SECTION 1

Middle East Water Issues

INTRODUCTION

In the Muslim, Christian, and Jewish worlds, water can be a symbol of destruction, as well as healing and cleansing. In the next 10 years, decisions regarding water allocation in the Middle East will, in a real way, be choices for destruction or order, for hurt or healing, or for separation or reconciliation. None of us--leaders in and outside the Middle East--will be able to avoid these choices. To ignore, suppress, or avoid Middle East water issues will most likely be to choose destruction, hurt, and separation.

Water connects nations and peoples in the Middle East regardless of how they feel about one another. In a profound sense, our knowledge of water and its flow is now beckoning us to reach for a new cooperative consciousness. If we don't achieve cooperation regarding water, we are unlikely to achieve it in other problems affecting the region. In fact, we may not even have the chance since there is no life without water.

Experts debate about how much water is available in the region. However, awareness is growing that the nations of the Middle East must cooperatively manage, engineer, and conserve available water resources. Without cooperative management, a zero-sum competition will emerge over water that is not always available at the right time and place. Seasonal and regional shortages could exacerbate social tensions and precipitate violence. From the resource perspective, we do not have to succumb to win/lose approaches. Sharing and cooperating can provide benefits that may even exceed those achieved by maximizing individual and national self-interest. However, cooperation requires new diplomacy and institutional arrangements based on hydroengineering. Perhaps, as with Europe in the post-World War II period, such cooperative resource arrangements could eventually lead to broader cooperation.

Whatever is done or not done in the Middle East, water needs will not go away. People will not stop drinking and using water! The only choice is how to deal with a scarce resource.

Rarely have humans been offered such compelling evidence for the convergence of pragmatic self-interest and moral imperatives to cooperate. Today, water is more than a healing and cleansing symbol (for Muslims, Christians, and Jews); it is also the pragmatic basis of self-interested cooperation. We should use our shared belief in the sanctity of water and our scientific knowledge of its behavior to affect the future social and political arrangements in the Middle East, rather than simply reacting to whatever emerges.

HISTORICAL BACKGROUND

The history of civilization in the Fertile Crescent is closely linked to humanity's dependence on the life-giving floodwaters of the Nile River in Africa and the Tigris and Euphrates Rivers of Mesopotamia. The political and institutional structures of civilization were born out of human success in controlling the vagaries of the hydrologic regimes of rivers flowing through arid lands. Religion, science, and culture evolved out of adaptations to the cycles of floods and droughts. The principles of engineering probably evolved out of the need to redistribute the seasonal pulses of water to irrigate croplands. Indeed, Herodotus attributes the discovery of geometry to ancient Egyptian attempts to predict flooding on the Nile.

Wittfogel (1967), in developing his theories of the rise and fall of hydraulic civilizations, asserts that large-scale hydraulic works are needed for agrarian society to adapt to a dry environment. These works brought about new schemes of social organization and in many cases centralized political authority. Hourani (1991) notes how closely linked the use of water and development of water resources were expansions of Islam. He writes that "...to bring water to the inhabitants of the cities was an act of sound policy, and irrigation of the land was a practice which spread with the expansion of the Arabs in the Mediterranean." Indeed, waterworks were seen as great works of public utility, the expressions of the power of the ruler.

In then-Islamic Spain, knowledge of the waterwheel was acquired from Syria and the technology of underground canals from Iran. Hourani also notes how rituals and procedures of state, such as those of the Fatimid rulers, showed a relationship with the rivers. Indeed, the location of cities was closely linked to the sources of water (the rivers). The Islamic historian Al-Tubari notes that Baghdad was founded where "...things can arrive by way of the Euphrates, Tigris and a network of canals ... (that) will support the army and general populace." Hourani notes that the rise of Arab power was quite dependent on wealth generated from rich, irrigated lands. When irrigation fell into disrepair, so too did the power of the rulers and cities.

WATER: TRENDS PUSHING TOWARD CRISIS

The major watercourses of the Middle East are increasingly becoming the focus of conflict between neighboring countries of this region. Although water from streams and ground water sources has always been a critical factor in the economic well-being of Middle Eastern countries, increasing utilization of these resources has raised awareness of their finite nature. Indeed, the Center for Strategic and International Studies predicted in 1988 that "by the year 2000 water, not oil, will be the dominant resource issue of the Middle East." The present study focuses on individual river basins as a means to understanding the water resource issues of the Middle East.

Despite phenomenal advances in water resources management, humanity's dependence on water is increasing. As population grows and water uses multiply, the supply remains relatively constant, and the sources are often far from the ever-growing centers of demand. Yet water resources management is not a simple matter of identifying reservoir sites, pipelines, agricultural irrigation schemes, and groundwater pumping. In the Middle East, religion, culture, politics and tradition greatly complicate what at best would be a difficult multinational resource-management problem.

Some experts say that time is running short, that disaster is around the corner. Others maintain there is no general problem because nations simply can reallocate water from irrigated agriculture to municipal and industrial uses. Beyond the quantity of water, and the use of that water, is the question of water quality. Deteriorating water quality may in effect be the trend that brings the Middle East to the limits of water availability. What's more, changing from agricultural to other uses has limits set by attitudes and ideology.

Proclaiming a water crisis is more complex than first meets the eye. Most experts agree that either current patterns of water use or attitudes toward cooperation will have to change. They also tend to agree that, at a minimum, there is a water-shortage crisis in the area of the Jordan River, West Bank and Israel. Also, water shortage and quality crises are rapidly emerging in some major cities in the region.

Today, a variety of forces that could precipitate a water crisis in the Middle East are converging.

1. Flow Variation in Time and Space

A major factor affecting water supply in the Middle East is its variability. The quantity of water that can be withdrawn easily from a stream or river depends on variability in flow. A small variability in flow and a relatively high proportion of base flow is generally favorable for maximum utilization. However, in the Middle East, stream flow varies markedly on a rhythmic basis throughout the year and fluctuates dramatically from year to year. Seasonal-flow variability is greater than annual variability. Maximum stream flow occurs during the spring (about one-half in a two- to three-month period) while low flows occur in late summer. Low flows typically average from one-fifth to one-tenth of the high-flow discharge. Year-to-year variations in annual stream flow are also the rule; yearly stream flow totals typically vary substantially from the mean. For example, low flows on the Euphrates have been recorded (within the last 60 to 70 years of record) that are less than one-third of the average annual flows; so, too, on the Tigris. On the Jordan, low flows have been recorded that are less than one-half of average annual flows. Although the average annual flow at Aswan in Egypt is estimated at 84 BCM per year, Waterbury notes that in 1878-79 flow was 150 BCM per year and in 1913-14, 42 BCM per year. There is also a history of recurrent and dramatic droughts. In such situations, contingency plans, along with long-term planning for storage capacity and conservation programs, are necessary to maintain a safety margin.

2. Population Growth

Population growth throughout the area is among the highest in the world. The World Bank notes that 217.4 million people lived in northeast Africa and the Middle East area in 1983. By 2000, the Bank estimates this will increase by 55 percent, or an additional 119.6 million people. This large population will need water to drink and possibly for irrigation. Even if more efficient use is instituted and economic development is limited, demand for water could easily increase by 25 percent--in an area already close to its limit during average-flow years, let alone low-flow years. The populations of Iraq, Syria, Jordan, and Saudi Arabia are growing at 3.5 to 4 percent per year, a doubling rate of less than 20 years. Turkey, Lebanon, and Kuwait are growing at well over 2 percent a year. Only Israel is growing at a significantly lower rate of approximately 1.5 percent a year; however, Israel is about to experience a influx of an estimated 1 to 2.5 million immigrants in the next few years, or a rapid 25-percent increase in population. At lowest estimates, per capita consumption rates could mean an increase of 20 percent in demand for water in a country already at its water-supply limit. As population grows, per capita consumption of water increases because of economic development and better living stands.

3. Agricultural Practices

Historically, agricultural practices and cultural values surrounding the use of land have been central to the rise and fall of power and authority in the region. Today, farming and cultural values have combined to create water shortages. Some experts say there is no water problem because the region has only to reduce the amount of water allocated to irrigation and agriculture. However, reduced water for irrigation can be perceived as jeopardizing a secure food supply or endangering the flow of hard currency. Reduced water for irrigation can also conflict with encouraging land settlement and expansion, which is justified by the argument that redemption is found in making the land productive. Frequently, the most powerful institutionalized interest in the matrix of water-allocation authorities in these nations is irrigation. As the perception and experience of water scarcity grows, pressure to use less water for irrigation and to distribute more of the available supply to other uses will increase. This pressure could generate internal political battles over realignment of powerful institutions that in turn could generate external political consequences. New definitions of food security will also emerge, and these may very well require regional or international guarantees.

