pricing based on increasing block rates has proved very effective in reducing demand for water and in reducing the volume of drainage water, when applied in California (United States of America) and Australia (Shatanawi and Joyousi, 1994; Dandy and others, 1997). Volumetric flat rate water charges were revealed to be strongly inversely related to agricultural water consumption when applied on canal irrigation in Texas (Giffen and Perry, 1985). Unfortunately, volumetric pricing of surface irrigation water is impractical in many developing countries because a number of technical and financial obstacles make it difficult to implement, especially when a large number of small farmers are involved. Under such circumstances, reliance on non-volumetric pricing techniques is the second best solution.

(b) **Non-volumetric rate**. In the agricultural sector, rates are based on volume of water used or fixed fees. Three main types of irrigation water charges can be employed. Each has a distinct impact on irrigation water allocation, and individual costs associated with its implementation. The first type is a fixed fee per unit of irrigated land per time period. In this case, the marginal cost of water is zero, owing to the assessment of a fixed fee regardless of the amount of water used. Therefore, a rate structure of this nature represents a fixed cost, and will have no influence on a farmer's decision regarding the optimum quantity of water that minimizes his cost of production. Accordingly, this type of charge offers no incentive to economize on the use of water. This rate structure, however, is easy to implement at minimal cost.

The second type of non-volumetric rate structure is a charge per irrigation application. The cost of water will vary directly with the number of irrigation applications. This kind of charge, though still not optimal, should induce some reduction in water use, in comparison with the fixed fee associated with unlimited water consumption. Some studies in Mexico have shown that districts with variable water charges exhibit considerably higher efficiency in water consumption rates when compared with areas with fixed water charges (Schramm and Gonzales, 1977). This irrigation tariff structure tends to penalize inefficient water use, and by influencing farmers' behaviour can serve as a significant instrument to boost conservation. The application of this rate structure, however, may be costly. This type of rate is best suited for regions with water shortages.

The third type of non-volumetric rate structure deals with setting water charges according to the type of crop. Both the value of the crop and the intensity of water use per crop enter into this rate structure. The value of the crop is justified on equity grounds but not on efficiency grounds, since the planting of higher value crops is discouraged. In India, for example, a reform scheme for irrigation charges suggested that water rates should be based on the type of crop or the gross income from the crop; however, when irrigation water is provided from groundwater sources the water charging scheme is based on the quantity of water supplied (Prasad and Rao, 1991). Water rates based on gross income of crops, as a general practice without differentiation, could produce reverse effects by penalizing farmers for the cultivation of higher value crops thus influencing them to switch to lower value crops in order to avoid higher water charges.

The intensity of water use per crop, where the charges are tied directly to the average amount of water required for irrigation of a particular crop, is another method of charging for agricultural water consumption. This type of rate structure would discourage the cultivation of water-intensive crops such as sugar cane and rice, and would promote the growing of alternative crops, which in turn would stimulate a move towards water conservation. However, such a rate structure could be resisted in some cases on the grounds of food self-sufficiency. In such cases, an economic assessment of the net social and economic benefits of implementing the tariff design would be required. In general, setting crop rates requires careful study because if rates are not properly set, it may alter the agricultural patterns of the country.

In conclusion, economic principles can provide an effective means to achieve water use efficiency and promote conservation. The successful implementation of pricing policies to achieve these goals depends on the socio-economic situation of the country, the political will of decision makers, and the existence of effective legal regulations and enforcement mechanisms.

II. WATER PRODUCTION AND CHARGES

A. INVESTMENT COSTS

The ESCWA member countries, because of increasing demand and the need to meet water requirements in the domestic, industrial and agricultural sectors, have been compelled to increase their investment in water production and distribution facilities. The degree of financial investment varies among the member States, and depends on the local economic conditions.

A brief review of trends in financial investments in water and water-related projects provides an indication of the cost of water production from both surface and groundwater sources, as well as desalination. Investment in water supply augmentation, especially for the domestic sector from both conventional and non-conventional sources, has been rising in most of the ESCWA member countries. The ESCWA member States have been investing a substantial portion of their annual budget on water development and distribution projects.

In Jordan, investments in water projects during the period 1976-1990 accounted for about 12% of the annual budget (Abu-Taleb and others, 1992). Total investment in the water sector reached 930 million Jordanian dinars (JD) during the period 1973 - 1992 (FAO, 1994). Meeting future water demand, particularly if desalination is to become a viable option, will require a considerable investment in excess of a US$ 1 billion. Similarly, in the Syrian Arab Republic, a large proportion of the annual budget, ranging from 60%-70% of the funds allocated to the agricultural sector, has been devoted to irrigation water projects and facilities (FAO, 1996b).

In the GCC countries large investments have been undertaken, mainly in sea water desalination facilities. In Saudi Arabia alone, during the period 1963-1993, investment in water supplies and desalination facilities reached approximately US$33 billion. During three successive five-year plans (1975-1990) the Government of Saudi Arabia invested $12 billion in water facilities. During 1996-1997, 4% of the annual budget has been allocated to municipal water projects and services (MEED, 1997b). This huge investment by countries in the Arabian Peninsula resulted in achieving 1,640 mcm of desalinated water production capacity in 1988, which increased to 2,120 mcm in 1997. Additional investment is needed to expand capacity to 3,000 mcm by the end of this century (ACSAD, 1997). It is expected that an additional US$15 billion may be needed after the year 2000 to replace ageing desalination facilities (Bushnak, 1993).

The economic situation in most of the ESCWA member States, with the exception of the GCC countries, has compelled them to seek foreign loans or grants to finance some of their development activities including water programmes. The World Bank represents one of the major project financiers. During the period 1960-1992, the World Bank provided loans for water projects in Egypt and Jordan amounting to 15% of these countries' total foreign loans. At the same time, loan percentages were 18%, 28% and 49% for Yemen, Iraq and the Syrian Arab Republic, respectively (World Bank, 1994b). In Egypt the World Bank devoted 79% of its loan value to finance irrigation projects. In Yemen, the percentage was 51%.

In addition to foreign loan investments, capital costs of water projects, as well as operation and maintenance costs, have been financed from the annual budget. Private investment in these projects is virtually non-existent in the ESCWA region. However, in the member States of Egypt, Jordan and the Syrian Arab Republic, the operation and maintenance costs have been partially recovered. In Egypt, for example, the Ministry of Public Works and Water Resources is responsible for carrying the burden of operation and maintenance costs for the main irrigation and drainage systems in the old agricultural areas, while farmers are responsible only for the cost of maintenance of their own irrigation canals (*mesqas*). For certain projects, the Government is partly reimbursed for these costs, as in the case of the Nile Drainage project, where farmers utilizing the system contribute funds over a 20-year period with zero interest (FAO, 1994). For new agricultural lands the situation is different: farmers bear the cost of operation and maintenance in addition to on-farm capital costs. In a country such as Jordan, only in the case of groundwater irrigation does the private sector, with drilling permits issued by the Ministry, bear all the costs of well drilling and equipment installation to abstract and distribute the groundwater, in addition to the cost of maintaining the wells (FAO, 1994).

In general, domestic water supplies and irrigation projects require initial capital investment. This investment includes the costs of capital, development and operation and maintenance, and is usually funded by the Government. Recently, however, construction projects, mainly in the domestic sector, have been given, on a limited basis, to private contractors.

The countries in the ESCWA region are giving high priority to providing adequate and safe water to all urban and rural communities. However, the lack of financial resources represents a major constraint confronting the Governments of the region with respect to the development of water supply and sanitation facilities. The costs of closing the gap between increasing demand and additional new resource development, as well as expanding water infrastructure, are beyond the reach of most of the member States. The GCC countries are in a better position, financially, to invest in water projects. However, the increasing rate of water consumption is creating additional burdens on their annual budgets. In the rest of the ESCWA member countries, there is a need for significant funding several times larger than the financial resources available. There is a lack of private participation in the funding of water projects including development, services and management. Private sector involvement can play an important role in generating funds for water supply and sanitation services. However, participation of the private sector requires the availability of a suitable financial environment that will encourage involvement in the water sector. Encouragement of private sector participation can only take place if the Governments of the region undertake institutional, regulative and financial adjustments for the purpose of directing funds to the water sector.

B. PRODUCTION COSTS

The costs of water, from production to distribution, may involve initial capital investment, treatment, storage and transmission, system operation, maintenance, administrative overhead, and financial costs. Cost components depend on the source of water being developed, the transport distance and topography, as well as the current and future status of the distribution system.

The cost of water is influenced by many factors, such as the nature of water resources (surface and groundwater, imported, desalinated, or treated wastewater), quantity and quality of water sources, accessibility (geographic location and depth), serviced areas, the size of beneficiary communities and their population concentrations, water rates and cost of living, as well as the cost of energy and other operating and maintenance costs. Surface water development costs involve construction of storage, treatment and diversion structures, pumping facilities and distribution networks. Groundwater costs involve the capital costs of well construction, development, and treatment, as well as water distribution. Desalination and wastewater systems involve capital costs for infrastructure, treatment, and distribution. Operation and maintenance costs mainly involve the management of all water sources.

Water production costs for surface water, groundwater and desalination vary among the countries of the region. Surface water costs are usually much smaller than the costs of either groundwater or desalinated water. Cost estimates usually depend on the water source. However, the cost of production at the source is influenced by the type of water treatment and energy costs for lifting and transporting water to distribution points. The initial quality of both surface and groundwater, as well as sea water, influences the cost of treatment. The depth of the groundwater aquifer influences the production cost with regard to the energy required for pumping it to the surface.

1. *Average water costs*

The availability of detailed water production and distribution cost estimates is essential for evaluating and selecting the most feasible development alternatives for water sources. The average cost of water supply, as displayed in table 4 and figure II, not only varies widely from one ESCWA member country to another, but also differs by sector within the country itself. For instance, the estimated average total cost of municipal water in Jordan in 1994 was more than twice the cost in Egypt. Similar figures are evident when comparing the operation and maintenance of surface irrigation systems in those two countries; Jordanian operation and maintenance costs for surface irrigation represent about four times the costs in Egypt. Unfortunately, cost estimates over time are not available in order to extrapolate the exact trends in average costs of water supply in these two countries. In addition, detailed water cost information is lacking in most of the ESCWA member countries, which makes it difficult to design effective pricing policy.

The general costs of water production from different sources, i.e. surface water (mainly perennial river flow), shallow groundwater, and sea water desalination, for selected ESCWA member countries is shown in table 4. Generally, the cost of surface water development is much less than for groundwater and substantially lower than the cost of desalinating sea or brackish water.

2. *Surface water costs*

Water production costs from surface and groundwater sources in the ESCWA countries display large variations. The cost of water production, as indicated in a 1985 study (ESCWA, 1985), was reported to be low for surface water. In Egypt, the estimated cost of water supply development in 1980 for surface water diversions, was estimated at US$ 0.037 cubic metre. Water production, including distribution costs, increased to US$ 0.25 per cubic metre in 1994 (ESCWA 1994). Surface water costs from large hydraulic structures in Iraq depend on the reservoir's storage capacity. For the Mosul dam, completed in 1983, with a storage capacity of 12.6 billion cubic metres, cost was estimated at US$ 0.046 per cubic metre, while costs for water from the Derbandi dam, with a storage capacity of 3.2 billion cubic metres, were estimated at U.S.$ 0.024 per cubic metre at 1961 prices. The cost of water from the Maarib dam (in Yemen), which was developed for flood water control with a storage capacity of 600 million cubic metres, was estimated in 1981 to be US$ 0.11 per cubic metre. Costs for water from the small capacity of the Wadi Musairita dam in Yemen, with a capacity of 0.9 million cubic metres (0.9 million cubic metres) were estimated at US$ 1.10 per cubic metre.

Recent data indicate that the total cost of water production over the last five years, including operation and maintenance, in countries with perennial river flow such as Egypt, Iraq and the Syrian Arab Republic, is relatively small. For municipal purposes, the range in cost per cubic metre of water is from US$ 0.12 in Iraq to US$ 0.29 in Egypt. The cost of irrigation water ranges from US$ 0.006 in Egypt to US$ 0.08 in the Syrian Arab Republic. The higher cost of municipal water can be attributed to distribution and treatment facilities.

3. *Groundwater costs*

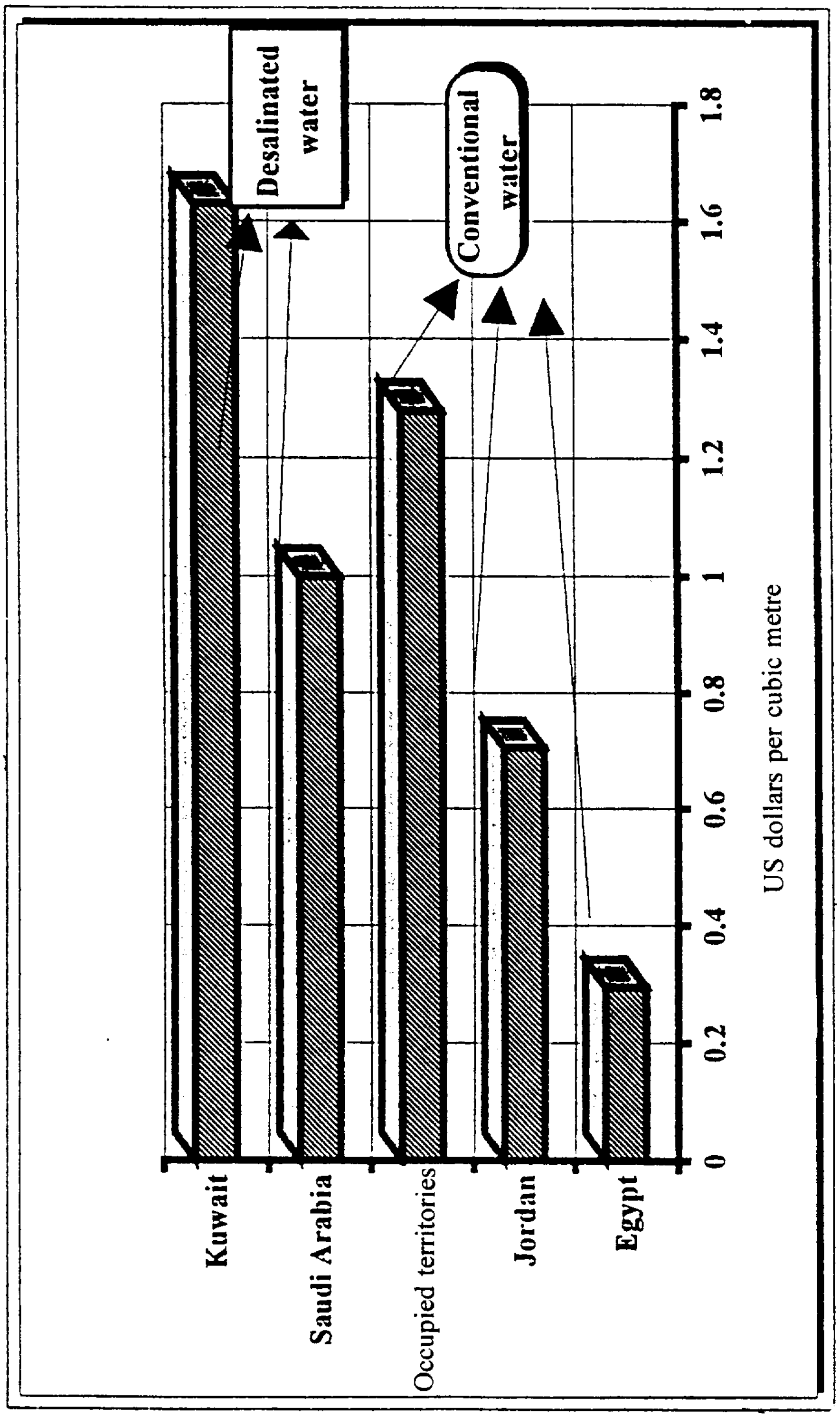
The major costs of groundwater development consist of capital costs for well construction and pumping, as well as for well operation and maintenance with regard to the energy required for lifting and moving water. Capital costs for well construction include drilling, casing and testing. The estimated cost depends on the aquifer's hydro-geological characteristics, the well diametre, and casing material. The

TABLE 4. AVERAGE WATER SUPPLY COSTS IN SELECTED ESCWA MEMBER COUNTRIES (1984-1994)

				Cost/m^3		
Country/area and reference	Year	Sector	Type of cost	Local currency	US$	Water source
Egypt (FAO, 1994)	1994	Municipal	Aver. total	1.00	0.295	Surface water
			O & M	0.45	0.133	
(Abu Zaid, 1992)	1992	Irrigation	O & M	0.01-0.02	0.003-0.006	
Iraq (Kuwait Fund, 1993)	1987	Municipal	Aver. total		0.118	Surface water
Jordan (FAO, 1994)	1994	Municipal	Aver. total	0.5	0.706	Groundwater
		Irrigation	Aver. total	0.0375-0.0598	0.053-0.085	For surface irrigation
			O & M	0.0099-0.0177	0.014-0.025	
			Pumping	0.35-0.65	0.071	From wells
Kuwait (IBS, 1995)	1994	Municipal			1.630	Desalinated water
Occupied territories (Medwan, 1995)	1991/94	Municipal	Aver. total		1.280	Groundwater
WARP Task Force, 1994) (ESCWA and FAO, 1994)	1990	Irrigation in Gaza			0.100	
					0.100-0.200	Shallow wells
					0.280-0.340	Deep wells
					0.740	Groundwater New well
Saudi Arabia (Kuwait Fund, 1993)	1987	Municipal	Aver. total	3.7	1.000	Desalinated water
Syrian Arab Republic (Ahmad, 1994; ESCWA, 1994)	1987	Irrigation		0.89-1.6	0.079-0.143	Surface water; groundwater
GCC countries (Bushnak, 1992)	1992		Aver. total	1.87-9.38	0.5-2.5	Desalinated water

Notes: O & M = operation and maintenance. References in this table are contained in full in the references for part one of this study.

