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JORDAN RIVER BASIN PAPER (DRAFT)

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Abstract

Of the three international basins in the Arab Middle East, the Nile, the Tigris-Euphrates, and the Jordan River basins, the last of the three is where the potential for future socio-economic development is most vulnerable to conflict over water shortage. Water rights issues and disputes affecting the potential for violent conflict are discussed in this paper. The most promising water development option in the Jordan Basin is the Yarmouk River, the only under developed stretch of the river system. Although substantial political conflicts exist among the riparian states, cooperative working relationships could yield significant economic and social benefits for each of them. In this paper, the economic benefits stemming from the development of the Yarmouk are quantified for each of the riparian states. The politics, ideologies, and requirements of the other riparian countries are then superimposed onto this economic framework. According to two international conventions, water rights are to be shared between nations according to size of population, need, and historical use patterns. In the case of the Jordan River system, complex political issues complicate sharing agreements, and therefore necessitate the need to seek out alternative water policies through which reasonable water sharing rights can be reached. This paper summarizes historical and existing water arrangements and conflicts, and discusses various water policy options and their most likely consequences.

The Jordan River Basin

I. Introduction

The Jordan River is an internationally shared water system that is among the most widely studied rivers in the Middle East (Naff and Matson, 1984). It is in this basin, by far the smallest of the three international basins in the region (the Nile, the Tigris-Euphrates, and the Jordan River basins), that the potential for future socio-economic development is most vulnerable to conflict over water shortages. These water shortages are the result of low and highly variable annual precipitation rates, high evaporation rates, and high rates of population increase. At the present time, water demands severely strain existing water supplies for agricultural and industrial development and municipal use in most areas of the basin.

Throughout history, this river system has been a critical water source for human needs and the natural environment. The lands bordering the river and its main tributaries consist of good quality soils which support a diverse array of agricultural products. Because of this, the water resources of the Jordan River have been extensively developed by the riparians of Lebanon, Syria, Jordan, Israel and the occupied territories of Palestine. The river system now supports over half of the water demand by Jordan, Syria, and Israel (Naff and Matson, 1984), and is prone to conflict over further development of its waters, especially the development of the Yarmouk River.

This paper examines some of the consequences of this development (high pollution and salinity), and presents the resulting political ramifications and water disputes. Because the system has been so widely discussed in the literature (e,g., Cooley, 1984; Cowel, 1989; Mathews, 1991; Moffet, 1990; Murphy, 1990; Naff and Matson, 1984; Starr and Stoll, 1987; Wishart, 1989), only a brief discussion of some of the background concepts involved is presented. After reviewing previous approaches to the disputes in the Jordan River system, this paper concludes that the economic and social benefits from development of the Yarmouk River (the only undeveloped stretch of the river system) to each of the riparian states clearly warrant continued attempts to overcome the complex political barriers that heretofore have stymied development of the river. An attempt is made to quantify the economic benefits stemming from the development of the Yarmouk for each of the riparians, and then to superimpose the politics and ideologies of those countries onto this economic framework. Historical and existing water arrangements and conflicts are discussed, along with various water policy options and their probable consequences, in the hope that cooperation among the riparians will be enhanced.

II. The Setting

The Jordan River normally is divided into two parts to allow for detailed study of its components. The "upper Jordan" consists of the headwaters of the Dan, Hisbani and Banias Rivers, which meet at a point six kilometers inside Israel, flowing into Lake Tiberias. The "lower Jordan" consists of the side wadis flowing into the main stem of the Jordan River below the Yarmouk Triangle and into the Dead Sea. Fig. 1 illustrates the river system.

The Jordan River Basin drains an area of 18,140 square km, of which 7,216 sq km are in Jordan, 6,445 sq km in Syria, 712 sq km in Lebanon, 1,842 sq km in the occupied West Bank, and 1,925 sq km are in pre-1967 Israel (Backhit and Salameh, 1990). Prior to the 1950's, the average annual flow of the Jordan River system (including all sources such as springs and rainfall) into the Dead Sea was approximately 1,850 MCM. The major flows are distributed among the tributaries as shown below in Table 1.

Table 1. Flows in the main tributaries of the Jordan River system

Tributary	Average annual flow, MCM
Dan	245
Hisbani	138
Banias	121
Yarmouk	400
Side Wadis; springs; runoff	350

Sources: Naff and Matson (1984); Bakhit and Salameh (1990).

A detailed description of each of the main components of the river system can be found in the above references. A summary is presented here, in terms of the water quality of the sources and their locations within the riparian countries.

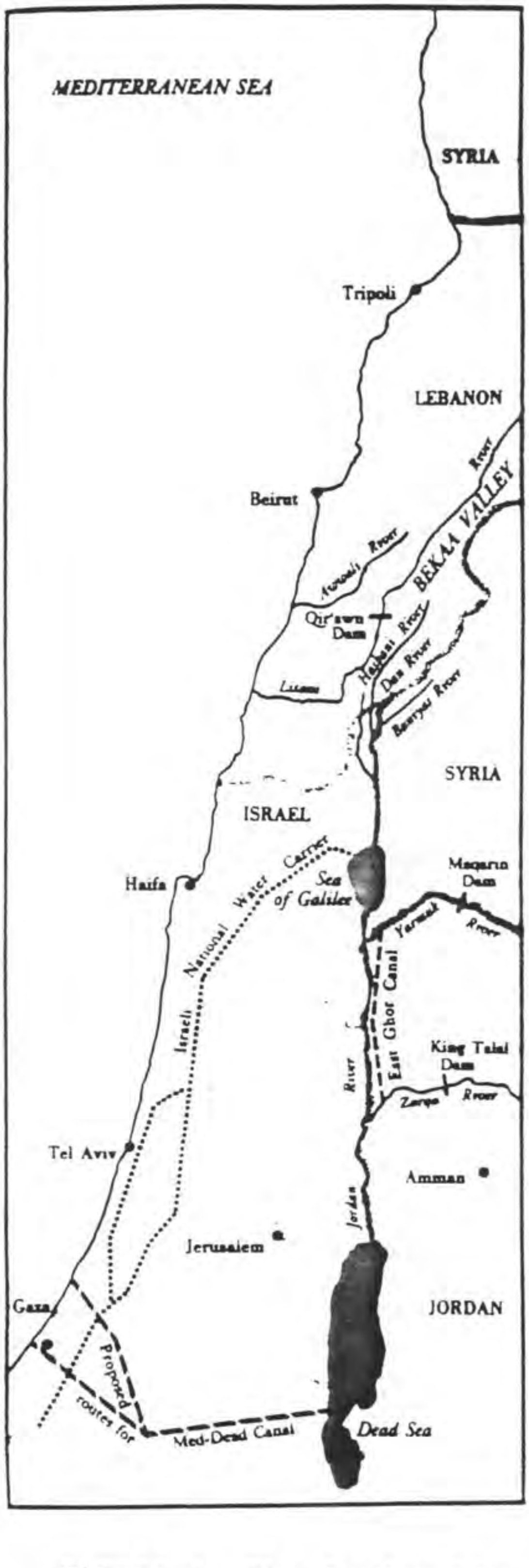


Figure 1. The Jordan River System

Source: Cooley (1984)

A. Water Balance

The main contributions to the Jordan River flow originate from the headwaters of the Dan, Hasbani, and Banias Springs, the Yarmouk River and other small tributaries. The contribution of the flow of the Upper Jordan to Lake Tiberias averages 660 MCM/year (Naff and Matson, 1984). The catchment area lying between the headwaters and Lake Tiberias contributes an additional average amount of 130 MCM of annual river flow to the upper Jordan stem. Along this same area, some 110 MCM/year are used for different purposes in Isreal. The water which collects in Lake Tiberias is exposed to evaporation with an average annual amount of 270 MCM. With the local catchment of Lake Tiberias contributing approximately 30 MCM/year to the Lake, and annual precipitation over the lake averaging 70 MCM/year, the mean annual net flow into Lake Tiberias is 510 MCM.

Due to the utilization of Lake Tiberias water by Israel, the effective annual flow from the lake into the lower Jordan is only 40 MCM. Israel considers this amount into the lower Jordan as "losses." This small flow, coupled with the diversion of some saline springs away from Lake Tiberias by Israel, has obvious environmental and quantity reduction impacts on downstream users.

