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PROSPECTS FOR COOPERATIVE WATER MANAGEMENT BETWEEN ISRAEL AND THE PALESTINIANS ON THE SHARED GROUND WATERS OF THE MOUNTAIN AQUIFER AND GAZA

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INTRODUCTION

This paper is written on the premise that as an out-come of the peace process started in Madrid, based on the Camp David Agreement, to which the Government of Israel is officially committed, some form of Palestinian autonomous area or entity will evolve in stages in all or part of the occupied territories*. If this develops, then it is apparent that the ground waters of the mountain aquifer and Gaza which are partly in the occupied territories (West Bank* and Gaza) and partly in Israel will be considered shared bodies of transboundary groundwater with claims and counter claims by both sides as to future utilization and control, which must be resolved if a peace agreement is to be achieved.

In the search for a resolution of the Israel-Palestinian conflict, the disputes over shared water resources can become a major roadblock in the path of peace. On the other hand if a just and equitable solution to the water shortages faced by both sides, which will bring benefits to all, can be developed it can provide a major impetus to the peace process (1). It is the goal of this paper to propose approaches to a resolution of this problem which can meet the legitimate needs of both Israel and the Palestinians.

*Note-The term "occupied territories" refers to areas formerly held by the Hashemite Kingdom of Jordan (The West Bank) and Egypt (Gaza) which were occupied by Israel in response to being attacked in the 1967 War. The area called the "West Bank" derives its name from the days of the Jordanian occupation, since it was thought of as the West Bank of the Jordan River while the remainder of the Hashemite Kingdom of Jordan was on the East Bank of the River. The areas are referred to by their ancient biblical names of Judaea and Samaria by official Israel Government sources. We shall refer to the area as the "occupied territories" or "West Bank" in accordance with international usage. The border between Israel and the occupied territories which was in reality the cease-fire line until 1967 was normally marked as a green line on Israel maps and is often referred to as the "Green Line".

GAZA AQUIFER

The Gaza strip is some 360 square kilometers(sq.km.) in area and while the exact population figures are not known, the 1992 population has been estimated to be between 600-750 thousand (5,7). The 1948 population was about 50,000 and has swelled to its present numbers due to the influx of refugees. The population density of the Gaza area is about 2000 persons/sq. km. or an area of about 5 sq.m/person. Thus Gaza is among the most densely populated areas of the world.

The mean annual rainfall in Gaza is about 350mm/yr. The main aquifer is a continuation of the shallow sandy/sandstone coastal aquifer of Israel to the north which is of Pliocene-Pleistocene geological ages. Most wells are of a depth of 25-30 meters. According to Dr. Isam R Shawwa of Gaza(7), during the period of the Egyptian administration of Gaza between 1948 and 1967 "there was inadequate control in the provision of permits for water drilling. As a result the number of bore holes increased markedly. Farmers drilled and used as much water as they wanted "

As a result of this laissez-faire policy there were some 2200 wells operating in the Gaza strip area prior to the Israel occupation in 1967. The aquifer had been severely over-pumped for years at the rate of 120 million cubic meters/year(MCM/Yr) and more resulting in a lowering of the ground water table below sea-level in many areas. This has led to intrusion of saline water from the sea and other saline strata. The salinity reached levels of over 1500 ppm of chlorides in some areas. In areas of the Gaza strip the contamination from the intrusion of sea water and other sources makes the water unfit for drinking or for agriculture.

After 1967, the Israel military government introduced strict measures to control overpumping, the digging of new wells and metering and regulating the amount of water used in agriculture, similar to the water control regime practiced in Israel. The overpumping rate has been somewhat reduced. These policies were not popular with the Palestinian population of Gaza and were perceived as a method of restricting local economic development. However, the estimated long term mean safe yield of the Gaza aquifer is only about 65 MCM/Yr (5,7), while it is still being pumped at the rate of 90-100 MCM/Yr. This aquifer faces the threat of severe salination and total loss of its use by the local population unless further restrictions are enforced and the amounts of additional water that are needed for survival are imported or generated by desalination of brackish water or sea water. All most all of the population now has access to drinking water with running water in 75% of the dwellings and court yard taps in 22%.

The present domestic consumption of the Palestinian population is not clear and various estimates range from 25-40 MCM/Yr (5,7). The remaining water is used for irrigation mainly for some 4,000 ha of citrus groves.

Some of the issues under dispute in the Gaza area concern Israel's settlement and water development activities in the area including: Israel has established a number of new agricultural settlements and dug new wells in the Gaza strip which have tapped the already over exploited local aquifer; Israel has dug a number of new wells on the Israel side of the border along the Gaza strip which the Palestinians claim has reduced the ground water flow to the Gaza strip(7); Israel has built dams on Nachal Besor* (Wadi Gaza) which has reduced the flood water flow entering the Gaza strip area which could be utilized by Gaza farmers(7) or would normally contribute partially to the recharge of the aquifer.

Both sides agree however that the water situation in Gaza, both in quantity and quality, has reached crisis proportions and requires an urgent solution.

THE MOUNTAIN AQUIFER

The mountain aquifer covers the central area of the occupied territories on both sides of the Judaeen and Samarian Mountain range* and extends generally from the Jezreal Valley (near Afula) in the North to the Beersheba Valley in the South and from the foot hills of the Judean Mountains near the Mediterranean in the West to the Jordan river in the East(See Figure 1).

The mountain aquifer is mainly of karstic limestone/dolomite formations with permeable recharge areas mostly along the upper mountain slopes and ridges at levels above 500 meters above sea level. Much of the exploitation of the aquifer is by deep artesian wells drilled in the confined areas of the aquifer on the western slopes of the Samarian and Judaeen Mountain range below the elevation of 500 m and in the coastal plain towards the Mediterranean sea, mainly within the borders of Israel (2,3).