Figure II. Average cost of municipal water (1987-1994)



operation costs are influenced by the depth to the water table in relation to the energy required. The approximate cost of pumping water from renewable underground water is positively correlated with the depth of the well. It was estimated that the average cost of extracted water rises consecutively from US$ 28 to US$ 40 to US$ 62 per cubic metre as the depth of the well increases from 70, to 100, to 350 metres respectively (Essa, 1994). In other countries and areas in the ESCWA region that depend mainly on groundwater, such as Jordan, the areas under the Palestinian Authority, and the GCC countries, some of the actual costs are much higher than that reported for countries that depend on surface water. Groundwater development costs in the areas under the Palestinian Authority, including pumping costs, ranged from US$ 0.1 to US$ 0.2 per cubic metre for shallow wells, while for deep wells, the range was $0.28 to $0.34 per cubic metre (Ahmed, 1994). In Gaza, user costs may reach U.S.$0.79 per cubic metre. The high cost of water is directly linked with topographic elevation and energy costs. Municipal water production costs range from $0.3 per cubic metre to $1.63, as shown in table 4.

In Jordan, capital costs for water production for all water projects were estimated at $0.68 per cubic metre. Operation and maintenance costs in 1988 were estimated at $0.28 per cubic metre (Salameh and Bannayen, 1993). Irrigation water cost is lower than municipal water cost as a result of easy accessibility and the absence of water treatment. In Yemen, according to 1985 data, costs associated with the development of groundwater from the alluvial wadi formations ranged from $0.02 to $0.1 per cubic metre (ESCWA, 1985). Groundwater production costs in the Syrian Arab Republic from major aquifers ranged from $0.034 to $0.34 per cubic metre. In Qatar, groundwater development for municipal purposes was estimated at $0.17 per cubic metre at the 1974 price, while for the agricultural sector costs were estimated at $0.03. High domestic municipal costs may be attributed to treatment and transportation costs. In 1996, groundwater development costs in Kuwait were estimated at $0.18 per cubic metre. The distribution costs for groundwater were estimated at $0.44 per cubic metre. Private vendors charge for groundwater supplies in Jordan, and prices range from $1 - $3 per cubic metre in the summer, while in Yemen the charge is approximately $5 (World Bank, 1994a).

Operation and maintenance expenses constitute one component of water development costs. The farmer in Jordan, specifically in the Jordan Valley, bears the cost of operation and maintenance. The cost of water represented by operation and maintenance costs in the Jordan Valley was approximately $0.03 per cubic metre in 1985 and increased to $0.05 per cubic metre in 1991 (Sadik and Barghothi 1994). Increases in cost were attributed to decreases in the availability of water. A large portion of the operation and maintenance costs, about 65%, were covered by the increased revenues. The cost of operation and maintenance decreases as the volume of available water increases as a result of more flow in the East Ghor Canal.

In the Syrian Arab Republic, charges for irrigation water from surface sources cover only a small portion of supply costs. Capital costs, and operation and maintenance costs are not covered. The water charge scheme for irrigation is based on the size of the irrigated area. In Egypt, part of the irrigation costs are indirectly recovered through land taxes.

4. *Desalination costs*

The GCC countries depend on desalinated water for municipal purposes and are faced with high production costs. Desalinated sea water costs, depending on the size of the plant, range from $0.4 to $3.5 per cubic metre, and between $0.4 to $1.5 per cubic metre for brackish water. Desalinated water represents a major component of water supply in these countries. The cost of water production using different types of desalination processes is influenced by the following factors: technology (multi-stage flash, reverse osmosis), the size and expected life of the plant, whether the plant is used for dual purposes with regard to water and power generation, water source and quality, plant location, interest rate, spare parts and other maintenance costs, cost of energy used, labour costs, and the plant factor load (ESCWA, 1987 and 1995a).

Desalination facilities require high initial capital investment and operating and energy costs. The high cost of energy is usually one of the most limiting factors of water production. However, the availability of fuel, either free or at subsidized rates as in the GCC countries, limits the impact of energy costs. Usually, costs decrease with increased plant capacity. Costs reported by the Gulf countries are usually less than for countries in the rest of the world because of subsidized energy costs. For example, the cost of producing desalinated water in Saudi Arabia ranges from $0.48 to $0.75 per cubic metre, for large-scale desalination plants. For small plants, the cost per cubic metre may reach $1.9. In the United Arab Emirates, water costs range from $1 to $1.45, in Qatar the range is $1.14 to $1.64, and in Bahrain the cost is $0.56. In Kuwait, 1996 reports showed costs at $0.94 per cubic metre, with an addition of $0.72 per cubic metre for distribution. In other parts of the world, where energy costs are not subsidized, production costs are somewhat higher; for example, in Florida and the United States Virgin Islands, costs range from $2.06 to $2.60. In Malta the cost is $1.18, and in the Canary Islands it is $1.62. In general, water production costs for desalinated water in many countries of the Arabian Peninsula are lower than in the rest of the world because of subsidized fuel costs. The costs of water production from desalination plants are shown in table 5.

TABLE 5. COSTS OF DESALINATING SEA WATER

Country/area	Process	Capacity m^3/D	Year	US$/$m^3$
Saudi Arabia Al-Jubail	MSF	1 100 000	1980	0.36** 2.61***
Saudi Arabia Jeddah	RO	57 000	1989	0.48
Bahrain	MSF	23 000	1975	0.56
Malta	RO	15 000	1986	1.18
Canary Islands	RO	36 000	1989	1.62
United States, Florida	MSF	10 000	1967	0.22* 2.69

Notes: RO = reverse osmosis.
MSF = multi-stage flash.
MBTU = million British thermal units.

* Initial period of operation 1967.
** Fuel substitutes as 0.22/MBTU.
*** Interaction mark of $2.25/MBTU.

Brackish groundwater desalination is being used more near major urban centres because the cost of production is less than for that of sea water. The major cost components consist of investment in desalination plants, well drilling and pumping, and brine water disposal. The disposal of brine resulting from the desalination of brackish water presents a major environmental constraint. For this reason, small desalination plants for brackish groundwater are usually found inland near urban centres, especially in Saudi Arabia. Plants generally have smaller capacities of up to 20,000 cubic metres per day in comparison with large sea water desalination plants where capacities may exceed 100,000 cubic metres. Small plants are common owing to the limited volume of extraction possible from a large number of wells. Brackish water desalination usually involves the use of the reverse osmosis process. However, the cost of treatment is much less than for sea water desalination, usually $0.3 to $0.65 per cubic metre, owing to low salinity. The cost of water production depends on plant size and on the concentration of certain salts, heavy metals and organic materials. The breakdown of construction costs is as follows: 38% for capital investment, 20.5% for energy, 21.3% for labour, 16.2% for maintenance, and 4% for chemicals. An example of the actual breakdown of desalination costs is presented for the city of Jeddah in Saudi Arabia, a major urban centre that depends mainly on desalination for its domestic water supply. The average cost of water is estimated at $0.67 per cubic metre, which includes annual capital outlay as well as operation and maintenance costs. The unit capital cost of water in Jeddah is estimated at $0.21 per cubic metre, assuming a 10% interest rate over a 20-year recovery period. In general, for most desalination plants in Saudi Arabia, the average operating and maintenance cost is estimated at $0.29 per cubic metre.

The total cost for water from the desalination plant usually reflects the cost of its production at the source. In addition, the cost of transporting desalinated water depends on the distance of the water source from the distribution points. Transport cost for water from large desalination plants located at Jubail on the Gulf, to the capital city of Riyadh in Saudi Arabia, located 460 kilometres away and 620 metres above sea level, was estimated at $0.2 per cubic metre. Additional costs are incurred for transportation, and distribution, the cost of which is sometimes influenced by the magnitude of leakage within the distribution system. When system leakage is considered, the true costs may increase substantially. For example, in Jeddah, a 30% leakage rate in the system translates to a cost for water of $3.6 per cubic metre (annual volume of desalinated water x cost of producing 1 cubic metre, divided by the percentage of water delivered, and by the volume of water).

5. *Wastewater treatment costs*

Treated wastewater presents a viable option for meeting rising demand in the agricultural and industrial sectors. Limited reuse of treated wastewater is being practised for selected crops and for recycling in industry. Thus, data on treatment costs are needed to evaluate this option. The cost of water treatment depends on the process used and the level of treatment required for a particular use, as well as reuse of effluent. The cost of advance treatment of municipal wastewater was estimated to be less than $0.4 per cubic metre in 1980 (ESCWA, 1985). The cost of treatment is decreasing as a result of technological advances. An ESCWA study on wastewater reuse (ESCWA, 1985) presented cost evaluations for a range of treatments from secondary to tertiary level. Based on the 1981 cost index, prices for treated wastewater ranged from $0.15 to $0.43 per cubic metre, as shown in table 6. The annual costs were reported for different cities in Saudi Arabia, based on the 1987 exchange rates, with a 20-year plant life operating at 60% of capacity, with a 5% interest rate.

The annual cost per cubic metre of water, according to the type of treatment process, as reported in 1988, for a plant with the capacity to produce 38,000 cubic metres per day ranged from $0.16 to $0.75. The cost of water produced using an activated sludge treatment system was estimated to be $0.16. Secondary treatment plus filtration was $0.19, secondary treatment plus activated carbon was $0.23, and advanced treatment plus reverse osmosis was $0.75 (Ukayli and Husain, 1988). The annual operation and maintenance costs were assumed to be 2.7% of the total capital costs. In the ESCWA region, however, increasing demand for water necessitates the evaluation of the cost of new water sources or marginal costs of new supplies. The scarcity of water resources also requires the evaluation of marginal cost to enhance economic efficiency. The marginal cost concept addressed previously will help identify costs associated with new source development or expansion of water facilities.

TABLE 6. WASTEWATER TREATMENT UNIT COSTS

Country/area	Capacity m^3/day x 10^3	Treatment level	Base/year	Costs \$/m^3
Bahrain	-	-	1984	0.28-84
Egypt	-	-	1980	0.05-2.9
Kuwait	343	Secondary	1981	0.18
Qatar	-		1981	0.26*
Saudi Arabia				
Jeddah	50	Tertiary	1988	0.43**
Mecca	50	Tertiary	1988	0.24
Riyadh	200	Secondary	1988	0.11
United Arab Emirates	200	Tertiary	1981	0.44
South Africa	-	Tertiary	1981	0.13-0.31
California				
Tahoe	28	Tertiary	1981	0.35
Santa Clara	15	Tertiary	1981	0.15
Orange County	57	Tertiary	1981	0.24

* Free energy.
** Reverse osmosis.

C. COST OF NEW WATER SUPPLY

The increase of water supply capacity in a country is not something that occurs gradually on a daily basis. The existing capacity is usually invariable in the short run. The large, indivisible nature of water production facilities needed to replace standing capacity or to augment future supply of water makes the incremental changes in production costs enormous. Such distinctive characteristics of natural monopoly utilities, such as electricity, communications and water, render the calculation of its exact marginal cost a difficult task. Therefore, estimates of the cost of water from new supply projects and from non-conventional sources of water can be used as an indicator of the marginal costs of providing additional water sources. Most of the ESCWA member countries, and particularly the GCC countries, are expected to initiate the use of, or continue to rely on, desalination facilities. Treatment of wastewater to appropriate levels for reuse represents a major water supply option for the region. The unit cost estimates of water from some new projects in selected ESCWA member countries, for surface, groundwater, treated wastewater and desalination, are shown in tables 6 and 7. The average estimated cost of producing water from non-conventional sources is presented in tables 7 and 8. For instance, in Jordan, private water vendors charge about \$3 per cubic metre in summer, and in Yemen the charge is approximately \$5 per cubic metre (World Bank, 1994a). In 1996, the cost of producing 1 cubic metre of desalinated water in Kuwait was estimated at \$0.94.

With regard to future development and its associated costs, a few feasibility studies of Al Wahda dam in Jordan indicated that the marginal cost of developing this additional surface water source will amount to \$0.34 per cubic metre, and operation and maintenance cost of \$0.1 per cubic metre (Sadik and Barghothi, 1994).

TABLE 7. MARGINAL COSTS OF DEVELOPING NEW WATER SOURCES IN SELECTED ESCWA MEMBER COUNTRIES

Country and reference	Water sources	US$ S/c.m. in 1984 prices	US$/c.m. in 1990 prices*
Egypt (FAO, 1994)	Reuse of drainage water	0.0014	0.0028-0.0039
	Surface water (upper Nile)	0.0022	0.0044-0.0061
	Groundwater	0.0056	0.0112-0.0156
	Treated wastewater	0.0095	0.0190-0.0264
	Treated industrial wastewater	0.0133	0.0266-0.0370
	Desalination	0.355	0.7100-0.9869
Jordan (World Bank, 1994b)			Year 1990-1993
	Wastewater treatment in Amman	0.37	
	Groundwater treatment	0.41	
	Surface water from Jordan Valley	1.00	
	Supply to Amman from suggested WHDA Dam	1.00	
(Abu-Taleb and others, 1992)	Desalination in Aqaba (in 1990 prices)	6.00-7.00	

Note: References in this table are contained in full in the references, for part one of this study.

* Estimates calculated by readjusting the figures in 1984 prices to 1990 prices by using the GDP price deflators of both Egypt (the lower figure) and the higher figure, using data of IMF, International Financial Statistics Yearbook, 1994.

TABLE 8. COST OF NON-CONVENTIONAL WATER SOURCES

Source of water	US$/cubic metre	Source of water	US$/cubic metre
Desalination	0.500-2.500	Rubber bags	1.700-2.200
Brackish desalination	0.400-0.800	Iceberg	0.020-0.850
Water reuse treatment	0.070-2.200	Proposed pipeline	0.735-1.758
Tankers	1.250-7.500		

Source: H. Khordagui, "Prospects of non-conventional water resources in the Arabian Peninsula", paper presented at the Symposium on Water and Arab Gulf Development; Problems and Policies, University of Exeter (United Kingdom), September 1996.

Recently, treatment cost estimates have become available for Oman and the United Arab Emirates. The cost of a waste treatment tertiary system in Oman, including collection and distribution costs, ranged from $1.53 to $1.74 per cubic metre. In the United Arab Emirates, the cost of waste collection and treatment was estimated at $0.30, while for reuse it was estimated at $0.40 per cubic metre. Wastewater treatment for reuse in the agricultural sector was estimated at $0.13, while distribution costs were estimated at $0.04. The use of bottled water is also increasing in most of the urban centres. The cost of bottled water ranges from $0.50 to $1 per litre, which gives an indication of the public's willingness to pay for water even if its cost is above the marginal cost of water production.

It should be pointed out that detailed cost components are lacking, and costs have usually been presented as a lump value estimate. The reported estimated costs do not take into account the social and environmental consequences. In countries that depend on groundwater sources, particularly those located in the Arabian Peninsula, marginal cost estimates would be best represented by the cost of water produced from the nearest alternative source, i.e. desalination plants. Another option would be to focus on user cost concept where a scarcity premium is applied in addition to marginal costs (Al-Dukheil, 1995) when dealing with non-renewable groundwater sources. The marginal cost reported in tables 7 and 8 includes the cost of tapping new water supplies, which may increase with time.

In conclusion, conventional water costs, even for countries that depend on groundwater sources, are much lower than those for non-conventional water sources. The cost of desalination, especially in small plants, and of wastewater treatment at the tertiary level is prohibitive. The presentation of the marginal costs of various supply options can be used to establish water charges (tariffs) in the ESCWA region, which is needed to achieve efficient water use and conservation.

D. WATER CHARGE CHARACTERISTICS

In the ESCWA region, the percentage of urban population served by the water supply system ranges from 75 to 93 (ESCWA, 1995b). The degree of sewerage coverage is small in comparison with the water supply distribution system. A small percentage of residents in rural areas are connected to municipal water supplies, while the rest receive their water by tanker trucks. These areas also may have public water taps, and limited storage facilities. In urban areas, the public is connected to the municipal water network, and are charged according to certain water tariff structures, or on a monthly basis.

The coverage of services in the domestic sector varies among countries of the region, depending on the financial conditions. Service time coverage also varies, ranging from continuous 24 hour water supply service to intermittent supply. Recently, domestic water demand increases have contributed to increased incidence of interrupted water services.

