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Water and the Peace Process: Two Perspectives

Both Arabs and Israelis recognize the critical importance of water for the peace process and the future of regional economic cooperation. In this light, The Washington Institute asked Israeli and Jordanian water experts to outline their views in this special Policy Focus. Their unedited responses appear as follows:

A View From Israel

By Shlomo Gur

Water is one of the most important subjects being discussed between the parties in the current Middle East peace talks.

It is estimated that between 100 and 150 million cubic meters of the Yarmuk River waters flow to the Jordan River and are lost, unused, in the Dead Sea. It should be expected that this water will be the subject of a tough confrontation in the course of the bilateral talks.

This confrontation could be avoided, given the possibility of producing large quantities of desalinated waters in the Jordan Rift Valley. The rift's geographic proximity to the Mediterranean permits the construction of a water carrier through a relatively easy topographic path to a desalination complex exploiting the reverse osmosis (RO) process which will be established in the Beisan Valley. The hydrostatic

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A View From Jordan

By Munther Haddadin

In the current Arab-Israeli peace process, the bilateral negotiations aim at a comprehensive and lasting peace in the Middle East based on UN Security Council Resolutions 242 of 1967 and 338 of 1973, while the multilateral talks aim at regional cooperation whose doors will swing open once the aim of bilateral negotiations is achieved. It is also hoped that the multilateral talks, as they are conducted in parallel with the bilateral negotiations, will provide incentives for progress on the bilateral front.

The multilaterals have been organized into five working groups, namely, Refugees, Economic Development, Water, Environment, and Arms Control and Regional Security. Additionally, a Steering Committee has been organized to oversee compatibility of the work of the five groups and to provide linkages with the bilaterals.

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"A View From Israel" (from page 1)

pressure differential between the level of the Mediterranean Sea and that of the Beisan Valley is 275 meters, and it allows saving approximately 60 percent of the energy required in the desalination process.

At this point, it should be emphasized that the restoration of the Jordan River, which is in the process of drying up, and the stabilization of the Dead Sea level, which is falling steadily, having already lost 19 meters as a result of the diversion of the Jordan River affluents, are conditional on the inflow of the Mediterranean Sea waters to the Jordan bed, and this will also have a beneficial influence on the ecological equilibrium of the rift.

THE JORDAN VALLEY'S PRESENT SITUATION

Until the 1950s, approximately 950 million cubic meters flowed yearly to the Jordan River from the Sea of Galilee and the Yarmuk River. During this decade, allocations of water to Israel, Jordan and Syria were set, about 57 percent of the said resources being drawn out of the valley, with only 26 percent of those waters having been earmarked for irrigation and other uses in the valley. Seventeen percent of the Yarmuk waters (principally winter floods) are not yet utilized, but instead flow into the Jordan River and disappear in the Dead Sea. Those waters cannot be apportioned, as they are included in the waters which were allocated to the Kingdom of Jordan. They are designated for storage in the Maqarin Dam upstream on the Yarmuk River. (Political reasons—in as much as they may still be valid—as well as problems of financing prevent the Jordanians from constructing that dam.)

There are no more free waters for additional apportionment. Carrying out a revision of the allowances of waters decided upon some forty years ago appears just as inconceivable. The result is that approximately 40 percent of the lands fit for tilling in the Jordan Valley are not cultivated. The agricultural areas appear during summer as green oases on the valley's gray landscapes. The ecological equilibrium is badly disturbed, and the Jordan River is progressively becoming a sewer canal for urban and industrial wastes.

Israel has already fully exploited the water resources of her territory, and is presently in a regime of water rationing. She has reduced the water allotment to her farmers by 18 percent, and is planning to recycle her waste water for agricultural use. According to Israel's master plan for water allocation in the year 2000, water for agricultural use will be reduced by 40 percent, and water for domestic purposes will be increased by 52 percent. Israel, in other words, is on the verge of the water desalination era.

The Jordanian Government still has the option of storing the water of the Yarmuk in the Maqarin Dam. Evidently, there still is the possibility—if and when that should prove necessary—of installing a water desalination plant in the Gulf of Aqaba. Those waters will be very expensive; and, in addition to the

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desalination cost, it will be necessary to pump those waters to an altitude of 1000 meters to the topographic plateau of the Kingdom of Jordan. That is a substantial extra financial load due to the high cost of energy; moreover, expenses will not stop at that point, since one must also take into consideration the price of building and maintaining a water carrier system from Aqaba to the said plateau. A preliminary examination shows that the cost of water will exceed one dollar per cubic meter.

Finally, Syria has not yet fully utilized the waters of the Euphrates in her territory to which she is entitled.

REHABILITATION OF THE JORDAN VALLEY

Already in the 1950s, the deviation of the waters from the Jordan and Yarmuk Rivers had been planned, and it had been forecast that those steps could affect the future of the Jordan River, which would be in danger of disappearing with the consequential substantial decrease in the level of the Dead Sea. At that very same time, the idea was entertained of having waters flow from the Mediterranean, by the shortest available route, through the Jezreel Valley to the course of the Jordan to the Dead Sea, and to exploit the level differential between the two seas to operate hydroelectric plants which would pay for the price of the canal. The details of those plans are known to the Israeli and Jordanian Governments. It is generally accepted in the two countries that the valley should not be neglected, and in suitable political circumstances, the implementation of those plans could be carried out in the framework of cooperation between the two countries.

From that period until now, there occurred a remarkable development of desalination by the RO method. This technology is relatively simple, and less expensive than other desalination technologies. It also allows the exploitation of the hydrostatic pressure differential between the Mediterranean Sea and the Jordan Valley, and the operation of a system of desalination plants, saving approximately 60 percent of the energy consumption compared to similar plants installed on the shores of the Mediterranean.