The mountain aquifer can be divided schematically into three general zones. The western aquifer which flows towards the Mediterranean Sea to its historic natural outlets at the Rosh Ha'Ayin Springs which fed the Yarkon River near Tel Aviv/Jaffa in the south and the Tanninim Springs near Hadera

*Note--The names of places, rivers, aquifers ect. used in this paper are those commonly used in Israel rather than those in use internationally or in the Arab world. Apologies to those readers for whom this is an inconvenience.

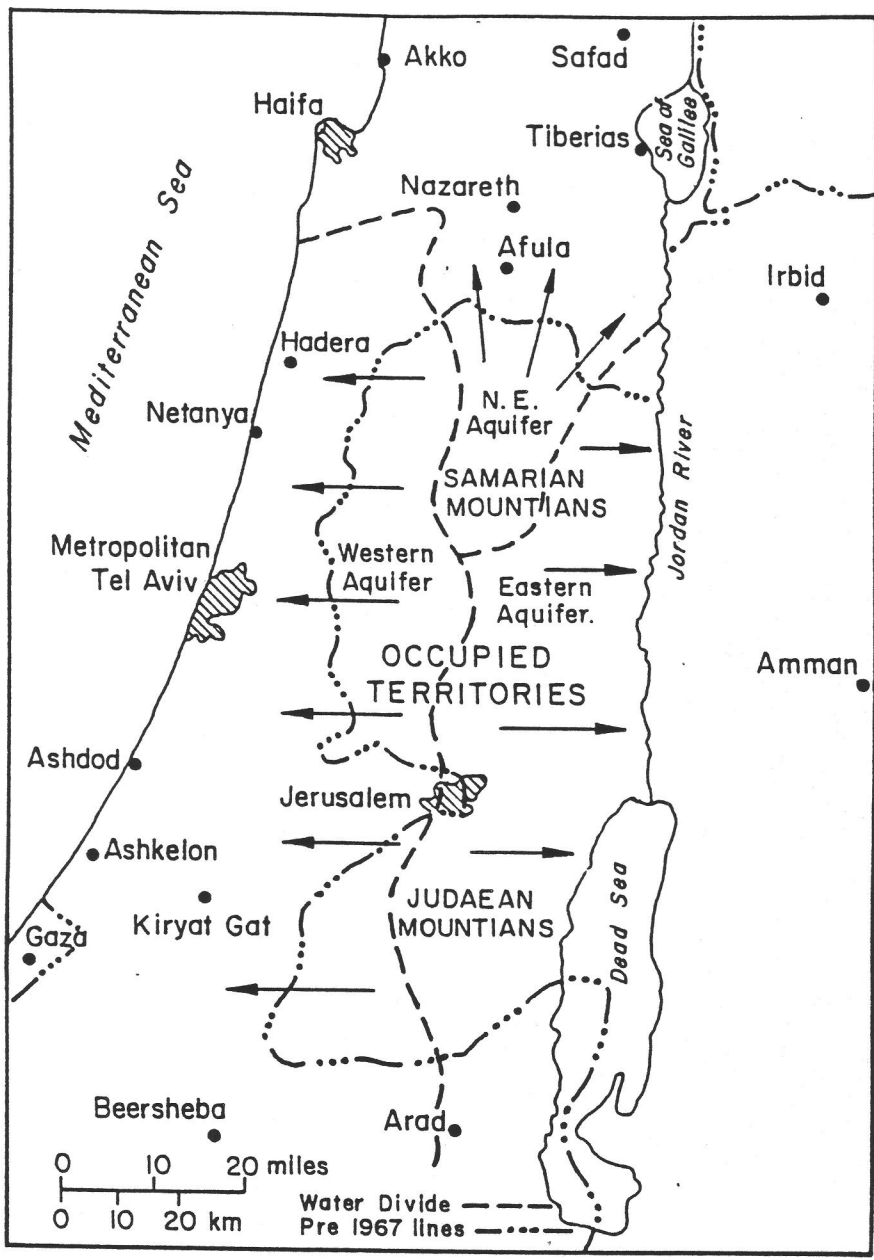


Figure 1. The Mountain Aquifer-A Schematic Presentation: The pre-1967 cease fire lines which serves as the border between Israel and the occupied territories (West Bank), mainly inhabited by the Palestinians, is shown with a heavy dashed and dotted line. The hydrological divide between the three subdivisions within the mountain aquifer is shown by the dashed line. The arrows show the general direction of the flow of the ground water.

in the north, is called the Yarkon-Taninim aquifer in Israel. This aquifer has an estimated mean average safe yield of about 350 MCM/Yr including some 40 MCM/Yr of brackish water-having more than 400 mg/l of chlorides (4).

A detailed and accurate inventory of the historic use of the aquifer is beyond the scope of this paper, however some qualitative descriptions of past use are presented. The early use of the aquifer, by the Palestinian Arab population, was limited to a part of the flow of springs such as those at Rosh Ha-Ayin and the Tanninim, as well as some deep traditional dug wells. The intensive exploitation of this aquifer was initiated by the early Jewish settlers starting in the 1930's included pumping from the Yarkon River to irrigate extensive orange groves in the area between Tel Aviv and Petach Tikva, and by numerous drilled wells (2). The British Mandatory Government also tapped the Rosh Ha'Ayin Springs as the source of the water supply for Jerusalem. Prior to the establishment of the State of Israel, in 1948, the Jewish settlers were already utilizing a significant portion of the safe yield from the springs, rivers and deep wells, while the remainder of the aquifer's potential was developed mainly by Israel in the period of 1948-1965. The main Israeli water project utilizing the aquifer was the 66" Yarkon-Negev Pipeline completed in 1954, which pumped some 200 MCM/yr, which is essentially the total flow of the Rosh Ha'Ayin Springs. Today the aquifer is tapped by about 200 hundred wells located within the "green line", that is, within the boundaries of Israel. From the engineering and hydrological point of view the most appropriate place to tap the aquifer is over the deeper confined artesian areas in the foot hills and lower slopes of the mountains towards the Mediterranean Sea, the major portion of which is within Israel. While it is technically possible to drill deep wells to tap the thinner non-confined zones of the aquifer from the mountain top areas within the West Bank, the wells required must be deeper and their yields are lower, thus the potential withdrawal of water from the western aquifer from within the territories is quite limited(3).