TABLE 9. DOMESTIC WATER TARIFFS IN SELECTED ESCWA MEMBER COUNTRIES

Country and reference	Year	Water sources	Consumption bracket (m^3)	Tariff/m^3		Comments
				Local currency	$/$m^3$	
Bahrain (GCC Sect., 1996)	1996	Desalination + groundwater	0-60	0.025	0.067	
			61-100	0.080	0.212	
			>100	0.200	0.532	
			Min. Charge	1.500	3.990	Monthly
Egypt (Medwan, 1995)	1988/89	Surface water	1-30	0.10	0.0295	Rates are for water only, i.e. they do not include charges for sewerage. A surcharge for sewerage on water bill of 15 Egyptian pounds as expected to be applied in some cities in 1997.
			>30	0.13	0.383	
	1993/94		1 to 30	0.23	0.069	
			>30	0.30	0.088	
Iraq (ESCWA 1985)	1985	Surface water	0-60	0.012	0.04	
			60-90	0.015	0.05	
			90	0.021	0.067	
Jordan (Ghazawi and Dajani, 1995)	1996	Groundwater	0-20	0.10	-	
			21-40	0.190	0.268	
			41-70	0.45	0.636	
			71-100	0.55	0.776	
			101-250	0.70	0.989	
			>250	0.73	1.031	Amman
		Groundwater + surface water	Min.charge	0.20	0.282	
			0-20	0.065	0.097	
			21-40	0.090	0.135	
			41-70	0.29	0.4152	
			71-100	0.52	0.735	
			101-250	0.70	0.989	
			>251	0.730	1.031	
			Min.charge	0.2	0.282	
			Water Tanker	2.0	2.825	Outside Amman

TABLE 9. (*continued*)

Country and reference	Year	Water sources	Consumption bracket (m^3)	Tariff/m^3 Local currency	$/$m^3$	Comments
Jordan (*continued*)	1996	Surface water & groundwater	0-40	0.065	0.0937	Rural areas
			41-70	0.130	0.184	
			71-100	0.270	0.381	
			101-150	0.45	0.636	
			151-250	0.65	0.918	
			7.250	0.73	1.031	
			Min.charge	0.015	0.021	
Kuwait	1997	Desalination mixes with groundwater	-	0.176	0.590	Area-metred
		on	-	0.220	0.739	Area-metred
		Desalination blend with groundwater	-	0.066	0.222	Tanker
	1997	Brackish water	Daily charge	0.30	1.01	0.5 inch connection
				0.50	1.68	0.75 inch connection
				0.8	2.68	1
Lebanon	1993	Surface + groundwater	monthly charge	60.000	8.71	
Qater (GCC Sect., 1996)	1996	Groundwater + desalination		4.4	1.210	Connected to network (all users)
			No limit	200.000	55.000	The value per tank not c.m.
Syrian Arab Republic	1990	Surface + groundwater	Fixed/month	36.00	3.21	
			1 to 20	1.25	0.11	
			21-30	2.0	0.18	
			>60	6.00	0.53	
Oman (GCC Sect., 1996)	1996	Groundwater + desalination	No limit	0.44	1.140	
United Arab Emirates (GCC Sect., 1996)	1996 1997	Desalination + groundwater	No limit	50 2.20	13.62 0.6	Monthly charge

Note: References in this table are contained in full for the references for part one of this study.

Water supply and sewerage systems in urban areas, and especially for large cities, are usually serviced by a single entity, either a water supply developer or municipality. In rural areas, the water department represents the agriculture or water ministry responsible for water and sewerage services. Most cities combine charges for water services with that for sewerage. In urban areas, the water authority provides water to residential, commercial and public and recreational areas. In some situations, it also includes consumption by the industrial sector. Evaluation of the prevailing water charges helps to identify the magnitude of cost recovery and water use efficiency.

Water tariffs differ widely among the ESCWA member countries, as well as between sectors within a country. However, tariffs are largely perceived as a means of partial cost recovery and revenue generation, rather than a means of managing demand. Water charges in all sectors are much lower than the total cost of water production, especially in the agricultural sector.

Most countries of the region levy water charges on urban water supplies for domestic use. In some countries, the industrial sector relies on the urban water system; however, water charges are higher in comparison with water charges for domestic uses. In the agricultural sector, water is usually provided free of charge, and a few countries charge a small tariff. Water charges in all sectors fall far short of covering capital investment and operation and maintenance costs.

Most countries monitor water consumption by metering as a means of calculating water charges in the domestic sector, mainly in urban areas. Tariff structure in urban areas is usually based on increasing block rates or volume rates. Limited metering is practised for industrial water consumption; it is not used in the agricultural sector.

E. Water tariffs

In setting up water tariffs in the domestic sector, the trend has been to use what is known as a lifeline rate schedule for water. In the ESCWA region, this tariff system begins with a low block rate for small water consumers, and increases to a high or penalty rate for large consumers. The lifeline rate addresses the concept of potable water being a right for the poor. Under such circumstances, the low block rate has been used to achieve some income distribution. The rationale for selecting a given block rate is based on the desire to meet minimum public water requirements without contributing to undue financial burdens on consumers.

In most of the ESCWA member countries, use of the progressive block rate is a common practice. This pricing structure has been adopted by most of the member States. The block rate structure has been specifically designed to accommodate the poorer section of society. The primary concern in the ESCWA region is the extension of services to communities, especially in urban areas, rather than achieving financial independence.

According to an ESCWA study (ESCWA, 1985), there was a wide variation in water tariffs within certain water consumption sectors, as well as among the different regions. Water rates charged to the domestic sector far exceeded those of other sectors. Domestic water tariffs in 1985 were charged according to the source. In Bahrain, a uniform monthly charge of $0.302 per house connection was assessed. Kuwait charges for water according to quality. The water rate was set at $0.64 per cubic metre for water quality of 500 TDS (total dissolved solids), while the charge for brackish water, including irrigation water, was $2.7 per month. In Qatar, the domestic water supply was free of charge. In the United Arab Emirates, the water charge was estimated at $0.9 per cubic metre, while in the capital of Oman, the charge was set at $1.30 per cubic metre. In Saudi Arabia, water charges were $ 0.07 per cubic metre. In Yemen, the tariffs range according to consumption level: volumes of between 1 and 10 cubic metres cost $0.51 - $0.70 per cubic metre, while for volumes of 11 to 20 cubic metres the rate ranged from $1.12 to $1.43. Higher rates, $2.3 per cubic metre, were charged for consumption in excess of 20 cubic metres (ESCWA, 1985).

In Yemen, the sewage charges ranged from $0.704 to $2.62 per cubic metre. Water tariffs per cubic metre for government organizations, health centres, schools and mosques were estimated at $1.32, $1.01 and $0.92 respectively. Charges for water sold from pull carts at times reached $10 per cubic metre. Different tariffs were set for restaurants ($0.79), and hotels and factories ($1.76) per cubic metre.

In Damascus, the domestic water tariff was estimated at $0.03 per cubic metre, but if the consumption exceeded 45 cubic metres in a three-month period, the charge increased to $0.078 (ESCWA, 1985). In Egypt, the water tariff schedule in 1986 was based on an increasing block rate for domestic, industrial and public uses. For bulk supplies, a fixed rate was used, particularly for government institutions including ports. The domestic tariff for volumes up to 10 cubic metres was set at $0.012 per cubic metre, and above 11 cubic metres the rate was $0.0187. For industrial and public purposes, consumers were classed according to the date of connection, either before or after 1976. Connection rates for old customers were set at $0.0492 per cubic metre, while for new customers or for use in excess of the limits set in 1976, the rate was $0.0738. Governmental institutions and ports had charges of $0.092 and $0.068 cubic metres respectively. Bulk supplies up to 500 cubic metres per day were set at $0.172, and for volumes greater than 500 cubic metres, the rate was $0.338 (ESCWA, 1985).

Iraq also uses the increasing block rate structure. For domestic water consumption up to 60 cubic metres, the tariff is $0.04 per cubic metre. For consumption between 60 and 90 cubic metres, the rate is $0.0533, and for volumes over 90 cubic metres, the rate is $0.067 per cubic metre. Raw water for landscaping was set at $0.0133 per cubic metre per month, or $ 0.333 per square metre of area or garden per year. Sewage services charged in Baghdad were established at 50% of the domestic water tariffs.

During the past 10 years there have been minor rate changes in tariff structure in the ESCWA region except in Bahrain and Jordan. Water rates are still much smaller than production costs, especially for desalination. The various water tariffs in the domestic, industrial and agricultural sectors that are currently applied in most of the ESCWA member countries are displayed in tables 9, 10 and 11, showing some modification. A careful examination of those tariffs for domestic, industrial and agricultural sectors reveals a number of facts. In the domestic sector, Bahrain, Jordan, Saudi Arabia, the Syrian Arab Republic, and Yemen, as well as the areas under the Palestinian Authority, are using a progressive block rate charging system. Egypt has only two blocks in their rate structure, which cannot be considered a progressive block charging rate. However, Egypt is applying a more progressive tariff rate for water consumption in the industrial, commercial, tourism and governmental sectors. Most of the ESCWA member countries apply a progressive block rate tariff for irrigation water. Nevertheless, groundwater for irrigation is provided free of charge once the user obtains the correct permit for well drilling and water use. Syrian Arab Republic charges for the use of surface water for irrigation based on a flat rate per unit of land irrigated (hectare) regardless of the volume of water used. Kuwait also uses a flat rate for charging farmers for the use of brackish water in irrigation, but based on the volume of water consumed. Egypt, Oman and Yemen and the areas under the Palestinian Authority, do not charge directly for irrigation water. Both Jordan and the Syrian Arab Republic have updated their irrigation tariff system several times in an attempt to cope with both cost increases and water scarcity. As of 1996, the Syrian Arab Republic was expected to raise their charges for irrigation water to 2,500 Syrian pounds (LS) per hectare (about $50).

F. Comparative Water Production Costs and Tariffs

When comparing the cost estimates of water production with water charges, it is evident that there is a substantial difference between what it charged for water and the actual cost of production and delivery.

TABLE 10. INDUSTRIAL WATER TARIFFS IN SELECTED ESCWA MEMBER COUNTRIES

Country and reference	Year	Water source	Consumption bracket (c.m.)	Tariff/cubic meter: Local currency	Tariff/cubic meter: US$ c.m.	Comments
Egypt (Medwan, 1995)	1988/89	Mainly surface water	Monthly	0.31	0.0914	Industrial
				0.20	0.0590	Government
				0.55	0.1622	Tourist
	1993-94		Average price	0.20	0.590	Industrial
				0.53	0.1563	Government
				0.40	0.1180	-
				0.85	0.2507	Tourism
Jordan (FAO, 1994)	1994	Groundwater	-	0.10	0.14	
	1986			0.24	0.35	Aqaba thermal plant + phosphate mine
	1982			0.085	0.12	Industrial Complex
				0.120	0.16	White cement factory
Syrian Arab Republic (Bakour, 1994)	1994	Surface water + groundwater		8.0	0.71	Industrial, Commercial, Government and Tourism
Bahrain (GCC Sect., 1996)	1996	Groundwater	1-450	0.300	0.800	Industrial and Commercial
			>450	0.400	1.060	Industrial and Commercial
Kuwait (GCC Sect., 1996)		Desalination and groundwater	Min. Charge	9.900	26.330	
			No limit	0.066	0.222	Desalinated water Shuaiba and Abdulla Port
			No limit	0.790	2.666	The value per tank not c.m.
			No limit	0.066	0.222	Metered network
			No limit	0.264	0.889	Non-metered
			No limit	0.159	0.591	

Note: References in this table are contained in full for the references for part one of this study.

TABLE 11. IRRIGATION WATER TARIFFS IN SELECTED ESCWA MEMBER COUNTRIES

Country and reference	Year	Water source	Consumption Bracket (c.m.)	Tariff/cubic metre: Local currency	Tariff/cubic metre: US$	Comments
Jordan (FAO, 1994)	1961	Surface water and groundwater	All quantity	0.001	0.0014	Rates are for the Jordan Valley only, not highlands
	1966		1-1800	0.001	0.0014	
	1974		All quantity	0.003	0.0042	
(Ghezawi and Dajani, 1995)	1989		All quantity	0.006	0.0085	
	1995		1-2500	0.008	0.013	The beginning of applying inceasing rates
			1001-3500	0.015	0.0212	
			350-4500	0.020	0.0282	
			>4500	0.035	0.0494	
			Average price	0.015	0.0212	
Kuwait	1977	Groundwater + desalination	0-36	0.022	0.074	0-50 dunums (area)
			36-72	0.011	0.37	50-100 dunums
			72-150	0.005	0.018	100-200 dunums
			150-227	0.004	0.012	>200 monthly charges
Syrian Arab Republic (Bakoor, 1994)	1970	Surface + groundwater		75.00	6.68	5 LS of rate is for O & M
	1989			1275	113.59	200 LS of rates is for O & M
Bahrain (GCC Sect., 1996)	1996	Groundwater	1 to 60	0.020	0.053	Brackish water all users
			61-100	0.025	0.067	
			>100	0.085	0.226	

Note: References in this table are contained in full for the references for part one of this study.

In the ESCWA member States, this can be attributed to a number of factors. In Jordan, for example, the price of irrigation water in the highest block represents no more than 58% of the average cost of water, while the average price per cubic metre hardly approaches the operation and maintenance costs for surface irrigation. In 1992, only 41% of the operation and maintenance costs were recovered from farmers (FAO, 1994). With regard to municipal water use, although the price of water in the two highest consumption blocks exceeds the average cost, the average price still falls short of covering these costs. This is because the majority of municipal water consumers fall into the two lowest consumption blocks, and revenues are insufficient to cover costs. In a study conducted in Jordan in 1995 (Ghezawi and Dajani, 1995), revenues were adequate to cover only 49% of domestic water costs, and just 16% of irrigation costs. In Egypt, municipal water charges do not even cover operation and maintenance costs. The same is true in the Syrian Arab Republic, where the prices of irrigation water do not cover operation and maintenance costs. For Egypt, the price of water in the higher blocks represents about 29% of operation and maintenance costs, and no more than 13% of the average cost of municipal water. In the industrial sector, water prices rose tenfold during the period 1970-1990; however, revenues covered at most only 20% of marginal costs during that period. In most of the GCC countries, desalinated water tariffs in the domestic sector are far below the actual production cost per cubic metre.

III. CURRENT WATER PRICING POLICY

A. DOMESTIC SECTOR

Water pricing policy has been known to influence the quantity of water consumed in the domestic, industrial and agricultural sectors. The demand for water is sensitive to the level of charges. For example, the introduction of effective pricing schemes in the former German Democratic Republic resulted in a 70% reduction in per capita consumption during the period 1989 - 1997 (Feder and LeMoigne, 1994). A smaller decrease of 30% reduction in consumption was experienced in Bogar, Indonesia, when the tariffs were increased.

The system of water charges in the ESCWA region does not reflect the real economic value of water. Water charges in all sectors fall short of covering the costs of water production, development, maintenance and operation. The water subsidization policy within the domestic sector, which many Governments have justified for various reasons, will be difficult to sustain in the future. Current water prices cover only a very small portion of the costs of water supplies and distribution, and cannot be considered effective tools for motivating water conservation in the face of increasing scarcity.

The concept that water charges should reflect the actual value of water is a sensitive issue at the present time in most of the ESCWA member countries as a result of existing social, legal and economic considerations. However, there is an indication that the principle of increasing water charges may be slowly accepted over time, as the public becomes aware of impending water shortage problems, especially in the domestic and industrial sectors. Notably in Bahrain, Egypt and Jordan, the issue of pricing policy is being debated, and the focus is on selecting some form of partial recovery policy for operation and maintenance costs, marginal or opportunity pricing costs, and some limited form of privatization. There is increasing realization by decision makers that the current pricing policy is not conducive to efficient use and conservation of water, especially in the agricultural sector. The increasing gap between water supply and demand in all sectors of the ESCWA region, as shown in tables 1 and 2, has drawn more attention to the need to improve the management of water sources through supply augmentation and conservation measures, including the introduction of effective pricing tools. Currently there is a great deal of inefficiency in water use, especially in the agricultural sector, in relation to pricing policy. It is evident that there is a need to allocate water optimally among the different sectors.

A review of current pricing policy indicates that the price of water is substantially smaller than the production costs, especially for desalinated water. In the domestic sector, and particularly on a regional level, prices do not even cover operation and maintenance costs.

Water utilities, owned and managed by the Government are heavily subsidized through budget allocations. Revenues generated, in most cases, cover only a portion of the operation costs. Allocation of funds for system rehabilitation is lacking, particularly to overcome the problem of leakage in large urban centres, which has proved to be a tremendous financial burden on existing water utilities. Some countries have taken the initiative by involving donor agencies in providing adequate funds for system rehabilitation. Rapid urbanization has placed excessive demands on the capacity of public utility supply networks to provide adequate distribution coverage and services.

Domestic water prices are still too small to provide revenues to cover the cost of water production. Efforts are being made to recover adequate revenues from the commercial and tourism industries. In order to overcome future water shortages in the domestic and industrial sectors, viable options may require an adjustment or shift in agricultural water allocation, as well as the gradual implementation of pricing schemes to cover initial expenses and operation and maintenance costs. A small reduction of 10%-20% in agricultural water allocation in the future will contribute towards fulfilling water requirements in the domestic and industrial sectors.

B. Agricultural Sector

Agricultural sectors in the ESCWA region, being major water consumers using in excess of 70% of the total water requirement, have traditionally been provided with water either free of charge or at minimum cost. Future demand for water in this sector is expected to either continue at the current level of consumption, or to increase to higher levels, as shown in figure III, for most of the ESCWA member countries. A reduction in agricultural water consumption, through the application of advanced technology, administrative directives on allocation of water, and efficient pricing mechanisms, can result in savings on water that can be used to meet demand in other sectors. Because of this potential, the agricultural sector has been more elaborately discussed than the other sectors. However, the need to increase efficiency and promote conservation in the domestic and industrial sectors must not be over looked.

The cultivated area of the ESCWA region was estimated at 18 million hectares in 1995 (ESCWA, 1995b), with 44.6% being irrigated from surface and groundwater sources, and the remaining lands being rain-fed. Countries with river flow, such as Egypt, Iraq and the Syrian Arab Republic, have allocated a large portion of the supply to agriculture. The other countries rely mainly on surface water supplemented with groundwater to irrigate the remaining 42.3% of the cultivated land, estimated at 16.8 million hectares (ibid.). The GCC countries devote a large portion of their groundwater sources to irrigate approximately 71% of the cultivated land. The agricultural sector, as a major water consumer, has been contributing only a small proportion to the gross domestic product (GDP). The contribution of the agricultural sector to the GDP was estimated at 14% in 1994, and the sector's contribution to total employment at 32%. However, it is the economic backbone of many countries with regard to food production and employment. The agricultural sector's contribution to the GDP in 1994 ranged from 0.3% in Bahrain, to 34.8% in Iraq, as shown in table 12.