Out of a desalination potential of 1.4 billion cubic meters, it is proposed to desalinate approximately 800 million cubic meters of water per year in the first stage; this quantity would satisfy the water requirements of the Jordan Valley on both banks of the river. The Sea of Galilee would serve as an upper regulating reservoir in its topographic situation upstream in the valley. The water would flow from there by gravity, through the existing water carrying system, to the Jordan Valley lands.

It is possible to construct four dams in the course of the Jordan River bed with hydroelectric plants, creating four lakes having a total area of 80 square kilometers (about one half the area of the Sea of Galilee). The lakes would have approximately 150 kilometers of shoreline (three times more than the shoreline of the Sea of Galilee), constituting a contribution to the quality of life in the valley.

Addition of Waters for the Kingdom of Jordan

The desalination plants would add 300 million cubic meters of water to those available to the Kingdom of Jordan and they would be designed to irrigate by gravity the eastern bank of the Jordan River. This quantity of water would suffice to transform the Jordan Valley into the kingdom's granary.

The waters of the Yarmuk River would best be stored in the Maqarin Dam, upstream on the Yarmuk;the waters which still flow to the Dead Sea and the waters flowing now in the eastern Gho'r Canal, represent a total of 250 million cubic meters of water per annum. The Yarmuk waters are of good quality, and would serve the consumption needs of the Jordanian population.

The Kingdom of Jordan presently consumes approximately 500 million cubic meters of water per annum. Around the year 2000, it will require a supplement of 400 million cubic meters—and the project under discussion would supply a quantity of 450 million cubic meters.

There is a desalination potential for the balance of approximately 600 million cubic meters of water per year. It should be possible to construct desalination plants on the east side of the lakes, to desalinate additional waters, exploiting the technologies which will be available at the opportune time. This program constitutes a real challenge to the Israeli and Jordanian Governments for cooperation in the rehabilitation of the Jordan Valley and in the development of additional sources of water. [See table on page 13.]

THE WATER PROBLEMS OF THE WEST BANK AND THE GAZA STRIP

The West Bank

The area of the West Bank is 5500 square kilometers and it has a population of 858,000 (as of 1987). This is a hilly region, at an altitude of 300-600 meters above sea level, some hills rising up to 700-1000 meters, with valleys extending from North to South and East to West. The Jordan Valley is at an altitude ranging from 275-400 meters **below** sea level. Precipitation ranges between 600-800 millimeters of rain per annum in the hilly regions, 500-600 millimeters on the hilly western slopes, and 50-200 millimeters in the valley. The make-up of the West Bank's land is as follows: Desert and rocky regions—27 percent; Pasture land—32 percent; Forests—5 percent; Tillable land—36 percent; Agricultural land—17.5 percent; Irrigated land—104,000 dunams (1 dunam=.25 acre).

On average, the water supply potential of the West Bank is around 600 million cubic meters per year. That quantity of water is stored in three underground aquifers: the western aquifer (Yarkon Taninim) supplying water to the coastal plain, 335 million cubic meters; the north-western aquifer (Gilboa region, Beisan Valley), approximately 140 million cubic meters, which supplies the Jezreel and Beisan Valleys; and the eastern aquifer, which supplies 125 million cubic meters of water to the Jordan Valley. The first two of the above aquifers jointly store approximately 475 million cubic meters of water (on a multi-year average) and suffer from overutilization, loss of level, and the danger of increasing salinity. Those aquifers supply approximately 25 percent of the water consumption of Israel.

The Israeli Military Administration imposes limitations on the quantity of waters which may be withdrawn from the aquifers. The allotment is 135 million cubic meters of water per year for a population of one million inhabitants. The present water allotment is 30 million cubic meters per annum for home and industrial consumption, 80 million cubic meters of water for agricultural uses, i.e. a total of 110 million cubic meters of water per annum. The aquifers constitute the sole source of water for the Palestinian population in the West Bank, but that population does not resign itself to the limitations imposed by the Military Administration, and neither does it resign itself to the sole control of the Israeli Government. But Israel cannot renounce its control of the sources supplying the waters for home consumption in the coastal plain region. That is the origin of the conflict on water, and in a sense of the possibility of surviving. The compulsory and sole possible solution should be joint management of the eastern and northwestern aquifers, by giving priority to the home consumption of the two populations, the Palestinians on the West Bank, and the Israelis in the coastal population centers.

The Palestinian population has natural rights over the waters of the Jordan River. At the time of the partition of the waters in the 1950s, the West Bank was under Jordanian authority, and accordingly the water allotment for the West Bank was included in that of the Kingdom of Jordan, by means of the planned west Gho'r Canal. Evidently, the West Bank does not renounce its rights, and at the peace talks it will be in good company with Israel, Jordan and Syria, all claiming for additional allotments of water from the Yarmuk and Jordan Rivers. Yet, reality is disappointing: there is not enough water for any additional allotment.

An allotment of 200 million cubic meters of water from the desalination system for the West Bank would increase the total quantity of available waters to 335 million cubic meters of water per year, an increase of 148 percent.

There is a potential for desalination of an additional 600 million cubic meters of water. At the proper time, when the necessity for more water will be felt, it will be possible to install desalination plants on the lakes along the Jordan River, and to desalinate additional quantities of water.

The Gaza Strip

The area of the Gaza Strip is only 365 square kilometers, while its population was 633,000 as of 1987, which means a population density of 1730 inhabitants per square kilometer, against 198 in Israel and 193 in the West Bank. Tilled land area is 168,000 dunams, out of which 110,000 are irrigated.