4. Precipitation

Throughout the region, precipitation varies from <100 mm to 1,600 mm annually, although most of the region averages <400 mm. Lowlands generally receive the least rainfall. Conversely, the mountains--especially the highest elevations--receive the most precipitation, much of it in the form of snowfall. Most of the precipitation falls during the winter and spring, with summers generally dry. The major steams in the region are fed primarily from winter and spring snow melt and runoff.

5. Water Use

Urbanization is increasing throughout the region. Although population has grown in both rural and urban areas, the latter are growing much faster. In 1960, slightly more than 40 percent of the population of Iraq, Syria, Turkey, Lebanon, Jordan and Saudi Arabia lived in urban areas. In 1990, Iraqi, Lebanon, Jordan, Israel, Saudi Arabia, and Kuwait were 70 percent urbanized or more. Turkey is close to 50 percent, with Syria over 50 percent urbanized.

Although the region is rapidly urbanizing, water withdrawals are still devoted overwhelmingly to irrigation. In Iraq, Syria, Lebanon, Israel, and Saudi Arabia, agricultural

sectors account for 80 percent or more of withdrawals. On the other hand, in Lebanon, Jordan, Israel, and Saudi Arabia, agriculture accounts for less than 10 percent of Gross Domestic Product (GDP); in Syria, about one-fourth of GDP; and in Iraq and Turkey around 17 percent. In Turkey, the agricultural sector uses close to 60 percent of water withdrawals, while Jordan uses 65 percent.

Overall, during the past decade, per capita usage in urban areas has been steadily increasing, as has water use by agricultural sectors. An example of increasing per capita usage is usage in Mosul, Iraq, where per capita consumption has been projected to grow from approximately 230 l/day in 1974 (366,000 population) to 330 l/day in the year 2000 for a population of 1,000,000 (Agha et al., 1980). This increase is a function of increased living standards. The existing hydraulic systems of many cities will be ill-prepared to serve new demands.

6. Groundwater Availability

The quality and availability of ground water are also becoming critical. Use is increasing and over pumping is occurring in a number of areas throughout the region--for examples, in the West Bank and Gaza, Jordan, and arguably in Saudi Arabia and other parts of the Arabian peninsula. This over pumping has caused groundwater tables to drop. Recharge rates and groundwater flow are still not well understood in most areas. Indeed, several Middle East countries may in effect be rapidly depleting their most precious resource. Groundwater has become a particularly important in Jordan and Israel. In Jordan, it represents 49 percent of withdrawals; in Israel, it accounts for more than 55 percent. Groundwater has also begun to dominate the water sources of Saudi Arabia and, to a lesser degree, other countries on the Arabian peninsula.

7. Water Quality

Water quality in arid regions usually deteriorates as water flows downstream and becomes contaminated by natural processes as well as by irrigation drainage. In the Middle East, this process is being accelerated. Evidence of this can be found in the fact that since the early 1970's many water utilization projects have been constructed. Many more are in the design stages, and more still in the planning stage. Some of these new projects (especially dams) have resulted in curtailed flows downstream, and downstream users fear more reductions. In partial reaction, downstream entities are developing their own water supply projects. Though downstream users have often complained about the quantity of water they receive, quality is also important. In the lower reaches of the major river systems, water is often unsuitable for agricultural and domestic purposes because of high salinity and agrochemical content. Because of increasing use and reuse of water for agriculture, quality is deteriorating rapidly as it moves down the river systems. Although most of the rivers in the region spring from clear water in upland mountainous areas, by the time they discharge into the sea, water quality has deteriorated significantly. The Jordan River has a natural chemical water quality that starts at around 20 ppm of dissolved constituents, but it reaches over 1,000 ppm by the time the Jordan reaches the Dead Sea. If Syrian plans for irrigation and those of the Turkish Southeast Anatolia Project (GAP) are realized, as much as 1 million acres of irrigated land along the Euphrates River in Iraq could be jeopardized by decreased water quantity and quality (Kolars, 1990). The quality of urban supplies is also increasingly at risk. A number of cities, such as Aleppo and Damascus, have reported or are concerned about deteriorating water quality.

8. Environmental

Environmental impacts and ecological trends need to be better identified and integrated into water resources planning and management. For example, most of the limited international

discussion of water sharing on the Tigris and Euphrates has apparently focused on quantity and not quality of water at the borders. The Middle East is an important flight path for migratory birds which could be affected by change in coastal wetlands. Lower flows and decreased quality on the Shatt al Arab waterway has probably changed the ecological composition of its estuary, with impacts on fisheries as well as on the paths of migratory birds. Global warming could further exacerbate deteriorating water quality conditions. A global temperature rise of between 2 to 4 degrees could mean that countries in the region will experience a 20 to 40 percent decrease in soil moisture. This could lead to decreases in river flows, groundwater recharge, and increased demand for irrigation.

9. Interdependencies

The problem of scarcity versus increasing needs is compounded by the international nature of existing supplies. The major river basins--the Euphrates-Tigris, the Jordan, the Orontes, and the Nile--do not respect national boundaries, and a fifth basin, the Litani, though entirely within Lebanon, is the focus of interest of other countries. Over 50 percent of the populations of the Middle East and North Africa (excluding the Maghreb) depend either upon water from rivers that cross an international boundary before reaching them or upon desalinized water or water drawn from deep wells (Kolars 1990).

The interdependence of two or more Middle Eastern countries upon a common water source frequently is linked to competition over adjoining river basins. For example, dependence of countries on Jordan River basin water resources has linkages to interdependencies in the Euphrates River basin. Israel depends at present, on the West Bank for about one-third of its water supply, and obtains another one third from the Sea of Galilee (also refered to as Lake Kinneret or Lake Tiberias) and one-third from within its own borders. Israel already uses 100 percent or more of the water available to it. Most projections call for water use well in excess of Israel's annual supply. Although these projections generally take into account Israel's modest population growth rate, the total population will surge with the influx of a million or more Soviet emigres over the next few years. Although Lake Kinneret serves as a reservoir for Israel, water from the Yarmuk River which enters the Jordan River from the east, is of great importance not only to Syria, its source, but also to Israel along with Jordan. Jordan has already overreached its renewable supply, and water rationing is in effect. This situation is expected to worsen. Jordan 's population is growing rapidly and will double in 20 years, and Jordan depends on irrigated agriculture for much of its income. A substantial source of water has been its rapidly depleting underground reserves. As such, Jordan views increased use of the Yarmuk as vital to its interests. However, as mentioned earlier, Israel and Syria also claim large shares of the river.

Syria, in turn, is experiencing an even higher population growth rate. Damascus, Homs, and Aleppo suffer increasingly severe water shortages. Both cities and agriculture are looking for more water and energy. Syria depends for its energy in large part upon another major river, the Euphrates, and the City of Aleppo depends upon Euphrates water for both human use and agriculture. Turkey, which controls the headwaters of the Euphrates, is developing a series of dams and irrigation projects along the river, and may significantly effect downstream users in Syria and Iraq. Both the quantity and quality of water are at risk, especially if Turkey realizes all its development dreams. Both Syria and Iraq have similar ambitious plans involving the Euphrates, and these plans could be threatened as Turkey completes its projects.

This regional interdependence is underscored by both Jordan and Kuwait recently looking to the Euphrates as a possible source of water, though these plans have since been abandoned. Thus on all scales, the Middle East is experiencing local and regional competition for scarce water supplies.

10. Institutional Frameworks for Water Management

The Middle East has few international treaties or institutional arrangements for dealing with the allocation and distribution of water and the control of water pollution. Of 286 international water treaties signed, over two-thirds are related to river basins in North America and Europe, and only one--on the Nile--exists in the Middle East. Virtually no formal agreements exist on the Jordan, Tigris, and Euphrates. The Middle East has no effective multilateral and multiparty arrangements. The current Euphrates commissions seem not to have been productive and are mainly for technical communications and exchange. Although Saudi Arabia has tried to mediate allocation disputes among Turkey, Iraq and Syria, its efforts seem to have met with little success. In the mid-1980's, Syria proposed a multinational Euphrates river authority; however, such an authority still doesn't exist. On the Shatt al Arab waterway, a variety of commissions have come into existence over the years, but have been primarily for the maintenance of navigation, rather than water quality control or the allocation of water. The Jordan River proposals in the 1950's were never formally adopted but have been used as the basis of defacto multilateral arrangements.

In this atmosphere, however, there have been recent attempts at bilateral agreements. In the 1980's, talks between Syria and Iraq reached accords on the use of the Euphrates, pending Turkish, Syrian, and Iraqi agreements. In 1990, Turkey and Iraq signed cooperative protocols with special attention to the Euphrates. In the late 1980's, Turkey and Syria reached an agreement of sorts on allocations of Euphrates flows. However, it is not clear what these agreements may or may not accomplish and whether they may be contradictory. Comprehensive and integrated arrangements are still lacking.

HYDRO-POLITICAL DIMENSIONS OF THE REGION

One doesn't have to look far to see how politics and hydrology mix in the Middle East. Examples are the current situations on the West Bank, Gaza, and the Jordan River; the Tigris and Euphrates; the Nile; and the Shatt al Arab waterway.