The potential safe yield of the eastern aquifer including the north east section is estimated by Goldberger of the Israel Hydrological Service (4) at 330 MCM/yr including some 120 MCM/Yr of brackish water. This figure is some 100 MCM/yr more than that mentioned in earlier reports(5). Data on the exact division is not clear but assuming that the 330 MCM/yr represents the best current estimate, then it may be estimated roughly as follows:

The eastern aquifer flows towards the Jordan River and has an estimated safe yield of some 200 MCM/Yr, half of which is brackish. Much of the flow from mountain springs, such as the Wadi Kelt, Ein Feshcha and Wadi Uja Springs and some

wells were historically utilized by Palestinian villagers and farmers. An ancient aqueduct from the Wadi Kelt Springs transported the water for irrigation by Palestinian farmers in the Jordan Valley. As the flow of the aquifer progresses down the slopes to the Jordan River it becomes more saline through contact with saline sources. More recently the Israel authorities in the occupied territories have tapped the sweet water sources of this aquifer with deep wells along the upper slopes prior to its becoming more saline, mainly for the use of new Israel settlements in the area. These new wells may partially explain the increased estimates of the aquifer's potential safe yield.

In some cases the Palestinians claim that this has reduced the flow from their traditional springs and wells(6). Some of the reported cases of flow reduction coincided with the severe draught period of 1988-91, while hydrological studies to support the claims are not available to the author.

The north eastern aquifer called in Israel, the Schem-Gilboa aquifer, starting near Schem (Nabalus) flows towards the Gilboa Mountains and Jezreal Valley to the north-east, and has an estimated safe yield of about 130 MCM/Yr(5). Some springs and wells have been utilized historically by the local Palestinian villagers while a portion of its flow was utilized by the early Jewish settlers, farmers and water companies before the establishment of Israel in 1948. One of the early large scale water utilization projects by Jewish settlers, was that at the Ma'ayan Harod Springs in the Jezreal Valley going back to the 1930's(2). These springs serve as the natural flow outlet of the aquifer and are located in Israel. After 1948 the aquifer was fully utilized within Israel. Thus the total long term potential yield of the mountain aquifer is now estimated at about 680 MCM\Yr of which 180 MCM/Yr is brackish(4). Of this amount some 480 MCM/Yr has been used historically within the "green line" in Israel and has always figured as part of the water resource potential of Israel within the "green line". Part of the remainder, estimated at some 35 MCM/Yr (5) is utilized directly by Israel settlements established in the West Bank since 1967.

As can be seen in Fig 1 the major portion of the recharge area of the western mountain aquifer is in the occupied territories. Gvirtzman(3) has estimated that while some 78% of the recharge area of the western aquifer lies to the east of the "Green Line" almost all of the storage area of the aquifer, which serves as its natural historic outlet and present optimal pumping area lies to the west of the "Green Line", that is within Israel. Almost all of the recharge area of the eastern aquifer lie within the "Green Line" area (3). Thus a rough preliminary estimate of the ground water flow of the western aquifer which originates as rainfall within the occupied territories indicates that it is some

80% of the flow of the western, Yarkon-Taninim aquifer and essentially all of the north-eastern, Schem-Gilboa aquifer and of the eastern aquifer.

CLAIMS, COUNTER CLAIMS, FEARS AND CONCERNS

In order to better understand the nature of the conflict and its intensity, it is essential to spell out, in some detail the claims and counter claims as well as the real and perceived fears and concerns of the sides of the dispute over the mountain aquifer.

Palestinian Claims and Concerns-

1. The Palestinians claim that the flow of the mountain aquifer that is derived from rainfall over the West Bank, 90% of which is currently extracted from deep wells mainly within Israel should be allocated for their use, and that Israel's much criticized, long term, over-pumping of the aquifer and susidiizing of water (8) is a serious threat to the Palestinians' future essential water reserves(6,9).
2. The Palestinians are concerned that Israel, due to development requirements resulting from the mass immigration of Jews from Russia and other countries will use more and more of the water from the mountain aquifer depriving the Palestinians of their fair share. Some Arab leaders have requested that the authorities in those countries stop the emigration of Jews to Israel, which they view as a threat.
3. The Palestinians claim that the Israel Civil Administration has effectively frozen Palestinian utilization of water sources in the occupied territories and has allocated insufficient amounts for urban and industrial use and practically no water whatsoever for increased agricultural development to meet the needs of the growing population. They claim that during the period of the occupation the Israel authorities have developed many new water supplies in the occupied territories and have allocated significant amounts of water for agricultural and urban use for new Jewish settlement in the areas(6,10). The Palestinians claim that by doing this Israel has violated the Geneva Convention and misused its authority as the "belligerent occupier"(11). Particularly aggravating to water short Palestinian villagers is the perception of wasteful Israeli water use and landscape practices which often include the irrigation of lawns and the construction of swimming pools.
4. The Palestinians claim that in the process of drilling new Israeli deep wells within the occupied territories there have been cases of lowering the aquifer and drying out traditional springs and shallow wells used for domestic and agricultural purposes in neighboring Palestinian

communities(6). They claim that Israel's pumping of ground water near the Gaza strip has caused the severe salination of the wells in Gaza. Even when the Israel authorities supply water to the communities that lost their original wells or springs, the cost to the villagers is increased, while this is viewed as a method of control(9).

5.The Palestinians point with concern to the fact that in all new water projects developed by Israel in the territories, serving Palestinian communities, key controlling elements such as regional reservoirs, valves and control points are located within Jewish settlements and are viewed as a method of domination.

5.The Palestinians fear that even if a peace settlement is achieved with an appropriate Palestinian entity being established, that the agreed upon division of the very limited shared water resources will leave them with insufficient amounts of water to allow for normal population growth and the resettlement of the Palestinian diaspora with the required urban, industrial and agricultural development to allow them to be economically viable.