Current land and water policies to increase agricultural production for the purpose of achieving food security have resulted in increased water consumption and depletion of groundwater resources. In addition, rapid population growth with regard to food consumption, combined with low irrigation efficiency, has led to an overall decrease in food self-sufficiency (ESCWA, 1994). Overexploitation of groundwater has been observed in many of the ESCWA member States.

1. *Water consumption*

Groundwater depletion by the agricultural sector, especially from non-renewable sources, owing to excessive pumpage in relation to recharge, presents a dilemma for many of the ESCWA member countries: Should this vital water resource be preserved for domestic use or should it be used in the agricultural sector to produce crops with a high economic return? In most of the ESCWA member countries, the use of groundwater without monitoring of water extraction, as well as the absence of water tariffs, is leading to the depletion of this important resource.

In Jordan and Yemen, for example, withdrawal rates have exceeded replenishment by 25% - 30% (MEED, 1997b). In Yemen, groundwater mining exceeded recharge by almost twofold. In the Syrian Arab Republic, pumping depth has already exceeded or is fast approaching the economic limits (FAO, 1996b). In some places it has been uneconomical to continue pumping. This means that the marginal cost of water extraction has become so high, relative to the value of its return, that continuing extraction will have a negative net effect on the farmer's income. In Saudi Arabia there is overexploitation of non-renewable groundwater for irrigation purposes. The utilization of groundwater has more than doubled during the period 1980-1995, and more than quadrupled for satisfying domestic and industrial needs (Al-Keneabat, 1997). The share of groundwater use in the Kingdom jumped from 50% in 1980 to 83% in 1990, but dropped slightly in 1995 to 79%. This can be attributed to a reduction in wheat subsidies and higher fuel costs. In the northern part of the United Arab Emirates, the water table is dropping at a rate of 1 metre per year owing to groundwater extraction (FAO, 1994). The share of groundwater consumption by the agricultural sector in some selected ESCWA member countries is shown in table 13.

Figure III. Projected agricultural water demand in the ESCWA region

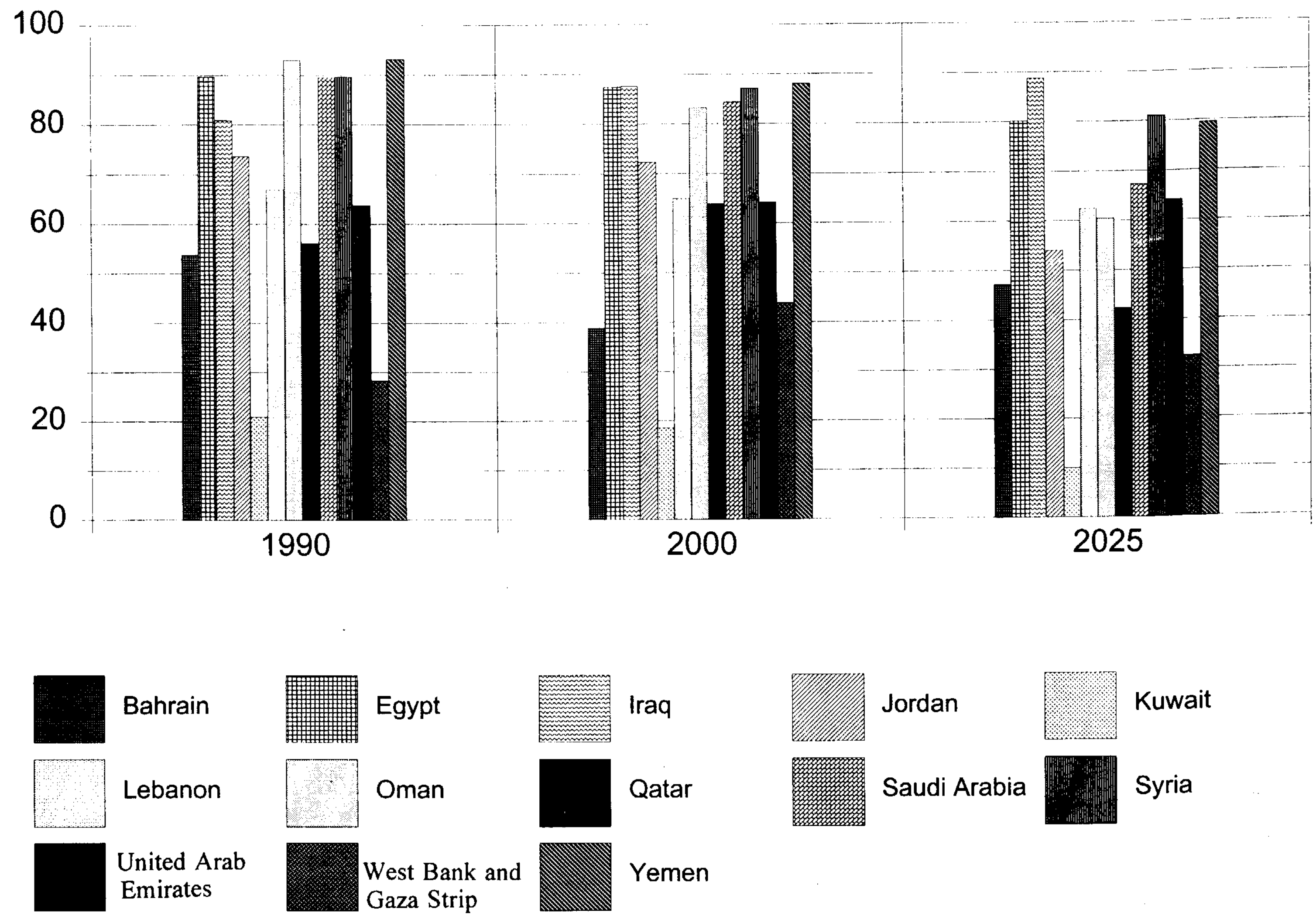


TABLE 12. MAIN FEATURES OF THE AGRICULTURE SECTOR IN THE ESCWA REGION

Country/area	Agricultural production (1994)		Irrigated area		Agricultural trade 1994 (In millions of US dollars)		Percentage of total trade		Agriculture employment 1990	Food staples self sufficiency ratio	
	Value in millions of US dollars	Percentage of GDP	(1,000) ha	Percentage of cultivable area	Imports	Exports	Imports	Exports	Percentage of labour share	1965-1967	1986-1988
Bahrain	49	1.0	3	100	303	11	8.1	0.3	..	..	..
Egypt	8 377	16.2	3 040	98.0	2 760	550	27.1	15.9	35	83	56
Iraq	24 047	34.8	2 550	46.8	684	4	36.0	0.9	..	98	37
Jordan	412	6.8	63	15.7	772	175	22.8	12.3	6	84	12
Kuwait	72	0.3	5	100	1 141	30	17.1	0.3	..	..	..
Lebanon	660	7.8	86	28.1	1 105	125	19.1	18.8	..	..	..
Oman	374	3.3	58	92	787	216	..	..		32	1
Qatar	79	1.1	8	100	296	13	13.8	0.5	..	..	..
Saudi Arabia	8 441	7.0	940	69.8	3 105	381	13.3	0.9	..	..	..
Syrian Arab Republic	4 351	28.6	1 000	17.0	774	700	14.4	19.7	24	100	84
United Arab Emirates	927	2.6	32	70.3	1 772	586	7.9	2.3	..	..	..
West Bank and Gaza Strip	..	..	17.7	9.9	..	..	..	..	..	..	..
Yemen	750	18.2	360	24.3	843	84	28.1	9.3	62	61	40
GCC subtotal	9 942	4.9	1 046	71.1	7 404	1 237	11.9	1.4	..	..	..
ESCWA total	51 539	14.0	8 162.7	44.6	14 342	2 875	15.6	2.9	..	..	..

Sources: Arab Centre for the Study of Arid Zones and Dry Lands (ACSAD), "Water resources and their utilization in the Arab World", Second Symposium on Water Sources and their Uses in the Arab World, 8-10 March 1997; and ESCWA, "Land and water policies in the Arab region", contribution to the Expert Group Consultation on Sustainable Agricultural and Rural Development, Cairo, September 1994.

TABLE 13. PERCENTAGE SHARE OF GROUNDWATER UTILIZATION IN SELECTED ESCWA MEMBER COUNTRIES

	Share of underground water		Reference
	in total water	in irrigation	
Egypt	7	5	Sadik (1997)
Jordan	60	47	ESCWA (1995b) and FAO (1994)
Saudi Arabia	83	100	UNCED (1992a) and Al-Keneabat (1997)
Lebanon	..	40	Sadik (1997)
Oman	60	..	Abdulbaki (1997)
Syrian Arab Republic	30	60	FAO (1996b)
GCC countries	85	..	Al-Megren (1997)

Note: Reference in this table are contained in full for the references for part one of this study.

The problems of groundwater overexploitation and the absence of water rights with regard to volume can be overcome by setting pumping quotas or through fuel taxes. Fuel taxes should cover the cost of pumping, and should be equivalent to the opportunity cost of water. Economic incentives could take the form of direct subsidies or tax credits. Subsidies and tax credits can be used to encourage the use of water saving or recycling technologies, or for the cultivation of water efficient crops. The amount of subsidization or tax credit should not exceed the economic value of the water saved (World Bank, 1994b). Water pricing based on opportunity costs can encourage water consumers to utilize water saving technology.

2. *Subsidies*

Subsidies as an instrument of public policy have been used to transfer government income to citizens to achieve income distribution, and for creating a favourable economic environment. Crop subsidies in agricultural sectors that rely mainly on non-renewable groundwater have been substantial, mainly in the GCC countries. The magnitude of price subsidies has contributed indirectly to the increase of water consumption. Price subsidies for wheat and barley in Saudi Arabia are set and guaranteed by the Government. Wheat subsidies were initially set at $930 per metric ton, or 3,500 Saudi Arabian riyals (SRls), changed to $530 (SRls 2,000), and finally reduced to $400 (SRls 1,500) in 1995. Barley subsidies were set at $265 (SRls 1,000) per metric ton. Irrigation system subsidies accounted for 45% of their cost. Interest free loans covered 80% of capital requirements for well pumps. Similar subsidies, in differing degrees, have been used in the agricultural sector in the GCC countries of Qatar, Oman and the United Arab Emirates. Such policy is contributing to overexploitation of groundwater resources.

Subsidies did not have a major impact on small farmers. For example, in Saudi Arabia, only a small proportion of the farming community benefited, mainly large wheat producers. The farming community has not achieved the desired income distribution, as most of the large farms are owned and managed by urban residents, and are worked and operated by foreign labour (Al-Sheikh, 1996).

The magnitude of subsidization is being reduced as a result of government budget constraints, and increasing water scarcity. In addition, reductions in subsidies are being used as an incentive to encourage farmers to invest in water-saving technology and cultivate water efficient crops, which can be considered a means of cost recovery. Some countries are moving towards recovering, as far as possible, the cost of providing irrigation water. Financial autonomy can be achieved by charging the full rate for operation and maintenance costs, and particularly for investment.

3. *Inefficient pricing policy*

Water pricing schemes for irrigation water in the ESCWA region are almost totally absent, with the exception of a few of the member States where water is extremely underpriced. The subsidization of already low water prices for irrigation has been used as a means to supplement the incomes of poor farmers whose incomes are low because of controlled produce prices (ESCWA, 1994). Subsidization has also been used to assist in the problem of exchange rates, and to encourage the establishment of Bedouin settlements. Irrigation water is either provided free of charge, such as in Egypt, Iraq, Yemen, and the GCC countries or priced at very low rates, as shown in table 11 in chapter II, as in Jordan and the Syrian Arab Republic. In Jordan, for example, the share of irrigation water in comparison with total agricultural production costs, does not exceed 0.6% for vegetables, 5% for apples and grapes, and 28% for bananas (FAO, 1994; Ghezawi and Dajani, 1995).

The implementation of low charges or free provision of water, in addition to generous governmental subsidies, encourages agricultural activities and consequently increased water consumption. This is true in several of the ESCWA member States. In Saudi Arabia, for example, during the period 1977-1988, the total cultivated area doubled from 0.558 to 1.2 million hectares. This rapid development was associated with a more than sevenfold increase in water consumption by the agricultural sector, from 1.9 bcm in 1980 to 14.8 bcm in 1989, 80% of which was drawn from non-renewable groundwater sources (UNCED, 1992a). In the Syrian Arab Republic, 80% of land newly cultivated since 1987 has been irrigated from groundwater wells, and fuel for running the wells was subsidized by the Government (FAO, 1996a).

Current pricing policies in the ESCWA member countries provide no incentives for boosting efficiency of irrigation, or for stimulating conservation through modified agricultural production. At the same time, revenues from the agricultural sector do not contribute enough to even cover operation and maintenance of irrigation facilities. A considerable volume of water is wasted through outdated and inefficient irrigation canals and unmaintained distribution networks.

4. *Water use efficiency*

Water use efficiency in some regions ranges from 30% to 50% in most of the ESCWA member countries (ACSAD, 1997). In some regions of Jordan and Saudi Arabia, however, efficiency exceeds 75% because of the use of modern irrigation techniques such as drip irrigation and central pivot systems.

It was estimated that irrigating one hectare of cropland in the ESCWA region uses about 12,000 cubic metres of water, whereas the average amount used in many other parts of the world does not exceed 7,500 cubic metres. Thus, the percentage of water wasted amounts to approximately 37.5% (FAO, 1996a ESCWA/FAO, 1994).

There are two main reasons for poor water use efficiency in the agricultural sector: one is the technical nature of water use in the field, and the other is related to economic performance of farms with regard to output, operation and maintenance. The technical aspect of poor efficiency levels is associated with irrigation technique and systems operation and maintenance. Both of these are related either directly or indirectly to inappropriate water pricing policies.

(a) **Technical aspects of irrigation methods**. A high percentage of cultivated land in the ESCWA region is irrigated by surface flooding. This method is usually characterized by low efficiency and high evaporation. The flooding technique has been used in the Arab world for about 70% of cultivated cropland (Al-Megren, 1997). In Egypt, flood irrigation techniques using flood flow from the Nile have been used to irrigate land adjacent to the flood plain. However accurate control of water is difficult, especially for different crops requiring specific quantities of water and frequencies of irrigation.

Using modern irrigation technology (pressurized irrigation such as sprinklers and micro-irrigation) could increase efficiency from 50% to 75% or 80% (FAO, 1996b). In Jordan, estimates show that the efficiency of irrigation was approximately 75% in lands irrigated using sprinklers, and 85% in areas using drip irrigation techniques (Ghezawi and Dajani, 1995). Modern irrigation technology, however, is capital-intensive when compared with surface irrigation methods. Accordingly, it is difficult to persuade farmers who are used to receiving their water free or nearly free of charge and pay practically nothing for installation and maintenance of their current irrigation system, to switch to more efficient irrigation systems which are considerably more costly to install and maintain. Therefore, increasing the tariff rates for irrigation water would encourage farmers to conserve water, and to install more water-efficient sprinkler and drip irrigation systems. Governments can assist in this regard. Instead of subsidizing water prices, it would be more economically justified to provide farmers with long-term loans at zero or very low interest rates for the purpose of installing water-efficient delivery systems, as is being done in most of the GCC countries. The present discounted value of expected savings in irrigation water could outweigh the social costs.

(b) **Technical aspects of operation and maintenance**. Inefficient operation and maintenance of irrigation systems is the other main problem contributing to inefficient water use in the agricultural sector. In Jordan, for example, the lining of water canals and the use of pipelines instead of open canals could save between 30% and 40% of the total amount of water used in agriculture (Sadik and Barghothi, 1997). However, to do so requires a substantial monetary outlay, and farmers are not willing to provide this for the reasons mentioned above. Again, higher prices for irrigation water would encourage farmers to take action towards upgrading their irrigation systems. The Government could intervene using the economic tools mentioned above to support farmers' efforts in this respect.

It is important to note that, when water cost represents a very small portion of the farmer's total cost of production, a small change in water tariffs may not have a significant effect on persuading him to upgrade the irrigation system, or establish better maintenance. In Saudi Arabia, for example, where there is a high rate of return on farm products, a small increase in irrigation water prices would not be effective in curtailing demand, and the higher water prices could easily be passed on to the consumer (Al-Dukheil, 1995). Therefore, prices have to be raised to a level that will significantly affect demand, but that does not discourage agricultural production. Empirical studies show that demand for irrigation water is likely to remain price inelastic until water costs rise sufficiently (Parashar and Gopalakrishnan, 1995). Hence, changes in water prices must be great enough to bring about the desired objective of decreased consumption.

5. *Economic aspects of water production factors*

The farmer, as a producer, wants to maximize his net profits. He uses production prices, along with product selling price, to determine the optimal combination of elements in order to accomplish this goal. A zero or minimal price for water, as is currently the case in all the ESCWA member countries, not only increases the quantity of water utilized as a cheap production factor, but encourages the farmer to use it to a certain extent, in place of other more expensive production factors such as initial capital expenses and fertilizer. The willingness of the farmer to use water in place of other production factors depends on its role in the overall production process and its marginal rate of substitution. In other words, cheap water gives farmers no incentive to economize on its use. It must be realized that water is not a free or inexpensive element of production in all countries, especially where Governments control the prices of agricultural products at levels below their market value, as in Egypt and the Syrian Arab Republic, or when the Government indirectly charges for water through a tax system such as in Egypt. However, what is important to the farmer in determining the optimal combination of production elements to maximize profits is not the lump sum costs the farmer pays as a fixed rate for water or through taxation, but the direct and variable costs that affect his overall production costs and profit margin. Therefore, indirect or fixed charges for water are irrelevant to the amount of water used in the agricultural process.