Approximately 40 percent of the world's population depends on waters flowing across national boundaries.* In Northeast Africa and the Middle East, over 50 percent of the total population depends on such flows.* Sixty-seven percent of all Arabic-speaking people rely upon transboundary water from non-Arabic speaking areas.* Almost 24 percent of the Arab people live in areas with no year-round surface streams (Kolars, 1990).

Water allocation and distribution will certainly be central to any Israeli-Palestinian accords. Indeed, water supplies could become a tangible index of equity and fairness in any future negotiations. A variety of commentators and officials in Israel have recognized the crucial role of water. For example, one major Israeli news commentator noted:

> "... any future agreement (of the states of the West Bank and therefore Palestine) will stand or fall on one essential issue: the water problem. ... he who controls the water sources in the West Bank can literally dry up Israel's coastal strip ...."

Recently, the Jerusalem Post (10 August 1991) carried a full page advertisement sponsored by the Ministry of Agriculture, headed by General Rafael Etan. The advertisement described the critical role of water and how giving up land could be impossible because to do so would put the quantity and quality of Israel's water at risk. The New York Times (21 April 1991) quoted a report by Israel Comptroller Mirrain Ben-Poret describing how water management has drained reserves. The report asserts that the low cost of water to farmers "allowed, and even furthered, the development of agricultural growth that did not contribute to the nation's economy."

The statistics tell the story. In the Jordan basin, almost 40 percent of the Israeli water supply now comes from beyond the pre-1967 "green line." Almost 90 percent of the water withdrawal from West Bank aquifers goes to Israel for intense irrigation, with the rest going to West Bank residents. Israelis consume water at about three times the per capita rate of Palestinians. Israeli settlers on the West Bank consume two to five times the per capita water use of other Israelis.

According to the Israeli water commission, the western basin of the West Bank can provide 320 MCM per year, but Israelis are using 335 MCM per year and the residents of western Samaria about 20 MCM. In the northern basin, which can yield 140 MCM per year, Israelis use the entire quantity with local residents using about 20 MCM per year more. Israel uses all of 30 MCM per year potential of western Judea's basins potential, with local residents using an additional 2 MCM per year. Of the east basin's potential 125 MCM per year, local residents use 60 to 90 MCM per year (Pedatzur 1989).

Thus, current uses for West Bank Jewish settlers and Arabs is over 800 MCM, but the "safe yield" or renewable average annual rate is estimated to be around 615 MCM per year. The 200 MCM shortfall is being met by pumping of the Jordan and groundwater draw-down (Pedatzur 1989).

Jordan, which has about 68 percent of the population of Israel, uses roughly 45 percent as much water as Israel does. Jordan's main sources are the Yarmuk River, which feeds the East

Ghor Canal, and limited aquifers. The Al-Azraq Oasis tapped to supply Amman has been rapidly depleted. Israel disagrees with Jordanian plans to enhance Yarmuk flow into the East Ghor.

In the past, Israeli water plans have included the use of the southern part of the Litani River and control over the headwater projects on the Yarmuk tributary to the Jordan River. In fact, some argue that the conflict over diversions on the Yarmuk precipitated the 1967 War.

Some experts estimate that the Gaza is being over pumped by around 60 MCM per year, and that salinization is increasing. It is estimated that Israel is operating at close to capacity for an average year. Many experts project deficits by the year 2000, as much as 750 to 800 MCM (Shahin, 1989). Many experts protect deficits for Jordan as well.

Furthermore, a comparison of projected demand versus availability fails to reveal the magnitude of the problem. Much of the so-called available water is storm runoff, some in isolated areas. Other resources may be contested. The projected immigration stream of over 1 million Soviet Jews to Israel in the next 2 years will increase the Israeli population significantly and dramatically escalate water demands, possibly by 20 percent.

As for the Tigris and Euphrates, in the 1970's Iraq almost went to war with Syria over the coincidental filling of Turkish and Syrian dams, which reduced the Euphrates flow dramatically during a dry period. Other incidents occurred in 1980 and 1990. Syria's hydroelectric dams at Tabqa Dam on the Euphrates are estimated to be operating at only 40 percent of capacity due to low flow in the Euphrates River due caused by Turkey's new GAP projects. In the summer of 1989, the Syrian dams reportedly operated at only 10 percent (Hindley, 1990). Low flow in the Euphrates is causing high salinity and reduced flushing into the Shatt al Arab waterway, thereby probably changing the ecological systems in that waterway with consequent impacts on fisheries. Some experts estimate that Iraq will be left with about 25 percent of the average annual Euphrates flow after all the proposed Turkish and Syrian dams are constructed. This represents a dramatic decrease from about 33 BCMs to 8 BCMs per year. Such reduced flow will significantly reduce the capacity of Iraq to reach its objectives in its current agricultural plans. Other problems may ensue with regard to the GAP projects. Since the GAP projects are close to Kurdish territory, possible anti-Turkish Kurdish activity directed towards the dams could be expected.

Nine nations share the Nile River. Egypt, the chief beneficiary of the Nile, contributes nothing to its flow. The Nile is the one river in the Middle East region with standing formal allocation agreements. However, these agreements involve only the lower two riparian nations, and Ethiopia is now pressing new demands for water. Egypt is allocated 55.5 BCM per year, but currently uses about 60 BCM per year. Given its projected population increase, Egypt is likely to use about 70 BCM per year by the year 2000. Currently, Sudan does not have economic backing to realize its development plans; but, if it did, Egypt's needs would then far surpass what would then be available. Seasonal fluctuations make the situation even more volatile.

Control of the Shatt al Arab navigation waterway was probably a proximate cause of the recent Iran-Iraq war. Historically, access to and control of the waterway have contributed to conflicts; but the disputes have mainly been over boundaries rather than allocation of water. The waterway represents access for Iraq to the Persian Gulf. Currently, this access is closed due to war damage, and some forms of joint cleanup will be necessary. Recently developed and proposed water resources projects on the Tigris and Euphrates portend ill for estuarine ecosystems along the Shatt al Arab. Decreased flows and increased salinities will impact fisheries, shrimping areas, and waterfowl migrations.

At a more conceptual and theoretical level, several scholars have noted that diminishing access to water resources can lead to either war or violence. Of the numerous theories of war,

many emphasize that anxiety and fear over natural disasters in general, and specifically drought, have been a major reason for violence and war. One could expect that violence will rapidly increase as resources diminish. Some scholars have also noted the dangers of increased centralization and authoritarian governments in the face of diminished water and other resources. In this sense, water is clearly linked to internal and regional security.

Among professionals, the discussion of resources management has moved from a focus on efficiency, to multipurpose, to comprehensive management, to today's concern for ecosystem management. This movement has fostered an increased need for interdisciplinary management and search for sustainable development.

These general theoretical concerns are especially acute and important in the context of today's Middle East. As stated, water flows typically may deviate from the annual average by as much as 30 to 40 percent in any given year. Such fluctuations, in conjunction with increased strains from growing populations and urbanization, are likely to increase the probability of diminishing access to water as well as associated anxieties.

The traditional role of the water engineer is to reduce such anxiety by providing a safety margin for society and redistributing the spatial and temporal risks. The safety margin allows social activity to continue with minimal disruption by assuring sufficient supplies for those times when flows may be dramatically less than they are in an average year. Engineering traditionally accomplishes this through interventions in the natural system--engineering structures such as dams and diversions-- or in the social systems through nonstructural conservation measures. Although recent debate in the engineering community has tended to put such structural and nonstructural approaches into adversarial positions, the Middle East of today demands both conservation and structural supply augmentation strategies. Indeed, reduced stream flows become an important impediment to achieving in-stream water quality since stream flow is the major means by which pollutants from non-point sources, including agricultural return flows, are flushed.

WATER: HOW MUCH IS THERE AND WHERE IS IT LOCATED?

Available data make estimates difficult; however, basic trends can be outlined. Lebanon and Turkey have net surpluses and are the region's natural exporters of water. Iraq, Syria, and Egypt could be exporters depending on what happens in the headwaters of the Nile in Sudan and the Euphrates and Tigris in Turkey and Syria. Israel, Jordan, Kuwait and Saudi Arabia are importers of water. Iraq, Lebanon, Turkey and possibly Egypt and Syria are likely to be the only possible sources of supply of surface water. However, if all the planned dams on the Orontes River are built, shortages could result along the lower reaches in Turkey. It is not clear whether Turkey will have sufficient surplus water to supply as much water as many speculate it has. Already, major cities in Turkey are experiencing water shortages.

Syria, Jordan, Kuwait, Saudi Arabia, and Israel are likely to be in deficit by the beginning of the next century. The combined water deficits of these countries could be as much as 5 to 6 BCMs per year (Figure 1). Iraq might face a deficit later in the 21st century if all of the projects planned by and Syria and Turkey are developed. Syria, which will lose much of the Euphrates flow it has counted on, will have to depend on its groundwater resources.

