PEACE AND WATER IN THE MIDDLE EAST

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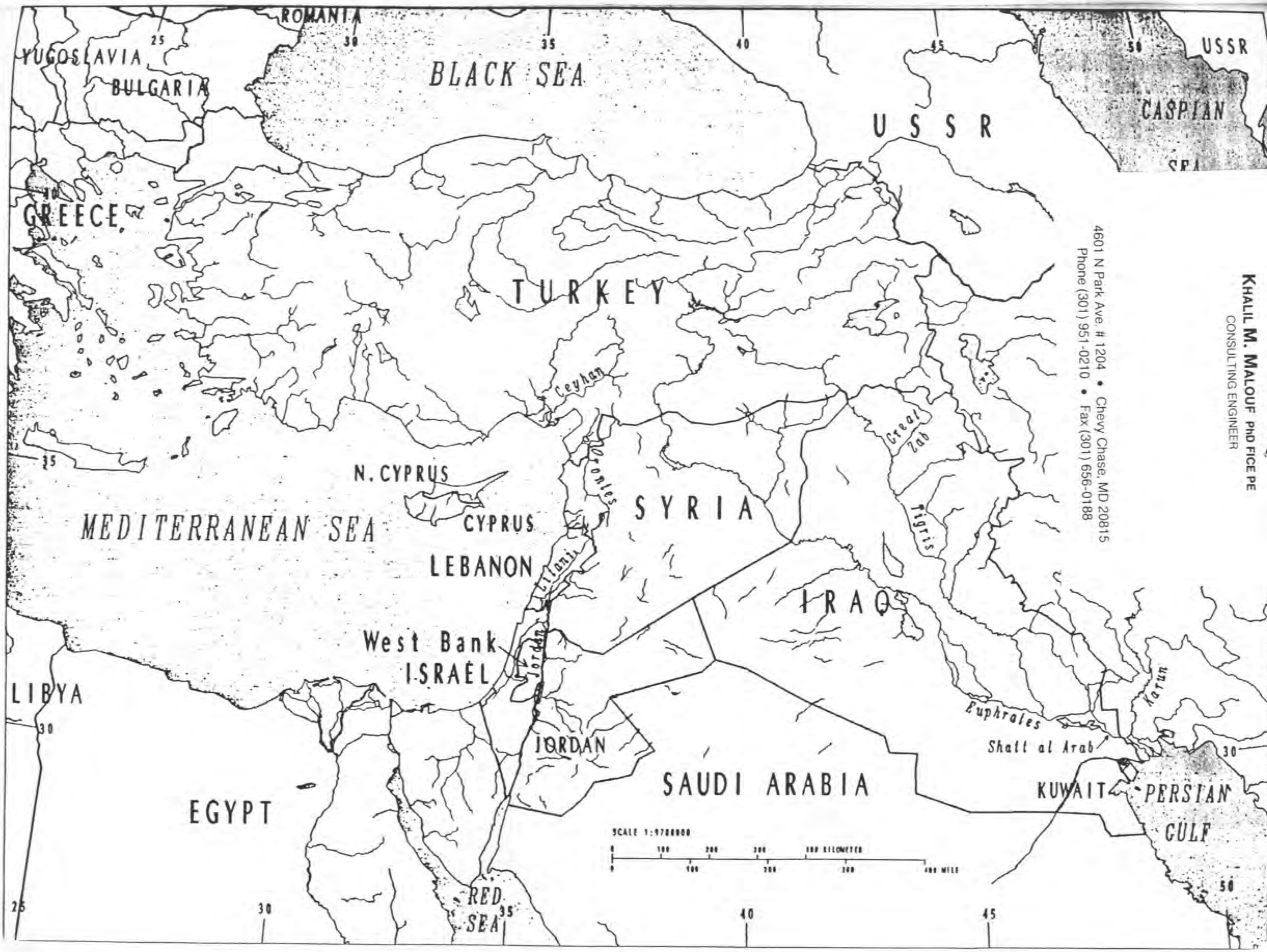

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ABOUT THE AUTHOR

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PEACE AND WATER IN THE MIDDLE EAST

1. Synopsis

This report takes an overview of the water resources in a selected group of eight* countries in the Middle East. (Egypt, Israel, West Bank-Gaza,* Lebanon, Syria, Turkey, Iraq, and Jordan)

After giving figures for all countries involved, the writer proposes a new criterion which he names: Water Sufficiency Index. This was used to compare the relative richness or poorness in water resources between the countries involved. The new Index placed Turkey as the richest through the year 2010 with Egypt and Iraq as second and third.