In the catchment lying between Lake Tiberias and the Dead Sea, various water sources feed the Jordan River. The main sources are the Yarmouk, the Zarqa, and Wadi Arab on the east bank, and Wadis Auja, Qilt, and Faria on the west bank. Before implementation of major development projects, the contributions of east and west bank wadis to the river system were 612 and 140 MCM/year, respectively.

The Table below indicates the approximate water balance for the Jordan River.

Table 2. Water Balance for the Jordan River

Category	Flow (MCM/year)		
	+	−	Total
A. **Flow into Lake Tiberias**			510
Upper Jordan Contribution	660		
Springs and Runoff from Wadis	130		
Irrigation use by Israel		110	
Local Catchment contribution	100		
Evaporation		270	
B. **Flow into the Dead Sea**			210*
Outflow from Lake Tiberias	40		
Yarmouk River	400		
Use of Yarmouk waters by			
Israel		100	
Jordan		120	
Syria		170	
Wadis and Springs in Valley (precipitation, use, and return flows combined)*			+160

* Rough estimates.
Sources: adapted from Bakhit and Salamen (1990); Gross and Zahavi (1985); Naff and Matson (1984); Wishart (1989).

Despite the fact that the above estimates of the surface flow in the Jordan Basin may imply perfect information. The existence of some uncertainty in these figures is widely accepted. This uncertainty, however, is less pronounced now than in the past. Groundwater data are even less certain. Wishart (1989) has suggested that "estimates of the groundwater resources of the Jordan Valley vary more widely than do the estimates for the Jordan River system's flow." The author reached that conclusion after presenting a review of the various estimates and studies performed on the basin in the past.

In recent years, a significant amount of effort has been expended on the improvement of the water data base on the Jordan River.

B. Macroeconomy of the Basin

A brief description of the socio-economic conditions of the riparian countries is now presented, with special emphasis on the water resources sector in each country and its contribution to national economic developement. It is important to note that agriculture and food production, at this time, represents less than half of the gross national product (GNP) of Syria, Jordan, Israel, and Lebanon. The water resources in the occupied West Bank and their uses by Israel are discussed within the framework of these countries.

Jordan

Jordan is a small open economy of 3.3 million people with scarce natural resources. It is heavily dependent on trade with Iraq, Kuwait and other Gulf countries, from which income in the form of loans, grants, and expatriate remittances played a major role in its development over the past 20 years. During the period 1964-1982, Jordan exhibited the highest GDP growth rate per annum out of all developing countries (McCarthy *et al.*, 1987). The major reasons for this growth were a well educated population, political stability, prudent economic management, and availability of Arab and International aid. However, during the 1980's overall debt grew to U.S.$ 8 billion. The main reason was the slowdown of the economies of the Gulf States due to lower oil prices, thus affecting expatriate earnings and the agricultural and industrial export market to those countries. In 1987, Jordan could no longer service this debt, and an economic adjustment program was subsequently formulated in 1989 by the Jordan Government in cooperation with the World Bank and the International Monetary Fund. The adjustment program involved devaluation of the currency, trade reforms, and austerity measures. This program was successful in producing 2% growth and lower unemployment in the first half of 1990. In the second half of 1990, the Middle East crisis began. The economic losses to Jordan were mainly due to the impact of the crisis on exports, transit trade, private remittances, expected official aid, tourism and the cost of oil imports. In addition, the number of repatriated Jordanian evacuees returning to Jordan from employment in the Gulf reached 200,000 people. Current levels of unemployment are estimated at 30%.

The water resources problems in Jordan are an externality of climatic conditions, population growth, and economic constraints. An overall feature of these problems is the inherent water supply-demand imbalances. In simple terms, these imbalances, if not alleviated, imply that Jordan can never realize its full potential for social and economic development. We now briefly discuss the water resources sector in Jordan.

Water available to Jordan is derived from surface water sources, groundwater sources, and wastewater reuse. Approximately 40% of the total surface water supplies available are presently being utilized. The most important development project by far is the proposed Al-Wehdah Dam on the Yarmouk River, which forms the border between Syria and Jordan. Groundwater resources on a nationwide basis are currently being extracted at a level of about 110% of the total available renewable supplies. The rates of withdrawal, in some cases, are greater than the natural recharge rates. Non-renewable groundwater is abundant in the south (e.g. the Disi Aquifer in the southern desert basin, but these sources are over 300 km from the major population centers in the North. Jordan is currently expanding its wastewater reuse system, and despite all its efforts in water conservation, efficiency enhancements, and future surface water development, the country is facing increasing problems of water shortages (Jordan Ministry of Water and Irrigation, MWI, 1990).

Numerous reviews and studies have appeared over the past decade addressing the water resources issues in Jordan, e.g., Cooley (1984); Naff and Matson (1984); Salameh (1990); Starr and Stoll (1987, 1988); World Bank (1988, 1990). These valuable documents will be cited during the course of this paper.

The total quantity of water consumed in Jordan in 1990 (730 MCM) was distributed in the following proportions: 175 MCM for residential use and 35 MCM for industrial use (both primarily from groundwater sources) and 520 MCM for agricultural purposes (60% of which was supplied from surface water sources). To place these figures in perspective, consider a "water poverty line" of 1 MCM per 1,000 inhabitants per year to be defined as a line below which a country would be experiencing water scarcity. In that case, Jordan can be considered a water poor country, producing approximately 1 MCM per 4,200 inhabitants annually. This is reflected in severe water shortages at certain times of the year, which is more apparent in the municipal subsector than in others.

Estimates of water availability were collected from several sources. According to the Ministry of Water and Irrigation in Jordan (Jordan MWI, 1991), the total available flow in the surface basins (consisting of base flow and flood flow) is 750 MCM on an average annual basis. However, the maximum economically exploitable quantity available to Jordan, even after all dams including the Wehdah Dam are built, is only 474 MCM. This difference is due to the extensive use of the Yarmouk by others, and the lack of dams on the Yarmouk and major wadis. The MWI estimate of safe yield from the groundwater basins is approximately 388 MCM/year. World Bank estimates of these surface and groundwater resources are 878 MCM/year and 356 MCM/year, respectively. Other sources (Al-Momani, 1987; Naff and Matson, 1984) give estimates within that range. A more realistic total safe yield figure of 862 MCM/year (ground and surface combined, 388 + 474) will be used here. However, only 730 MCM out of this 862 MCM is presently being exploited and utilized annually to meet demand. It is only after the completion of the Al-Wahdeh Dam with a storage capacity of 200 MCM per annum (effective additional supply to Jordan of 200-125 = 75 MCM), and other supply augmentation projects, that the figure will approach the 862 MCM ceiling.

In terms of the demand for water, three main subsectors compete: the municipal, agricultural and industrial subsectors. A discussion of Jordanian agriculture, the largest use of water, is now presented.

Just over 10% of Jordan's area is arable. Most of this fertile land is in the Jordan Valley (see Figure 2), which is comprised of the east bank of the Jordan River between the Yarmouk River and the Dead Sea. The valley is slightly more than 100 km long ranging from 4 to 9 km wide. Two rivers, the Yarmouk and the Zarqa, and nine wadis flow through the valley draining into the Jordan River. Low and highly variable rainfall patterns have caused the area to be dependent on irrigation. There are approximately 36,000 hectares suitable for irrigated agriculture in the Valley. By 1992, the total area developed is projected to be 31,000 hectares.