Excluding interbasin transfers from Turkey and Egypt, the available supply is likely to be around 7 BCM per year. However, the story cannot be told in absolute numbers. Figure 1 shows shortfalls and surpluses all of which are a few BCM either side of zero. Knowing that primary surface water supplies experience enormous yearly (and seasonal) fluctuations means that these gross estimates of average annual supply compared with use paint an alarming picture. The estimates for Iraq, Israel, Jordan, Kuwait, Saudi Arabia, Syria, and even Lebanon are only a few BCM either side of zero. However, low flow variations are likely to be measured in 1 to 1.5 BCM around the Jordan and 10 BCM around the Euphrates. These low flow figures could turn even the surplus into large shortfalls while aggravating already projected shortfalls. Even Lebanon, which is projected to have surplus, may not if planned projects are completed.

Some experts believe that Syria could also be in deficit by about 1 BCM per year; Jordan by about .25 BCM per year; Israel by .75 BCM per year; and Saudi Arabia, depending on how one assesses that nation's groundwater supply, by as much as 2 BCMs per year or more. The continued capacity of Kuwait to provide its supply through desalinization, given growth rates, is questionable; Kuwait could be in quite large deficits by the year 2000.

The Middle East has water, but cooperation will be required cooperation to allocate and distribute it. Jordan, Kuwait, Saudi Arabia, and the rest of the Arabian peninsula could obtain some water from Iraq. Jordan, Israel, and Syria, with coordination, could obtain some supply from Turkey and possibly Egypt.

Figure 2 portrays interdependencies of the surface river systems in the countries in the region. Lebanon generally withdraws far less than it generates on the Jordan, the Litani and the Orontes. Syria withdraws about one-sixth of what it generates in the Jordan. On the Orontes, Syria may withdraw more than it generates. On the Euphrates, Syria withdraws less than what it generates. In the future, it is likely to withdraw more than it generates within its boundaries. The only surface water currently available to Israel and Jordan is the Jordan River and its tributaries. However, doubt exists how much flow the Jordan generates.

During the 1950's, the various development plans in the Jordan valley allocated anywhere from 20 to 50 percent of the Jordan River to Israel and the rest to the Arab states of Jordan, Lebanon and Syria. The 1955 Johnson Plan allocated 40 percent of the Jordan's waters to Israel and 60 percent to the other Arab states. Israel accounts for approximately 25 percent of the surface water sources, while other Arab states account for 75 percent of the sources of the Jordan River.

PRELIMINARY - NOT FOR ATTRIBUTION

	Iraq	Israel	Jordan	Kuwait	Lebanon	Saudi Arabia	Syria	Turkey
Population (million): 1/								
Present (1989-1990)	18.8	4.6	3.1	2.0	2.9	13.6	11.7	55.5
Year 2000	24.0	5.4 *	4.9	2.8	3.6	20.7	16.9	65.4
Growth rate (%) [world = 1.8%]	3.9%	1.6% *	3.5%	2.5	2.1%	3.4%	3.8%	2.1%
Urban population % (1960/65/90):	43 61 74	77 87 92	43 55 68	72 84 96	40 69 84	30 59 77	37 45 52	30 42 48
Human development index:	75.9	95.7	75.2	83.9	73.5	70.2	69.1	75.1
Econ sector (% GDP), 1990: 2/								
Service	47%	32%	70%	47%	71%	48%	54%	47%
Industry	37	58	22	51	21	45	19	36
Agriculture	16	10	8	2	8	7	27	17
Labor force (%), 1985-1990:								
Service	48%	62%	64%	67%	58%	37%	36%	31%
Industry	22	32	26	32	27	14	32	18
Agriculture	30	6	10	2	14	48	32	40
Water withdrawal by sector, 1988-1989: 3/								
Domestic	3%	16%	29%	64%	11%	45%	7%	24%
Industry	5	5	6	32	4	8	10	19
Agriculture	92	79	65	4	85	47	83	57
Per capita usage (liters/d), u = urban; r = rural [35-90 lpcd for developing countries]	150 u 100 r	220	40-60 u 20 r			400 u		
Sources, BCM/yr: Surface	54.1			-	0.699	1.044	4.38	
Ground water	0.9			0.356	0.160	4.746	2.5	
Desalination				0.404		0.782		
Waste Water Reuse				0.08		0.195		
Present Water Resources (mostly 19975-1980 est.):								**
Water available (BCM/yr)	72.4 11/***	1.95 6/	0.90 9/	0.64 13/	4.98 4/	5.21	26.00 11/***	52.6
Water withdrawn/supplied (BCM/yr)	53.6	1.93 7/	0.69 6/	0.84 4/	0.86 4/	6.83	6.88 4/	3.1 10/
Projected (Year 2000):	(yr2000+)							** (yr2000+)
Water available (BCM/yr):	47.4	1.95	0.90	0.64?	4.98 4/	5.82	23.30 11/	52.6
Water demand (BCM/yr):	59.9	2.50 8/	0.87 10/	1.58 4/	1.45 4/	7.89	8.49 4/	33.8
Surplus/shortfall, BCMyr:								**
Present:	27.0	0.02	0.21	<-0.20>	4.12	<-1.62>	19.12	49.5
Year 2000:	<-6.3> (2000+)	<-0.55>	0.03 *	<-0.96>	3.53	<-2.07>	14.81	18.8
Interdependencies: annual river flows From/to other countries (BCM/yr): 3/	66.0/ --	0.45/ 0	0.40/ --	0 / 0	0.00/0.86	0 / 0	28.9/ 30	7.00/69.00

* Some of Jordan's water resources are long distances from users and infrequently available (flash flows)
** Tigris-Euphrates basin only (IWR est.)
*** Presently less available because of filling of Ataturk Reservoir

1/ Source is mostly: Vu, Mi, 1985. World Population Projects, Johns Hopkins Univ. (for World Bank)
2/ The Economist Book of Vital World Statistics, 1990 3/ World Resources, 1990-1991, World Resources Institute
4/ Shahin, 1989 5/ Naff & Matson, 1984 6/ Naff, pers comm. 7/ Nativ 1988 8/ Gruen 1990
9/ modified from Jordan Natl Water Authority 1977 10/ Arar 1987 11/source partially Kolars & Mitchell (in press)
12/ Kolars & Mitchell (in press) 13/ Akkad 1990
Other sources include: Population Reference Bureau, 1990; Social Indicators of Development (World Bank), 1989

Today, Israel uses almost 40 percent of the Jordan River Basin's runoff, excluding the Yarmuk River and Jordanian contributions.

Turkey clearly is a major potential supplier of water in the area. Though it currently withdraws about one-quarter of what it generates in the Euphrates, that demand is likely to double by the year 2000, as the GAP projects come on line. On the Tigris, Turkey currently withdraws very little of the substantial flow generated on that river. This use is likely to increase somewhat by the year 2000. Two projects (including dams) are presently under construction. Three more major projects are planned. Iraq, which generates essentially no flows in the Euphrates, in recent decades has withdrawn 17 BCM. On the Tigris, it has withdrawn almost double that which it generated within its own boundaries.

On the Syrian-Turkish border, groundwater connections are potentially important for recharging the Khabur River. This ground water could be drawn down by Turkey and thereby reduce flow into the Euphrates as the GAP projects get underway. This action would greatly exacerbate the deteriorating water quality in the Khabur River expected because of GAP irrigation return flows to the Khabur. At the same time, Syria is developing the Khabur Valley into an important agricultural area.

Throughout the Arabian peninsula, groundwater is the essential water source. One of the most water-poor countries of the area, Saudi Arabia is irrigating almost 39,000 km^2 -- among the highest in the whole region. The much-noted agricultural miracle of Saudi Arabia has been bought at a heavy price--water. Although heavy subsidies for wheat and other crops produce cash crops and promised food independence, many experts believe it has endangered limited ground water supplies. The situation in Saudi Arabia is debatable. Using an estimate of 800 MCM per year of rainfall recharge, the accumulated deficit in the aquifer could be almost 6 BCM per year. If 40 percent of an estimated 500 BCM groundwater was recovered per year, some experts suggest that supply will run out in 30 years (Kolars).