The aquifers constitute the sole source of water for the Gaza Strip, out of which 140 million cubic meters of water are extracted from the aquifers, against the limited 60 million cubic meters precipitation adds each year, thus resulting in a substantial overdrawing of waters from the reserves. Consequently, the aquifers have been impoverished, their water level is in constant decrease, and sea waters penetrate them. In the wells, water has a salinity of 500 to 1000 parts per million in certain areas.

In some parts of the Gaza Strip there is a true and proper water shortage. Water supply to the Gaza Strip is in a particularly severe and harsh crisis. Immediate steps must be taken to ensure an increase in the quantities of water available. The sole possible solution is therefore water desalination.

THE JORDAN RIFT VALLEY— A REGIONAL DEVELOPMENT PLAN

This proposal refers to the geographical region of the Jordan Rift Valley, from the Sea of Galilee to North of the Dead Sea. The Jordan River once flowed in this valley; its source was in the Sea of Galilee. In its flow to the Dead Sea, the Jordan received the waters of the Yarmuk River on the East as well as seasonal affluents. The Jordan River no longer flows in the valley, its water sources having been diverted, in compliance with the agreements of the 1950s for partition of water allotments to Israel, Jordan and Syria. As a result, the level of the Dead Sea decreased by 19 meters from 390 to 409 meters below the sea level. Its salt concentration is increasing, making it more difficult to pump its waters to the evaporation ponds of the two chemical plants, one Israeli and one Jordanian. This development has upset the ecological balance of the Jordan Rift Valley.

At that time, it had been agreed upon by the parties interested in the diversion that once it was completed, it would be necessary to divert Mediterranean Sea waters from the Haifa Bay by the Jezreel Valley canal to the Jordan River bed so as to "rehabilitate" the river, and to stabilize the Dead Sea at a level of 390 meters below sea level. This was accomplished through a hydroelectric program to operate a system of power stations by exploiting the hydrostatic gravity pressure existing between the Mediterranean and the Dead Sea levels which would supply electricity at the daily peak consumption hours to the electrical grids of Israel and the Kingdom of Jordan. This project is economically sound. The suspension in its implementation arises from the suspension of the peace process between the two countries.

Priority to the Sea Water Desalination Plants

The hydroelectric project is of secondary importance by now, and it is preferable to exploit the hydrostatic gravity pressure in the Beisan Valley to desalinate large quantities of sea water by the RO system. The two countries are now in a situation of acute water shortage. Both of them have adopted a regime of water rationing, to the point of constraining Israel to a future reorientation of its agricultural sector. Israel has no additional water sources to develop, nor external water sources, and she is now preparing to desalinate sea water—an inexhaustible source of water, but one implying high energy consumption and high capital investments.

Similarly, the Kingdom of Jordan has no additional water sources to develop within its borders, except the Maqarin Dam which is projected upstream on the Yarmuk River to store the winter floodings.

The plants in the Beisan Valley could desalinate 800 million cubic meters of water per year. This situation makes it compulsory to convert the hydroelectric project in the Beisan Valley to a sea water desalination complex by the RO method. The hydrostatic gravity pressure in the Beisan Valley could save approximately 60 percent of the energy requirements in the desalination process.

The quantity of water which can be desalinated annually is limited by the annual evaporation rate of the Dead Sea surface at it stabilization level (-390 meters), that is to say approximately 1,200 million cubic meters per year.* By means of the Jezreel Canal it is possible to divert to the desalination complex 2 billion cubic meters of sea water per year, and to desalinate 800 million cubic meters per year. 1,200 million cubic meters

* Mediterranean—Dead Sea Project Co. Ltd., December 1984.

of sea water will flow in the Jordan River to the Dead Sea. Filling will extend over a period of about 20 to 25 years, until the level of the Dead Sea is stabilized at an altitude of 390 meters below sea level.

It will be possible to desalinate an additional 600 million cubic meters of water per year of the waters flowing in the Jordan River by the RO process, the multistage distillation process (MED), or by a system combining the two methods.

It is reasonable to assume that the desalination plants will be constructed in stages, in accordance with water requirements of the two countries. The first stage should consist of building the Beisan Valley desalination plants, whose energy consumption is small. The second stage will consist in building the Jordan River banks units. By means of the two desalination facilities, it will be possible to desalt approximately 1.4 billion cubic meters of water per annum.

The realization of this plan is conditional on generous financing terms from international development funds, such as the World Bank and similar financial institutions. The project deserves support as it will encourage the Kingdom of Jordan and Israel to cooperate in solving their water shortage problem, and will have a beneficial influence on bilateral and regional relations.

To assess the cost of the desalination project and the unit cost of water, we may refer to the data included in Dr. P. Glueckstern's paper dealing with the cost of large RO systems,* with a daily output of 200,000 cubic meters of water, representing 66 million cubic meters of water per annum. His assessment is that the cost of a desalination plant per one cubic meters of water per day is (U.S.) $1,030, or $3.12 per cubic meters of water per year. To that price, one should add $0.40 per cubic meter of water per year, which is the cost of the Jezreel Canal, $3.52 per cubic meter of water per year in the Beisan Valley desalination plant, and $3.12 per cubic meter of water per year for the plant on the Jordan's banks.

Dr. Glueckstern suggests the following unit costs to determine prices: Energy (5 kilowatts required to desalinate one cubic meter of sea water)—$0.28, membranes $0.13, operational and maintenance costs $0.07, chemicals $0.04. On the basis of this data, the cost of the Beisan Valley desalination plants would be approximately $2,800 million, and the cost per cubic meter of water would be $0.50, on the basis of a 3.5 percent discount rate, $0.58 on the basis of a 6 percent discount rate.