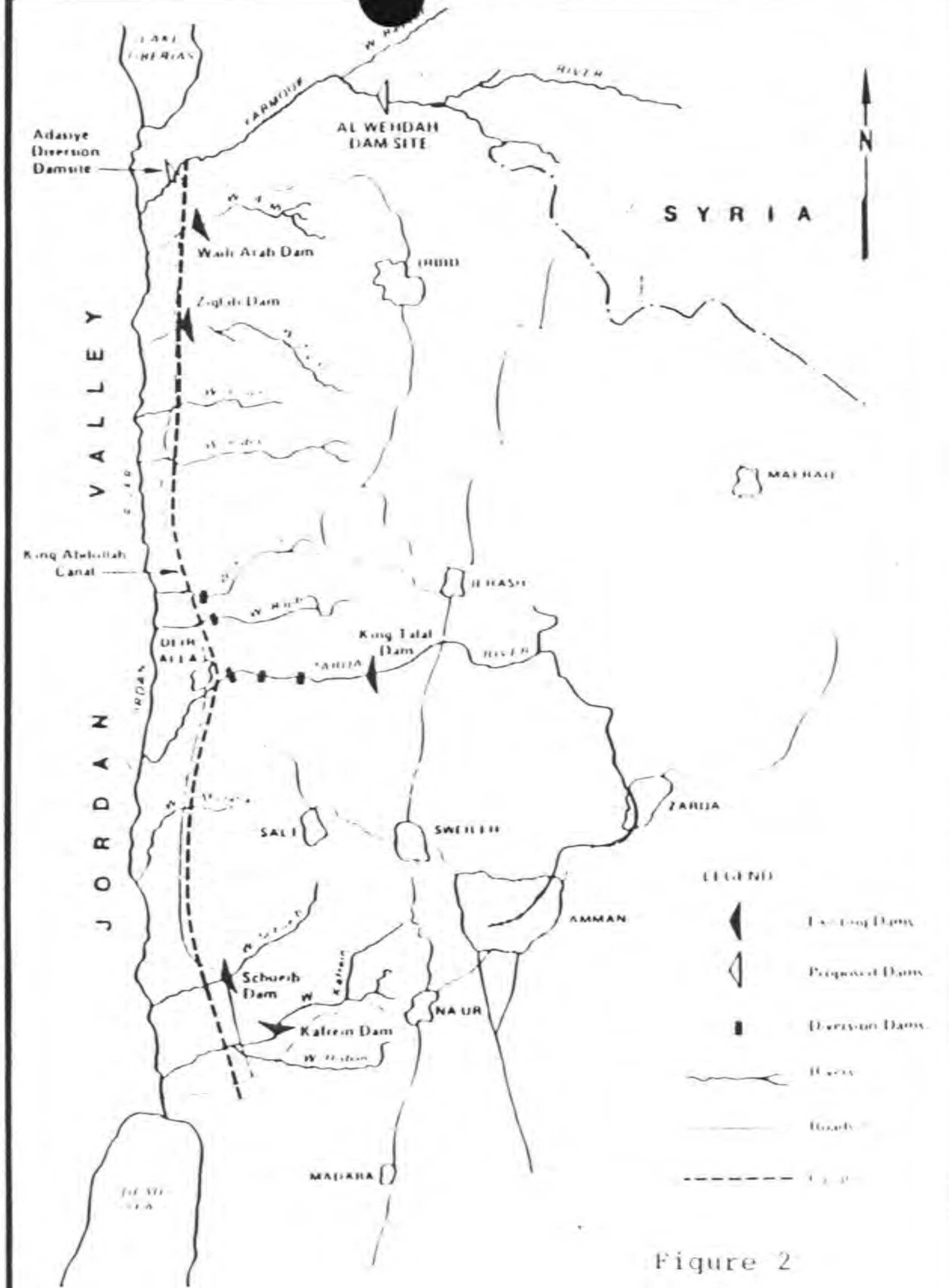


Figure 2

The Jordan Valley

However, because of anticipated depletions of water for irrigation purposes in Syria, and for M&I use in Jordan, the avilable water supplies will be insufficient to support new land development in the valley.

The Valley's agricultural production is diversified among vegetables (70%), orchard crops (24%), and field crops (6%). Most of the orchards are located in the north, while field crops are planted in the north and central areas, Vegetable crops are evenly distributed throughout. Average cropping intensities in recent years has averaged 110% (World Bank, 1990).

For the purposes of agricultural development, Jordan's East Ghor Canal (now called King Abdullah Canal, KAC), and the Israeli National Water Carrier, were completed in 1966 and 1964, respectively. The Israeli National Water Carrier was intended for development of the Negev desert area in southern Israel, while Jordan's KAC constituted the basic infrastructure necessary for agricultural development of the Jordan Valley. The developed area for irrigation by 1989 included 22,800 hectares plus a new 6,000 hectares addition at the southern end of KAC for a total 28,800 hectares. The last addition of 6,000 hectares was intended to be irrigated during the winter months from stored flood waters of the Yarmouk. Due largely to the lack of availability of Jordan and Yarmouk River waters to Jordan, the area developed for irrigated agriculture in the Jordan Basin is severely underutilized. Furthermore, the Deir Alla to Amman pipeline is running at 1/3 capacity due to water shortage in KAC.

Anticipated demand for each of the municipal, industrial, and irrigation subsectors is presented below (Figure 3). The safe yield figure from all sources, fully developed, is 862 MCM / year.

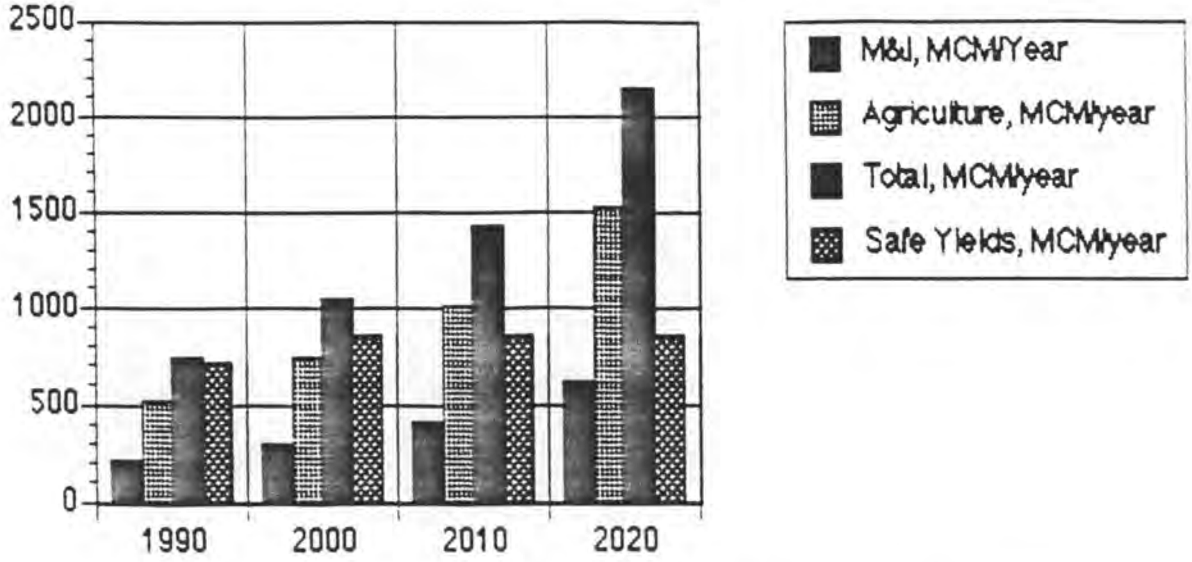


Figure 3. Projected water demand by each subsector in Jordan

Reasonable deficit projections are displayed in Table 3. These figures are estimates that the authors believe are representative of the actual situation, after reviewing the various available demand and supply projections, and considering the economic feasibility of various supply augmentation projects. They are based on an M&I demand of 190 lpd, and an irrigation demand of 1000 CM per year per 0.1 ha, assuming a constant population growth of 3.8% per annum for the period.

Table 3. Projections for the Jordanian water deficit (1990-2005)

	1990	1995	2000	2005
Water demand	740	890	1045	1200
Water supply	730	862	862	862
Net annual deficit	10	28	183	338

Source: Abu-Taleb, Deason, and Salameh (1991).

Over the years, the Jordan government has established laws and guidelines regarding groundwater extractions, allocations of water for different uses, and effluent re-use. These have been reinforced as recently as October of 1987, with the reorganization and centralization of water sector institutional arrangements in a move considered essential to ensure integrated water resource management. The water sector now is controlled by the Ministry of Water and Irrigation, which consists of two major departments: the Water Authority of Jordan (WAJ), and the Jordan Valley Authority (JVA). Each of these authorities is headed by a board of directors reporting to the Minister. The Water Authority is solely responsible for providing water for municipal uses and for extracting groundwater to meet demands. The JVA, on the other hand, is responsible for the development and use of water resources in the Jordan Valley for the purpose of irrigated agriculture. JVA and WAJ are organized as illustrated in Figure 4.