6.In the event of major regional projects to import water to the area, for Jordan, Palestinian and Israeli use there is concern and fear over the possibility that Israel will obtain practical as well as political control over the waters to be supplied to the Palestinians and Jordan through, for example, the use of the Sea of Galilee as a long term inter-seasonal and inter-annual storage reservoir. There is likewise concern that other nations of the region, who may supply the additional water or through whose country water pipelines pass, will use the water supply lines for purposes of political control, as Turkey did in the case of the Iraqi oil pipelines during the Gulf War of 1990-91

7. In general the Palestinians claim the priority rights to complete and total control of "Palestinian" water (the mountain aquifer) and suggest that complicated schemes to import water from other nations or desalinated sea water be allocated to Israel which in return should forgo claims to the local, easily accessible, "Arab" water sources.

Israel's Claims and Concerns:

1.Israel claims that it has legitimate historical riparian rights to the mountain aquifer, based on the principle of prior use, major portions of which flow naturally into its territory and which has been developed at great expense and fully utilized over a period of time going back some 60 years(2).

2. Israel is concerned that if the Palestinians achieve autonomy or independence as part of the Hashemite Kingdom of

Jordan or separate from it, in all or part of the currently Israel occupied territories of the West Bank, they will, once they gain physical control of the territory, insist on making good on their claim that all of the water of the shared Yarkon-Tananim Aquifer (mountain aquifer) that is derived from rainfall within the West Bank (estimated to be about 80% of the total flow of the aquifer) be allocated exclusively for their own use. This fear is compounded in Israel's eyes by Palestinian stated goals of returning large segments of the Palestinian diaspora to any independent entity which is established.

Some Israelis claim that if there is a major unregulated increase of pumping from that aquifer in the West Bank area, it might mean a drastic reduction of Israel's most important, high quality, source of drinking water. It might mean a reduction of Israel's current utilization of that aquifer by some 300 MCM/yr. cutting off of the drinking water supplies for some 3,000,000 people. This would result in a serious threat to Israel's viability, that it would find to be completely unacceptable.

3. Even if an equitable agreement is achieved on the division of the waters of the mountain aquifer between Israel and any future Palestinian entity, there is serious concern about the possible degradation of the quality of the water of the shared mountain aquifer as a result of inadequate monitoring and control of urban pollution, wastewater and toxic agricultural and industrial wastes in the West Bank that could cause serious pollution in the highly susceptible karstic lime stone aquifer in the downstream areas of Israel, making the water unfit for human consumption.

In 1990, General (Reserves) Raphael Etan, at that time the Minister of Agriculture of Israel, published a full page ad in the Israel press (Jerusalem Post, August 10, 1990) expressing many of the above concerns, declaring that because of the water issue alone, Israel can never give up the physical control of any of the occupied territories since they are absolutely essential for the preservation of the country's vital water resources. He cited both the threat of the diversion and/or overpumping of water vital to Israel and the danger of environmental pollution of the shared aquifer.

4. There is also concern that unregulated overpumping of the mountain aquifer in the West Bank areas could lead to a serious lowering of the water table with the resulting danger of sea-water intrusion and irreversible damage to the shared aquifer which could be a real threat to both partners.

5. Palestinian calls for the ending of immigration to Israel from Russia and other countries for various reasons, among them, so as not to increase the burden on the limited water resources of the area, is seen as an unacceptable interference in Israel's internal affairs. Israel views unrestricted immigration of Jewish refugees as the foundation stone and raison d'etre of the country and any demand to restrict immigration is seen as inadmissible.

5. Israel officials holds that the Palestinians have not been deprived of the use of needed water. They cite the construction of hundreds of new village piped water supplies, introduced by Israel since the end of Jordanian rule in 1967; the granting of permits to the Palestinians to drill some 40 new deep wells and the importation of water from the Israel National Water Carrier to increase the water supplies to Palestinian cities and villages in the West Bank and Gaza. According to Israeli claims, the total water supply and per capita use in the West Bank has increased significantly during the period of the Israel administration. Israeli hydrologists say there is limited connection between the ground water in Gaza and Israel and that the salination of wells in Gaza is solely the result of years of overpumping by the Palestinians mainly before 1967. Israel also points out that many of the claims of drying up of Palestinian wells and springs coincided with the 1988-91 drought period and may have nothing to do with the Israel water development projects.

In light of the above partial list of the claims and counter claims of the parties which seem irreconcilable, what can be done to resolve this conflict? Let us examine the possible contribution of international water law?

THE ROLE OF INTERNATIONAL WATER LAW

There have been many severe conflicts over the use of shared international bodies of water. Both upstream and downstream countries have claimed absolute sovereign rights to such waters and have at times gone to war over such questions. International water law has evolved mainly over surface water issues, but according to an early paper by Caponera and Alheritiere(12) the legal principles and practice which have evolved for questions of surface water disputes apply by extrapolation to questions of ground water. Since then the status of ground water law has become well established in key documents of the International Law Association and the International Law Commission (13,14)

In the current era, where the concept of peaceful cooperation between nations over the use of shared resources are hopefully becoming the normative pattern in international relations, new views in international water law have developed. More recent concepts are those of

"equitable apportionment" and "community of interest" based on the emerging principle of "limited territorial sovereignty" over shared resources(12,13,14). This more enlightened and peaceful approach is summed up in the "Helsinki Rule" of 1966-- recommendations of the International Law Association (13) which propose that water disputes be settled by negotiations. Article IV of the Helsinki rules state that "Each basin state is entitled, within its territory, to a reasonable and equitable share in the beneficial uses of the waters on an international drainage basin". These rules further provide for taking into account , among other means, possible alternative water sources that might be available to one of the parties, the possibility of economic compensation and the economic and social needs of each state. Most of the effective international water treaties provide for the establishment of joint commissions for inspection, monitoring, control and management of shared water resources so that all parties can be assured that the terms of the agreement are in fact being adhered to. However, despite the moral weight of the principles of international water law many nations have not yet fully accepted them.