The Jezreel Canal

Seventy cubic meters of Mediterranean sea water will flow every second to the desalination plant in the Jezreel and Beisan Valley. The Jezreel water carrier will have a total length of approximately 70 kilometers. Its path will be parallel to the bed of the Kishon River passing over poor aquifers, without polluting the underground waters—if any exist.

The carrier will commence at the Mediterranean coast, at 4.5 kilometers north of the Crusaders fort at Atlit. This coastal strip is thinly inhabited by a rural population, without any chemical plants, or other pos-

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* P. Glueckstern, *Cost Estimates of Large Reverse Osmosis Systems*, Proceedings of the International Symposium on Desalination and Water Use, Tel Aviv, April 15-18, 1991.

sible sources of pollution of the Mediterranean sea waters.

The 2 kilometer long underground water carrier crosses the sea shore eastwards, to the first pumping station, raising the water into the Carmel tunnel (13 kilometers long) at a 40 meter level. The waters will then follow their course eastwards into the Jezreel Valley Canal, at a 30 meter level. The second pumping station, located 11 kilometers from the tunnel exit, will raise the waters to a 40 meter high canal, and the third pumping station, located at 13 kilometers from the tunnel exit, will raise the waters to a canal at a 55 meter level. This last canal will cross the Afula plateau through an underground 5 kilometer long carrier into the Ramat Zvaim Canal, up to the regulating reservoir overlaying the Beisan Valley, at a 50 meter level. From that point on, the waters will flow by hydrostatic gravity pressure into the desalination facilities operating under the RO method, installed along the western shore of the Beisan Lake. An additional desalination plant will be located on the eastern shore of the lake.

Hydroelectric Plants on the Jordan River

The desalinated water from the RO units would be diverted to the Sea of Galilee, serving as a regulating reservoir for the Jordan Valley. Mediterranean sea water will flow into the Jordan River at a rate of 1.2 billion cubic meters per annum.

It is possible to install and operate on the Jordan River, on the way to the Dead Sea, a series of hydroelectric plants placed at the foot of four dams, creating four lakes having a comprehensive area of approximately 80 square kilometers, and shores extending on approximately 150 kilometers. The installed capacity of the hydroelectric plants is 200 megawatts, producing 350 million kilowatts per annum for the daily peak hours consumption. The lakes will contribute to the quality of life in the Jordan Rift Valley, by creating natural reserve parks, vacation and sport camps, and fishing.

The Dead Sea

Back in the 1950s, the Dead Sea level was 390 meters below sea level and its surface was 1000 square kilometers. It consisted of two basins: the deeper North Basin and the shallow South Basin, which were separated by the shallow Lisan Strait. The diversion of the Jordan sources to the Negev, and the Yarmuk waters to the East Gh'or Canal in the 1960s started the gradual decline in the sea level. A negative water balance and reduced water inflow have upset the sea's equilibrium. The Dead Sea's level has been dropping at a rate of 40 centimeters per year, and is today at 409 meters below sea level. The North Basin has been severed from the South Basin, which has disappeared, and now constitutes the salt ponds for Israel's and Jordan's potassium works. The North Basin has shrunk to 740 square kilometers.

Surface floods, subterranean flow from its drainage basin and rainfall will continue to feed the North Basin with some 330 million cubic meters of water, in a multi-annual cycle.

The average evaporation rate of the mineral saturated Dead Sea water is 1.4 to 1.5 meters per year. Given the climatic conditions of the Dead Sea, the Mediterranean waters will evaporate at a rate of 1.9 meters during the filling and level raising period.

The required inflow of Mediterranean water to the Dead Sea has been determined on the basis of 1.8 meters yearly evaporation throughout the filling and stabilization period.

The guideline in determining the target level is stabilizing the Dead Sea at its historical level of 390 meters below sea level, when all the tributaries of the Jordan River were still flowing into it. Restored to that level, the Dead Sea would cover an area of 850 square kilometers.

The Lisan Dam

Today the el-Lisan Strait, at 402 meters below sea level, separates the Dead Sea in the North (North Basin) from the evaporation pans of the South Basin potash plants. The pan dikes are made of salt and contain a sealing clay core. By filtering into the pond area, Mediterranean waters could dissolve some salt and threaten the stability of the dikes, or even inundate the evaporation pans if the North Basin level should rise. It is therefore necessary to divide the two basins by means of a dike-dam stretching across the width of the el-Lisan Strait. It should be 4500 meters long and up to 14 meters high, starting from 402 meters below sea level; its crest elevation should be 388 meters below sea level.

The critical level of 402 meters is expected to be reached after 4 or 5 years of filling. During that period, the two basins will be separated by the el-Lisan Strait. Over the next 20 to 25 years of water influx from the Mediterranean, the Dead Sea will stabilize at 390 meters below sea level. In anticipation of this final stage, it will be necessary to proceed with the gradual construction of the dam.

THE GREAT RIVERS OF THE MIDDLE EAST

Water is a magic word in the enormous and arid region of the Middle East. The valleys of Mesopotamia (the Land of the Two Rivers), the valley of the Nile in Egypt, and the Jordan Rift Valley are arid valleys whose dependency on the waters of the rivers is absolute.

The Basin of the Nile

The basin of the Nile is common to nine countries: Egypt, Sudan, Ethiopia, the Central African Republic, Zaire, Rwanda, Burundi, Tanzania and Kenya. On its way, the Nile takes in two large rivers, the White Nile, having its origin in Lake Victoria and Lake Albert, and the Blue Nile, having its origin in Lake Tana. The length of the Nile is approximately 6600 kilometers out of which 1300 kilometers are in Egypt. A 45 percent population increase from 229 million in 1987 to 334 million in 2000 has been forecasted.