The report finds that the area as a whole is fairly rich in water. It has total renewable surface water resources of about 280,000 million cubic meters per year (MCM/yr). This serves a present population of 153 million, which is expected to grow to 255 million in the year 2010. Of the 280,000 MCM/yr, however, about 86,000 are unused and flow into the sea while over 25000 MCM/yr are wasted, mostly in overirrigation.

The writer condemns such waste as criminal and reminds the reader that water is a Holy Commodity to all three main monotheistic religions, and it should therefore be treated as such.

The concept of a Water Common Market is hinted at, but kept within the more important Peace Scenario - hopefully an overall Peace for the entire area.

In concluding the report finds that there will be a demand gradually building up for an additional supply of about 2550 MCM/yr by the year 2010 and with an immediate urgent requirement of about 450 MCM/yr in Israel and the West Bank-Gaza Areas, followed soon after by Jordan.

In view of the magnitude of the above requirements, the only two viable suppliers are Egypt and Turkey, with any other source serving only as a short-term stop-gap arrangement. The report shows a preference for Egypt as the supplier of the adjacent areas in spite of the cleaning-up operations required, but does not dismiss the Western Pipeline from Turkey.

* Technically seven countries and "the occupied territories of the West Bank and Gaza".

2. - INTRODUCTION

In the Mid-1980s President Ozal of Turkey championed the proposal for pipelines from Turkey carrying water Southwards from the basins of the Seyhan & Geyhan rivers. An Eastern pipeline would head in the direction of Kuwait and another would go towards Jordan. The proposal created interest and raised questions. A Middle East Water Summit was convened for the first week of November, 1991, and later cancelled. This report was originally prepared in an abridged form for presentation at that conference. It is intended to give the interested reader an overall comparative picture of the water resources in the whole area. Any opinions expressed are solely those of the writer.

To look at water distribution on a regional basis with the possibility of excess in one country being diverted to make up for a deficit in another is undoubtedly a unique approach. It is not only unique; it is practically unheard of. But if someone dreams of applying such an approach in the area, this dream, under the prevalent circumstances, will certainly qualify as a nightmare.

And yet there are some who for the last decade or so, at least, have come to believe in the inevitability of such an approach as a necessary complement to a permanent Peace, if Peace is ever to be achieved in the Area.

But what are the difficulties? Here are some background facts on the region which may be relevant:-

- The Palestinian problem has now been gnawing at the socio-economic structure of the area for over 40 years.

- Israel has moved from a hesitant birth in 1948 to an arrogant statehood defying - not only its neighbours but, with the US as an ongoing ally, the entire world body at times.

- Previously with the Camp David Agreement between Egypt and Israel, and more recently with the Iraqi debácle first in Iran then in Kuwait, the very semblance of a balance of power in the area has all but disappeared.

- Because of lack of water Syria, historically part of the grainary of the region, has large tracts of undeveloped fertile lands (especially in the South). Planned projects in Turkey do not improve the picture.

- Lebanon, a country apparently rich in water resources, has been shattered by 15 years of proxy wars, leaving all of its infrastructures in a sorry state. It is not certain how much of its water resources are being 'borrowed' by its neighbours.

- Jordan has been hovering on the brink of water thirst since the 1950s and is now in bad need of extra water, but too weak to do much about it.

- The occupied West Bank, with some 80% of its water resources being expropriated, is in a sorry state of water starvation.

- Two of the regions nations have openly stated that water was the only matter which could take them to war. One other leader has intimated as much by his actions.

- Israel, sometime ago, reached a dangerous level of "overdraft" as far as its own resources are concerned. Now it is practically on the brink of water bankruptcy and some rationing cut backs already exist.

- Israel, has also drawn on the aquifers of the Occupied West Bank for about 25% of its total water supply. There appears to be no chance of Israel giving the West Bank back without being assured of an alternative water supply.