Figure 2 **WATER INTERDEPENDENCIES**

In MCM/yr, Present

	Lebanon	Syria	Jordan	Israel			
Jordan River:							
Q generated	130	520	380	730*			
Withdrawn	0	90	160	600			
Ground water shared			yes	yes			

* Includes runoff from West Bank & Golan Heights
Note: 700 MCM/yr est. flow into Dead Sea @ 2,000ppm

	Lebanon						
Litani River:							
Q generated	920						
Withdrawn	440						

	Lebanon	Syria			Turkey		
Orontes River:							
Q generated	420	720			?		
Withdrawn	80est	740			negli		
Ground water shared:							

		Syria			Turkey	Iraq	Iran
Euphrates:							
Q generated		4,500*			28,200	300	
Withdrawn:							
Present		4,700**			3,100**	17,600	
Yr2000+		12,600			24,300	17,600	
Ground water shared		yes			yes**		
Tigris River:							
Q generated					23,990	18,500	4,400
Withdrawn:							
Present					0	34,200	0
Yr2000+					9,500	40,400	0
Ground water shared							
Euphrates–Tigris Rivers:							
Q generated		4,000			52,600	18,500	4,400
Withdrawn:							
Present		4,700			3,100	51,800	0
Yr2000+		12,600			33,800	58,100	0

* Kolars & Mitchell (In Press)
** Turkish ground water – Syrian surface water (& springs) interface & sharing; Most of flows generated in Khabur and Belikh drainages (about 1800–2000 MCM/yr) spring from an aquifer underlying the Turkish plans of Urfa, Harran, and Mardin; thus, much less than 4,700 MCM/yr is generated in Syria.

Annual flows:	Lebanon	Syria	Jordan	Israel	Turkey	Iraq	
From:	0	27,900	400	450	7,000	66,000	
To:	860	30,000	—	0	69,000	—	

Source: World Resources, 1990–1991, World Resources Institute

ALTERNATIVE WAYS TO COPE WITH THE SITUATION

For the last 20 years, water resource professionals have been debating the viability of structural versus nonstructural approaches to providing water. The use of structural approaches in arid areas has been increasingly questioned as we come to understand the limits of those areas in terms of sustaining population and the great fluctuations in flow. Focusing on structural approaches may divert attention from society's real problem of carrying capacities and sustainability of water systems. On the other hand, society's capacity to command water-use behavior change is limited by notions of freedom and practicality. The Middle East clearly calls for both structural and nonstructural approaches. In both cases, increased cooperation will be needed.

We will look at six categories of approaches: supply augmentation, increasing efficiency of transmission and use, changing behavior, research and development, and hydrodiplomacy.

1. Supply Augmentation

Short of war, water professionals have looked to a ways to augment current supplies. Desalinization, both large and small scale, was viewed for a long time as the technological savior. Today, Kuwait and the UAE depend on desalinization as a primary source. Saudi Arabia, which accounts for much of the world's desalinization capacity, is still only about 10 percent reliant on desalinization. Israel, which has looked to desalinization as a significant solution to its water shortage, is still only 2 to 5 percent reliant on this technology. Desalinization is principally for urban use and not irrigational agriculture. Desalinization plants typically last about 25 years and have high capital costs along with high energy costs. With the exception of some nations in the Arabian peninsula, desalinization alone is not the primary solution.

New technologies for aquifer development have also been suggested as approaches to solving shortages in an atmosphere of limited cooperation. New well drilling techniques in Israel and the Gaza may produce more water; however, it is uncertain whether these new technologies could exceed the recharge rates. Also, the quality of deeply mined water is somewhat uncertain.

Aquifers could also be used for storing flood water and other runoff. Such approaches could marginally increase available supply and storage locally. Programs of stormwater interceptors in communities have also been proposed. Although they will add some localized storage capacity and thereby enhance the ability of communities to sustain droughts, in the overall picture they will add only marginally.

Wastewater reuse and reclamation is a major new area for increasing supply. Tel Aviv, for example, is reusing 36 percent of its wastewater. Overall, this source is estimated to supply around 5 percent of the entire water use for Israel. By 2000, the Jordan Water Authority expects nearly 25 percent of irrigation water used in the east Jordan Valley to be recycled sewage water (Hindley, 1990). As urbanization and per capita demand increases, the possibilities of wastewater reuse will be enhanced. The most critical elements in the use of wastewater are public health and treatment costs. Use must be limited to purposes other than potable uses. If used for groundwater recharge and prevention of saline water intrusion, the treated wastewater should be close to drinking water standards. Wastewater reuse can be particularly attractive when used in conjunction with environmental measures--for example pollution control measures (Arar, 1987). Unit costs are certainly reasonable comparing favorably with seawater desalination (Arar, 1987). However, religious taboos on reuse of water could limit application of this technology. Also, considering fluctuations in flow of more than 30 percent flow fluctuations from the mean in any one year, wastewater use could be not expected to exceed between 5 and 10 percent of the supply

augmentation in any Middle East country. Nevertheless, that percentage could still be important in an area of limited water and under conditions of limited cooperation.

Cloud seeding has also have been discussed, especially in the upper Jordan valley. However, this approach does require cooperation, and it is unclear whether precipitation can really be directed to fall in specific areas. Israel and Jordan have a joint project in the drainage basin of the Sea of Galilee (Ben-Sharhar, et al., 1989).

2. Increasing Efficiency

With agriculture's very high percentage of water withdrawals, even modest increases in efficiency of use and decreases in consumptive losses could have a major impact on water availability. Increasing efficiency is especially vital in situations of limited cooperation. Israel, and to a lesser extent Jordan and Egypt, have led the way in the use of advanced irrigation techniques, such as drip technology. For example, between 1965 and the late '1970's, while the Israeli population increased by 39 percent and total water consumption by 17 percent, irrigation use increased by only 9 to 12 percent. An increase in efficiency of 10 to 20 percent could greatly increase the safety margins for low-flow years. However, advanced irrigation technology, has serious limitations under Iraqi, Turkish, and even Syrian conditions. These countries grow grains and cotton. Also, the technology is not always applicable in highly saline soils with drainage problems. Thus Syria, a country where gains in efficiency would be most beneficial, may have limited use for such technologies.

Seen in another way, if Turkey, Iraq, or Sudan develop land as projected and increase agricultural output, costs of food for the region could be lowered. Regionally available food in a cooperative atmosphere could reduce the need for agricultural water withdrawal in countries such as Saudi Arabia, Israel, Jordan, and Syria. However, an atmosphere of trust and security guarantees would be required, and export-generating cash crops would be reduced in some countries. Increased efficiency in water used for irrigation could be realized in two ways: through new technologies and redistribution of agricultural products in the region.

3. Changing Behavior

Middle Eastern countries are not water-intensive users, especially compared with the U.S. However, without major new sources and cooperative agreements, behavior will have to change. The most likely major long-term change would be a shift from agricultural to domestic industrial use. Already, in periods of crises and emergency water shortages, we are seeing that this shift is the first line of reaction to serious droughts. Throughout the world, pricing subsidies for water, particularly in arid areas, is being reexamined. To a great degree, this reflects past tendencies to use water as a means of encouraging settlement and agriculture. Although better pricing is needed to reflect water's value, it is not clear that a pure market exchange is preferable or even viable as a way of allocating water. Institutionally, the power of water planning and control resides in organizations primarily directed to agricultural production. Thus, any shifts in water consumption water and allocation are likely to enhance internal political conflict among national water establishments. The power of such organizations is now being challenged, and in the future the power will likely be shared.

4. Research and Development

New research in biotechnology and genetic engineering could reduce water demands in agricultural sectors. Crops which may be irrigated with saline water, hydroponic technologies, and crops which have been bioengineered to require less water for growth, could reduce water demands for agricultural crops in the future. New biotechnology membranes could improve

desalinization technology and reduce costs. However, advances in these areas are likely to have little effect on the reduction of water use in the near future.

5. Hydro-diplomacy

A variety of cooperative management and engineering projects have been offered as ways to deal with water problems. These range from unilateral to bilateral to multilateral engineering approaches. They also range from interbasin transfers to better cooperative sharing within basins.

Several proposals have been made for multilateral interbasin transfers. The most prominent of these are the Turkish peace pipelines. These pipelines would come from the Ceyhan and Seyhan River basins in Turkey. A western pipeline would follow the coast of the Mediterranean and go all the way to Mecca. An eastern pipeline would take water to Sharjah and other areas in the Persian Gulf and Arabian peninsula. The western line would carry about 1.28 BCM per year and the eastern about 1 BCM. Each pipeline could support 6 to 9 million people at a level of 400 liters per capita per day. As such, pipelines could have a major impact in reducing projected water shortfalls in Israel and Jordan as well as Kuwait and Saudi Arabia. The lines have been assessed as technologically feasible. Some experts assess the costs at between $17 to $20 billion or about one-third the cost of desalinization. However, pipelines have been criticized by Arabian peninsula countries as too expensive. Pipelines would also increase the dependence of the region on Turkey as a major source of water.

A smaller pipeline from Turkey through Syria to Jordan has also been suggested. Such a line could be built quickly and alleviate problems in Aleppo and Amman. It would also reduce the number of countries involved, as well as the cost.

Another interbasin transfer from Turkish water in the Manavghe River has been proposed. Water from this basin could be shipped by special plastic barges to Israel. Such an approach is estimated to be able to produce 2.3 MCM per year.

A more exotic 700-kilometer pipeline from Pakistan (Baluchistan) across the Gulf to the United Arab Emirates has been proposed. This pipeline would carry 520,000 cubic meters per day or 185 MCM/yr. Feasibility studies on such an approach indicate that the pipeline can be built but would push the edge of available technology.