Beginning in 1984, the water sector was reorganized under the direction of two independent ministerial level authorities, the JVA and the WAJ. Although this new arrangement was an improvement over the previous one, the division between the JVA and the WAJ caused some major difficulties. For example, the conflicts in the water uses of the different subsectors were not addressed adequately, and the impracticality of employing comprehensive policies within this arrangement proved to be an obstacle for development (MWI, 1990). As a result, the two authorities were placed under the central control of the MWI, created in 1987.

Ministry of Water and Irrigation
Organization and Breakdown of Activities

Water Authority of Jordan

- Administration of Water Resources
- Planning, Development and Information
- Administration of Projects
- Operation, Maintenance and Inspection
- Financial and Administrative Affairs

→ Responsible for water related activities in all areas of the Kingdom, except in the Jordan Valley. Responsibilities include planning, allocation and distribution of water to M&I and for irrigation in the uplands.

Jordan Valley Authority

- Operations, Maintenance and Mechanics
- Land Administration and Rural Development
- Soil and Land Reclamation and Drainage
- Dams, Watersheds and Irrigation Projects
- Administration and Finance

→ Responsible for planning and development of surface water resources in the Valley area, and for allocation of water for irrigation.

Figure 4. Institutional Organization of the Jordanian Water Sector

Syria

Syria occupies an area of 185,000 square kilometers and has a population of 12 million, growing at a rate of 3.6%. A third of the labor force is employed in agriculture which contributes 27% to GDP. Syria's natural resources include crude oil, natural gas and phosphates. Annual precipitation over the country varies in the range of 100 mm in the southeastern regions to 1,000 mm in the western highlands and the coastal areas, for an average precipitation amount of 45 MCM per year (Taki Deen and Masri, 1989).

The water resources in Syria are usually divided into three categories: rivers and seasonal wadi flows; springs; and groundwater aquifers. The potential average annual flow from each of these sources is indicated below:

Rivers and Seasonal Wadis	6,700 MCM/year
Springs	1,000 MCM/year
Groundwater aquifers	1,903 MCM/year
Total	9,603 MCM/year

The major rivers in Syria include the Euphrates, the Tigris, the Orontes, and the Khabour. A number of important dams have been built (e.g., Al-Thawra Hydroelectricity and Irrigation Project), and others are proposed (e.g., on the Khabour River) to accomodate the rapid population growth and increased agricultural water demand. In the north, a surplus of water exists for irrigation and hydropower use, while in the south, the Damascus region has well-publicized seasonal water shortages (Anderson, 1991).

The Tigris River forms a part of the border between Turkey and Syria in the extreme northeast and its waters are mainly used locally for irrigation.

The water quality of the Euphrates and Tigris is slowly declining due to the rise in the return flow from major irrigation projects. This quality will probably deteriorate even further due to the implementation of the Grand Anatolian Project in Turkey, which will eventually consist of 22 dams and 19 hydroelectrivc plants to be constructed on the Tigris, Euphrates and their tributaries (Anderson, 1991b).

The organizational structure of the water sector in Syria is as follows. A Ministry of Irrigation was established in 1982 to share in the responsibilities of the Syrian water sector, along with the Ministry of Housing and Public Utilities. This new Ministry of Irrigation is responsible for water resources planning, management, and legislation for agricultural water use. In 1984, a public sector company was established by the government within this ministry to perform studies and investigations into the design of various water resource and irrigation projects. In addition, a number of water directorates within the ministry are responsible for operations and maintenance in the different water basins in the country.

Israel

The population of Israel is over 4.5 million growing at a rate of 1.8%. The populations of the West Bank and Gaza are approximately 1.0 million, and 600,000 respectively. In 1988, GNP per capita was over U.S$ 9,000, the unemployment rate stood at around 6.5%, and the percentage of the population employed in agriculture was about 5%.

Israel's annual water supply potential from conventional sources, both within its borders and from occupied Palestinian lands, has been estimated at 1,600 MCM. Israel uses 620 MCM of water supplies from the Jordan River Basin, which is expected to increase to 660 MCM by the end of the decade.

Along with surface waters, groundwater supplies, and recycled wastewater, Israel produced about 2,000 MCM in 1985. About 70% of the water supply is used for agricultural purposes, mainly during the dry summer months. In physical terms, this water is used efficiently, but not in economic terms, since water costs are heavily subsidized in Israel (Wishart, 1989).

The main sources of water supply for Israel are (1) Lake Tiberias, and the tributaries of the upper Jordan, (2) Yarmouk River (100 MCM are used annually in the local area, and 45 MCM/year is diverted in the winter months to Lake Tiberias for use by Israel), (3) groundwater aquifers originating in the occupied territories and flowing westward toward the Mediterranean (Cooley, 1984), and (4) reclaimed wastewater which is discharged into the coastal groundwater aquifer. Lake Tiberias and the upper Jordan tributaries provide 35% of annual water needs. The groundwater aquifers provide 60% of needs, and the rest is derived from the non-conventional sources (recycled wastewater and desalted water).

Israel's water development plans have focused on the the three basin system of Lake Tiberias, and the two major groundwater aquifers, comprising what is known as Israel's National Water System. The three sources are interlinked by the National Water Carrier (completed in 1964) with branching regional water supply systems (Hillel, 1991). Thus, the hydrologic balance of the system is dependent on a smooth underground flow of water toward the Mediterranean from the occupied territories (which is tapped by an elaborate system of wells along the coast between Tel Aviv and Haifa), and on the flow of the upper Jordan. The flow of groundwater into Israel is controlled by severely regulating water drilling operations in the occupied territories. More details about the use of the water resources of the occupied lands by Israel can be found in Naff and Matson (1984), and Cooley (1984).

Other development plans include desalinization plants in the south, a proposed Mediterranean-Dead Sea link and related Dead Sea projects (for details, see Assaf, 1976; Gross and Zahavi, 1985; Hochman *et al*, 1984; Weiner, 1980), as well as other regional schemes, such as the Hasbani-Dan System Project used for irrigation and hydroelectric power generation in the north (Oron *et al*, 1991).

The organizational structure of Israel's water economy is elaborate and requires some elucidation. A Water Commision, functioning as a separate entity under the jurisdiction of the Ministry of Agriculture, has the ultimate responsibility for the country's water sector. The Ministry of Agriculture sets policies and guidelines through the advice of a National Water Council, two thirds of which consists of members form the general public, and one third from the Government. The Ministry then expects the Water Commision to undertake the planning, management, and supervision of all water related issues. Parliamentary supervision is exercised through a specialized committee. In addition, a number of other organizations are involved in the water sector at various levels of operations, maintenance, and planning. These include, Tahal Water Planning for Israel, which is the official planning body, and the Mekorot Water Company, which constructs, and maintains water supply networks across the country. This company supplies approximately 65% of all water used in Israel.

Lebanon

The importance of water resources to the productive sectors of the Lebanese economy prior to 1975 had been quite significant. In fact, at that time, even though agriculture contributed only 13% of output, it provided employment for 50% of the population. In addition, the water resources of Lebanon had been a mainstay of its tourism sector, enhancing its image as a major tourist center. The services sector, which includes the effect of tourism on the national economy, contributed 70% of output (Ba'asiri, 1990).

Lebanon can be considered a water rich state with 18 major rivers providing approximately 4,000 MCM/year in average flow. The largest of these rivers is the Awwali, with an average annual flow of 284 MCM. But the Litani River (and the Qir'awn dam constructed on it) is the most important, in terms of its potential impact on the Jordan River Basin. The Qir'awn Dam on the Litani was completed in 1967 to channel water to a hydroelectric power plant providing the coastal cities with electricity.

Additional development projects that could provide Lebanon with more water for municipal demand, and increase irrigated lands (especially in the south), are virtually at a standstill now. Once peace and security returns to this once prosperous nation, the implementation of these projects will enhance the rebuilding and development process.

C. Riparian Countries and International Law

As described above, the Jordan River system drains different climatic and hydrogeologic areas in the riparian countries mentioned. The river rises from the mountains and hills of east Lebanon and flows southwards to the lowest point on earth, the Dead Sea. The contributions of these countries to the river flow vary according to the size of the drained area, amount of precipitation, land use of the drained area, runoff-precipitation ratios, and groundwater discharges into to the river course and its tributatries. The basin is subdivided among five riparians whose lands contribute to the water source, and whose populations utilize it for different functions and in different quantities. The possibilities for conflict are numerous, since extracting water anywhere in the basin affects both the quality and quantity of water available to downstream users.