Israel, however, has one great asset: when it has a problem, very soon the World Community hears about it, and sooner or later something is done about it. Without being too cynical, one may add that, had Israel enjoyed an abundance of water, the world community would have probably shown much less interest in the other thirsty peoples of the area.

The economic and political problems which need to be tackled in order to start solving these issues are too mind boggling. So they will be ignored for the time being and left in more capable hands.

But in the meantime some questions must be answered: Are there surplus waters? Where are they located? Can they be made available? Having answered these in the affirmative, possible engineering solutions will than be considered. It should be pointed out that such cooperative projects are completely dependent upon good relations between the parties concerned and hence largely hypothetical at this point in time.

This paper will therefore now attempt to look at the joint water resources and possible requirements of Egypt, Israel, West Bank-Gaza, Lebanon, Syria, Turkey, Iraq and Jordan. The other adjoining water thirsty (but oil rich) States of the area have been included only peripherally as possible water recipients. Their participation, however, will be necessary in setting up policies and providing assistance in any project implementation.

3. Overall Water Resources & Use

Comments on the individual water resources and use of the eight* countries considered in this report are found in Appendix A. A summary of surface water resources of major rivers (above 100 MCM/yr) by country is given in Table 3.1. Table 3.2 shows water and other data for the entire area.

It will be seen from Table 3.2 that the area as a whole disposes of a total surface flow of approximately 276,500 MCM/yr for a present population of 153 million. This population is forecast to increase to around 255 million in the year 2010 at the present relatively high rates of growth. (Israel is presently compensating for a lower natural rate of population growth by immigration).

Any one who attempts to discuss water balances over such an area and with such a variety of interrelated resources (not to mention a mass of conflicting information) is going to be asking for trouble. The present writer is no exception, and must hasten to mention that a few of the individual figures may be off and will need further verification. However, the numbers in Table 3.2 give a fairly valid overall picture of the area in question.

At first glance the area appears to enjoy an abundant surplus of water since total future consumption is forecast at about 50% of the present total surface flows. Table 3.2 also shows that 70% of the total water resources of the area are located in Turkey and Egypt. If the present unused portion in Turkey (85000 MCM/yr) is excluded the ratio becomes 57%. Also water is obviously a scarce commodity in a number of the countries under discussion. The disparity between the eight countries is strikingly apparent. The geographical distribution is also of interest. The larger countries are on the periphery, with the two water colossi at the North and South and three small members in the center. (Also refer to map.)

Again a first glance at Table 3.2 appears to lead to an inescapable conclusion: Turkey and Egypt should be the suppliers and Israel, Jordan and the West Bank-Gaza the recipients. This may turn out to be true, but it would be a more convincing conclusion if some questions are first answered: How rich are the apparently rich? How destitute are the poor? Where do the other countries stand in relation to the group?

In order to try and determine relative richness and poorness within the group criteria are proposed in Section 4 and fully discussed in Appendix B. Comparative results are given hereunder with respect to

* See Footnote on Page 1

TABLE 3-1: WATER RESOURCES - MIDDLE EAST AREA - MAIN RIVERS AND SPRINGS IN EGYPT, ISRAEL, LEBANON, SYRIA, TURKEY, IRAQ, JORDAN

NAME OF RIVER	ANNUAL FLOW (MCM)	RIPARIANS
1. Transboundary Rivers		
1.1 Nile	55500	Egypt (+ 8 upstream riparians)
1.2 Jordan	1440	Lebanon, Syria, Israel, Jordan (includes the Hasbani, Dan, Banyas & Yarmouk Rivers plus Zerka plus misc Wadis & springs)
1.3 El-Assi (Orontes)	500	Lebanon, Syria, (Turkey)
1.4 Euphrates	33000*	Turkey, Syria, Iraq
1.5 Tigris	18500	Turkey, Iraq (See s-t Iraq), Syria**
s-t Item 1	108940	
2. National Rivers		
2.1 Litani	700	Lebanon (410 at Karaoun Dam)
2.2 Six Other Rivers	1240	" (Abu-Ali, El-Bared, Ibrahim, El-Kalb, Damour, & Awali)
s-t Lebanon	1940	
2.3 Ras-Al-Ain Spring	1250	Syria
2.4 Others (estiamte)	550	" (Include Ain Figeh, Barada, Al-Awaj)
s-t Syria	1800	
2.5 Geyhan & Seyhan	13200	Turkey
2.6 Twenty-Two Rivers:	105800	" (Include Marmara, Susurluk, Bati Akdeniz Sulari, Orta Akdeniz, Bati Karadeniz, Kizilirmak, Dogu Akdeniz, Dogu Karadeniz, Aras)(1)
s-t Turkey	119000	
2.7 s-t Iraq	26725	(Total of 5 tributaries of the Tigris including Greater & Lesser Zab River and Diyalah)
Total Middle East Area:	258405	MCM/yr.