Due weight should be given to the fact that the water flow of the Nile is erratic and sporadic, rather limited, and dependent on the climate and on the monsoon regime in the Equatorial zone. In 1871, the water flow was 137 billon cubic meters, while in 1987 it was only 37 billion.

Before the construction of the Aswan Dam, there were floods in the Nile River, in its high tide years, as well as years of drought. Indeed, in ancient times, populations counted their age in Nile flood cycles!

The construction of the dam was completed in 1968, and its filling was accomplished in 1975, creating Lake Nasser, which can be considered the largest man-made lake in the world. It has a capacity of 170 billion cubic meters of water, stored for low regime years. The lake helped Egypt survive many floods, in the years 1964 and 1975, and it saved her from the threat of two drought years, the consequences of too low a flow in the 1972-3 and 1983-4 years. The Nile flows into the lake at an average rate of 84 billion cubic meters of water, of which 55.5 are allocated to Egypt, 18.5 are allocated to Sudan, and approximately 10 evaporate yearly from the lake surface.

The solutions to the problem of storage of more water for Egypt are to be found outside of its borders, in the countries upstream on the river. The White Nile indeed loses in Sudan's Sudd swamps something like 20-30 billion cubic meters of water per annum. The 280 kilometer long Jungley Canal, a joint Sudanese-Egyptian project, is designed to divert the waters of the White Nile and to bypass the Sudd Swamps, adding approximately 4 billion cubic meters of water per year to the Nile. The canal works were interrupted in 1984 due to the civil war.

To avoid the loss of considerable quantities of water during the monsoon season, it is possible to store them in Lake Victoria and Lake Albert, which would require the assent of the Government of Uganda, Kenya, Tanzania; to use the Tana Lake requires the assent of the Government of Ethiopia.

But Ethiopia and Sudan are drought and famine-stricken countries, they suffer from profound poverty and have an appalling socio-economic infrastructure and situation, making it difficult to expect any substantial improvement in the near and medium term by the development of water projects. A 45 percent increase in population from 70 to 100 million is expected for the 1987-2000 period.

Given the above described circumstances, it is reasonable to assume that in the mid-term range, up to the year 2000, no "salvation" (or much less) can be expected for Egypt from the sources of the Upper Nile. The quantities of water presently available serve a population of 52 million people, expected to reach 71 million by the year 2000. Water consumption will in the meantime increase in all sectors—including agricultural, industrial, and home sectors.

It would therefore appear that the Nile, in its present capacity, is a finite resource, and this should bring about an improvement in water utilization efficiency, as well as in the priority to allocate to other, non-agricultural, economic activities (as of now, approximately 26 million dunams—6.5 million acres—are irrigated, using about 49 billion cubic meters of water per year). Furthermore, it is estimated that an additional potential source of 3 to 4 billion cubic meters of water is to be found in underground aquifers.

The problem of the water in the Nile Basin is most difficult and vexing, and its solution undoubtedly requires international cooperation and assistance. In the Southern Nile Basin, with a monsoon regime, an abundance of precipitations and giant lakes such as Lake Victoria, Lake Albert, and others, lie drought and hunger-stricken countries. Their socio-economic situations are so appalling as to endanger the very existence of the populations—not to mention their growth. This is indeed a pathetic problem of human survival.

The Euphrates and The Tigris

Both those great rivers originate in Armenia. The Euphrates flows to the Kaban Dam in Anatolia, and from there to the Djezireh Plain (Syria), where it absorbs its last effluents, receiving no more water before entering Iraq and merging with the Tigris, terminating its course in the Persian Gulf. The average yearly flow of the Euphrates is approximately 30 billion cubic meters of water on its leaving Turkey and entering Syria and 32 million cubic meters on its entering Iraq. The extreme flows recorded for the Euphrates over multiannual periods range from 17 to 43 billion cubic meters. The 2330 kilometer long river's waters carry much silt.

The Tigris River—whose length is 1850 kilometers—flows directly from the heights of Anatolia into the Mesopotamia Plain until it merges with the Euphrates, creating the Shatt-el-Arab combined river. The Tigris receives numerous effluents from the Zagros mountains of Iran. The silt transported by those two rivers in their flow over thousands of years were responsible for the creation of the great plain, over a length of approximately 800 kilometers, with an average 200 kilometer width. Baghdad has an altitude of 38 meters (125 feet) above the sea level, at a distance of about 700 kilometers from the Persian Gulf, with a slope of approximately 5 centimeters per kilometers. The annual flow of the Tigris River is larger than that of the Euphrates, about 18 to 23 billion cubic meters of water on its entering into Iraq from the Zagros mountains; it collects 24 to 29 additional cubic meters of water on its way, reaching a total of approximately 52 billion cubic meters of water per year on a multi-annual average.

Turkey

That was, at any rate, the historical flow rate of those two rivers until the Turks started building a system of dams on the course of the Euphrates, determining the quantities of water which will from now flow downstream in the Euphrates to Syria and Iraq. Turkey did not actually begin with the projects on the sources of the Tigris. Syria and Iraq follow with concern the plans of the Turkish Government to utilize the waters from the two rivers. To date, no binding agreements have been reached regarding the apportionment of the waters among the three countries.

The policy of the Turkish Government is to exploit the hydroelectric potential of the Euphrates and the Tigris, in combination with agricultural irrigation facilities. The plan includes the construction of 80 dams, 66 hydroelectric power plants, having a total installed capacity of 7700 megawatts of electricity and 68 agricultural irrigation projects, covering 16 to 20 million dunams (4 to 5 million acres).

The Ataturk Dam under construction, with a capacity of up to 82 billion cubic meters of water, will be one of the five largest dams in the world. The projects integrate a hydroelectric plant, having an installed capacity of 2400 megawatts of electricity, and an irrigation project covering 5 million dunams (1.25 million acres) and utilizing approximately 10 billion cubic meters of water per year. Presently, the region is under-developed, populated by Kurdish tribes, and is designed to become the granary of Turkey.