In 1990, Iraq and Kuwait were reportedly close to agreement on a water pipeline from the Tigris-Euphrates to Kuwait City. Such a pipeline, which was first studied in the early '1950's and later in the '1960's and the '1970's, could produce roughly 6,200 cubic meters per day. Current cost estimates are at about $1.5 billion.

A smaller pipeline from the Euphrates in Iraq to Jordan has also been suggested. This one would produce around 160 MCM per year. This proposal reportedly has been shelved. Among the reasons given are lack of enthusiasm for dependence on Iraq.

Proposals for using Nile waters for supply in the Sinai, Gaza and the Negev have also been put forward, and Israeli and Egyptian discussions have taken place. The Nile, with about 86 BCM per year, is clearly the largest river of the area; however, there is much controversy over the availability of water for export. Some optimistic estimates show almost 8 BCM to be available in the near future on the Nile, dependent on upstream construction. Bringing Nile water across the Sinai and Gaza could be integrated with Israeli water in a variety of schemes, each of which would relate to the provision of water for West Bank Palestinians. Water could either be integrated directly into the Israeli water-carrier system or could be used in the southwestern parts of Israel, and water in the more northern West Bank areas could be waterbanked.

Since the Johnson Plan in the 1950's, a variety of schemes have been introduced for diverting water from the Litani River in southern Lebanon into the Sea of Galilee. Such schemes were designed to produce hydroelectric power as well as water supply. In the early plan preceding the Johnson Plan, the Litani River was considered as part of the Jordan basin area. Israeli schemes for diverting the Litani are estimated at about 100 MCMs per year from the southern Litani.

Libya has undertaken the Great Manmade River (GMR) project for mining deep water resources. This project will be capable of carrying 2 million cubic meters per day and will cost $25 billion. However, the quality of such water is suspect. Also, the viability of such mining in the short run with limited knowledge of long-term recharge is questionable. Also, this aquifer is a joint resource, so that Libya could be, in effect, drawing down the water resources of Egypt and other countries.

Short of interbasin transfers, a variety of river basin approaches have also been put forward. Since the Johnson Plan of the early '1950's, dams on the upper Jordan-Yarmuk River have been debated and, indeed, fought over. Just previous to the 1967 Six Day War, Syria, Lebanon, and Jordan initiated plans to divert headwaters of the Jordan, which would have reduced Israel's water supply. Under such a plan, the Hasbani River would be diverted to the Litani in Lebanon, and the Dan and Banias Rivers to the Yarmuk in Syria. Israel attacked the preliminary work on these projects.

Since the Johnson Plan, the Unity Dam and Muhkeiba Dam have been proposed and discussed. Both would provide storage and thus increase the quantity and reliability of the Yarmuk's supply. However, the building of such dams requires the agreement of Syria and Israel along with Jordan, and the projects are currently being mediated. The Unity Dam would increase storage by 350 MCM, while the Muhkeiba Dam would increase it by 200 MCM.

Jordan and Israel have discussed diversion pumping on the Yarmuk to enhance storage into the Sea of Galilee. The diversion of the Litani into the Jordan has also been suggested. Use of the Ghor Canal to supply water to the west of Jordan has been presented as well. Israel and Jordan in the past have looked at the feasibility of building dams on the lower Jordan. Today it appears expensive; however, in the future environment of reduced water and increased price, it may not be. A drawback is that, these waters are of poor quality.

A Dead Sea canal is another proposal. A canal would bring 800 MCM a year into the Dead Sea thus stabilizing the lake's level. It would provide hydroelectric power for Israel and presumably free up some upstream water for agricultural use. However, Jordan fears a rise in lake level, which would destroy a phosphate-extraction industry along with other chemical industries. Cooperative management on common aquifers of the Yarmuk and Aravada have also been proposed, as have salinity control projects in Lake Tiberias (Sea of Galilee). Finally, a new East Ghor Canal is yet another suggestion.

With the exception of navigation on the Nile, the Shatt al Arab waterway represents the region's only major inland navigation use for water. The Shatt al Arab needs to be cleaned up, and the four ports of Umm Qasr, Khawr ar Zubayr, Al Basra and Al Faw need to be opened. In addition, some discussion has occurred over a new port to provide access for Jordan and Iraq to Mediterranean shipping.

POSSIBLE ACTIONS: LESSONS LEARNED IN THE WATER RESOURCES FIELD AND BUILDING COOPERATION

Introduction

A variety of lessons have emerged from the water resources field and from experiences in negotiating international environmental regimes that could be important to encouraging cooperation and enhancing security in the Middle East.

Water is not simply a factor of production, like energy, which can be transformed through technology and made available whenever or wherever needed. The exploitation and development of water resources has long-term environmental and socioeconomic consequences that must be part of the decisions of current planners. A variety of analytical tools have emerged to structure and help integrate these factors into decision making. They include environmental assessment, risk analysis, multi-objective planning, socioeconomic assessment, including benefit cost analysis, and ecosystem management.

Beyond analytical techniques, a variety of institutional considerations have also emerged. These include public participation, dispute resolution and various cooperative authorities. Frequently, constraints to implementation reside less in technical feasibility and cost than they do in building cooperative attitudes, institutions, flexibility and perception of fairness and equity.

We have begun to learn some essentials about negotiating international environmental and natural resources regimes. Thacher (1991) has identified three necessary components that must be included in any comprehensive environmentally related action plan. Paraphrased, these components are:

- assessment activities directed at improving understanding and reducing uncertainty;
- management activities involving new policies, practices, and agreements; and
- support activities that strengthen financial, institutional, and human resources.

Although analytical techniques alone are not sufficient for building water allocation agreements, some combination of techniques usually are, in effect, negotiated as rules of the dialogue. In some way, analytical assessment and institutional techniques will have to be brought into Middle East water considerations. The following include some of the more important lessons learned from the water resource field and experiences in negotiating international environmental regimes:

1. Integrated management across water uses and jurisdictional boundaries is the key to sustainability. However, traditional institutions and jurisdictional structures are often insufficient for integration and planning of water resource development and management. As new environmental and community groups representing new values demand participation in the planning and operating of water systems, they will also challenge the values of established water institutions. The reality of increased complexity, which manifests itself in claims of community groups and environmental interests, is pushing for increased public participation in all phases of water management. As such, solving complex water problems is becoming a major opportunity for building new democratically accountable administrative structures and providing significant democratic experience for broader populations.

2. Water development and management must move from a project-by-project focus to programmatic planning and systems management. The use of the river basin as a unit of regional planning is reemerging.

3. A variety of institutional models for managing and developing water resources are available. These range from authorities and bilateral agreements to multilateral compacts to river basin and regional authorities. The continuing cooperation along the Mekong is a notable example. Even during the Vietnam conflict, parties arranged to continue the same level of required water cooperation.

4. Data are rarely neutral. Data collection itself is driven by values and is ultimately negotiated. However, agreements on actions can be achieved even where there is disagreement on the "facts." Indeed, recent experience with international environmental negotiation shows that data generation and sharing can be a useful catalyst to further action. Therefore, achieving durable agreements requires at least as much attention to the procedural and psychological factors as to the substantive "data factors." In reflecting on international environmental negotiations, Eliot Richardson (1991) notes the importance of establishing procedural devices designed to stimulate action rather than to prescribe substantive outcomes.

5. Technical expertise is necessary, but not sufficient, for achieving integrated water management--so too with political agreements. The critical water management skills and institutional arrangements increasingly are those designed to facilitate management in the gray area between the political and technical design and operation. Institutions and processes are needed to better integrate technical and political administration in a timely fashion to create feasible water management options. As Thacher (1991) notes, data assessment is often the first step in starting movement toward negotiating international environmental regimes.

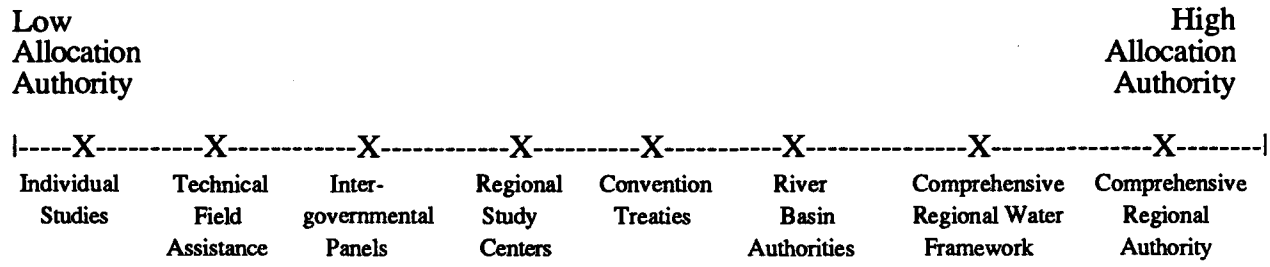
6. Changing demographics in both arid and humid areas are requiring new agreements or institutions to reapportion old allocations and facilitate negotiations on new apportionments. Urban areas are demanding a greater share of water. As demands push supplies closer to limits, increased reservoir capacity is less feasible. Thus, upstream and downstream interests must communicate with each other. Regardless of existing compacts, the combination of reaching limits and reacting to yearly flow fluctuation will require new trust. Upstream and downstream interests will need to negotiate burden sharing now that will have to be compensated for in future years. Thus, immediate and spatially generated interest will have to be met through spatially flexible future promises. This will require a level of trust and relationship building that is currently not present in most water institutions. As witnessed in negotiating international environmental regimes (Richardson, 1991), procedural incentives for overcoming inertia are also critical in water resources management.