While the Helsinki Rules had only a limited reference to ground water, the Bellagio Draft Treaty on Ground Water of 1989(14) , the Souel Rules and the Geneva proposals (13) covers this area in a most specific manner so that today experts in international water law generally accept that all of the above principles apply equally to surface water and to ground water. This acceptance is less universal among the nations of the world, however.

If we are to accept the point of view of the experts in international law we would come to the following conclusions; The position of some, that only by the physical occupation of territories which serve as a source of its water resources can a country assure its water rights is not generally supported by the normal practice of peaceful nations or international water law. Similarly there is little legal basis in international water law for the claim of others that they have exclusive rights over the use of water derived from sources within their territory. The claim that prior historical use assures immutable water rights is also not absolute in terms of international water law.

Whether or not international law is actually binding at this time, the community of nations will undoubtedly expect that Israel and the Palestinians negotiate a settlement based on the mutual recognition that they do share common ground water resources and that an accommodation should be reached in the spirit of the principles of international law.

Thus, based on modern principles of international water law both the historic riparian rights of Israel as the

downstream user and the rights of the Palestinians as the upstream party on a shared body of water must be considered on the basis of equity and legitimate needs. Both parties to the conflict would be expected, in the first instance, to negotiate directly between themselves to arrive at a settlement based on the principles of "equitable apportionment" and "community of interest" rather than to enter some type of confrontational litigation, expecting some supra-government authority to enforce a judgement based on what each side views as their legitimate rights.

Nevertheless, the concept of "equitable apportionment" and "reasonable and equitable share" is not clearly defined and there are many conflicting factors and considerations in determining it under present international law. What solution is there at hand for the Israel-Palestinian conflict?

ESTIMATING THE LEGITIMATE WATER NEEDS OF THE PARTIES-- BASELINE WATER NEEDED FOR WATER SECURITY

In order to approach the resolution of this issue from basic principals rather than dwelling on the legal arguments or historic claims of the past it is suggested that we consider looking at the developing human needs of both partners on some fair and equitable basis. An attempt shall be made to estimate the minimum legitimate baseline water needs of the parties, required to ensure a reasonable minimum standard of living and "water security". It can be assumed that the partners to the dispute will each require a minimum degree of "water security"--that they will have access, mainly from within their territories to adequate and equitable allocations of good quality water for domestic, municipal and industrial use as well a certain limited amount of assured water for the irrigation of essential fresh food products for the direct use the local population. The basis proposed for estimating the quantities of water required to meet these needs on an equitable basis would be to assume an equal amount per capita for both sides for domestic, municipal, industrial use and minimum basic food needs. Other water, for additional agriculture, including export, is excluded from the baseline needs calculation.

It is suggested that we consider, for example, that the basic allocation for domestic, urban, and industrial use be 100 cubic meters/person/year (CM/P/Yr). This figure, is considered in Israel as an adequate minimum baseline water allocation to support a good hygienic standard of urban life and industrial development, if coupled with sound measures of water conservation. It is recognized that at this time the actual domestic water consumption of the Palestinians in Gaza and the West bank is less than half of the mean Israeli domestic consumption, but it is assumed for the purposes of this estimate that with increasing standards of living over

a 30 year period both partners will require the same amounts of water for domestic purposes on a per capita basis. The basic allocation suggested for minimal growing of fresh food supplies and for domestic animals could be 25 CM/P/Yr.

Water allocations for further urban, industrial and agricultural development can become available from recycled purified municipal wastewater which is estimated at 65% of the urban water supply. Further water needs beyond locally available sweet water sources can be met by imported water and/or desalination of brackish water or seawater, if it is economically justified, in the framework of the regional Water-for-Peace plan, as it develops.

Since it is difficult if not impossible to plan for all future developments and population growth it is suggested that estimated requirements for a 15 year period be determined as a first stage starting point with a preliminary estimate for a second stage of 30 years. As an illustration it can be assumed that the estimated populations in about 15 years (the year 2007) and 30 years (2022) will be as follows: Israel-7 and 10 million and the Palestinians-3 and 5 million. The true populations maybe greater or smaller than these figures depending on many demographic factors which are difficult to determine at this stage. These figures are presented as one possible scenario. Based on these assumed populations the suggested requirements of baseline water--to assure water security-- mainly from sources within each territory are as shown in Table 1:

	Population millions		Baseline Fresh Water		Recycled Water		Total Baseline Water	
	15yr	30yr	15yr (MCM/Yr)	30yr (MCM/Yr)	15yr (MCM/Yr)	30yr (MCM/Yr)	15yr (MCM/Yr)	30yr (MCM/Yr)
Palestinians	3	5	375	625	195	325	570	950
Israel	7	10	875	1250	455	650	1330	1900
Totals	10	15	1250	1875	650	975	1900	2850

3.5%
3.0%

Table 1. ESTIMATED ISRAELI AND PALESTINIAN BASELINE NEEDS TO ASSURE "WATER SECURITY"- An illustration of a possible basis for a fair and equitable estimation of essential baseline water needs for urban/domestic and fresh food use for the Palestinians, and Israelis mainly from available sources within the territory based on estimated populations for a 1st stage of 15 years (2007) and a 2nd stage of 30 years (2022), with uniform allocations of 125 CM/P/Yr for urban/domestic and essential fresh food. It is assumed that 65% of urban water supplies can be recycled for agricultural, industrial and urban non-potable reuse.

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Without going into details it is not unreasonable to estimate that a part of the above minimal quantities of essential baseline water supply required for the 15 year first stage up to the year 2007, can be made available to the Palestinians from existing or potential sources mainly with direct access from within the territories, however some additional external sources will be essential both for the West Bank and Gaza. Importation of water will be even more essential for the second or 30 year stage in the year 2022 with the estimated total quantity of fresh renewable water required of 1,875 MCM/Yr, which is most likely beyond the estimated outer limit of all natural fresh water resources available within Israel and the occupied territories including Gaza.

This would mean, that additional water for all uses including agriculture for local markets or for export from local sources of fresh water would have to be severely restricted by both partners.