6. *Economic aspects of crop patterns*

Current water pricing practices in most of the ESCWA member countries do not reflect the marginal productivity value of water in the agricultural sector. Farmers, like any other producer, seek to grow crops which give them the highest rates of return, regardless of the intensity of their water application. For instance, wheat production in the Kingdom of Saudi Arabia has expanded to levels beyond domestic market demand owing to the relatively high rate of return, which is guaranteed by the Government's multi-dimensional subsidization policy. In Egypt, 30% of the country's irrigation water, provided free of charge, is used to grow rice and sugar cane (Abu-Zeid and Rady, 1992). These two crops in particular are characterized by their low average yield compared with the amount of water they consume, as shown in table 14. If water is accurately priced, the cultivation of crops with high rates of water productivity would increase, while the growing of other crops would diminish. In the Syrian Arab Republic, maize is still cultivated using all available irrigation sources, despite negative average productivity, as shown in table 14. A study in the Syrian Arab Republic (FAO, 1996b) indicated that there was a rationale for increasing water charges as a result of high economic returns, estimated to be between 6 and 10 times the water price farmers paid. In the Jordan Valley, the productivity of water consumed in irrigation per cubic metre has outweighed the cost of operation and maintenance; the latter is still higher than the irrigation tariff. In the West Bank and Gaza Strip, citrus crops receive over 55% of irrigation water, although they contribute only 14% of agricultural income (WARP Task Force, 1994).

A rational irrigation pricing policy should at least cover the variable costs of operation and maintenance. This would be a justified step towards more efficient water use in the agricultural sector. By increasing efficiency of current irrigation systems, enough water can be saved to meet increasing urban and industrial demand without compromising food production (MacLean and Voss, 1996). In Egypt, improvements in irrigation efficiency by 10% are expected to reduce land irrigation requirements by about 3 bcm annually. In Jordan, a 5% diversion of water from the agricultural sector can increase domestic water supply by 15% (ESCWA, 1994).

C. Industrial sector

Low prices for industrial water use in the region not only encourage inefficient consumption, but also discourage the industry from investing in recycling or water treatment as part of its technology and capital investment in the long run. In Egypt, a clear link was established between low water prices and the limited extent of recycling in the industrial sector in general, mainly the power industry, which consumes about 79% of industrial water. The treatment and recycling of cooling water could become economical in the power sector if water tariffs were increased.

Empirical evidence in some of the GCC countries such as Kuwait and Saudi Arabia shows that when industries have to bear the cost of their water supply, they tend to rationalize their consumption and adhere to conservative patterns of water use. In Saudi Arabia, total water consumption in the industrial sector has declined by 50% since 1980, despite a several-fold increase in industrial production (Al-Dukheil, 1995) over the past decade. Refineries and other major industries have been forced to build their own desalination or reclamation plants to guarantee their water supplies at reasonable prices.

TABLE 14. EXAMPLE OF WATER USE PRODUCTIVITY FOR SELECTED CROPS IN EGYPT AND THE SYRIAN ARAB REPUBLIC

Country and reference	Measures of water productivity	Cotton	Wheat	Maize	Sugar beets	Sunflower	Beans	Potatoes	Tomatoes	Sugar cane	Rice	Long Berseem	Short Berseem
Egypt based on data from (FAO, 1994)	LE/cm of water	0.65	0.81	0.038		0.83	0.67	0.44	0.82	0.13	0.15	0.47	0.28
	% in value added/% in water use	1.56	1.89	0.93			2.00	1.00	2.33	0.33	0.38	1.25	0.67
Syrian Arab Republic (FAO, 1996b)	LS/cm of water from: deep wells	1.44	2.45	-1.49	4.25	1.32	2.14	3.77	2.91				
	Shallow wells	2.36	4.19	-0.45	5.37	3.05	3.9	5.14	3.99				
	Rivers	2.73	4.81	-0.06	6.24	3.7	4.5	5.69	4.36				

Notes: LE = Egyptian pounds; LS = Syrian pounds. cm = cubic metre. The return on water (LE/c.m.) or (LS/c.m.) is measured by the value added per unit of land divided by the volume of water use per unit of land (feddan or hectare). The second measure is the share of the crop in its value added relative to the share of the crop in total irrigation water.

References in this table are contained in full in the references for part one of this study.

D. Legal aspects of water pricing

The current legal instruments governing water resource development, utilization, production and conservation in the ESCWA member countries are the Shariah laws and Ottoman and French codes, as well as some traditional customs (ESCWA, 1996b). Water legislation implicitly addressed the role of water, as well as water rights and ownership. Islamic Shariah laws implicitly addressed cost recovery, the sale of water, water use efficiency and conservation through water rights, ownership and use priorities.

According to Islamic principles, individuals may not own water itself, but can own the rights to use and administer it. However, the acquisition of such rights is conditional on the value added to the water through either physical or financial investment and/or through devotion of time and/or labour to obtain water from its natural source. Also included are the efforts made to contain, develop, distribute and maintain the water source. Islamic jurists elaborated further on some aspects of Shariah law with regard to water cost issues. They acknowledged that all beneficiaries of a water source have the responsibility to contribute to defraying the costs associated with the operation and maintenance of the watercourse. Costs are distributed according to the share of water each individual holds. Cost recovery has been emphasized in Shariah law, especially for irrigation purposes, and allows for the establishment of appropriate pricing schemes for agricultural purposes.

Existing water legislation, based on Islamic Shariah, Ottoman and French codes, in most of the ESCWA member countries has directly or indirectly addressed some aspects of water economics, with regard to development, operation and maintenance costs, and some form of water sale. Only fragmented legislative efforts have thus far been carried out in countries that depend on surface run-off, for the purpose of indirectly recovering costs associated with the operation and maintenance of irrigation systems. The content, coverage and jurisdiction of the existing legislation do not meet the requirements for implementing an effective water pricing policy, which is needed to promote efficient use and conservation of scarce water resources.

In the Syrian Arab Republic, for example, water network investments are public projects. However, laws and regulations stress that beneficiaries are to be charged an irrigation tariff in the form of a water tax on an annual basis (Al-Masry, 1996). This irrigation tariff would cover the costs of operation and maintenance for the water delivery system, and would periodically increase to cover rising costs. In Lebanon, irrigation project costs are paid by beneficiaries over a period of time (ESCWA, 1996b). Regulations specify that annual irrigation fees must be assessed to cover original investment charges, and operation and maintenance costs. In the domestic sector, the Government establishes appropriate fees and charges the public for water use, taking the above factors into consideration, as well as Government expenses.

Egyptian water legislation allows the Government to collect revenues that cover the cost of network drainage systems, over a period of 20 years, at an interest rate of 2%, as specified in the law of 1949 (Fahmi, 1996). The law determines that all costs related to the drainage network should be shared by the beneficiaries according to the size of the property they own, and collected as part of the real estate tax. However, a fair way of working things out would be for maintenance of the network, as well as maintenance of canals and bridges, to be taken care of by the residents of each village using the water. Recently in 1994, the Ministry of Public Works and Irrigation was assigned the legal responsibility of setting water rates for irrigation by region, according to the type of crop, type of pump and fuel costs.

In Oman, the implementation of established customary law is carried out by local people, and provides for the maintenance of the *aflaj* (underground canal) water source and protects it from groundwater mining (ESCWA, 1996b). The cost of maintenance is covered by what is known as a poll tax, and through sales of water shares. Water rights are not associated with land ownership, and the sale of irrigation rights from wells and *aflaj* is independent of the sale of land. However, new legislation drafted in 1995 prevents the sale of water if it leads to depletion of or interferes with nearby water sources. The transfer of water to nearby land is not allowed except under certain technical circumstances, or during droughts.

In Jordan, the sale and transfer of water, by anyone from any source is allowed only with prior government approval (ESCWA, 1996b). Similarly in Kuwait, the transfer of water from one area to another requires a special permit.

IV. POLICY REFORM

A. Background

Water policy reform is sometimes required as a component of a more comprehensive strategy for the development and management of water resources. In the ESCWA region, the use of effective water pricing mechanisms to achieve water resource management must become one of the cornerstones of effective reform. Reform could involve modification of laws in order to implement effective pricing policy, the formulation and enforcement of comprehensive regulations, improvement in institutional structure, particularly of existing water utilities, and the creation of new utilities with the active participation of the private sector in ownership and management.

There is no suitable universal model that can be applied for water pricing policy reform. Policy is the product of strategy formulation, taking into consideration religious, social and economic factors. Some countries have formulated water pricing policy, legislation and price regulations, but fail to implement or enforce them. Water policy reform to manage scarce water resources and achieve efficient delivery of water supplies and sanitary services must stress two pricing principles based on the cost of water provision or market price. Both principles take into account the importance of cost recovery by water providers (United Nations, 1996). Private sector participation, in the form of user associations and privatization, is expected to raise the level of cost recovery for capital investment, as well as improve the quality of services. User associations in the agricultural sector and water supply privatization, in the form of management contracts for parts and/or operation, and full ownership of water and wastewater utilities can contribute to water use efficiency and better cost recovery

B. Water user associations

The creation of water users associations may contribute to the improvement of farmers' welfare and enhance the development of irrigation and drainage services. The global success of this approach is mixed. However, whatever methods are applied to achieve reform, their success will depend on diligent administrative monitoring and effective law enforcement (Bochniarz, 1992).

Water user associations have been cited as an alternative to public utilities under some circumstances. In the Republic of Korea, the establishment of water user associations has led to full user participation in water resource management. There is still room for improvement, however, as water subsidies have not been entirely eliminated owing to the fact that charges are not based on volumetric pricing. In Mexico, the new strategy for water management relies heavily on the constitutions of local water use associations. These groups are responsible for the operation and maintenance of irrigation systems on a district basis, and design and implement pricing schemes for achieving financial self-sufficiency. While water prices vary from one region to another, and according to the source of water, these associations have been able to recover fully the cost of operation and maintenance in most districts (World Bank, 1994b). Water user associations have proved to be successful in other countries as well, such as Argentina, Indonesia, and the Philippines (ESCWA, 1994). In France, each water basin has its own managing committee, which consists of consumer, professional, academic, and government representatives. The basin committees fall under the jurisdictions of the Ministry of Environment, and the Ministry of Finance.

In the Arab region, some form of water association has been initiated in Egypt, Morocco, and Tunisia (Ahmed, 1994). The farmers in Morocco and Tunisia participate in water distribution. It is too early to draw conclusions about the performance of these associations. In the ESCWA region, experiences with small-scale farmer associations in Egypt, representing a simple form of water user association, have resulted in the overall improvement of farm management skills. Overall irrigation efficiency was increased by 10% - 15%, and productivity increased as much as 30% (Stiles, 1996). Experiences in other developed and developing countries suggest that involving local communities in the measuring and pricing of water, as well as maintaining the water system, can help to increase the acceptability of higher water charges and promote conservation.

C. PUBLIC PARTICIPATION IN WATER PRICING

Another possible mechanism for effective public participation would be the establishment of a localized pattern of water costing for both groundwater and surface water sources within a country. Usually, the term "water market" refers to the localized informal sale of water users, and can be used as a tool in the allocation of water supplies. The sale of water can also involve the transfer of water rights between buyers and sellers for compensation. The price of water is determined by supply and demand, the cost of water mobility, and the reliability of supply. The price of water in this case is independent of tariffs paid for the use of water. The water market concept was developed for conditions in the western United States, and is now being considered in many developing countries.

The success of the water market is contingent on a number of conditions including social acceptance, the clarity with which water rights are defined, well-established regulatory market structure, water mobility, and the ability of institutions to resolve water disputes. The absence of clear and comprehensive water right delineations can lead to legal and administrative difficulties during implementation. A successful water market requires the participation of a large number of buyers and sellers, sufficient water supplies and infrastructure, as well as a means to settle water disputes.

Another prerequisite for successful water markets is the ability to enforce established water rights. Water markets for surface water sources, in general, would be more difficult to implement. Surface water sources are more likely to be affected by external circumstances than are groundwater sources; for example, downstream users would be affected by increased upstream diversion. Therefore, water market principles would only be applicable to surface water sources in cases where farmers are allotted specific quotas of water. In this situation, farmers may be able to transfer any unused portion of their allotment to other farmers using the same water source, provided that this would not affect other beneficiaries in terms of quantity and quality.

There are, however, some drawbacks in the water market system, particularly if water prices are not properly regulated. Groundwater mining would take place as a result of farmers expanding their annual pumping to levels exceeding the recharge rate of the aquifer. Increasing the rate of depletion of groundwater may result in diverse economic and environmental consequences. Water allocation through a marketing mechanism may force some marginal farmers out of business because of competition for scarce water resources. Crops with higher market values (so that the higher cost of water can be recovered) may become prevalent, at the expense of less water-intense and more easily grown lower value products. Finally, the owners of water rights may find it more profitable to sell water than to grow crops, which would defeat the entire purpose of this system. The knowledge that water is available through the water market will discourage farmers from investing in private water wells, and indirectly reducing the amount of uncontrolled pumping and well interference. Water markets can also provide access to water for those who do not possess water rights, or those who require more than their legal limit. Farmers can be both buyers and sellers, at different times or in different locations. Through water markets, users are protected from water shortages during droughts, which is particularly reassuring for the agricultural sector. With regard to production, under this system efficient allocation through appropriate pricing mechanisms allows water to be transferred from low value uses to higher ones.

The evaluation and restructuring of pricing policies has begun to receive more attention in the ESCWA member countries as a result of water shortage and increasing demand. However, very little attention has been given to the potential for developing local water markets. The issue of tradable water rights is being investigated by academicians and donor agencies as a means of efficient allocation of water resources. There is a strong belief that water is too important to life, especially from the security standpoint of the region, to be given up to free market forces. Accordingly, the concept of a water market may be a suitable means of controlling this important natural resource in several of the ESCWA member States.

In most of the ESCWA member countries a primitive form of water market is already operating. Farmers sell a share of their irrigation water to the domestic sector and transport it to the city by tankers (World Bank, 1994b). While this satisfies the needs of urban consumers for water and results in a monetary profit for farmers, it can be considered at best an inefficient, unorganized method of water transfer, rather than a water market strategy.

In Oman, the sale of water from the *aflaj* system is allowed as long as it does not contribute to the mining of groundwater or interfere with any other beneficiary's right to the water. However, during drought conditions, the sale of water from the *aflaj* is prohibited.

Water markets, therefore, can be an effective mechanism for equitable allocation of water among those who are with and without water rights, provided that they are effectively regulated and continuously monitored. Types of water use and rates of extraction must be controlled in order to avoid misuse of water resources and water rights. One of the prerequisites for maintaining a workable water market is to make sure that holders of water rights do not consider the sale of water as a primary objective. A number of checks and balances can be applied to assure a successful water market:

(a) Quantify an upper limit on the amount of water a farmer can sell to others during an established period of time;

(b) Limit the time period over which the farmer is entitled to use a water permit;

(c) Stipulate that the restrictions specified in the permit, with regard to the use of water and the land to be irrigated, should be adhered to in order for permits to be renewed;

(d) Price or tax water appropriately so that farmers will not overextend their water rights at the expense of the water source.

D. PRIVATIZATION

Another form of market- oriented pricing policy is privatization of water supplies and services, which has been gaining in popularity in different water use sectors throughout the world. Privatization, however, is not an easy task to carry out owing to problems of scale and the danger of monopolies. Water supply systems need an enormous amount of fixed capital investment, and it is not easy to implement or economically justifiable to have more than one organization competing for the provision of water services to a certain community, unless the market is extremely large. In the case of municipal water supply, water utility companies are commonly viewed as a natural monopoly by public authorities because large volume production capacity results in lower unit costs. If more than one company competes in the local market, this leads to unnecessary excess capacity. There are many arguments both for and against privatization of municipal water supplies. However, it is believed that neither increased water use efficiency nor a reduction in water consumption would occur unless control of water utilities is turned over to the private sector.

Prevailing trends indicate that the potential exists for dramatically improving the efficiency of water services if water agencies become well-managed businesses through privatization, regardless of ownership.

It is true that private management can achieve objectives in a much shorter period of time at the lowest possible costs, when compared with government agencies. However, appropriate and effective safeguards must be in place to prevent private monopolies from abusing the public in terms of charges and reliability of service and quality. Privatization can be considered a way of shifting the heavy burden of future water supply costs from the public sector to the private sector. Although privatization may be desirable in some circumstances, it is not always feasible. Switching public water utilities to the private sector requires the establishment of well-defined policies, and legal and administrative regulations in order to control both the water supply and public demand.

1. *Trends in privatization*

Private water companies comprise a significant proportion of supply agencies in several countries such as France, the United Kingdom of Great Britain and Northern Ireland and the United States (Winpenny, 1994). In England and Wales, privatization of the water supply was initiated in 1989. The water and sewerage services that were previously under the control of established water authorities, were transferred to commercial companies. The services were owned and managed by a private company, but monitored through comprehensive regulations. Shares in the company were floated on the stock market (ESCAP, 1996).