The three countries have adopted—and started implementing—development plans exploiting the waters of the Euphrates, and at the time when the execution of plans is expected to be completed (by the year 2015) they shall be in need of 28 to 36 billion cubic meters of water per year, while the average yearly flow of the river is only 32 billion cubic meters of water. The plans are not being implemented in compliance with the time-tables which were adopted, the works progress only slowly, protracted by a lack of sufficient financing means.

Of the three countries sharing the river basin, Syria and Iraq are the most desertic, their needs in irrigation waters are the greatest, and they have historical rights on the waters of the two great rivers since the most ancient times of human history in Mesopotamia. By contrast, Turkey has a more favorable climate, with large volumes of precipitations, and has available alternative sources of water.

Syria

Syria has an area of 185,000 square kilometers; its population of 11.3 million inhabitants (as of 1987) is expected to reach 18 million by the year 2000. The flow of water in the Euphrates passing through Syria is 24 to 26 billion cubic meters of water per year, on average.

The Assad Dam was constructed on the Euphrates, creating a lake having a capacity of 7.8 billion cubic meters of water. This is a combined project of regulating the flow of the river, a hydroelectric plant having an installed capacity of 880 megawatts, and agricultural development on an area of 6.4 million dunams (1.6 million acres), out of which 2.4 million dunams (0.6 million acres) are located in the valley of the Euphrates, the balance being located in nearby areas. Approximately 6.4 billion cubic meters of water of Lake Assad are designed for irrigation (the balance is taken by evaporation from the surface of the lake and seepage in the ground). A twenty-year period has been allocated for completion of the project. In reality, the development of agricultural areas is slow, and as a result the waters designed for irrigation are not fully utilized.

Iraq

Iraq has an area of approximately 435,000 square kilometers and a population of 17 million people (as of 1987), expected to reach 26 million by the year 2000.

The Euphrates has a regime of floods. Several dams were constructed on the Euphrates, and an additional two are planned, so as to smooth its course, avoid floods, and store waters to improve the seasons cycles, in as far as this should prove possible. Seventeen billion cubic meters of water are on the base of a multi-annual average withdrawn from the Euphrates, in Iraq. Numerous dams have also been built on the Tigris, for the similar objective of regulating the flow of the river avoiding floods, and storing water for irrigation purposes. About 32 billion cubic meters are extracted yearly from this river.

The total water flow of the Euphrates and the Tigris is in the average range of 73 to 84 billion cubic meters per year. In dry years, the flow can be as low as 25 billion cubic meters per annum—about half the yearly consumption.

An average 50 billion cubic meters of water is extracted yearly from the two rivers, 10 billion or so are lost by evaporation, the balance flowing to the Persian Gulf. To preserve the rivers' ecosystems, about 10 billion cubic meters of water are to be poured in the Persian Gulf. Iraq faces harsh problems in preserving the quality of the irrigation waters, and avoiding the increase in salinity of the underground waters and the land.

The salinity of the waters in Northern Iraq regions is approximately 250-500 parts per million, increasing with the nearing of the waters to the sea. This salinity is the resultant of geological conditions and human intervention. Irrigation causes an increase in the level of underground waters, and the lack of suitable draining conditions causes an accumulation of salts in the ground. Due to these reasons, many areas were abandoned. Rinsing the lands of their salts requires large quantities of water.

Possible Apportionment of Water from Desalinization Plants in the Jordan Valley (in millions of cubic meters)

	Kingdom of Jordan	West Bank	Israel
Present consumption	500	135	1,800
Desalination plant output	300	200	300
Yarmuk waters still flowing to the Dead Sea	150	—	—
Total	950	335	2,100
Additional waters, as percent of present consumption	90 %	148 %	16 %

"A View From Jordan" (from page 1)

In reality, the bilaterals and the multilaterals are two sides of the Middle East peace coin and water issues are posed on both. Not surprisingly, water is needed to keep the talks alive and to have them bear fruit. Alternatively, water is capable of inflicting damage and devastation when floods are not controlled. In other words, by its very nature and occurrence, water can promote fruitful cooperation, or may trigger and escalate destructive conflicts.

In Jordan, we view the former role of water as more becoming of civilized behavior, which is also capable of restraining the emergence of the latter role, and of converting it to enhance progress as indeed civilization has done since before the Christian Era in the Near East.

What is the Jordanian perspective on the "Middle East Water Problem," and how did it originate and progress with speed that has surprised many?

The characteristics of the water cycle in our region set limitations on the potential of rain-fed agriculture and of renewable water resources. While these resources, basic to human life and growth, are finite, the population dependent on them has not been, and is not expected to stop its growth. Over the past four decades, population growth in the region, especially in the area between the Mediterranean and the desert, has not been natural.

The average rate of population growth in Jordan has exceeded 8 percent per annum; more than half of this average growth rate was generated by successive waves of refugees and displaced persons forced out of their homeland to make room for immigrants and newcomers that flooded into the land of Palestine. Neither the outgoing nor the incoming waves carried with them a bucketful of water (nor other natural resources) and thus had to rely on the resources of their destination.

Throughout these decades of hostilities and armed conflicts, cooperation in the development of shared water resources has not been possible; the alternative has been unilateral, often competing, efforts to harness the flows of the Jordan River Basin and of shared aquifers to the disadvantage of the downstreamer or to the advantage of power. In the process, Jordan's rightful share of the Jordan River Basin has been partially eroded, and its relentless efforts to regulate the flows of the Yarmuk River were frustrated on more than one occasion.