The situation of the Palestinians in the West Bank and Gaza would according to these estimates be most difficult. The present available water supplies for the Palestinians are about 120 MCM/Yr in the West Bank and about 65 MCM/Yr safe yield in Gaza for a total of 180 MCM/Yr, while the estimated needs would be 325MCM/yr after 15 years and 625 after 30 years. The Palestinians may expect unrestricted use of the eastern mountain aquifer with a safe mean annual yield of about 200 MCM/Yr (half of which is brackish) which has little connection with Israel's ground water systems. However the use of water by the Israel settlements on the West Bank will remain a question that must be resolved.

As shown previously, Israel has a strong case of historical rights concerning its use for some 60 years of most of the ground water in the western mountain aquifer (the Yarkon-Taninim) and the north-eastern aquifer (Schem-Gilboa) which flow naturally into its territory. Israel considers this water vital for its own survival and will not agree to any uni-lateral reduction in its current use of those aquifers. This will mean that in general the Palestinians in the West Bank will not be able to meet their baseline needs of water from internal sources alone, and will need to reach agreements on importation of water or larger allocations from the shared aquifers.

Without questioning Israel's legal rights to that portion of the mountain aquifer that it has used historically, it will undoubtedly be asked to consider the possibility of negotiating an agreement on the shared use of that aquifer with the Palestinians in order to reach an accommodation in the framework of interim autonomy plan or final peace agreement. Various quid pro quos may be suggested including

financial compensation for water or water rights or compensation in the form of water from alternative sources such as the Litani River, the Yarmuk River or subsidized desalinated seawater which could be achieved in the framework of a regional Water-for-Peace plan. The shared use of the mountain aquifer will be one of the key issues in the peace negotiations with the Palestinians dealing with the water issue and it is beyond the scope of this paper to suggest the outcome of such negotiations.

The present safe yield of the coastal aquifer in Gaza is estimated to be only 65 MCM/Yr due to serious past over pumping mainly during the period of the Egyptian occupation, which resulted in the encroachment of sea water in many wells. Gaza is already in a severe water crisis with its drinking water hardly fit for human consumption. Gaza can not survive without the immediate importation of good quality water from desalination or an external source such as the Nile-El Arish pipeline. A crash program to develop a joint Israeli/Palestinian desalination plant for Gaza is already under consideration. The recent Israeli action in connecting water short areas of Gaza with a pipeline from the Israel National Water Carrier is a step in the right direction.

After the year 2020, as populations grow and water demands increase it will undoubtedly be necessary to increase the amounts of imported water and/or desalinated seawater. For all these reasons it is essential to developed a phased Regional Water-for-Peace plan in the early stages of the peace process.

THE ONLY SOLUTION--ADEQUATE AND EQUITABLE ALLOCATIONS BASED ON ADDITIONAL WATER FOR ALL IN A REGIONAL WATER-FOR-PEACE PLAN

This article will not attempt to go into the political, legal and military history of the disputes over water rights between the parties to the dispute, nor will it try to unravel where justice, if any lies. Arguing over legal rights and the claims and counter claims of the past could be endless and would most likely not bring the disputants nearer to a solution and accommodation. It should be clear that a simple reshuffling of the already inadequate water resources of the partners to the dispute, is a "zero sum" game with very high stakes. Both partners start the game with less than enough so that taking significant quantities of water from one to increase the share of another will be perceived as a serious hazard and unacceptable threat to its viability. Only if additional sources of water and appropriate guarantees on joint monitoring, inspection, and control, are a sure outcome of the negotiations, is there a chance that they will succeed.

With increasing populations, Israel will undoubtedly have to severely reduce its allocations of fresh water supplies for agricultural purposes and will have to decrease its subsidies for agricultural water so as to assure its rational use. It is important to understand the deep ideological commitment of Israel to preserve its agricultural base as an essential part of its heritage and national goal of "the return to the soil" in its ancient homeland. It is no more logical to expect Israel to completely give up its deep national commitment and support for agriculture than it is to propose such a move to the Swiss, French or Americans which are nations with equally deep commitments to their agricultural heritage. Likewise the Palestinians will have to accept the serious limitations on their agricultural potential based on the limited availability of water resources and their cost but they cannot be expected to completely forgo the agriculture base which has been a deep rooted part of the Arab economy and tradition.

The Palestinians are fully aware that there is a wall to wall national consensus in Israel favoring an open immigration policy for the Jewish refugees while rejecting the concept of "right to return" of Palestinians to Israel territory proper. However, there is a growing realization that neither side will agree to restricting immigration and the return of their respective diasporas within their areas, as a water conservation measure. Both sides have deep commitments on this matter and would view any restrictions on immigration as an unacceptable constraint.

There is a need to develop a bold regional Water-for-Peace plan. This plan should be based on the principle of sufficient and equitable allocations for all, which can be aided by bringing in quantities of additional water to all the countries of the region from the large water resources reserves available for many years to come in countries such as Turkey, Lebanon and Egypt and/or by the construction of major sea-water desalination plants(1). It will be much more feasible to reach an accommodation based on equitable allocations if the size of the pie is increased and neither side is left without sufficient water to assure its future development within the framework of their own national goals which includes unrestricted immigration and an economically feasible agricultural base.

A REGIONAL WATER-FOR-PEACE PLAN

Since there will not be sufficient amounts of water from existing or potential local sources to allow for optimal urban, agricultural and industrial development of the partners to the dispute, particularly for the Palestinians it is essential to develop additional sources of imported water under a regional Water-for-Peace plan. The actual amounts of water that can and should be imported into the



Figure 2 . Proposed alternative or complementary projects for bringing in additional water supplies to meet the long term needs of Jordan, Israel and the Palestinians which should be evaluated as part of a multi-billion dollar Water-for-Peace Plan. The following pipelines are proposed for evaluation: Nile River to Gaza Strip and the Negev ; Litani River in Lebanon to West Bank and Israel; Turkey to Syria, Jordan, and the West Bank. Major seawater desalination plants (DS) could be built on the Mediterranean coast between Israel and Gaza and on the Israel-Jordan border between Aqaba and Elat.

region over the next 30 year planning period have not been determined as yet, and only very preliminary estimates can be given. Kally (15) has estimated that the Palestinians will require some 200-350 MCM/Yr of imported water for the West Bank and Gaza. As shown in Table 1 above, my own estimate of the minimum needs of the Palestinians in the year 2020 will be about 625MCM/Yr, more than half of this amount may well have to be imported. Israeli planners have suggested^{that} Israel will need some 400 MCM/Yr of additional water, assuming no reduction of its present water sources. A rough estimate of possible long term needs for imported or desalinated water may reach the figure up to 1000 MCM/Yr unless there are drastic cuts in agricultural use on all sides.