7. Assisted negotiation approaches such as mediation by a third, neutral party are proving useful to meet such needs. Mediation on the Indus and the Cyprus water supply are two international examples. As experience with assisted negotiation grows, we are learning more about the requirements for convening mediations on water disputes. The major distinction is between use of neutral parties as arbiters/judges versus facilitators/mediators. In the first case, parties talk to the neutral party and minimally to one another. In the latter case, environments are created to encourage parties to talk to one another. Because it encourages shared ownerships and commitment to agreements, the facilitated/mediated approaches can produce more durable arrangements. This approach also encourages creative problem solving. However, it can be initially more difficult to begin and appear more lengthy than other approaches.

Options

Applying such lessons to the realities of the Middle East can generate a variety of options. Figure 3 shows a continuum with options ranging from low allocative power/authority to high allocative power/authority.

Figure 3



The left of the continuum represents allocative action based solely on individual national autonomy. To the right, the continuum represents regional, comprehensive authority for decisions in the water resources field. Moving from individual autonomy towards regional authority, a variety of approaches are noted: individual studies, regional study centers, treaties, conventions, and river basin authorities up to comprehensive regional authority. As water professionals have begun to understand water flows in light of increasing economic development, interdependence, sustainability, and population growth, the realities of the water resource push us from the left to the right of this continuum. On the other hand, legitimate and important political realities generally resist such regional notions driven by natural resource conditions.

Few comprehensive regional authorities have come into existence. The Tennessee Valley Authority is one outstanding example. On the other hand, a variety of river basin authorities have and do exist, along with treaties and numerous regional centers. The allocative power/authorities of water resource agencies can also be thought of as moving from low levels of planning to higher levels of allocation operation and revenue generation. Regional and comprehensive water basin authorities, while they exist, tend to be primarily concerned with planning. Those empowered with higher levels of allocative power/authority tend to focus on single purposes such as navigation. Few comprehensive authorities that cross jurisdictional boundaries exist for allocation and operating.

Nevertheless, our knowledge of water resources is pushing toward a vision of developing ways and means for comprehensive analysis and operation so we can better integrate uses. It is also calling us to integrate resources management across jurisdictions. As we begin to reach the limits of use, the flexibility of our organizations to respond to water flow fluctuations becomes crucial. This flexibility is most needed to provide new forums for dealing with political tradeoffs which cross both time and space. Nitze (1991) also notes that flexibility has been central to negotiating international environmental regimes.

Unlike the Indus River and other such international mediations, the Middle East situation involves more than one direct lender, more than two countries, and multiple rather than a few definable issues. Nations must relate to one another as participants in transboundary river basins but also as transboundary basins linked to broader regional issues. Descriptions of nine possible options, moving from high allocative power/authority to less allocative power/authority, follow. Given the situation, there is a need for broad regional, as well as less broad river basin forums, to develop and package limited, but implementable, technical options for subsequent political debate. Moving beyond unilateralism and even bilateralism to multilateralism is ultimately the key to obtaining water security in the region. However, intra-country debate over water allocations among sectors will also be crucial. Intra-country debate is likely to be linked to broader, inter-country negotiations.

Although commentators frequently advocate water treaties, treaties--where they occur--have been bilateral. However, multilateral treaties of some type would be most effective. The following nine suggestions look beyond treaty arrangements. They try to create some different ideas based on a melding of what professionals in the water field have learned together with the Middle East problems and issues.

1. Comprehensive Regional Water Resources Planning and Management Framework

A framework for water negotiations for the region should include three tiers: regional assessment and guidelines, river basin authorities, and implementation. While clearly idealistic, such a framework, at a minimum, could provide a vision for framing less ambitious proposals.

Through integration and cross-jurisdictional decisions are necessary, they clearly would be difficult to achieve in the Middle East. Nevertheless, individual and bilateral water negotiations and agreements without reference to broader regional trends may be self-defeating. Therefore, a three-tiered approach similar to was developed in the U.S. in the 1970's may be useful.

Level 1 Regional Assessment

At this broad level, countries could come together to negotiate agreement over general trends and relationships of water supply to growth and needs in the region. Broad guidelines or even rules of analysis could be set. Such regional assessment could facilitate data gathering and be a forum for broad policy negotiation.

Level 2 River Basin Authorities

River basin planning authorities could be established on the Jordan, the Tigris, and the Euphrates. It is at the river basin level where planning for eventual allocations occurs. Planning around the river basin would allow for integration of purposes and the participation of new groups. Lebanon, Israel, and Jordan could focus on the Jordan River basin, while Syria, Turkey, and Iraq could look to the Tigris and Euphrates Rivers.

Level 3 Implementation

Even if broad assessments are negotiated regionally, and even if river basin authorities reach agreement, ultimate implementation, construction and operation of projects is likely to depend in the short run on individual national sovereignty. Implementation at this level allows for and recognizes the autonomy and sovereignty of the implementing nations; however, implementation of projects should occur within the framework of river basin agreements and regional assessment agreements. It is both the operation of new systems and the reapportionment of old systems to new realities that generate contentions.

2. A Middle East Framework Convention for Water

At the broadest regional level, such a framework convention could develop criteria for funding individual national and river basin projects. Such criteria could be used as a funding test and would essentially serve as principles and guidelines for regional water development. Such a convention could also provide for assistance from third, neutral-party negotiation for future disputes as well as for future collaboration within the region and at the river basin levels. The criteria could also provide and include participation of nongovernmental organizations (NGOs).

Such a framework convention would provide a way of connecting bilateral, river basin and national water actions to the broader good of the region without dramatically impinging on

prerogatives of national sovereignty. Such a convention could be convened by the United States and the Soviet Union along with the major international lending institutions and Gulf states. One major incentive for participation in such a convention is that if agreement is achieved, these convenors and lending institutions would then use such agreement as a basis for evaluation and funding of projects in the region. Essentially, a convention would communicate that the nations within the region that are generally at odds with each other could develop and control the criteria for funding of projects; however, this control would be bought at the price of agreement.

A convention could establish formulas for multiobjective operations and other water resources management targets. Some examples of target goals for such a convention could be identifying or defining:

- Efficiency of consumptive use goals;
- Goals for water use by sector;
- Agriculture substitution;
- Water quality goals; and
- Quantity of use by source.

The convention negotiations could go on for 1-1/2 to 2 years. Within the context of the convention, a variety of appropriate technical studies could be commissioned. These studies themselves would be run as single text negotiations among the parties and be facilitated/mediated by neutral parties. Special boards could be established, combining experts from each country and neutral parties, to review data conflicts not able to be negotiated through the facilitation of the studies. Each of these studies, like the general convention negotiations, should include the participation of NGOs. Essentially, the technical negotiations may begin to look like river basin negotiations or sidebars to the overall convention negotiations.

The use of assisted negotiations, single-text negotiations, and disputes panels would provide a valuable sense of procedural and psychological equity. Substantive satisfaction would emerge as such negotiations proceed, it is hoped, and as parties began to realize that they can exercise a great deal of control over the substantive outcomes of regional water cooperation. The use of sidebar technical studies in connection with a broader regional framework would allow for the difficult melding of individual national and river basin needs into those of the overarching region. Finally, such an approach builds on what we have already been learning in the water resource field, namely, that assisted negotiations are essential, that regional considerations must be integrated, that jurisdictional boundaries can't be ignored, and finally, that the participation of NGOs and new groups, especially environmental groups, are absolutely essential to any kind of implementable water agreement.

3. <u>The Establishment of a Jordan River Basin Authority</u>

It is likely that successful Israeli-Palestinian negotiations will be linked directly to water. The statistics on the West Bank argue forcefully for such connection. It is difficult to see how land and water could be traded for peace since Israel would be giving away 40 percent of its current water supply and possibly more than 50 percent of its future supply. Therefore, some form of regional water resources security authority around the Jordan, especially the West Bank, must be considered. Hydrologically, the West Bank aquifers on the Jordan are linked even though the hydrology is somewhat controversial.