* Includes Khabur flow of 1700 MCM/yr. (fed by Ras-Al-Ain Spring)

** Syria has only a 20 mile border on the Tigris and is not allotted any of its waters in this study (see Map)

(1) Buyukdoluca

TABLE 3.2 SUMMARY WATER BALANCE – MIDDLE EAST AREA

COUNTRY	POPULATION (MILLIONS)		AREA SQ. KMS (1000)	AREA IRRIGATED SQ.KMS.		ANNUAL CONSUMPTION (DEMAND) MCM/YR				1990 TOTAL WATER RESOURCES MCM/YR	
	YEAR			YEAR		IRRIGATION		DOMESTIC		TOTAL RENEWABLE	WASTED OR UNUSED
	1990	2010		1990	2010	1990	2010	1990	2010		
EGYPT	52.6	86.0	1000.0	24750	28300	33600	37100	1720	3470	55000	13900
ISRAEL	4.6	6.3	21.5 PRE 67	2100	2100 + (1)	1680	2055 (1)	470	645	2000 (1200) (PRE 67)	--
WEST BANK & GAZA	2.0	4.2	6.1	150	740 (1)	120 + (1)	740 (1)	25	190 (1)	130	550 (2)
LEBANON	3.0	5.0	10.4	850	2850	850	2425	165	275	2260	860 (EST)(3)
SYRIA	12.5	24.9	185.0	5000	6000	6250	7500	685	1360	7410	?
TURKEY	56.0	88.0	780.0	16750	33000	16750	33000	2050	3540	138000	85000 (EST)(3)
IRAQ	18.0	32.5	438.0	37000	39000 (4)	49200	39000	580 (WAR)	1780	70800 (5)	15000 (EST.)
JORDAN	4.2	8.3	89.0	500	650	580	1160	180	310	900	70 (2)
TOTALS	152.9	255.2	2530.0	87100	112640 +	109030	122980	5875	11570	276500	?

(1) DEPENDS ON WATER (2) TAKEN BY A NEIGHBOUR (3) FLOW TO SEA (4) FAO GIVES 18000 (5) 58000 IN 1991 AND 48000 BY 2010

two criteria:- the "Competition Level Index" proposed by Ms. Falkenmark and the "Water Sufficiency Index" (WSI) proposed by the writer. The Competition Level* is a "water" index defined as the number of people competing for 1 Million* cubic meters of water per year. The Water Sufficiency Index is a "Land-Water" criterion defined as the ratio of available water resources to the combined Irrigation & Domestic demand.

The resulting rankings for the eight countries being considered are as follows:

RANKING	COMPETITION LEVEL		WATER SUFFICIENCY INDEX (WSI)	
	1990	2010	1990	2010
1st (Richest)	Iraq	Turkey	Turkey	Turkey
Second	Turkey	Iraq	Egypt	Egypt
Third	Egypt	Egypt	Iraq	Iraq
Fourth	Lebanon	Lebanon	Lebanon	Syria
Fifth	Syria	Syria	Syria	Jordan
Sixth	Israel	Israel	Jordan	Lebanon
Seventh	Jordan	Jordan	Israel	Israel
8th (Poorest)	West Bank-Gaza		West Bank - Gaza	

There are really few surprises in the above, but one or two comments are in order. Iraq appeared on the scene by virtue of its high ratio of resources to population. It is a pity that it can not be a more active player. Lebanon which placed fourth in 1990 dropped two places in 2010 on the WSI in view of the large increase forecast in irrigation area to make up for 15 years of internal disturbances. Conversely both Jordan and Syria rose to higher ranks mainly due to the relatively small increase in irrigated areas forecast for 2010. The insufficiency list for 2010 thus includes Lebanon and Jordan in addition to Israel and West Bank-Gaza (See Table 4.2). The situation is therefore essentially back to where it started with Egypt and Turkey as potential suppliers - but with Iraq as a questionable substitute.