France is the leading country in Europe in initiating privatization in the provision of water and sewerage services. Large numbers of water supply facilities were privately financed and operated, while sewerage facilities were financed by the Government or private water supply companies. This arrangement served about 65% of the population as of 1985 (ESCAP, 1996). In one city in France, the operation of the urban water supply system was taken over by a private joint stock company, in conjunction with a French company, under a mixture of concessions and lease contracts. The arrangement has shown a high level of performance over the last 25 years. The percentage of urban population who had access to safe drinking water rose from 30% in 1974 to 72% in 1989. Operating efficiency also improved in urban areas, with only 12% unaccounted for water. Revenues increased by 98% among private customers. Tariffs were raised in industrial areas, resulting in reduced water demand as industries shifted to recycling their water.

In the Latin American countries of Argentina, Brazil, Chile, Mexico and Venezuela, extensive efforts were made to privatize the water industry. French and British companies were awarded 10- to 30-year concessions to manage water and sewage services, including collection and treatment (ESCAP, 1996).

Countries that have initiated privatization schemes include Australia, China, Malaysia, the Philippines and Thailand. The States of Johor and Kelantan in Malaysia have privatized their water utilities (ESCAP, 1996). In other Malaysian States, contracts were awarded to manage existing facilities privately. In China, major municipalities are negotiating with private companies to build, operate and transfer (BOT) water concessions. The Philippines is exploring the possibility of privatizing their water and sewerage facilities following the success of their BOT-type power generator.

Previous trends in Australia have been initially to corporatize water utilities with the intention of privatization. The Sydney Water Utilities has recently been transformed into a water corporation in order to promote private sector participation (ESCAP, 1996). The programme called for the BOT approach. Most of the concessions were given to French and British companies with small participation of Australian companies.

Privatization trends in the water industry in different parts of the world have been based on long-term concessions or leases (United Nations, 1996). Concession contracts usually involve BOT-type turnover. This method covers the aspect of financing, as well as the release of facilities to public water authorities. The major feature of the BOT-type concession is that increased water charges partially cover capital investment and operation costs. The lease contract generally involves transfer of management, operation and maintenance of water facilities to the private sector over a period of 10 to 20 years.

In developing countries such as China, the transfer of responsibility for the water supply to the private sector has resulted in an increase in revenues from 15% to 50% (Serageldin, 1995).

2. *Privatization in the ESCWA member countries*

(a) **Successes**. In order to reduce the increasing financial burdens associated with operation and maintenance of water supply systems, a number of the ESCWA member countries have taken steps towards the privatization of water utilities. Qatar and the United Arab Emirates gave permission to private companies to build desalination plants and sell water to major industrial users. In Abu Dhabi, it was reported that a French company offered to buy one of the power and desalination complexes in order to offset costs, a deal in which the company would hold 49% of shares, and the remainder would be held by the Government and local investors. In Oman, plans for a privately run power station and desalination plant were formulated in early 1995. The project involves the creation of a joint stock company to build, own and operate the plant under a 30-year concession (Allan, 1995). In Lebanon, the trend is to give private companies concessions for operating and managing domestic water facilities (World Bank, 1994a). In Egypt, under a project financed by USAID (United States Agency for International Development), a private company is working with a non-governmental organization in Cairo, Suez and Ismaelia for system inspections, leak repair, and the installation of water meters in houses and government buildings (World Bank, 1994a).

(b) **Difficulties**. Privatization of water supply systems in different parts of the world has been accomplished as a result of the existence of a well-developed market, trade liberalization and effective legal mechanisms and regulations.

Privatization of the water industry requires the existence of large, well-established capital markets and the availability of sufficient private funds to absorb share offerings (Al-Alawi, 1997). In the ESCWA member countries, however, the socio-economic situation may not be conducive to rapid implementation of privatization unless some aspects of reform take place. There are several barriers hindering the move towards privatization of water supply systems in the ESCWA region. One of the most important is the insufficient size of the capital market and the less than optimal level of its performance. These conditions do not facilitate the absorption of the huge amount of capital involved in selling public utilities to private institutions. In most of the ESCWA member States, the size of utilities does not justify the fragmentation of production, transport, and distribution services. The prevailing high-level subsidies for water production and distribution outweigh the anticipated benefits of privatization. Therefore, a gradual restructuring of the tariff system must take place prior to the initiation of privatization. The need for desalinization in some countries presents the opportunity to combine water and electric production in order to maximize efficiency and reduce overhead (Al-Alawi, 1997). Finally, in order to avoid abuse by private monopolies, the Government needs to establish a sound system of regulations governing water tariffs, establish regular monitoring of performance, and determine an adequate rate of return on investment in order to attract capital for expanding the system.

Privatization may take place gradually to solve water problems in the region, and can be used as an effective means of easing the financial burden associated with an increasingly expensive and continually expanding water infrastructure. Privatization does not necessarily have to be complete; local municipalities or Governments may retain a portion of control when necessary. Alternative arrangements such as management, subcontracting, and contract concessions can be used to combine private administration with public ownership. Private companies, whether service operators or concessionaires, must deal properly with pricing and efficiency issues in order to make profits. Therefore, either partial or complete privatization can result in more efficient water utilization. In many ESCWA member countries, private administration and/or management may prove to be more appropriate than total privatization and would be an initial step in the direction of total privatization in the future.

E. WATER PRICING POLICY STRATEGIES

The increasing water consumption experienced by all member States in the ESCWA region makes the adoption of a national water strategy increasingly necessary to address future water shortages and the depletion of groundwater resources. Some countries have taken the initiative as part of their short-term policy to reduce subsidizations in the agricultural sector, to rehabilitate water supply systems, and to reform water pricing by changing urban water tariffs. However, in spite of all these actions, the required comprehensive long-term water policies, with the objectives of integrated water resource development and management, have not been implemented. Other important objectives include effective pricing approaches to achieve optimal allocation of water resources, and improvement in water use efficiency, especially in the agricultural sector. In addition, the success of water pricing policy is contingent upon the existence of a favourable economic environment which addresses the imbalances and inefficiencies in fiscal and trade policies. Thus, a water pricing strategy must meet specific economic, social and environmental requirements within the country concerned.

Specifically, appropriate water pricing strategy should:

(a) Be based on a long-term comprehensive plan;
(b) Enhance integration with other sectors of the economy and any structural reform;
(c) Be preceded by an intensive media programme to address water users at various levels;
(d) Be implemented gradually in order to gain public support and acceptance;
(e) Be subjected to continuous revision to evaluate its impact.

The general framework for successful formulation and implementation of water pricing strategy should be consistent with the following requirements:

1. *Objectives of pricing policy*

The formulation of an effective strategy is significantly influenced by the identification of the intended objectives of the pricing policy. The objectives should be clearly delineated and precisely defined with regard to what is to be accomplished, as well as the feasibility of implementation. The objectives should address local, regional and national interests, and should be compatible with national strategies for all sectors of the economy. The plan of action to implement pricing policy objectives should include the availability of a reliable database, and consideration should be given to the prevailing and expected legal, financial and administrative aspects of the policy.

2. *Comprehensive database*

The establishment of a comprehensive database, through the use of the current literature and field surveys, is needed to make appropriate pricing and investment decisions in the water sector. The database should include information on:

(a) Characteristics and status of water production and distribution capacity in the domestic, industrial and agricultural sectors;

(b) Categorization and enumeration of beneficiaries in all sectors, including water consumption variation and required water quality;

(c) Water use efficiency, magnitude of waste by sector, and recycling capacities;

(d) Water production costs including capital investment, operation and maintenance, from different water sources, as well as investments to augment existing capacities;

(e) Types and magnitudes of water charges in each sector, water subsidies to water production and distribution, tax level, and tax for cost recovery, as well as financial performance of water utilities;

(f) Supplementary information obtained through market surveys to eliminate data gaps and provide information on public perceptions of water pricing policies.

3. *Assessment of supply and demand*

(a) A reliable assessment of water from different sources should be undertaken in terms of spatial and temporal variations, and availability including reserves and replenishment. The assessment should include feasible water supply augmentation options;

(b) Current water consumption and demand projections for all sectors should be estimated. The demand projections for certain growth rates should include different scenarios for various anticipated trends as well as demand management measures with emphasis on the evaluation of the impact of the water pricing policy;

(c) Current and future water balance for the selected scenarios should be estimated and measures should be identified to bridge the gap with regard to water shortages in each consumption sector: domestic, industrial or agricultural.

4. *Administrative and legal measures*

There should be an evaluation of possible actions that may be implemented simultaneously with regard to the introduction or modification of administrative, legal and financial measures. These may include the following:

(a) Improve administrative efficiency as well as enhance capacity-building in the water institutions involved in water resources development, operation, maintenance and monitoring;

(b) Evaluate the major legislative and institutional barriers that are expected to hinder the implementation of water pricing policy;

(c) Modify or introduce new legislation that will provide a flexible and comprehensive framework, and plan of action for implementing pricing policy.

The undertaking of legislative reform, if reform is necessary, encompasses all legal aspects of privatization of water supply and services, water user associations, or any economic, administrative or management measures used to achieve improvement in water utility performance and independence. The legislation must identify the regulations and obligations of the private sector and the monetary aspects. All feasible incentives and implementation plans should be evaluated for the purpose of encouraging the public to support and comply with pricing policy guidelines. These incentives may take different forms, including free availability or partially funded water conservation devices (such as free loans and training) to be used in the targeted sectors for the purpose of water demand reduction.

5. *Building a constituency for reform and public support*

The success of pricing policy is dependent on public acceptance and enforcement. A variety of measures are needed for the successful implementation of policy on a continuous basis, including periodic evaluation of impact and modification, if necessary. These measures should include the following:

(a) Design of a comprehensive public education programme on water scarcity, water use inefficiency, and overconsumption;

(b) Publicizing the objectives of water pricing policy with emphasis on improvement of services, safety, supply availability on a continuous basis, saving water for future generations, and contributing to the financial savings of the national economy.

6. *Policy implementation*

All previously identified components must be implemented in sequence or simultaneously prior to the undertaking of implementing policy. Policy implementation should encompass the required financial resources, the availability of trained personnel, flexible administrative procedures and effective legal mechanisms. Legislative decrees may be needed to implement officially pricing policy in each country, as well as to establish enforcement mechanisms.

The implementation procedures must include tools to enable policy impact to be evaluated and modifications or amendments to be made to achieve effective pricing policy.

V. SUMMARY AND CONCLUSIONS

In the ESCWA region, scarcity of water coupled with increasing water consumption in all sectors presents a major challenge to planners and policy makers. Demand for water already outstrips the supply in a number of countries, and the gap is expected to increase in the immediate future. Water availability is already approaching its development limit, and the provision of new water sources is costly. Past significant achievements in the provision of adequate and safe water supplies must be complemented by extensive efforts to manage water resources properly. Supply augmentation options and demand management measures need to be an integral part of future policy. One of the most important demand management tools is water pricing policy, which can be implemented through effective economic mechanisms. Pricing represents one of the most important policy instruments available to influence water demand.

Emerging practical pricing policies in different parts of the world emphasize the linking of price to either the cost of providing water or its market value. Current pricing policies in the ESCWA member countries are inefficient, and generally contribute to the waste of water, rather than promoting efficient use and conservation. Pricing subsidies, and the lack of awareness and acknowledgment of the importance of demand management measures, not only lead to wasteful consumption, but will also result in costly investments in water infrastructure.

Such inefficient pricing policies in the ESCWA member countries may be attributed to the prevailing economic and social circumstances of the concerned country. The issue of water pricing tends to be a sensitive topic for policy makers, especially with regard to water allocation in the agricultural sectors, because water has traditionally been supplied free of cost, or at rates substantially below production costs. In most cases, the issue of water pricing has been dealt with indirectly in order to avoid additional financial burdens on the public. The misconception that there are abundant water resources, and the belief in some segments of society that water should be provided free of charge, further compounds the problem of water pricing. Islam recognizes that access to water should be easy and equal for all people. Certain logistic costs and conditions must be observed by all the beneficiaries, namely, the proper use, maintenance and conservation of all water sources. This condition implies that water does have value, and that financial resources are required to distribute water and maintain water sources.

In the domestic and industrial sectors, water charges are substantially lower than the actual total cost, especially for desalination. Water charges do not even cover the operation and maintenance costs. The availability of free water in the agricultural sector, or its provision at significantly low costs, is contributing to overconsumption and depletion of groundwater, especially from non-renewable sources.

The implementation of pricing policy for the purpose of optimizing water allocation in the agricultural sector represents a major challenge in the ESCWA member countries. The pricing of water for irrigation involves imposing higher costs on the farmer, which will in turn be passed on to the consumer in the form of higher costs for produce. Such measures may be met with scepticism by both the farming community and consumers. Decision makers fear that increasing water prices will alter production and distribution patterns in favour of those who can afford the higher prices. The close association of food self-sufficiency and employment with agricultural production means that any suggested reform to bring the price of water closer to its actual value will result in resistance from the segment of society that would benefit most. In the past, efforts even to discuss agricultural water issues were avoided, and where these issues were raised, they were quickly settled in favour of the farmer. However, any apprehension about the impact of water pricing on income or water allocation could be overcome through the design and implementation of new pricing policies.

It is not just that current prices cover only a small portion of the cost of water supply and distribution in most countries; they are also unacceptable as a tool for motivating water conservation in the face of increasing scarcity. The gap between water costs and water tariffs is wide in all sectors. In the agricultural sector, which is the dominant water consumer, water is provided free of charge or in a manner that provides no incentive for rationalizing consumption or enhancing use efficiency. Even in the domestic and industrial sectors, low water tariffs send the wrong signal to water consumers.

In many of the ESCWA member countries, the implementation of progressive block rates in the domestic sector has not been effective as an economic tool, as a result of the rate being set well below the incremental cost of supply. Pricing policy may be based on setting charges equal to the marginal or use costs, depending on the water source. For surface water, it would be appropriate for most of the ESCWA member countries to use short-term marginal cost pricing which reflects operation and maintenance costs. Such pricing schemes may be gradually implemented or changed to include capital costs. Short-run marginal cost pricing would be easy to develop and administer as a first step towards the promotion of efficient use of scarce water resources.

The user cost concept may be appropriate for countries that depend on groundwater, especially from non-renewable sources. The true cost of water would reflect the future costs of subsidizing a new source such as desalination. Thus, the pricing of water from groundwater sources could approximate the actual cost of desalinated water. It should be pointed out that the appropriate pricing structure must meet certain criteria within the countries concerned with regard to social, political and economic conditions.

In addition to the political and social considerations involved in water pricing, the existing water legislation and water institutions lack essential elements: socially acceptable and effective pricing mechanisms and enforcement that allow for optimal water allocation and use, and ultimately financial independence Existing water legislation is known to lack coverage of the detailed aspects of cost recovery, the means for establishing appropriate water rates, and market-oriented practices covering areas such as water markets and privatization.

The implementation of efficient pricing policy requires the modification of existing water laws and regulations, taking into consideration water market requirements and privatization schemes, price monitoring and enforcement mechanisms. Appropriate water legislation should provide the mechanisms for ensuring the most equitable economic and sustainable use of water resources, taking into consideration the socio-economic conditions and the need for natural development.

Some suitable economic tools can be used to promote public acceptance of a water pricing reform policy. Public awareness is one of the most important tools that Governments and/or those who deal with the provision of water can use to promote reform in a positive way. The objectives of the pricing reform, both short-and long-term, can be emphasized. At the same time the long-term drawbacks of current inefficient water use and wastage can be explained in detail. Any reform policy will, of course, be strongly opposed by certain segments of society, for whatever reason. However, emphasizing and quantifying the benefits of pricing reform, both at a sectoral and macroeconomic level, will help to place the debate in a more positive light. A great deal of effort will be required to change the public's attitude, and convince them of the need for water conservation and appropriate water pricing. For this reason, the need to formulate and implement appropriate pricing policies constitutes one of the major challenges to decision makers throughout the ESCWA region. It is a challenge that must be overcome, in the context of the political, social and religious circumstances, in order to preserve and properly manage the scarce water resources of the region

Involving the beneficiaries in operating, distributing, financing, and managing the water facilities through various forms of water users associations has proved successful in a number of developing countries. It has a number of advantages that merit consideration in the ESCWA region. Although the idea of a local water market may meet with opposition or possible rejection by some policy makers, it should be considered as a practical tool for equitable water allocation and for increasing productivity in the agricultural sector. Water marketing may be considered as a form of cooperation among farmers in times of need.

Some potential gains in efficiency of water services could be achieved by turning water agencies into businesses well-managed by the private sector. Privatization can be approached gradually and may not necessarily lead to the complete transfer of ownership. Alternative arrangements such as management, subcontracting, and contract concessions can combine the advantages of private administration and public ownership. Such comprehensive long-term plans need to be geared to the specific conditions of each country in order to secure their eventual success.

The ESCWA member countries, in order to meet future water requirements, must formulate and implement measures, including pricing policies, to decrease the gap between supply and demand. Efforts must be focused on the agricultural sector, which represents the major water consumer. In addition, the agricultural sector is depleting the region's non-renewable groundwater resources, especially in the Arabian Peninsula.

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PART TWO

WATER PRICING POLICY IN JORDAN

VI. JORDAN CASE-STUDY

Introduction

Some countries in the ESCWA region have taken the initiative of reviewing their water pricing policies. Recently Jordan formulated a strategy to address the aspects of water recovery, with the emphasis on cost pricing. Jordan has been selected as a case-study for the present paper owing to the persistent efforts exerted by the concerned authorities in the water sector in Jordan to manage the limited water resources available. The securing of uninterrupted supplies of water is vital to sustain Jordan's socio-economic development.

Since the early 1950s, Jordan has been implementing water policies and developing its institutions to meet its water requirements from the limited water resources available. Water strategies were formulated to deal with development and management of water resources. In 1997 the Ministry of Water and Irrigation introduced water policy guidelines under the water utility policy. The policy addresses institutional development, water conservation measures, water pricing and cost recovery, investment and private sector participation.