The Jordan River basin authority could be established to collect data; monitor hydrologic system performance; assess investment options in the area; allow for the participation of NGOs and other groups; and make recommendations to the countries. Such an authority could be composed of representatives of each nation, and funded by regional security guarantees and international

funding organizations. The authority should also include a professional staff to provide support and analysis for the deliberations. Such an authority could be a structured forum for debate on water and growth issues. As such, it could package implementable and technically feasible projects into policy options that would be subject to political debate in the individual countries. Such a forum could also be a place to develop consensus approaches among high level technical administrative staff. The authority could also respond to requests. It would encourage the discovery of shared interests and creation of options by building on the shared technical subculture of water management that crosses individual nations.

Under such arrangements, the sovereignty of nation-state action will still be with the nations, but the national political debate would be supported by technical and administrative debate to clear the air and provide added value. Although such authorities as conceived are is still advisory, they would exercise a great deal of moral and technical influence in any subsequent debates over equity and fairness of allocation of waters. Of course, one could conceive of a regional arrangement with far more allocative authority; however, given the history of conflict in the region, that doesn't seem appropriate at this time.

4. The Euphrates River Authority

A commission among Syria, Iraq, and Turkey already exists but is not well-known and does not appear influential. An authority such as the one for the Jordan River Basin could be structured for the Euphrates as well. One of the more specific needs is for a forum to facilitate tradeoffs over time among upstream and downstream users. That is, given the fluctuations of the river, agreements based on flow in Year 1 need to be made with the understanding that those who gave up benefits this year would be compensated 2 or 3 years down the line when fluctuations changed. This authority would require a level of documentation and guarantee that does not exist along the river at this time.

5. Regional Research, Data Gathering and Monitoring Policy Centers

Moving farther to the left along the authority line in Figure 3, a regional policy center(s) could be developed. Such a center would make recommendations concerning coordination of policies in the various nations and could collect and analyze data. It could help assemble and disseminate technical research and R&D applications. It could also provide for the evaluations of investments, and more important, it could be a center for training.

Economies of scale can be realized in gathering data for the region. Individual countries are not likely to be able to build sufficient water data bases. Regional centers could help gather data and also achieve better comparability and reliability.

6. Intergovernmental Panel on Middle Eastern Water Problems (IPMEWP)

An "Intergovernmental Panel on Middle Eastern Water Problems" (IPMEWP) could be implemented to initiate a series of technical assessments of Middle Eastern water problems. An IPMEWP could complement other ongoing activities.

The panel could be initiated by the UN, acting as an honest broker of technical issues. The process should last about 2 years and produce an assessment of--and agreements among the parties--regarding what is known and what needs to be accomplished from a technical and conceptual standpoint to enhance the efficiency of subsequent diplomatic negotiation and political debate.

An IPMEWP would provide a forum for technocrats, scientists, engineers and planners to discuss the administrative-technical side of highly charged solutions from perspectives that are amenable to convergence on facts. The process would explicitly build on a shared water resources professional subculture that crosses national boundaries. It could generate a variety of technically viable options, that satisfy a range of interests and positions.

The product of such an Intergovernmental Panel on Middle Eastern Water Problems would be a comprehensive report that: (a) Describes the basic information known, such as hydrology, current system capacity, water demand, withdrawals, consumption, operating rules, problems, needs, etc.; (b) Assesses future socioeconomic and environmental impacts under various growth scenarios without international intervention other than the incremental effects of "business as usual"; (c) Develops guiding principles, objectives, and evaluation criteria that would help to formulate strategic, tactical, and operational solutions to identified needs and problems; and (d) Formulates and evaluates technically feasible solutions, including cost estimates and impacts. In other words, the report could serve as a term of reference for future debate and negotiations over specific actions.

One possibility would be to organize working groups around river basins, such as the Nile, Tigris-Euphrates, and the Litani-Orontes-Jordan system. These groups could work independently of each other but deal with similar issues and assessment requirements. Each group would undertake a common assessment process and would come together in plenary sessions to exchange viewpoints and plans insofar as they relate to or intersect with the other river basins.

7. Specially Sponsored Studies

Even without supporting special mediation and negotiations, at a minimum special studies are essential in the area. Any conventions that may be developed clearly will need to rely on such studies. Special studies done in connection with negotiations would of course have far more powerful impacts. Nevertheless, studies are needed to deal with upstream and downstream extreme fluctuations and management tradeoffs over time. Studies are also needed to ascertain the value of water per cubic meter for irrigation and present and possible future levels of efficiency in hydroelectric power. Special optimization and simulation models applied to the regions could be extremely helpful both to understanding the area and to providing a forum for negotiation among technical people. Special studies can provide input for more comprehensive and interregional studies.

8. Joint Water Management and Dispute Resolution Dialogue Training and Workshops

The more we learn technically about water, the more we learn that it is not purely a technical matter. Nor is it purely a political matter. Managing the gray area between technical and political is crucial for successful water management. In the Middle East this need is dramatically apparent. Throughout the world, we have begun to find that joint (international) training of water resources managers can have tremendous benefit. That is, when potential adversaries--whether they be nations or environmental groups or resource engineers--are brought together to talk about the management of the resource and strategies for resolving disputes, a better appreciation of others is developed, greater capacity to share technical water resource concerns is created, and adversaries are seen as fellow humans.

In the United States and other areas of the world, such joint training has had a tremendous impact on the capacity of engineers, environmentalists, and state and regional authorities to resolve disputes. On an international scale, joint training could be sponsored by the United Nations or other credible international organizations, would cost little, and could be begun almost

immediately. Such training should include technical and administrative water authorities at a high level, that is, water professionals who are interacting with political as well as technical issues. Such an approach seeks to build partnerships based on shared technical or professional subcultures. This training may hold best hope for cross-national agreements in the Middle East.

9. Technical (Field) Assistance

A variety of technical assistance programs, even if carried out on a purely bilateral basis, could be useful. For example, projects designed to improve short-term projections of river flow are needed. One approach could be to combine GIS and satellite data with data generated by people along the river basins. Such models would greatly enhance the capacity to respond to flow fluctuations and to operate on a systems level. By depending on the participation of local populations, this approach would increase the feeling of ownership of and responsibility for management of the river. Such feeling could help build a democratic culture.

A variety of other assistance projects have been suggested, ranging from agricultural assistance to comprehensive river monitoring and river basin optimization modeling and simulation. Another suggestion is the use of foreign assistance funds to influence water management behavior.

WHAT COULD BE DONE: POSSIBLE IMMEDIATE NEXT STEPS

1. Undertake Immediate Assessments of:

- Institutional arrangements for allocating, developing and managing water resources within and among countries of the region;
- Agricultural practices, uses and conditions within countries of the region;
- Available information on public health, environmental quality, and water quality in the area;
- Assessment of political, social, economic and environmental impacts of the major water resource management alternatives that have been put forward;
- Assessment of the opportunity costs for water;
- Assessment of immediate training needs and development of multilateral and multidisciplinary training-assistance programs;
- Inventory and review of detailed demand forecasts from World Bank, USAID, and others;
- Inventory and review of environmental problems;
- Development of thorough low-flow probability and water balance analyses;
- Dynamic modeling of selected river systems.

2. Assess and Improve the Available Water Resources Data Base in the Region

Water data for the region needs: consistent definitions; explicit description of withdrawals versus consumption; hydrogeographic mapping; new water quality statistics; and data on uses and patterns of consumption. The following could be initiated:

A) A water resources data assessment for the region. This would include:

- assessing data needs and locations needing data
- encouraging political sharing of data
- enhancing comparability of data over time
- developing data-retrieval systems
- monitoring water flow and uses

B) Identification of existing water resource institutions in the region that have experience in data-gathering and adding to that capability. Perhaps creation of a new international institution for planning and data management support that would be credible within the region.

C) Formation of an interagency group within the U.S. government to coordinate data gathering on water in the Middle East and analysis of that data.

3. Develop Strategic Vision(s) of Alternative Water Futures for the Middle East as an Aid to Water Management and Diplomatic Decision Making

Using state-of-the-art interactive strategic planning methods, this vision should be developed during a period of approximately one year. Both the U.S. and the Soviet Union should be involved. The vision statement should integrate technical models, data and policy judgments. As such, it should include experts from across the region. The vision(s) should be concrete enough to describe how various management options are either foreclosed, preserved, or opened as a result of different scenarios.

4. Initiate Immediate Support Activities

- Assessment of the Shatt al Arab water-cleanup needs and wetland and other ecological impacts on navigation and upstream agricultural activities.
- Assessment of the implication of internal shifts from agricultural to urban use of water in the regional system.
- Examination of engineering alternatives to current configurations of proposed peace pipelines such as building shorter pipelines or developing new guidelines for river management.
- Examination of policy and technical water options for the West Bank and Jordan.
- Examination of the Litani's available supply.
- Creation of models to show how changing procedures for operating GAP could enhance water supply and also how optimization and multiobjective planning could also enhance downstream supply security in the Tigris and Euphrates.
- Determination of actual water available for export from Turkey.