It is to be noted also that of the total Resources figure of 276500 MCM/yr shown in Table 3.2 about 86000 now discharge directly into the sea (about 35000 into the Black Sea). This leaves only about 51000 MCM/yr as partly recoverable in as far as this study is concerned. The amount of about 25000 MCM/yr presently wasted in overirrigation has not been included and must be considered as completely recoverable through scientific irrigation.

* The writer has queried an apparent inconsistency in the figures given by this approach (See Appendix B). The Competition Level is therefore presented only for comparative purposes, since the ranking results are not affected.

4. COMPARATIVE CRITERIA OR INDICATORS

Three different criteria are fully presented in Appendix B.

- Water Duty and Per Capita Consumption are well established. They represent respectively the amount of water needed for irrigation and domestic consumption.

- The Competitive Level Index is defined as the "Number of people competing for 1 Million cubic meters of water per year" MCM/yr. As proposed the index ranges from less than 200 people to over 2000 people with the lower values representing "richness in water".

- The Water Sufficiency Index (WSI) is presented by the writer as an attempt to introduce an agricultural or 'Food' variable in addition to water and population. It is very simply expressed as the ratio of available water resources to the combined Domestic and Irrigation demand. A WSI value of 1.0 or over thus represents sufficiency.

The results of the Competitive Level Indicator and Water Sufficiency Index for 1990 and 2010 are given in Tables 4.1 and 4.2. Values of the WIS are

TABLE 4.1 Competition Level and Water Sufficiency Indicators - 1990

Country	Competition Level Number of People Competing For 1 MCM/yr of Water	Water Sufficiency Index Ratio of Total Water Resources to Domestic Plus Irrigation Demand
1. Egypt	956 (3rd)	2.062 (2nd)
2. Israel	2300 (6th)	0.882 (7th)
3. West Bank-Gaza	15380 (Poorest)	0.583 (Poorest)
4. Lebanon	1327 (4th)	1.458 (4th) (net)*
5. Syria	1687 (5th)	1.358 (5th)
6. Turkey	406 (2nd)	2.820 (Richest) (net)*
7. Iraq	254 (Richest)	1.880 (3rd)
8. Jordan	5060 (7th)	1.271 (6th)
Average for Area	553	2.057 (net)*

* Total Resources Less Discharge to Sea

based on across-the-board values of 100 lpcpd (36.5 cum/yr) for Domestic Consumption and an irrigation Water Duty of 1 m (See Appendix B).

The relative rankings given by both indicators are very similar. The individual numbers or absolute values of the Water Sufficiency Index, however, are obviously much more meaningful. Competition level figures have to be read only as providing comparative rank. (See Appendix B.2)

TABLE 4.2 Competition Level and Water Sufficiency Indicators - 2010

Country	Competition Level Number of People Competing For 1 MCM/Yr of Water	Water Sufficiency Index Ratio of Total Water Resources to Domestic Plus Irrigation Demand
1. Egypt	1560 (3rd)	1.750 (2nd)
2. Israel	3150 (6th)	0.733 (7th)
3. West Bank & Gaza	32310 (Poorest)	0.146 (Poorest)
4. Lebanon	2210 (4th)	0.745 (6th)*
5. Syria	2643 (5th)	1.072 (4th)
6. Turkey	638 (Richest)	3.811 (Richest)
7. Iraq	677 (2nd)	1.194 (3rd)
8. Jordan	10000 (7th)	0.871 (5th)**
Average for Area	92.3	2.073

* Assumes development of all additional irrigated areas (2000 sq kms) which is difficult to achieve.

** Assumes an increase of only 150 sq kms in irrigated area over the 20 year period.

5. POSSIBLE PROJECTS

5.1 Introduction

The idea of interbasin exchange and even transboundary exchange of water resources is not new to the area. It could even be said to date back to Roman times.