The sharing of jointly owned water resources is a complex issue in many areas of the world. The number of shared river basins in Africa, for example, is 57, covering 60% of the total area of the continent. There are 40 shared basins in Asia, accounting for 65% of its area (Anderson, 1991a). In the special case of the international rivers in the Middle East region, the Nile is shared principally by four countries (although it threads its way through nine African states), and the Tigris-Euphrates is basically divided between three. However, there is probably no other area as difficult as the Jordan River Basin, where, in addition to the hydrologic complexities of the river, socio-economic, historical, political and strategic dimensions interfere and overlap.

In the case of the Jordan, adequate long range planning demands a reliable method for allocating the international waters of this river system. If a comprehensive agreement could be reached under the framework of international law, it could be enacted to cover the rights and obligations of riparians and ultimately reduce the potential level of conflict. As Anderson (1991a) notes, however, there is no generally accepted international principle on riparian law, and at present, agreements must be based on mutual goodwill. After analyzing a number of international river issues, Anderson concluded that the likelihood of cooperation (or conflict) depend upon (1) the relative position of the riparians within the basin, (2) the degree of national interest in the problem, and (3) the power available externally and internally to pursue policies.

Hillel (1991) indicates that, according to two international conventions (the Helsinki Rules of 1966, and a U.N. convention of 1972), water rights are to be shared between nations according to size of population, need, and historical use patterns. The information in the two conventions was left "purposefully vague" so that even now, practical problems of enforcement and conflict of interest among states (political issues), are difficult matters to address comprehensively. In the case of the Jordan River, such political issues overshadow all other concerns, and therefore necessitate the need to seek out alternative avenues in order to move forward on a reasonable water rights agreement. Section III (Part B) of this paper addresses water rights issues and disputes more fully.

III. Water Management Policy Issues

The importance of water as a factor for socio-economic development historically has been clearly recognized by all riparians of the Jordan River Basin. Even at times of water surplus, water issues were discussed and debated, with each country insisting on having large shares to satisfy anticipated growth and development. In addition to normal conflicting uses, the overall Arab-Israeli conflict has overshadowed cooperative use of the river system. Such rivalries among countries often blocked the achievement of optimal policies or projects. This is particularly true as it relates to Jordan, where conflicts over the main tributary of the Jordan River (the Yarmouk), have delayed the implementation of the Al-Wehdah Dam, a much needed water supply project for Jordan.

Policy makers in the Jordan Basin riparian countries face not only the lack of a water rights agreement upon which future development planning functions could be based, but also the complexities associated with all large water systems. Ascher and Healy (1991) suggest that natural resource policy making is complex at best, and that it is quite common for policy makers to complain about the complexity of the issues they face. Two aspects of natural resource policy making discussed by those authors are the inherent interrconnectedness of natural resources with the overall economic planning function, and the long time periods involved in water resources project feasibility, design, and implementaion. Both of these characteristics are true of the Jordan River Basin.

This section discusses these difficulties in water resources policymaking, as magnified by the regional conflicts of the Jordan River Basin, to development projects and planning functions in the respective riparian countries. First, development projects resulting from unilateral or bilateral planning endeavors are discribed, along with a brief discussion of their environmental consequences. Water disputes in the Jordan Valley are then summarized.

A. Development Projects, Planning, and the Environment

Most of the development in the Jordan River system in recent decades has involved the diversion of saline springs, construction of irrigation canals and water carriers to supply municipal demand. Lake Tiberias has been a focus of Israeli attention because it is considered critical for Israeli freshwater supplies. Water quality in the Lake is very good, because of the relatively low salinity of inflowing rivers (the Dan, Hisbani, and Banias).

The diversion of the saline springs flowing into the Lake from the west (6,000 ppm) directly into the Jordan River was undertaken by Israel to maintain the quality of the lake. Coupled with all other development projects, and the degrading effects of irrigation return water, this has elevated the salinity of the lower Jordan, making it unfit for many uses.

Faced with the necessity of expanding water supply, Israel has developed most of what it can unilaterally, or has acquired control of what it requires, as explained earlier. The quantity of water presently entering the lower Jordan from Lake Tiberias is effectively nil. Only around 30 MCM of saline waters (6,000 ppm) are discharged into the lower stem of the Jordan from previous saline springs diversion operations. The flows of the Yarmouk have also declined over the years because Syria extracts some 170 MCM/year of this water, Jordan some 120 MCM/year, and Israel another 100 MCM/year. Therefore, only 30-40 MCM/year flow into the main stem from the Yarmouk. From the western wadis, about 55 MCM/year still flow into the river as flood flows during the rainy season. In Jordan, the major wadis are already developed and their water is being stored and utilized for different purposes. Thus, from the eastern side, the only contributions to the Jordan River are flood flows of small wadis not yet dammed and runoffs from areas downstream of existing dams. In addition, irrigation return flows contribute some 30 MCM/year to the system. On aggregate, the total flow now entering the Dead Sea is estimated at 210 MCM/year.

As mentioned previously, long range planning within the basin requires above all the existence of a reliable method for allocating the international waters of the river system. It is this significant drawback that causes proposed projects, that would potentially benefit more than one riparian, to be shelved or not to be considered within an overall comprehensive plan. In the next subsection, attention is focused on a number of proposed projects, whose planning and feasibility studies exemplify the lack of a water rights agreement.

Regional and Basin-Wide Development Projects

The major development actions of Jordan River riparians took place in the 1960's. Additional development has continued at a slower pace since that time. The development actions that have taken place since the early 1960's has resulted in severe reductions in both the quality and the quantity of water flowing into the River. For example, prior to any major development projects, the amount of water reaching the Dead Sea was around 1,300 MCM/year. The total amount flowing into the Dead Sea at present is estimated at only 210 MCM/year primarily due to the abundance of development projects utilizing the replenishing waters of the tributaries. This subsection briefly summarizes some of the existing and proposed regional projects and their potential implications on the water balance of the region. The two major existing projects include The King Abdullah Canal (KAC) of Jordan, and the Israeli National Water Carrier (NWC).

The proposed regional development projects include, the Mediterranean-Dead Sea Canal, the proposed Turkish Peace Pipeline, the Euphrates River Diversion from Iraq to meet requirements in Jordan, and speculative ideas about the Litani River Diversion in Lebanon. The Al-Wehdah Dam project, the most feasible of all of these proposed development projects, will also be discussed.

The Israeli National Water Carrier (NWC) A major portion of the water supplied in Israel is diverted from the upper Jordan River to the country's southern regions via the National Water Carrier (see Figure 1). Completed in 1964, the NWC is an intricate supply system capable of transferring water over 250 km to the Negev Desert.

The NWC originates on the northwestern shores of Lake Tiberias and consists of a 23 km long canal and 87 km long pipeline (2.7 m diameter) branching off into local supply networks along the coastal plane. Water at the terminal point of the NWC is transferred to a dual system of pipelines to the Negev desert covering a distance of 95 km. In the summer months, the water conveyed in the system is mainly used for irrigation, and in the winter months, the water is used to recharge groundwater aquifers.

The King Abdullah Canal (KAC) Since its construction in 1966, the KAC has constituted the basic infrastructure necessary for agricultural development of the Jordan Valley. The KAC is a concrete lined gravity system consisting of an intake tunnel at Adassiyeh on the Yarmouk, a canal conveying water for irrigation in the Valley, and related outlet works. The canal has been lengthened three times and now is 110 km long, covering the entire Jordan Valley (see Figure 2).

A major international issue related to conflicts in the region concerns the inability of Jordan to dredge the opening of the King Abdullah Canal (Naff and Matson, 1984), whose inlet at the Yarmouk River has been partially filled with sediment. Israel has thus far made it difficult to perform maintenance at the mouth of the canal, with the result that water is flowing at low rates. In addition, the flow in the extension recently completed to irrigate the southern part of the Jordan Valley area from the

KAC is at a trickle. The effects are devastating to that area of potential high agricultural productivity.