1. *Institutional development*

According to the policy statement on institutional development (Ministry of Planning 1997), the Government of Jordan will adopt the most efficient and effective means for optimizing national objectives in the water sector. Among the main requirements for facilitating and accelerating this achievement is an institutional framework compatible with the complexities of water sector issues and a management system that best serves them. A significant reorganization of the water agencies will be necessary to increase efficiency and responsiveness. In this context, a thorough assessment of the institutional setting and constraints has been made, and a programme of implementation was adopted. The role of the Ministry of Water and Irrigation will be centred on planning, development of the sector, formulation of a policy framework and the regulation of various activities related to the water sector. The restructuring programme will produce an overall framework supported by the three entities whose responsibilities are outlined in the Water Utility Policy as follows:

> "The Ministry of Water and Irrigation (MOWI) will remain as a government entity responsible for sector governance. The role of the Ministry will center on providing policy formulation decision making, centralized data collection, Geographic Information System, monitoring and national water planning for the water sector of Jordan)".[1]

> "The Water Authority of Jordan (WAJ) is moving to separate its bulk water supply and retail functions. The majority of the retail water delivery functions in the Amman Governorate will be managed by the private sector. BOT or similar private sector mechanisms will be considered for new bulk water supply and wastewater treatment facilities. The role of WAJ will change with the expected separation of bulk water from the retail supply, and the adoption of cost accounting methods based on Generally Accepted Accounting Principles (GAAP). WAJ will monitor retail supply contracts, and will become a smaller organization of higher caliber with a major role in the operational monitoring of a number of management contracts with private sector utilities and BOT providers. WAJ will manage the resources as well as those bulk supplies, which are not privatized.

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[1] The Hashemite Kingdom of Jordan, Ministry of Water & Irrigation, Water Utility Policy, sect. 2.

Furthermore, it will provide support to smaller retail distribution units... [and] will be operated along commercial lines, with greater local autonomy and with higher stakes for the users."[2]

"The Jordan Valley Authority (JVA) ... [plan] to take a course that builds on the achievements and charts new territories with more focus on such sectors as tourism, industry, manufacturing, advanced technologies, and others. The mandate of the JVA as stipulated in Law No. 19 of 1988 will be sustained. The private sector will be called upon to assume a proper role in development as well as operation and maintenance activities that are being restructured on a more commercial basis. Furthermore, cost accounting methods based on Generally Accepted Accounting Principles will be introduced."[3]

2. *Water conservation programme*

"Water conservation and efficiency improvement play a major role in mitigating the problem of water scarcity and shall be given the proper consideration in the Kingdom's water resources development and management programs. ... Water conservation is a means of enhancing water availability by managing both supply and demand. Generally, this can be addressed by enhancing the efficiency of use through the utilization of improved water saving technologies and management practices, and the behavior modification of current practices through, in part, public awareness programs. ... Therefore, the Ministry of Water and Irrigation will endeavor to undertake all the necessary measures leading to the establishment of comprehensive programs for water resources conservation, reduction of water losses, and improvement of water use efficiency in all sectors."[4]

With regard to the public, an educational campaign should be put into effect to inform people about the value of water for the well-being of the country, for the sustainability of life, and for economic and social development. Facts about water in Jordan need to be disseminated to the public, including the costs incurred to provide water services and the mounting pressure of population growth on water resources. Economic measures must also be adopted to reinforce public awareness.[5]

A. AVAILABLE WATER RESOURCES

The Ministry of Water and Irrigation, which includes the Water Authority of Jordan and the Jordan Valley Authority, has the responsibility of water resources development and management in Jordan.

Available water sources in Jordan consist of limited surface water, renewable and non-renewable, and non-renewable groundwater in shallow and deep aquifers as well as treated wastewater. Surface water is either baseflow which flows permanently in rivers, wadi's or springs, or flood flow which occurs only in winter. There are 15 surface water basins in the country, where surface water is unevenly distributed; the most significant of these is the Yarmouk basin, which is the major tributary of the King Abdullah Canal, the backbone of development in the Jordan Valley. Water from this basin accounts for about 50% of the total surface water in Jordan; it is of good quality with TDS in the 400-800 ppm range (Abu-Niaaj, 1996).

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[2] Ibid.

[3] Ibid.

[4] Ibid., sect. 10.

[5] Ibid., sect. 9.

Surface water flows were estimated at 692 mcm, with potentially usable volume of 475 mcm. The volume of water being used in agriculture is estimated at 402 mcm (Ministry of Planning, 1997).

Groundwater is the major source of water in Jordan, for all sectors. There are 12 groundwater aquifers in Jordan, 10 of which are renewable aquifers receiving annual recharge while the other two (Disi and Jafer) are non-renewable. The estimated potential safe yield of renewable aquifers was 264 mcm (Water Authority of Jordan, 1995). However, owing to the great pressure of water demand since the early 1980s, the majority of these basins have been exploited beyond their safe yield; the abstraction at present exceeds this safe yield by about 180 mcm, a condition which resulted in degradation of water quality and groundwater mining. The annual (WAJ, 1995) safe yield of the non-renewable deep basins is estimated at about 143 mcm (Al-Nasser and Zaid, 1994).

Brackish groundwater is abundant in Jordan. The most recent study, in 1995, by a Japanese team (JICA, 1995) concluded that it is economically and technically feasible to utilize annually 60 mcm of brackish groundwater, after desalination, in the Kafrein and Deir Alla areas of the Jordan Valley alone.

There are 14 wastewater treatment plants in the country. The volume of treated wastewater produced by these plants is estimated at 66 mcm, of which about 51 mcm is being reused in restricted areas of agriculture.

The Jordan-Israel Treaty of Peace, signed in October 1994, entitled Jordan to an additional 215 mcm/year of water from different sources.

With regard to water demand in Jordan, the major water consumer is the agriculture sector, followed by the municipal and industrial sectors. The municipal sector includes domestic uses, light industries, and public municipal uses. In 1995 this sector used about 20% of the total water used in Jordan, or 246 mcm (Water Authority, 1995). However, large losses, estimated at 30% of the supply, are incurred as a result of leakage. The actual per capita share of water was about 41 cm/year or 113 litres/day. This is much lower than the average consumption level recommended by WHO for acceptable health and social standards (150-180 litres/day). It is estimated that total demand for municipal uses may reach 496 mcm by the year 2010.

The agriculture sector is the major user of water. In 1995, it used about 875 mcm, which constituted 76% of the total water consumption in Jordan. This estimate includes the water used for irrigation in the Jordan Valley and the highlands and for livestock usage in these two areas. It is estimated that the total demand for agriculture use in the year 2010 will be 1,026 mcm, assuming a 1% annual increase.

Industrial water consumption in 1995 was estimated by a joint committee, with representatives of the Ministry of Water and Irrigation, the Water Authority of Jordan, and the Jordan Valley Authority, to have reached 50 mcm. Large industries, especially mining factories, usually have their own private wells and have not been dependent upon the Water Authority of Jordan supply. Small industries are supplied from public networks and are included in municipal use. Industrial activities are slowly growing; this is due to an improved investment environment, and this trend is expected to accelerate and continue. In 1995 the Water Authority of Jordan supplied industries with 24.6 mcm from its network. It has been estimated that the industrial sector will need approximately 110 mcm of water by the year 2010.

It is clear that there is an acute imbalance between supply of and demand for water in Jordan. Priority in water allocation is being given to municipal and industrial purposes; whatever remains has been directed to agricultural use. Potential water supplies from different sources and sectoral demand are shown in table 15 and figure IV.

There are some options that can be used to reduce the water shortage in Jordan. These options which require further study are listed below:

(a) Further exploitation of the non-renewable groundwater resources;

(b) Construction of all proposed dams on rivers and side wadis;

(c) Full implementation of the Jordan-Israel Treaty of Peace with regard to water;

(d) Implementation of an efficient programme for artificial recharge of groundwater aquifers;

(e) Implementation of surface-water-harvesting measures;

(f) Full utilization of treated wastewater by reuse;

(g) Desalination of brackish groundwater in the Jordan Valley area;

(h) Rehabilitation of municipal and agricultural water supply and distribution systems;

(i) Demand management measures, including campaigns for public awareness and education in water-saving behaviour.

Jordan's Ministry of Water and Irrigation has stressed the need for a reliable water supply to sustain development. The water strategy adopted by the Jordan Council of Ministers in April 1997, stresses the need to improve resource management and its sustainability at present and for the future. Emphasis to be given also to protection against pollution, quality degradation and depletion of resources. The Ministry is working to achieve the application of integrated supply and demand management tools with emphasis on advanced technology.

TABLE 15. SECTORAL DEMAND IN JORDAN

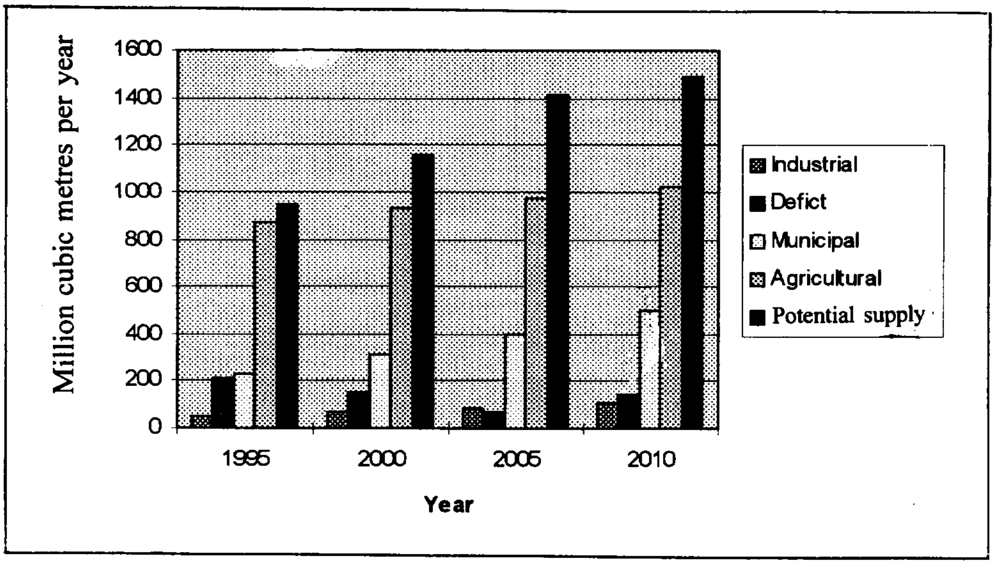
Year	Population (millions)	Sectoral demand (mcm)			
		municipal	industrial	agricultural*	Total
1995	4.29	229	50	875	1154
2000	5.09	317	65	929	1311
2005	6.03	398	85	976	1479
2010	7.08	496	110	1026	1632

* Only a 1% increase in the annual agricultural demand is assumed.

From table 15, it is clear that even with the implementation of all supply enhancement measures, the deficit still persists. Supply management methods are simpler to implement because they deal more with physical facilities rather than with people. Therefore, demand management (use reduction) is also essential. The burden of saving water through reduction in use is borne mainly by the private sector; this means the options of demand management have far-reaching socio-economic effects and are thus vulnerable to social and economic pressures. A successful water management programme must call for the cooperation of users.

Intensive campaigns to promote public awareness and education must be waged, and considerable legal efforts are needed for enforcement.

Figure IV. Potential water supply and sectoral demand



B. CURRENT PRICING POLICY

The costs of water production and services and the type of water tariffs are principal factors in the demand and delivery of water. Water services representing operation and maintance have costs. The Jordan Valley Authority and the Water Authority of Jordan have more than one source of income. Water sale constitutes the main revenue-generating activity for both authorities. The main sources for WAJ revenues are from water and sewerage charges, connection fees; and sewerage taxes; for JVA the main source of revenues is from irrigation water charges.

1. *Municipal tariffs*

For municipal water in Jordan, the increasing block rate method has been applied since 1975. In this approach, consumers pay different rates for different "blocks" of water used, where the rate increases as the consumption increases. There are sub-schedules of increasing block rates for various areas of the country-they differ in Amman, the Jordan Valley, and the rest of the country. "Special" rate schedules are applied for tanker services, public water taps, the military, and some individual and institutional users. Billing is done on a quarterly basis.

Since 1975, eight different schedules of tariff block rates have been used. In June 1997-the minister of Water and Irrigation announced that a new rate schedule would be implemented, in October 1997. The water tariff structures that have been implemented through Jordan, in the Amman Governorate, the Jordan Valley, and in towns and rural areas are shown in tables 16, 17 and 18. The rates for the lower consumptive blocks (under 41 cm/quarter) were kept low because of social welfare considerations. The lower block rates are used to reduce the financial burden on the poorest people in the society. These low rate brackets are heavily subsidized by the Government and make only a minimum contribution to the WAJ revenues. Although about 65% of subscribers were within these low blocks they use, on the average, about 28% of the municipal water and contribute only 9% to WAJ water sales revenues.

Water costs in 1996 for each consumer in the first block range (0-20 cm) for the Amman area totalled about 6.8 fils/day,[6] and 4.4 fils/day in all other areas of Jordan. In the second block (21-40 cm), each consumer pays 12.9 fils/day in Amman, 6.8 fils/day in Jordan Valley the consumer pays 6.1 fils/day in the rest of the country. Cost estimates were based on average daily water consumption.

TABLE 16. MUNICIPAL WATER RATES (1975-1996) FOR THE AMMAN GOVERNORATE
(fils/cm/quarter)

Block (cm)	1975	1978	1979	1982	1986	1988	1990	1996
0-20	60	60	80	150	120	100	100	100
21-40	60	80	120	250	200	190	190	190
41-70	90	180	250	400	400	400	400	450
71-100	90	180	250	400	400	400	500	550
101-250	120	260	350	500	500	500	600	700
251 & over	120	260	350	500	500	500	600	730
Min. charge (cm/quarter)	-	-	10	10	10	10	10	20

TABLE 17. WATER RATE FOR THE JORDAN VALLEY AREA

Block (cm)	1979	1982	1986	1988	1990	1996
0-40	100	80	65	65	65	65
41-50	100	80	65	115	115	130
51-70	100	120	115	115	115	130
71-100	100	120	115	250	250	270
101-150	100	250	250	400	400	450
151-250	100	400	400	600	600	650
25 & over	100	400	400	600	600	730
Min. charge (cm/quarter)	-	-	-	-	15	15

* Billing is done on a quarterly basis.

The changes in those schedules did not always follow logical economic reasoning; they did not ensure financial viability for WAJ, nor did they help to reduce its chronic deficit. The effect has been a continued deficit over many years. For example, in 1986, and again in 1988, the rates for the lower consumption blocks were reduced, while at the same time the difficult economic situation resulted in the devaluation of the Jordanian dinar by more than 45%.

Some efforts were made to revise the tariffs. A 71-100 cm bracket was introduced in 1990, and a new bracket for 101-250 cm was introduced in 1996 in the Amman governorate. This is an important change in scheduling approach, because it paved the way for differentiating between essential and recreational use of water, and emphasized the subsidization of small users by larger ones. In Amman, unit prices in the lower blocks are greater than in other areas of the country (by 35% to 110%). This is due to the high cost of transporting water to Amman from a great distance.

6 1,000 fils = 1 Jordanian dinar (JD).

TABLE 18. WATER RATES FOR ALL OTHER AREAS OF JORDAN

Block (cm)	1979	1982	1986	1988	1990	1996
0-15	80	100	80	65	65	65
16-20	120	120	96	90	65	65
21-40	120	120	96	90	90	90
41-45	120	120	96	90	300	320
46-70	230	300	300	300	300	320
71-75	230	300	300	300	500	520
76-100	300	400	400	400	500	520
101-250	300	400	400	400	600	700
251 & over	300	400	400	400	600	730
Min. charge (cm/quarter)	10	10	10	15	15	20

2. *Industrial tariffs*

The industrial sector depends on public water supply from municipalities and private groundwater wells. Small industries rely on the municipal distribution system for water supply. Industries have recently started to pay for the groundwater they extract from their own wells, in compliance with a Ministry of Municipal and Rural Affairs and the Environment regulation that imposes charges on groundwater utilization. It is a linear charge and amounted to 100 fils/cm.

The Water Authority of Jordan had special reduced rates for water supplied to some major industries. However, as of October 1993, the application of those reduced rates was discontinued. Those major industries which benefited from that reduced rate included:

(a) *The Aqaba Thermal Station.* A uniform rate of 300 fils/cm was applied from February 1986 till May 1986. After that it was reduced to 240 fils/cm;

(b) *The Jordan Phosphate Mining Company.* (Mining and fertilizers). A uniform rate of 300 fils/cm was applied starting in October 1984, but it was reduced to 240 fils/cm in May 1986;

(c) *Industrial Estate Corporation of Sahab.* The rate for bulk water supply of 85 fils/cm since April 1982;

(d) *The Tomato Processing Factory in the Jordan Valley.* A uniform rate of 100 fils/cm was applied;

(e) *The White Cement Factory.* A uniform rate of 120 fils/cm was applied.

The water cost for industry includes not only the price of water supplied or extracted: it has to include the costs of pumping, transportation and pretreatment. The cost of pumping from wells could average 40-70 fils/cm depending on the depth of the water table, but pretreatment costs for some industries are substantial and can be as high as 1,500 fils/cm. These figures do not include wastewater treatment costs.

In general, water costs in industrial activities do not represent a sizeable portion of total production cost. It was calculated by a survey team from the German Development Institute in 1994 that the groundwater abstraction charge of 100 fils/cm introduced in 1994 amounted to only 0.017% to 1.39% of overall costs, with an average of 0.24%.