WATER STRESSES ON JORDAN

The demographic pressures on Jordan, and the erosion of its rightful water share of the Jordan River Basin, created unprecedented water stresses with profound adverse social, economic, financial, and envi-

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ronmental impacts. At no time since 1948 has Jordan been able to supply its population more than fifty cubic meters per capita per year of urban water at a high cost of 5 percent of the average share per capita of the Gross Domestic Product (GDP), nor has it been able to arrest the ever growing deficits in its foreign trade in agricultural commodities, or to put enough food on the table to generate more than an average of 2000 calories per capita per day even throughout the years of its maximum economic growth. As a matter of fact, the past decade witnessed economic slowdown followed by a recession, shrinking incomes, higher cost of living, high unemployment rates and the re-entry of poverty.

Four million people depend on the land and water resources of Jordan, though these resources are capable of sustaining only some 1.4 million people. This imbalance in the population-resource equation has triggered a chain of adverse impacts. The per capita annual share of renewable water resources has dropped from a comfortable 3000 cubic meters in 1947 to about 200 cubic meters today. Irrigation water has been diverted to urban use, and has been partially replaced by treated urban waste-water at a high environmental cost, and at times, adverse conditions for public health. Groundwater is being abstracted at about 165 percent of its sustainable yield with visible adverse environmental consequences. Though expensive basin transfer projects have been implemented to cope with the escalating urban water demand, deficits in the water budget persist. The marginal capital cost of development of the limited undeveloped resources is high by any standard, and so too the operation and maintenance cost increase in parallel, particularly the cost of the energy component that has to be imported.

If this is the water picture of Jordan, how does it look like in Israel and the occupied Palestinian territories? The answer is: better and worse. Better in Israel and worse in the occupied territories. As this answer implies, they are only better or worse comparatively. All three parties have almost arrived at a dead end in their attempts to secure additional water stocks out of the renewable water resources. Unlike other water-short countries in the region, the three parties are importers of their total needs for energy.

A VISION OF "EQUITABLE SHARING"

So, to quote T.S. Eliot in his "Love Song of J. Alfred Prufrock," "how do I proceed?" and "where shall I begin?"

As we look toward an era of lasting peace and regional cooperation, we see formidable tasks awaiting our collective performance. Equitable sharing of sharable water resources will not make Israel that much poorer, but will make both Jordan and the occupied territories that much less water-poor at this time; neither will it provide a solution for the complicated problems we are facing, but it will nonetheless provide a very solid confidence-building measure that will prompt the bilaterals and multilaterals to "snowball" and accelerate the overall process.

How is "equitable sharing" defined?

Before this terminology emerged in the works of the International Law Commission of the United Nations, it was discussed in the literature of international waters and their non-navigational uses. While it came to the fore in the Helsinki rules of 1966, it was as a matter of fact, exercised in the attempts of the United States to work out a water sharing formula between the riparians of the Jordan River Basin in 1955.

Equitable sharing is, in effect, the middle ground between two extremist "water sharing" doctrines that have been adopted by riparians on international water courses, each according to his own advantages and interests: the "Harmon Doctrine" that advocates absolute sovereignty over water originating and flowing in the territories of a country, and the principle of the "Absolute Integrity" of the river basin. The former is normally adopted by upstream states and the latter by the downstreamers. Workable solutions are usually something in between, and provide reasonable room for negotiations with a set of guiding principles. And that is what "equitable sharing" is all about.

Principles Guiding the Equitable Sharing Formula

Whereas conditions of unilateral water uses of the Jordan River basins have changed since 1955 when the equitable sharing formula was first devised, the principles guiding its formulation have not. It is this author's view that its adoption today will save a lot of time, effort, and resources, especially since:

a) The readjustment of water shares will not bring about substantial losses to Israel, nor will it solve the water crisis we all are facing; and

b) Collective efforts are urgently needed to break away from the zero sum game in water sharing, towards a multilateral cooperation in basin management where there will be net gains for all parties.

The same issue is less clear in the case of shared groundwater resources, but its resolution will undoubtedly provide a solid base for mutual confidence, co-existence, sovereignty issues, and future cooperation. Experience elsewhere in the world should be tapped; guidelines could be found in the final Bellagio draft of the International Water Law Association on the trans-boundary groundwater sharing and management, while other and similar guidelines could be based on the works of the International Law Commission of the United Nations.

Looking to the bilateral negotiations, the issue is less clear. Success in resolving the water problem will facilitate progress in these negotiations and can spill over to propel the multilateral talks and advance regional cooperation. The significance to the region of such a successful resolution will be immense. Resolution of water sharing issues in the Jordan Basin and the aquifers shared between Israel and its neighbors, and subsequent success in fulfilling the aim of the bilaterals in concluding peace treaties, longed-for though these achievements may be, will not, on their own, ensure regional stability and peace. Although not sufficient, they are, however, a necessary condition for regional stability.

Few professionals would disagree that other than the Jordan basin, the Tigris—in particular the Euphrates, the Orontes and Nile rivers—are each a potential source of regional problems and instability. Even when success in the bilaterals and the multilaterals will sustain tranquility among former foes, the region cannot possibly be guaranteed stability and investments to enhance peace if the water sharing issues of the other international rivers and the beneficial water management thereof are not resolved.

Suffice it to say that, taken together, plans by each of the riparians on the Euphrates integrate in a sum requirement of about fifty-five billion cubic meters annually from the river, close to double its average annual yield of thirty-two billion. Obviously, a crisis is in the making and could erupt in a hot conflict in the region unless it is averted sooner rather than later. The Euphrates is one example which clearly shows the contrast between national desires on the river and the capability of that river to deliver; it should not be surprising that the total storage capacities of dams already built on the Euphrates approach 106 billion cubic meters to regulate the average flow of thirty-two billion, equivalent to one-third of the total storage capacity.