The Mediterranean-Dead Sea Canal One development project that has temporarily been shelved is the Mediterranean-Dead Sea Canal. The canal would use the drop of about 400 meters between the two seas, to convey water eastward into the Dead Sea to drive electric turbines. The project has a list of major drawbacks, such as (1) the economic feasibility of the project has always been in question (conservative cost estimates exceed U.S.$1 billion, excluding the costs of environmental effects, reduction in potassium production, and others); (2) the consequent rise in the level of the Dead Sea would destroy the Jordanian chemical industries in the area; and (3) the incoming seawater would contaminate much of the fresh waters of the streams and aquifers in the Jordan Valley. According to Cooley (1984), such issues pose serious difficulties for Jordan

Despite the major uncertainties about its economic and technological feasibility, adverse environmental impacts, and political ramifications, several preliminary studies have been performed on the optimal route that the canal would follow to maximize energy production (e.g., Gross and Zahavi, 1985; Hochman *et al*, 1984). According to Gross and Zahavi (1985), the entire project would consist of several components: (1) an upstream reservoir at zero sea level; (2) a water carrier; (3) an upper reservoir at the outlet of the water carrier to regulate flow; (4) a hydroelectric unit capable of reverse operation; and (5) a downstream reservoir at the Dead Sea.

The Turkish Peace Pipeline This project, as proposed by Turkish Prime Minister Turgut Ozal in 1986, would consist of two pipelines conveying water from the catchments of the Seyhan and Ceyhan Rivers in Southern

Turkey to various countries in the south. According to the proposal, an eastern pipeline would convey water to Kuwait, eastern Saudi Arabia, Qatar, Bahrain, and the United Arab Emirates. The western pipeline would convey water to Syria, Jordan, the West Bank, and western Saudi Arabia. It has been reported that terrain feasibility studies have been completed and that possible obstacles and threats from terrorism can be overcome (Anderson, 1991b).

Other major obstacles to the project include its cost and political objections. The cost of the project is estimated at U.S$ 20 billion (Starr and Stoll, 1987). Political considerations, on the other hand are not as easily quantifiable; downstream countries argue that it is difficult to imagine relying on water supplies that are controlled by outside sources. However, the proposal argues that (1) regional conflicts could be reduced by virtue of the pipeline; (2) cooperation among countries would improve; and (3) standard of living indicators throughout the Middle East would rise (Starr and Stoll).

Diversion of Euphrates River Water. In 1982, a study was performed by the Jordan Government (with an understanding between Jordan and Iraq) to determine the technical and financial feasibilities of conveying water from the Euphrates River in Iraq. The project would consist of treatment facilities and pumping stations to provide Jordan with 80 MCM/year in the first stage, ultimately providing 160 MCM/ year in later stages. The proposed 1.2 -1.5 m diameter steel pipelines would cover a distance of 590 km, and the pumping stations would raise the water through a head of 1,400 m. The estimated capital cost of the first stage of the project in 1982 prices was the equivalent of U.S.$ 1 billion. A similar amount is required for the final stages. Thus, the economic feasibilty aspect of this project has been the main obstacle.

Litani River Diversion There has been wide speculation that Israel, after invading South Lebanon in 1982 and controlling the lower reaches of the Litani River, is contemplating its diversion into the headwaters of the Jordan River system. In that same year, Israel built a new road and a new bridge over the Litani, and fortified military camps in the region (Cooley, 1984). The speculations have only added to raising the level of unease over the water situation in the Middle east.

Al-Wehdah Dam Project As previously indicated, the Jordan Valley depends upon two main rivers, the Yarmouk (through the KAC) and the Zarqa (through the King Talal Dam and reservoir), for its basic irrigation needs. The Yarmouk, which forms part of the border between Jordan and Syria in the north, is the largest and most important underdeveloped surface water resource in Jordan. Although water demand has increased in the Jordan Valley in recent years, upstream diversion and the construction of small dams in the upper Yarmouk watershed by Syria are reducing the amount of water available to Jordan. In time, Syrian diversions are expected to increase, making imperative the construction of a major storage reservoir on the Yarmouk to control and regulate its flows.

Without Al-Wehdah Dam, future water needs of the agricultural and municipal sectors could not be met. It is only by storing and regulating the flood flow resulting from the concentrated winter rainfall between December and March that the economic development of the Valley and the Amman-Zarqa areas can progress.

The Al-Wehdah Dam will be located in a narrow, steep sided portion of the Yarmouk River Valley about two kilometers downstream from the confluence of Wadis Alland and Shallaha. The Dam will be a concrete-face rockfill dam with a gated chute spillway and a power plant producing a rated capacity of 8 MW in two generating units, and will be designed for construction in two stages. The first stage involves the construction of a 100 meter high dam with provision for raising the dam by 40 meters in the second stage. After the dam has been raised, the gated cute spillway will operate as an orifice spillway. The dam will impound a reservoir with a gross storage capacity of 225 MCM. The live storage capacity will be 195 MCM, with a 30 MCM sediment storage pool equivalent to 50 years of deposition. At present, the status of the dam construction is on hold. However, the diversion tunnel for the construction site was completed recently, after Jordan and Syria ratified an agreement on the construction of the dam in 1987.

The Yarmouk River itself flows into the Jordan River after draining the high plains of Golan in Syria, and the desert plateaus of both Syria and Jordan. The drainage area of the basin near its confluence with the Jordan River is about 6,970 square kilometers with a mean annual runoff of 411 MCM. Above the damsite, the drainage basin has an area of 5,950 square kilometers with a mean annual runoff of 246 MCM. The runoff is comprised of a base flow, which is derived primarily from two major springs, and flood runoff. However, over the past thirty years, Syria has continuously increased its use of the Yarmouk flow. With further development planned upstream of the damsite, additional reduction of the flows available to Jordan can be expected. As a result, over the life of the dam, it is estimated that the average annual flow at Al-Wehdah will be reduced to 151 MCM/year.

Project economics were derived by comparing direct project costs against direct project benefits, using the present worth technique over the dam's economic life. The investment cost was estimated at JD 176 million, (JD 76.9 million local financing, and JD 99.1 million foreign financing) assuming that cost escalation during project implementation will average 7% per year for the local currency and 4% per year for the foreign currency. The foreign currency component was assumed to be financed by a 36 year loan with interest of 8% per year. A six year grace period was assumed before repayment begins. The annual irrigation benefits in the Valley were estimated at JD 6.5 million. The highland irrigation benefits amount to JD 550,000. The benefit for municipal and industrial water was estimated at JD 12 million, while the power benefits total JD 416,000.

The economic analysis indicated that the project is economically feasible, predicting an internal rate of return of 12%. The net present value of the project is JD 52 million for a discount rate of 8%.

According to the Ministry of Water and Irrigation, the implementation of the Al-Wehdah Dam project will result in the following benefits:

* Irrigation of an additional 3,550 hectares in the Valley.
* Supply of 50 MCM of water to Amman-Zarqa area for M&I use.
* Irrigation of 500 hectares in the highlands using return flow from M&I supply to Amman-Zarqa.
* Increase the annual water release to the Yarmouk Triangle from 17 to 25 MCM.
* Generation of 18,800 MWh of electricity annually and addition of 3.6 MW of dependable capacity to the national electrical system.
* Increased settlement opportunities in the Jordan Valley.
* Positive impact on employment resulting from increased economic activities.

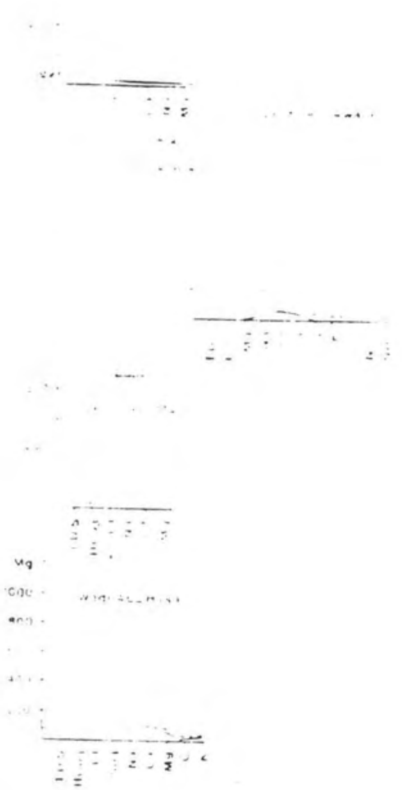
* Positive impact on public health resulting from a firm supply of municipal and industrial water to the urban areas of North Jordan.