It is proposed that the major economic powers including the United States, the European Community, Japan and the Gulf States and their financial institutions such as the World Bank, interested in promoting the peace process in the Middle East finance these major water projects through both grants and loans, as one sure way of making the peace process attractive to all participants. The investments involved might reach some five billion dollars, but this sum is small compared to the amounts spent on the arms expenditures of the major powers in the Middle East and the direct and indirect costs of the wars of the region.

At this stage it is premature to go into the detailed engineering or economic considerations of the possible alternative or complementary elements of the Water-For-Peace Plan in the Middle-East which could include all or some of the following projects, if proved feasible, which could eventually bring into the area the additional water required. The concepts presented here relate to purchasing water from neighboring countries on a fair commercial basis, not depriving countries of their water rights or even purchasing water rights.(see Fig. 2):

1. NILE RIVER-EL ARISH-GAZA AND NEGEV: President Sadat first broached the idea that a pipeline be built from the Nile through El Arish to the Gaza and Negev area. Dr. Elisha Kally has made some preliminary evaluation of it and suggests that it is an economically feasible project(15,16). The idea is that at a relatively low cost it would be possible to relieve the critically severe water situation in the Gaza Strip area which threatens its very viability. At the end of the normal investment life of the project, in about 40 years, it would be possible to replace it with a desalination plant which should be considerably cheaper by that time. This project might supply some 100 MCM/Yr.

2. THE WESTERN GHOR CANAL FROM THE YARMUK TO THE WEST BANK This project was originally conceived as part of the Jordan Valley Authority plan of the Hashemite Kingdom of Jordan

with Yarmuk River water allocated for that purpose under the Johnston plan of 1956. Jordan would also be expected to help in meeting part of the Palestinians basic needs in the West Bank by agreeing to construct the Western Ghor canal from the Yarmuk, siphoned under the Jordan River to run along the western side of the Jordan as called for in their own water plan. About 100 MCM/Yr could be supplied from this source, but it would depend on Jordan obtaining additional water from the planned Syrian/Jordanian Unity Dam on the Yarmuk or other external sources such as the Litani River or water from Turkey.

3. LITANI RIVER-GALILEE-WEST BANK-JORDAN: Some early Lebanese planners suggested the idea of selling excess water to Israel on a commercial basis. Along the lines of Kally's ideas (15,16) it has been proposed that a project be developed to supply water from the Litani River in Lebanon through a short pipeline to Northern Israel, the West Bank and possibly to Jordan, on a commercial basis, with Lebanon receiving fair compensation for the sale of the water. Lebanon also has a significant water surplus in the South. The Litani river flow is utilized mainly for power production and is only partially used for irrigation at this time and is wasted to the sea, through a diversion to the Awali River. Here too at the end of the 40 year investment life of the project it could be replaced by desalinization. This project might be able to supply some 100 MCM/Yr. The supply could be increased if the water diverted to the Awali River is tapped and compensation to Lebanon for lost electrical power is included in the price of the water.

4. TURKEY-SYRIA-JORDAN- WEST BANK: President Ozal of Turkey suggested the bold concept of the Peace Pipe Line to supply water to their neighbors to the south. A more modest version of that idea is a 600 km pipeline from Turkey through Syria and Jordan to Amman and to the Palestinian communities in the West Bank. This concept has been described as the Turkish Mini-Peace Pipeline and could supply 600 MCM/Yr to the area. The Sea of Galilee and/or the proposed Unity Dam on the Yarmuk River could be used as a operational reservoirs for supplying water to Jordan and the Palestinians(17).

Turkey has significant water reserves at this time, of some 180,000 MCM per year, only about 15% of which is currently utilized. Within the next 50 years and with optimum economic and agricultural development much of the country's water reserves will remain untapped, so that the Mini-Peace Pipeline would not deprive Turkey of needed water resources in the foreseeable future(18).

Even if such a project is feasible from an engineering and economic point of view there remains the question of whether such a complicated multi-national project can be achieved in

the tension laden Middle East between long term rivals with little faith in each other.

The supply of Turkish water to Israel through such a system is improbable both because of difficulties in obtaining agreement of all the countries involved and no less because of Israel's serious concern with being dependant on water sources from such great distances which can be cut off at any time by any one of three potentially hostile neighbors. However, even if the Turkish project supplies the additional water needs of Syria, Jordan and the Palestinians only, it can make a major contribution to alleviating the water problems of the area.

5. SEAWATER DESALINATION- It has been proposed to develop major multi-national seawater desalination plants at appropriate sites on the coastline between Israel and Gaza and on the border between Israel and Jordan at Aqaba and Elat. The Gaza plant could supply significant amounts of desalinated water to Israel, Gaza and the West Bank area and could be an alternative solution if the above pipeline projects prove to be too complex or as an additional water source in the early stages of the project, or at some future time when desalination becomes more economical.

Since the desalination plant must operate at full capacity twelve months a year it will be essential to provide a system of flow regulation and storage. Recharge of the mountain aquifer during the winter months with an agreed upon schedule of withdrawal by Israel and the Palestinians during the summer irrigation period should be evaluated as a possible solution to allay concerns of control and to provide a method of direct access to additional water sources for the Palestinians in the West Bank areas.