Again, there is an urgent need to break away from the zero-sum game on these other rivers and foster an environment where cooperation can yield positive benefits to all riparians, cooperative efforts that diffuse the time bombs in the region and enable the mobilization of its resources for the improvement of the quality of life of its peoples.

Moreover, success over the Jordan Basin and the sharing of groundwater aquifers between Israel and its neighbors will provide a stepping stone toward a resolution of similar issues facing regional riparians on other international rivers. In preparation for such a success, we in Jordan will advocate in the multilaterals the formation and adoption of a Water Charter for the region, a charter that specifies the ethics to be observed and practiced in the utilization and management of shared water resources, that will define the mechanisms for the joint cooperation and for the peaceful settlement of disputes, and that interprets the nature of water as used to sustain life and not to destroy it, to put fires out and not to ignite them. This, in fact, has been Jordan's view, reinforced by practice throughout the past decades of hostilities.

TOPICS FOR REGIONAL COOPERATION

Major topics for regional cooperation in the field of water resources, in my view, include incremental water supplies and incremental water yields.

Incremental Water Supplies

Jordan, the West Bank and Gaza are almost at a dead end in their attempts to secure additional water stock. They have been overpumping from aquifers beyond their sustainable yields. Equitable sharing of water resources with Israel will ease the current water stress but will not provide a solution for the future. Israel, on the other hand, has come up against a similar dead end despite its use of the water rights of other riparians. Unlike other water-short countries of the region, the above three parties are importers of their total needs for energy. Urban Syria is short of municipal water supplies as well, and requires basin transfer projects to meet those shortages.

Incremental supplies may be made available for **municipal uses** through:

a. *Desalination of brackish water and sea water.* This measure is energy intensive and requires capital. The difference between the open seas (such as the Gulf of Aqaba) and the inland Dead Sea can be utilized to generate pressure needed for a reverse osmosis process of desalination. Linking the two seas via a canal running through Wadi Araba will also have immense environmental benefits, not the least of which will be the control of the Dead Sea level, and the preservation of groundwater aquifers in the escarpments to the east and west of the Dead Sea.

b. *Transfers of water from water rich countries.* This measure is both capital and energy intensive. An attractive option for consideration is one that would increase the flow of the Euphrates River. This would bring benefits to the three riparians on it, ease the potential conflict in the region, and would make additional supplies available to the region for municipal uses from the Euphrates augmented flow.

This option in turn calls for the diversion southward of rivers that flow from Anatolia in Turkey north into the Black Sea. These rivers have a total annual flow of 36 billion cubic meters, and the irrigable lands in their basins total about 1.3 million hectars. Because rainfall is adequate, their irrigation needs do not exceed 10 billion cubic meters per year. The surplus water can be diverted southward into the Euphrates basin where there is already sufficient storage capacity to regulate the increased flow. Agricultural drainage water from the areas irrigated in the basin will eventually return back to the river downstream and will raise salinity levels in the river to the detriment of the downstream waters. A main drain parallel to the river, if constructed, will collect the drainage water for possible re-use to develop regions in the Badia (semi-desert) for fodder production and livestock.

This option is proposed for consideration in lieu of the "Peace Pipeline" project.

c. *A regional municipal water supply network that would connect the networks of the countries in the region, in a way similar to the regional connection of power grids.*

All of the above measures require that the cost to the consumer be affordable, which in turn necessitates the improvement of the per capita share of the GDP. This should be the task of the Economic Development Group of the multilateral peace talks.

Incremental supplies for **irrigation water** can be attained through:

a. Augmentation of resources through treated wastewater re-use.

b. Use of brackish water in agricultural production, including the re-use of agricultural drainage water.

Incremental Water Yields

This is a ripe field for regional cooperation, and for support from developed countries. Its objectives can be attained through:

a. Improved efficiency of water use including efficiencies of storage, conveyance, distribution and on farm application. Introduction of automation systems will further enhance these efficiencies.

b. Employment of advances in genetic engineering and biotechnology in plant production and animal husbandry.

c. Improvement of yields from rain-fed agriculture, and productive use of rain harvesting.

d. Improvement of agricultural management systems including marketing, research, and extension.

From such a water "terminus" one could extrapolate and suggest that, in addition to a Water Charter, a Social Charter and an Environmental Charter are key instruments that should be pursued in the multilaterals. An effective environmental policy, for example, needs to be broadly defined as relating to the environment for peace within the context of human settlement in the wider region. The mass migration of people, their dynamic but stable rights, their economic and social well-being and requirements as well as confidence and security building measures are issues integrally linked to an effective process for security and cooperation in the Middle East.

As a matter of fact, the organization and categorization of the multilaterals are somewhat reminiscent of the four Helsinki Baskets of the Conference on Security and Cooperation in Europe. The Final Act of Helsinki, signed in 1975, consisted of four baskets: Security; Economics; Science, Technology and the Environment; and Humanitarian and other fields.

The Middle East is essentially no different from other regions of the world, and the multilateral talks can beneficially draw from a close parallel: the most important part of the Security basket in the Helsinki process was the Declaration of Principles. Among its ten fundamental principles were:

- Respect for human rights and fundamental freedoms, including freedom of thought, conscience, religion or belief.

- Equal rights and self-determination of peoples.

Such principles are of particular relevance for promoting the peace process in the Middle East.

While this may seem afield, that is how water flows and crosses man-made boundaries, back to where it originated in its cycle—the oceans. Of water's magnificent size in the globe, man is feuding over and playing with only one percent of its volume. He can, instead, put his energies to render the remaining ninety-nine percent usable for his well-being.

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