Environmental Issues

For the Jordan River system, environmental problems are a direct externality of the supply-demand imbalances (reflecting water scarcity) in the riparian countries. Because of the generally low flows in the region, surface streams have relatively low assimilative capacities. Treatment levels of wastewater are inadequate in view of the low assimilative capacities of the receiving water bodies, and therefore downstream uses are adversely affected.

In addition to inadequate treatment levels, the waters of the Jordan River are highly polluted for a number of other reasons. It receives the return flows from irrigated fields on both sides of its banks, and now directly receives the flow of the saline springs that were diverted into the Jordan River by Israel. The diversion of these springs was undertaken unilaterally by Israel in order to conserve the quality of Lake Tiberias, which provides a substantial portion of Israeli water. This practice has rendered the main stem of the Jordan River unsuitable for use in its present condition. In fact, the salinity level just before entry into the Dead Sea reaches 5,000 ppm (Dead Sea salinity is 300,000 ppm). Figure 5 illustrates the results of water sampling tests performed in Jordan in 1986 (Jordan National Geographic Center, 1986).

The Yarmouk River waters are of good quality and a study is under way to evaluate the environmental impacts of constructing the Al-Wehdah dam on the Yarmouk. The World Bank is to provide a significant share of the associated construction costs in the form of development loans to Jordan.



[illegible]	Total Dissolved Solids
HCO3	Bicarbonate
Cl	Chloride
Ca	Calcium
SO4	Sulfate
Na	Sodium
Mg	Magnesium
CO3	Carbonate
K	Potassium
SiO2	Silicone Dioxide
NO3	Nitrate
NH4	Amonian

The environmental impact study is in line with a recent World Bank assessment policy which elevates environmental impact analysis to the same level of importance as other more traditional economic, financial, and technical analyses (Munasinghe, 1991).

B. International Riparian Issues

The subject of international riparian issues in the Jordan River Basin is extremely sensitive. However, the subject is critical to any significant approach to the solution of water resource problems in the region, especially those of Israel and Jordan. Unfortunately, discussions of this subject cannot be conducted completely apart from considerations of the motivations of riparian nations for past actions. To the extent that such issues are addressed in this paper, it is done solely because an understanding of such subjects is necessary to have any real chance at making real progress toward significant solutions that are beneficial to all riparian countries.

In this section, previous water sharing agreements, especially the Unified Johnston Plan, are discussed followed by a thorough account of water rights issues and disputes.

Water Sharing Agreements

Dating back to 1913, formal schemes have been sponsored and developed in order to estimate the needs of the local populations in the region. Naff and Matson (1984) survey these development schemes for agricultural development in the Jordan Valley. In order to understand the level of attention the region has enjoyed over the years, a list of some of the development schemes for the Jordan River is presented. Table 4 lists the major water surveys and plans for the River system since 1913, the most important of which, the Unified Johnston Plan of 1955, will be discussed in more detail.

Table 4. Plans for the Jordan River

Year	Plan	Sponsor
1913	Franghia Plan	Ottoman Empire
1922	Mavromatis Plan	Great Britain
1928	Henriques Plan	Great Britain
1939	Ionides Survey	Transjordan
1944	Lowdermilk Plan	U.S.A.
1950	MacDonald Report	Jordan
1951	All Israel Plan	Israel
1952	Bunger Plan	Jordan/U.S.A.
1954	Arab Plan	Arab League Tech. Comm.
1955	Baker-Harza Plan	Jordan
1955	Unified (Johnston) Plan	U.S.A.
1956	Israeli National Water Plan	Israel
1964	Jordan Headwaters Diversion	Arab League

Source: Naff and Matson (1984).

In the early 1950's, the issue of the Jordan River water was on the agenda of various national and international organizations. The potential for conflict was growing, and each country unilaterally prepared its own plans to exploit as much water as it could from the riparian river system. A detailed account and a historical discussion of these plans can be found in Naff and Matson (1984), and Cooley (1984), but a brief historical account is presented herein.

The most important water sharing plan is the "Unified Johnston Plan" of 1955. Eric Johnston, a special envoy of U.S. president Eisenhower, visited the area several times and prepared his plans for the sharing of the Jordan River Basin. The plan did not reach the status of an agreement due to various political reasons that are discussed in detail in Naff and Matson (1984).

The Johnston Plan allocated the following shares for the different riparians as compared with current levels of use in Table 5. At that time, the West Bank was a part of Jordan.

Table 5. Allocation of Jordan and Yarmouk River Waters, MCM/ year

Riparian Country	Planned allocation, 1955		Current use levels, 1990	
	Jordan	**Yarmouk**	**Jordan**	**Yarmouk**
Jordan	100	275	0	120
Syria	42	90	0	170
Israel	25	25	540	100
Lebanon	35	0	0	0

Sources: Naff and Matson (1984); Salamen (1990).

At the time of formulation of the Johnston Plan, Yarmouk River flow was estimated at 390 MCM, and the upper Jordan River Tributaries at 550 MCM. According to the plan, Jordan's share from the Yarmouk was to be 275 MCM, and its share from the Jordan River was fixed at 100 MCM to be stored in Lake Tiberias. This gave Jordan a total allocation of 375 MCM. However, Jordan only uses 120 MCM of this flow due to (1) other riparians using more than the planned allocation, (2) the fact that Jordan does not receive any of the 100 MCM potentially stored for it in Lake Tiberias, and (3) the fact there is no control of flood flow on the Yarmouk. As indicated in the table, neither Syria nor Lebanon currently utilize any water from the upper Jordan.

Jordan, which is the riparian country most dependent on the Jordan River system, would need the entire 375 MCM allocated in the Johnston Plan to develop and permanently irrigate the whole Jordan Valley, estimated at 36,000 ha, and to provide much needed supplies in its municipal and industrial subsectors. In this way, the water shortage for Jordan could be alleviated and any impending water crisis would be delayed by at least two decades. By that time, the government expects that population growth will decline to a moderate level, and alternative energy sources could be harnessed for desalinization of sea water.

Water Rights Issues and Disputes

This section draws heavily from a review of previous literature on water rights issues within the Jordan River Basin conducted by Wishart (1989). According to Wishart, the literature on water issues and disputes in the Basin can be grouped into four categories: (1) the hydraulic imperative hypothesis (use of military forces to ensure availability of water resources), (2) the ideological imperative (use of water for traditional or cultural purposes rather than for optimal economic purposes), (3) the model of water conflict by Frey and Naff (1985), and (4) Wishart's new economic approach to addressing Jordan Valley water disputes. This section will briefly review each of these ideas, and will extend some elements of Wishart's approach to the Yarmouk Basin, keeping in mind that the main determinant to the success of any solution approach is the potential reduction in the level of conflict over water rights.

According to Cooley's (1984) hydraulic imperative hypothesis, Israel has continually felt the need to acquire--by virtue of its military force-- a larger share of the water resources in the region to ensure its continued growth. Israeli occupation of the West Bank and Golan Heights in 1967, and its invasion and control of Southern Labanon in 1982, are direct manifestations of the hydraulic imperative. Naff and Matson (1984) share the view that the hypothesis does, in fact, provide a significant perspective on regional affairs. Wishart, however, downplays that point of view by pointing to, among other things, Israel's return of the Sinai (with large volumes of groundwater resources) to Egypt as part of the Camp David accords.

Several factors, however, do tend to support the "hydraulic imperative" perspective. For example, control of most of the headwaters of a river system (such as the Jordan) imparts great potential for future leverage on downstream riparians. Moreover, implementation of projects such as the Dan-Hisbani water system to provide hydroelectric power generation and irrigation water to the area (Oron *et al*, 1991), may tend to support such a model.

The "ideological value of water" concept is based on a study performed by Thomas Stauffer in 1985. He argues that, since Israeli agriculture is heavily dependent on subsidies, the economic value of the water used is zero. However, because of the ideological imperative of Israel, water has a very high ideological opportunity cost, within the range of U.S.$ 1.2 to 1.8 billion per year. This estimate is the replacement cost of 600-700 MCM/year of water that Israel uses from the Upper Jordan and some groundwater aquifers, if it were supplied by desalinization techniques.