3. *Agricultural tariffs*

Irrigated agriculture is the largest consumer of water in Jordan. In 1994 agriculture used about 72% of the total water supply. Irrigated agriculture developed extensively over the past two decades, especially in the highlands. Recently, however, its growth has been constrained by the acute shortage of water in Jordan.

Most irrigated agricultural lands in Jordan draw their water supply from the public supply networks in the Jordan Valley. All upland irrigated areas, except in Disi and Mudawwara, are privately owned land irrigated by privately owned wells and, where available, by surface water springs or small artificial ponds. The highland farmers and industries are not charged for the water they extract from their private wells, but they still pay the pumping cost (40-70 fils/cm).

The Jordan Valley Authority, created in 1977, has the responsibility to develop the Jordan Valley (below the 500-m contour lines above sea level) in a comprehensive manner. Today, the management of irrigation networks in the Valley is the main responsibility of the JVA. The first tariff on water used in agriculture was introduced in 1961; it was 1 fils/cm. In 1966, the rate was changed and a one-step increasing rate price structure was applied for the first 1,800 cm of water; 1 JD was charged, and 2 fils per cm for quantity over that base block. In 1974 a uniform rate of 3 fils per cm was applied till 1989, when it was raised to 6 fils/cm. Those rates were heavily subsidized and had no built-in water conservation incentive. Upland farmers who do not have private wells pay WAJ prices according to current rate schedules; these have been much higher than those paid by farmers in the Jordan Valley. In February 1995, the previous rate charged by JVA was replaced by a rate schedule shown in table 19, and this rate is still valid .

TABLE 19. JORDAN VALLEY AUTHORITY PRESENT VARIABLE BLOCK RATE FOR IRRIGATION WATER

Quantity consumed cm/farm unit/month*	Rate - fils/cm
0-2,500	8
2,501-3,500	15
3,501-4,500	20
4,500 and above	35

* A farm unit is an area of 30-40 dunums (equivalent to 3-4 hectares).

The WAJ issues licences for drilling water wells. After 1984 a maximum water extraction limit was set for the licences; before that time there was no limit. It is estimated that there are about 2,500 licensed wells in Jordan; in addition, there are about 600 agricultural wells illegally drilled, especially in the Azraq area. Most of these wells, (about 95%) are used for irrigated agriculture; the rest are used for industrial activities. Since 1993 no licences have been issued except for a very few special cases.

C. Financial evaluation

The policy on investment was addressed in the Water Utility Policy issued by the Ministry of Planning in 1997. The Policy noted that nearly all of Jordan's available renewable water resources had already been developed. Current use significantly exceeds the country's available renewable water resources, but still falls well short of meeting demand. Options for increasing the supply are limited, and development costs are increasing. Options including rehabilitation and replacement of inefficient networks, wastewater reuse, shared water resources, and non-conventional water resources, particularly brackish water desalination, are being either used or investigated for possible application. Development and implementation of these options will require large investments from the public and private sectors.

With regard to water pricing and cost recovery, the Water Utility Policy noted that, in view of the increasing marginal cost of supplying water in Jordan, the growing demand for water, the low rate of cost recovery and in line with the Ministry of Water and Irrigation's policy to move towards private sector participation and privatization, the Ministry will set municipal water and wastewater charges at a level which will cover at least the cost of operation and maintenance by the first quarter of 1998. The Ministry will also move towards the recovery of all or part of the capital costs of water infrastructure. Until full cost recovery has been achieved, and the national savings reach levels capable of domestic financing of development projects, project financing will depend on concessionary loans, private borrowing and/or BOO and BOT arrangements.

The water tariff mechanism is considered a tool to recover the cost of water projects. However, profitable undertakings in industry, tourism, commerce and agriculture will pay fair water costs. Moreover, the Ministry will attempt to set differential prices for water based on water quality, the end-users, and the social and economic impact of prices on the water quality and the end-users, as well as the social and economic impact of prices on the various economic sectors and regions of the country. The Ministry will also attempt to review regularly and adjust water tariffs based on the costs of supply and operations and comprehensive analysis of economic data.

Revenues have been collected by the WAJ and the JVA through connection fees and from water charges in the domestic, industrial and irrigation sectors. The following is a brief evaluation of revenues generated.

1. *Municipal sector*

Information on water supply costs and revenues collected by the Water Authority of Jordan as well as other sources (GTZ/CEC 1993, JVA 1995) is shown in tables 20 and 21.

Table 20. Water Authority of Jordan revenues and expenses for the period 1984-1991
(*Millions of Jordanian dinars*)

	1984	1985	1986	1987	1988	1989	1990	1991
Water & sewerage revenues	15	20	21	23	24	24	22	24
Current expenses	17	26	33	32	37	51	58	61
Annual deficit	2	6	12	9	13	27	36	43
Accumulated deficit	8	14	26	35	48	75	111	147

Source: Water Authority of Jordan, Financial Analysis, 1992.

The 1996 WAJ fiscal data had not yet been issued at the time of this writing. If the tariff schedule of 1995-1996 sales and services revenues is applied, table 22 gives an indication of the impact of the new tariff on WAJ finances; the tariff adds 3.5 million JD to WAJ revenues. The actual 1996 picture may not look much different from that table.

TABLE 21. ANALYSIS OF CONSUMPTION AND REVENUE OF MUNICIPAL WATER FOR ALL JORDAN, 1995

Block (cm/quarter)	Bills issued (No.)	Block bills as % of total	Consumption in thousands of cm	Block consumption as % of total	Block revenue in thousands of JD	Block revenues as % of total
0-20	692	32.2	7 774	7.5	615	2.3
21-40	707	32.9	21 719	21.2	2 081	7.7
41-70	474	22.0	25 222	24.7	4 050	15.0
71-100	158	7.3	13 162	12.9	3 306	12.2
101-250	93	4.3	12 053	11.8	4 416	16.3
251 & over	27	1.3	22 354	21.9	12 564	46.5
Total	2 151	-	102 284	-	27 042	-

Note: Bills issued, consumption and revenues are rounded to the nearest 1,000.

TABLE 22. COMPARISON OF REVENUES FROM TWO TARIFF STRUCTURES
(*Thousands of Jordanian dinars*)

	By 1995 rate	By 1996 rate	Difference
Amman	12 826	14 415	1.589
Jordan Valley	756	857	101
Other areas	13 885	15 700	1.815
Total	27 467	30 972	3.05

Table 23 shows the expenditure and revenues of WAJ in 1995 from water and water services only.

The quantity of water sold through the distribution network was 103.3 million cm. Therefore, the average cost of one cubic metre supplied to customers was 627 fils/cm, and the revenues amounted to 279 fils/cm. Thus the ratio of revenue to cost was only 44%.

2. *Industrial sector*

The estimated annual loss of revenues to WAJ from those special reduced rates was about JD 500,000 in 1995. WAJ supplied 24.6 mcm to industry, which meant additional revenues of JD 2.46 million.

Water productivity is defined as value added per cubic metre of water used. It is an indicator of the economic value (return generated) of water used in a productive activity. It varies greatly within different industries.

The employment-water ratio (EWR) is the number of employees per cubic metre of water used in the industry. Usually it follows roughly the same pattern as the water productivity.

TABLE 23. EXPENDITURE AND REVENUES OF THE WATER AUTHORITY OF JORDAN, 1995
(*Thousands of Jordanian dinars*)

	Amount	Ratio%
A. Expenditure		
- Salaries & wages	11 444	17.7
- Operation and maintenance	20 835	32.2
- General administration	506	0.8
- Assets depreciation	20 617	31.8
- Interest on loans	11 332	17.5
Total	**64 734**	**100**
B. Revenues		
- Water charges	25 197	87.4
- Meter maintenance fees	645	2.2
- Bank interest	11	0.04
- Connection fees	2 198	2.7
- Other revenues	781	2.7
Total	**28 832**	**100**

Source: WAJ financial records.

The German Development Institute (1994) surveyed a sample of 35 industrial companies in 1994 which consumed about two thirds of the total amount of industrial water used in the country. Table 24 shows the water productivity for selected industries from that survey.

TABLE 24. WATER PRODUCTIVITY OF SELECTED MANUFACTURING ACTIVITIES
(*Jordanian dinars/cm*)

Industry	Productivity
Paints	981
Pharmaceuticals	372-891
Household appliances	210-874
Poultry slaughtering	181
Detergents	58
Steel bars (melting & rolling)	34
Noodles	6
Tomatoes processing	2

Source: Survey by the German Development Institute.

Jordan's GDP in 1994 was JD 5,751 million at constant 1992 prices, and the number of persons employed in industry was 109,361, including mining and manufacturing. Industrial activities contributed JD 664 million to the GDP or 11.6%. From these figures, water productivity was calculated to be 16.6 JD/cm and the employment-water ratio was calculated at 0.65 employment/1,000 cm.

3. *Agricultural sector*

The contribution of the agriculture sector to GDP in 1994 was only 4.7%, most of which was by irrigated agriculture (3.5%) and the rest (1.2%) by rain-fed agriculture. Water productivity is on the average 60 times higher in industry than in irrigated agriculture, and employment per unit of water is about 13 times higher. However, these figures do not mean that water is used in an inefficient way in agriculture; the physical needs of plants constitute the major reason for the difference. Techniques for increasing the efficiency of irrigating systems are already widely used by farmers in Jordan.

In practice all revenues are remitted to the Ministry of Finance. Accordingly, JVA cannot generate funds internally for capital expenditure, and has to depend on the Government for any financing.

Years of partial cost recovery and debt financing put great financial constraints on JVA, and its deficit continues to grow. Water prices are still heavily subsidized, and they do not cover more than a fraction of operation and maintenance costs, let alone capital costs. The new block structure is not expected to add substantially to cost recovery. Table 25 presents a financial analysis of the operations of JVA for the period 1991-1995.

TABLE 25. FINANCIAL ANALYSIS OF JORDAN VALLEY AUTHORITY OPERATIONS DURING THE PERIOD 1991-1995

(Millions of Jordanian dinars)

	1991	1992	1993	1994	1995
Expenditure:					
Operation & maintenance	3.91	4.98	5.30	5.85	6.44
Depreciation	4.21	4.20	4.24	4.19	4.16
Interest on loans	4.71	4.71	4.88	6.49	6.49
Total	12.83	13.89	14.42	16.53	17.09
Revenue	0.69	0.69	1.03	0.88	1.36
Deficit	12.14	13.20	13.39	15.65	15.73

Source: Jordan Valley Authority records, 1993-1995.

Table 26 was drawn up on the basis of table 25 and of JVA supply records on total water available and total water used.

In the years immediately prior to 1995, when there was no tariff increase, the JVA revenues averaged about JD 800,000 annually. The new tariffs increased revenues to about JD 1.36 million, which fell below the anticipated figure of JD 2 million. This increase was only a small fraction of operation and maintenance expenditure.

In 1995, a Jordan Valley irrigation management efficiency study evaluated the production cost of selected crops using different irrigation methods (Deliotte and Touche, 1995). The study revealed different water productivity rates, ranging from JD 0.01/cm to JD 0.93/cm for each cubic metre of water utilized by crop, as shown in table 27.

TABLE 26. JORDAN VALLEY AUTHORITY UNIT COSTS OF WATER
(*Fils/cm*)

Water operations	1991	1992	1993	1994	1995	Five-year average
Total water available						
- O & M expenditure	15	9	12	18	18	14
- Depreciation	17	7	10	13	12	12
- Interest on loans	19	8	12	20	18	15
Total	51	24	34	51	48	41
Total water used						
- O&M expenditure	30	25	23	33	29	28
- Depreciation	33	21	19	23	18	23
- Interest on loans	37	24	21	36	29	29
Total	100	70	63	92	76	80

Notes: Total water available = water spilled owing to limited storage and quantity constraints + losses owing to evaporation and transporting systems + unaccounted for water; total water used includes billed water and water supplied to Amman.

TABLE 27. WATER PRODUCTIVITY FACTORS FOR DIFFERENT CROPS AND IRRIGATION METHODS IN THE JORDAN VALLEY

Crop	Technology	Ratio* (%)	Productivity (JD/cm)
Tomato	Plastic	0.8	0.93
	Drip	2.0	0.06
	Surface	2.9	0.01
Eggplant	Surface	6.4	0.02
Peach	Surface	2.3	0.23
Apple	Surface	3.6	0.10
Banana	Surface	17.5	0.02
Citrus	Surface	3.3	0.31

* Ratio: water cost to total production costs.

Table 27 shows great variation in ratios of water costs and productivity. This is a clear indication that changing crop patterns is an efficient way of managing agricultural water demand.

In 1994, as noted above, the GDP in Jordan was JD 5,751 million. Only 197 million (3.4 %) of that GDP was generated by agriculture—irrigated and rain-fed. The number of employees in agriculture was about 58,000. From these figures, water productivity is calculated to be JD 0.27/cm. The employment - water ratio was 0.08 employees per 1,000 cm of water used.

D. Trend towards privatization of water sector activities

Privatization is private sector participation in the activities of a publicly owned utility. It can take different forms, and it is not new to Jordan. The Government is committed to securing water services at affordable prices and acceptable standards. It is also committed to extending these services to remote and less developed areas, although in the future, demand and competition are expected to increase for the limited available water resources. The Government intends, through private sector participation, to transfer management of infrastructure and services from the public to the private sector in order to improve performance and ensure the delivery of services to all the country's population.

The role of the private sector will be expanded, with management contracts, concessions and other forms of private sector participation in water utilities being considered and adopted as appropriate. The practices of BOT/BOO will be evaluated, and the impact of such practices on the consumer will be continually assessed, and the negative impact mitigated. The role of the private sector in irrigated agriculture will be encouraged and expanded. Emphasis will be placed on social benefits in conjunction with private investment. The private sector is currently active in the fields of electric power, health, transportation, and petroleum services supplied, to a greater or lesser extent, to the majority of public institutions. In the water sector, the following services are provided:

(a) Networks and major facilities rehabilitation—design, supply of spare parts and components, construction, supervision of construction or maintenance;

(b) Revenue collection through banks;

(c) Supply and servicing of equipment and machinery.

Despite the far-reaching involvement of the private sector in different economic activities in the country, no government policy on privatization has yet been officially adopted. Some general principles related to privatization were enounced in the five-year Economic and Social Development Plan of 1993-1997. The most important of these principles are outlined below:

(a) Activating the role of infrastructure and basic services, and increasing private sector participation in management and services, as well as in the management and ownership of public sector institutions, on an equitable and well-considered basis;

(b) Encouraging the private sector to expand its role in various economic activities;

(c) Restructuring public institutions undergoing financial difficulties so that they can operate on a commercial basis.

The trend towards privatization is strongly encouraged by donors and international development agencies in the context of overall reform of the water sector.

Management consultants envisage privatization as a device offering many advantages, a few of which are:

(a) Enhancement of organizational performance;

(b) Potential for attracting new capital;

(c) Quicker response to public needs and to changed circumstances;

(d) More flexibility in problem-solving;

(e) Rapid introduction of new and improved technologies, staffing strategies and organizational models;

(f) Reduction in government investment and subsidies.

All these benefits hinge on certain prerequisites. A climate should be achieved so that private sector investment, and eventually other involvement, is feasible. It is essential to enhance public awareness and support. An appropriate legal framework is needed to ensure the autonomy necessary for good management, staff relations and sustainable financial operations.

The realities in the Jordanian water sector listed below will have a direct impact on the decisions regarding privatization, and what type of contract options will be considered. There is a range of privatization arrangements with different degrees of responsibility transfer from the public to the private sector: services contract, management contract, lease, BOT, concession, BOOT (Build-own-operate-transfer), and full privatization. A combination of more than one type of contract could be considered depending on the advantages offered.

These realities are:

(a) The Government's objective is to bring a commercial approach to the management, operation and maintenance of the existing water supply and sewerage services. Commercialization is not privatization; it may, however, be a prerequisite to privatization;

(b) The authorities in the Ministry of Water and Irrigation, WAJ and JVA need to revise current structural and management practices and improve the financial position of these bodies, which currently operate at a deficit;

(c) Water is a scarce and strategic commodity, and governance in the water sector should be separated from other services. There should be a clear delineation between the activities that strategically should remain in the public sector and those that should be run on a sound commercial basis;

(d) Finance is the common driving force behind privatization. In general, the objective of any private sector company is to generate adequate profits from a reasonable level of turnover, and not to accept contractual responsibilities for risks which are outside its control. The main considerations for bankers providing commercial loans for "privatized" contracts are the viability and risks of the proposed agreement.

Taking all the above realities into consideration and given the current legal, regulatory, financial and political constraints, it is evident that the water sector in Jordan is not ready for full privatization at this time.

Introducing privatization involves significant change in the management of water services. Privatization should be introduced gradually if it is to succeed. The experience of other countries with major institutional changes rated low on the performance scale. Each change in working relationships, professional bonds, trust, and mutual understanding of mandates and boundaries takes time to develop.

The basic ingredients for success in the privatization process are careful and clear planning, a realistic approach, training, public awareness and education, and political support. These should be guaranteed beforehand.

However, carefully planned utilization of limited private sector services can be satisfactorily achieved. BOOT and BOT contracts can be successful if used to build infrastructural components that can be easily operated as separate facilities; such arrangement can provide a facility at little or no direct cost to the Government.

Some forms of services or management agreements (contracts) could enhance performance and reduce costs if given the needed public, political and regulatory support.

In any of contractual arrangement, the quality of the service provided should be monitored by the Government to prevent abuses and monopolies, to ensure proper maintenance of assets, and, at the same time, permit the continued financial viability of the "privatized" organization.

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