Based on current estimated costs of desalination of seawater of about \$1.00 - \$1.50 per cubic meter. Such expensive water would not be an economically feasible source of water for most normal agricultural purposes. Some, more optimistic estimates predict that desalination costs will go down to 80 cents per cubic meter in new plants currently on the drawing boards. There are, however, no indications that desalination will become dramatically less expensive in the near future, although in time, some further reductions of cost can be expected. Desalination of brackish water up to 5,000 mg/l of total dissolved solids by the reverse osmosis process is much more attractive and is estimated at one half or less than the cost of desalination of sea water. It could be a feasible source for all domestic and industrial uses and ever for some forms of agriculture. Major portions of the mountain and Gaza aquifers are brackish and if desalinated could thus become valuable and economically feasible sources of water for domestic industrial or even agricultural use.

The Nile-Gaza and Litani River pipeline projects, mentioned above, have been estimated roughly at one quarter to one third the cost per cubic meter of desalination (15,16,19). No reliable cost estimates are available for the Turkish Mini-Peace Pipeline but general cost estimates of very large water transport systems carrying over 500 MCM/yr have been estimated at about 10 cents per cubic meter per 100 km for pipelines and about 5.5 cents/cubic meter for open canals (19). This would indicate that the 600 km Turkish pipeline might provide water which is still cheaper than desalination. These estimates may, however, be too optimistic. It should be pointed out that there are decided long term economic and engineering advantages to piping in water, even with long pipelines. While initial capital costs may be high, operating costs are low and dependent only to a limited degree on energy costs. A major portion of the cost of desalination of seawater is fuel for energy. Energy costs are bound to increase substantially with time as fuel supplies get more scarce.

It must be recognized however, that desalination, while expensive, might well be the most attractive solution, particularly for Israel and the Palestinians, since it would not involve water supply sources from across multiple international borders and long exposed pipelines from potentially hostile countries. It also may be the simplest politically since it would require the least degree of multi-national agreement. The additional cost, provided as a grant, may be justified as part of the international contribution to peace in the Middle East since it may be the only immediate solution offering an assured source of additional water for Israel, Jordan and the Palestinians that will not require third party agreement.

However, some planners and economists suggest that the money invested in seawater desalination could be more productively invested in providing other forms of economic infrastructure and industrial capacity which could provide a better level of economic support for the densely populated area under discussion. Agriculture cannot be expected to provide the many new jobs required to absorb millions of new immigrants.

AN AGREEMENT ON EQUITABLE APPORTIONMENT AND JOINT CONTROL OF WATER RESOURCES--AN ESSENTIAL ELEMENT OF A PEACE TREATY IN THE MIDDLE EAST

In the peace negotiation process on the question of the shared water resources in the Middle East, including the mountain aquifer, the partners to the dispute will have to give serious consideration to ways of applying the principles of the Helsinki Rule, including an agreed upon formula for equitable apportionment and cooperative water management including eventual joint monitoring, inspection and control on both sides of the border(13). This is

essential to assure all partners, that the water allocations, from surface and ground water sources, agreed upon are being abided by. There must also be arrangements for the cooperative management and operation of water import facilities and joint desalination plants. No less important is to assure that there is proper control of potential and actual sources of environmental pollution which might threaten the quality of the shared water resources. This will require a recognition of the reality that the use and management of a shared resource for mutual benefit, such as water, means that both side must accept a certain symbolic degree of limitation on their territorial sovereignty.

Accepting a degree of limitation on territorial sovereignty may well be a bitter pill to swallow for the parties to the dispute in the Middle East, but it is not hard to find examples where powerful sovereign nations have accepted that principle in treaties, in order to end conflicts and protect their mutual interests in shared water resources. This is particularly so in Europe among the countries belonging to the EEC. An outstanding example of international cooperation is the joint management of the Rhine River which started in 1815 and today has evolved into the ten nation International Rhine Commission (IRC) which regulates and controls chemical, microbial and thermal pollution, fishing, flood control, navigation and water use. The IRC carries out joint monitoring, inspection, control and research on all aspects of the river's management. These countries have agreed to a certain degree of limitation of their territorial sovereignty in order to achieve shared goals of orderly management and pollution control of shared international bodies of water(20).

An essential element of the agreement is that the riparian rights of the Palestinians and Israel to a fair portion of the shared mountain aquifer be recognized and regularized. Another important section of the treaty should be an agreed upon procedure for resolving difference that arise out of the agreement by such procedures as negotiations, mediation followed by binding arbitration or adjudication before the World Court.

ISRAEL-PALESTINIAN COOPERATIVE WATER MANAGEMENT- UTOPIAN DREAM OR HARSH NECESSITY.

According to a newspaper report in Israel, a study by Tahal-Water Planning for Israel Inc, the country's most authoritative professional water planning group and the prestigious Jaffa Center for Strategic Studies of Tel Aviv University, headed by General (Reserves) Aaron Yariv, formerly head of the Israel Army Intelligence (Ha'Aretz 10 March 1992) presented "...possible alternative political arrangements and included maps of possible lines of withdrawal from the occupied areas including the upper areas

of the Golan Heights" which could still assure the security of Israel's water resources. While according to the newspaper report, the publication of this report has been held up by the Military Censor at the request of the Minister of Agriculture, it is apparent that some of Israel's leading water professionals and strategic planners share the opinion that there are indeed possible alternative political, legal and technical solutions to the question of the shared water resources through cooperative management that provide an appropriate degree of water security for Israel other than physical control of the territories in dispute.

While providing a solution to the water conflicts in the Arab-Israel dispute, including that over the mountain aquifer, is not a sufficient condition for peace it is undoubtedly a necessary condition. The United States and the other major powers should help to broker the peace process in the Middle East by sponsoring a Water-for-Peace Plan with an assured major infusion of funds for the benefit of all the partners. Just because the situation is so desperate the partners to the dispute may finally realize that only by joining hands in a cooperative effort can they survive.

A bold and generous Water-For-Peace Plan can not only remove an important obstacle on the path to peace but can provide a real motivation for peace which will enable the partners to the dispute to solve urgent problems for the social welfare and economic benefit of all.

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