Wishart argues that an economic resource, such as water, should not be be valued at its replacement cost, but rather its opportunity cost, i.e., the value of the water in its next best alternative use. He maintains that it is pure conjecture that Israel would be willing and able to acquire desalinated water in order to continue agricultural production. In Wishart's opinion, to calculate the ideological value of irrigation water, one would need to calculate Israel's GNP in the absence of irrigation subsidies. Without subsidies, it is assumed that water used in agriculture would be transferred to higher-value domestic and industrial uses, and Israel's GNP would rise. The difference between this increased GNP and the actual GNP would be an estimate of the ideological value of water.

In 1985, Frey and Naff developed a water conflict model to predict the probability of violent conflict. Their model is based upon three country specific parameters (similar to Anderson's "likelihood of cooperation or conflict approach" outlined previously): the relative position of a riparian along a water course, the power available for projection externally, and the degree of national interest in capturing a water source. Although Wishart argues that such models may be helpful in providing insight as to whether or not water disputes will result in violence, he does not see how these models could avert violent outcomes.

Thus, Wishart proposes a new "hypothesis that relates conflict over water rights to economic variables (such as transaction costs to settlement and the rate of adoption of water use and water discovery technologies)." Such a framework of analysis could produce realistic policy recommendations, according to Wishart, in sharp contrast to the shortcomings of other models bereft of practical significance.

The economic approach advocated by Wishart employs what may be termed a two stage simulation approach. In the first stage, the price of water would be set at or near its cost of supply. This would have the following effects: farmers would reduce water consumption for irrigation and adopt more efficient water-use technologies; a search for new water sources would take place due to the higher prices for water; and transfer of water rights from low value agricultural use to higher value uses would be adopted.

The second stage involves the ripple effects of the above mentioned actions on the stock of efficient water-use technologies. With increased use of these technologies, demand for water would be reduced, thereby reducing the potential for violent conflict in the region. In addition, the whole simulation experiment could provide other countries in the region with valuable information on the use of market forces and their effects on the agricutural sector.

In formulating his approach, Wishart fails to identify some important interrelated factors which could act as stumbling blocks in the practical implementation of the proposed approach. First, Israel may not wish to adversely affect the rural population in the country and jeopordize its food production capability for the sake of reducing the potential for violent conflict. Agriculture plays a dominant role within the framework of social, economic.

Second, the Arab-Israeli conflict unfortuantely is not conducive to approaching the problem from a solely economic point of view, even though Wishart states that his solution is a reasonable starting point "given that all other paths now appear to be blocked." Social, historic, cultural and religious considerations may be determining factors of any peace or agreement reached on water rights in the region.

Because of its simplicity in addressing complex issues, however, Wishart's approach does have strong appeal. It may be applied to the present situation in the following way. Since the main objective of the approach is to reduce the potential for violent conlict, a proxy for raising the price of water in Israel -- construction of the Wehdah Dam -- could be used as an alternative means of achieving the same objective. This alternative could achieve the desired goal of reducing the unease in the area among the riparians Israel, Syria, and Jordan, especially since two of the parties (Jordan and Syria) have a standing bilateral agreement on the Al-Wehdah Dam. It is on this alternative that attention should be focused.

As previously described, the Al-Wehdah Dam could potentially benefit Jordan in a number of positive ways. Its benefits to Syria and Israel are also numerous. According to Cooley (1984), "U.S. planners realized that the proposed dam on the Yarmouk could not only help Jordanian agriculture by controlling the Yarmouk's winter floods and providing water for irrigtion projects, but also give Syria and Israel a more even flow of water on a year round basis." This would in turn achieve the desired goal of reducing the potential for violent conflict.

IV. Future Scenarios and Recommendations

As briefly described above, many solutions have addressed the conflict over the waters of the Yarmouk and other Jordan Valley water disputes. In this section, we limit our discussion to the Yarmouk itself. The parties to this conflict are Israel, Syria and Jordan. One needs to consider and emphasize the fact that the waters downstream of the Yarmouk are so polluted and saline as to be rendered useless.

After considering the hydrology of the river system and the socio-economic and land use factors in the three riparians of the Yarmouk River, it becomes clear that Jordan is suffering the most from the current impasse concerning further development of the river. Its food production, labor employment, and food exports depend crucially upon the river water, which constitute only 40% of its share, according to the Johnston plan. Initial development plans in the Valley dating back to the fifties and sixties were planned and implemented on the basis of allocations specified by the Johnston Plan.

At present, Syria extracts more than the share specified by the Johnston Plan, and uses most of the water for irrigation in the highlands, which already receives an average annual precipitation exceeding 450 mm. This amount of precipitation is enough to support field crops, fruit trees and even summer crops. Also, the irrigated areas along the Yarmouk River are very small and lie in very awkward terrain, thus depriving the necesary feasibility from the whole activity. Moreover, Syria is relatively rich in water resources and the Yarmouk does not represent a vital or important source for the future.

Israel's case is similar in many ways. The country extracts some 100 MCM/year from the Yarmouk although the share of the occupied Yarmouk Triangle is only 25 MCM/year. An additional 45 MCM of water is pumped to Lake Tiberias in the winter months to supplement the sources used for domestic and irrigation purposes outside the Jordan and Yarmouk catchments. In all, the Yarmouk contributes approximately 4% to Israel's requirements. This relative lack of dependence upon the Yarmouk as a water source is dramatized by the fact that part of Lake Tiberias water is used to irrigate areas in the Negev Desert in the South, through the National Water Carrier and its regional water supply schemes.

If Jordan is able to obtain its share in the river water according to the Johnston Plan, its water problems will be postponed for two decades, its food production will cover a good portion of its needs, and its labor market will ultimately grow. On the other hand, if the Al-Wehdah Dam is not constructed and the present exploitation of the water resources in the region continues, one of the last unexploited water resources in the region, the winter flood waters of the Yarmouk will continue to be wasted. Under that scenario, it is estimated that the present 110 MCM annual diversion of the Yarmouk by Jordan will decline to 90 MCM in the next few years. This will adversely affect its agricultural production, increase unemployment, and lead to domestic conflicts over water use and allocation. At the same time, this situation would also not be advantageous to Syria since the outcome of the projects built on the Yarmouk are not feasible on a cost-benefit basis. That is, Syria's benefits from the Al-Wehdah would be less than the costs, if it alone were to implement the project. For Israel, the Yarmouk River is not as essential, since it represents only 4% of its water resources, and part of the water is used to irrigate portions outside the catchment. In fact, the Al-Wehdah Dam would make Israel's Yarmouk supply more dependable, thus alleviating tensions with an adjacent neighbor. In sum, for both countries (Syria and Israel), the Yarmouk River water and its future development is not as economically essential and feasible to those countries as it is to Jordan.

V. Conclusion

There is no doubt that the hydrological balance of the Jordan River system essentially is controlled by Israel. The problem is such that any future interference with the surface flows and groundwater flows of the system would upset this hydrological balance -- a balance Israel has sought to control for so long. Based on this argument, Israel has opposed any further surface and groundwater development by other parties, which may affect the balance in any way.

The issue of why Israel occupied certain territories (whether out of the desire for control of more water resources, or out of the desire to maintain secure borders at the expense of other countries' lands) is irrelevant in practice. The bottom line is that Israel *does* control these areas and their water resources in defiance of international law and U.N. resolutions on the West Bank and Gaza, the Golan Heights and Southern Lebanon. The ensuing drawn out debate serves no purpose, and prevents optimal utilization of the precious resources of the Jordan River system.

In addition to time delays, the overall complexity of the issue is responsible for the failure to uphold appropriate standards of environmental protection within the basin. Thus, it is in the best interests of all parties to come to a decision soon concerning water rights agreements and the construction of the Al-Wehdah Dam on the Yarmouk to regulate its flows and provide much needed water to the area. Syria and Jordan had ratified an agreement in 1987, and wish to implement the project to their mutual benefit.

It is hoped that, through conferences such as this, recommendations can be imparted to the world community, so that adequate attention can be focused on a problem that has so far, alluded all attempts at resolution.

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