In as far as the writer knows, the first attempt in recent time was when Theodore Herzl in 1903 proposed setting up a colony in the Sinai under a lease agreement from the Egyptian Government, and "the question of the eventual supply of water from the Nile" was to be agreed later(1).

In 1948 Sir Alexander Gibb and Partners prepared a study for Lebanon in which he proposed a tunnel diverting the Hasbani waters into the Litani River basin(2). Around the same time there was a report by the same authors proposing the supply of waters from Iraq to Kuwait. In 1948 the TVA-Hays report was published. This was later adopted and followed in 1953 as the 'Johnson Scheme' for the integrated development of Jordan Valley waters.

Around the same time a 500 MCM storage reservoir on the Yarmouk River at Maqarim Station was proposed by M.E. Bunger (Point IV mission Jordan).

About 2 years ago this same idea was modified and the Wehdah Dam proposed slightly further upstream on the Yarmouk.

In 1980 a report(3) (limited circulation) was published showing a possible pipeline from the Nile Delta to Sinai and beyond. Ben-Shahar (1989) also mentions a similar project coming from the Nile Delta.

And more recently the so-called Peace Pipelines from the South-Western corner of Turkey towards Kuwait and Jordan. In this connection even the concept of Peace for Water is not new. An International Conference held in Washington in May <u>1967</u> (e.g. see Fawaz) was on the subject of Water and Peace.

However, it would help in moving forward if some pre-conditions are fulfilled. First and foremost are serious and positive steps in the Peace process with some small but tangible results. Then, and maybe only a few steps behind, the start of discussions on possible cooperative projects on water. But here again, major changes in thinking and attitude will be necessary.

To list but a few:

- Responsible people will have to start thinking of water as a commodity - a very special commodity, but nevertheless a commodity. In view of this, are Governments prepared to give up some of their national sovereignty to allow logic and/or technical considerations to dictate water use policies?

(1) Patai
(2) Gibb
(3) Malouf

- A start must be made on a intensive social education program which will make the population look at waste as a sort of "Taboo" - especially water waste. New technologies designed to save in water use must be introduced.

- It may be difficult to limit cooperation just to water. Once this is achieved the area will become in effect a Middle East Water Community. Why not a WATER COMMON MARKET?! A Middle East Economic Community could thus become a natural and logical next step.

- With peace achieved, hopefully in the entire area, are the people of the region ready to start thinking of old projects such as a Middle East highway program and a Middle East electrical grid?

- Can the Governments reverse direction and, for instance, cut back on marginal food growing land if it can be grown and purchased at a cheaper price somewhere else in the area or outside it?

- And last and most importantly again the point of waste: The doctrine that water is a "Holy Commodity" from which God created all living things may help Governments in bringing the point home to farmers. But if this does not succeed, then a realistic price (the price of transportation at least) must be set for water - even if it has to be in the form of a Water Levy or 'Water Tax'.

The above are but some examples of how, and how drastically, the thinking and attitude in the area will have to change.

Can it be handled? Are the Leaderships capable of attuning themselves to it? This remains to be seen, but in the meanwhile let optimism prevail as the next step is considered.

5.2 PROJECTS

Bearing the preceding discussion in mind, the following are a few brief ideas and comments. The projects are of course, mentioned simply as examples of what may be done and fall into two categories:

- Projects which increase the efficiency of water use or produce sweet water from new sources locally.
- Projects for the importation or transfer of water from outside.

It is essential that the start should be made in water saving techniques.

a - Drip irrigation and saline water farming are already being attempted. Israel is a leader in the techniques.

b - Cloud seeding has also been mentioned, but the forecast of results is not very encouraging.

c - Another project which has long been on the books is the better utilization of the Yarmouk waters. Two possibilities are mentioned - either a dam on the river proper , or a diversion channel into the Sea of Galilee. The Dam is of course much more expensive, but avoids the very high salinity and evaporation losses in the Sea of Galilee. The Sea of Galilee presently has a salinity of 800 ppm (Yarmouk about one tenth) and an evaporation rate of about 300 MCM/yr. However, Syria is building a number of diversion projects on several upper tributaries of the Yarmouk. If these continue they can render the main Yarmouk Dam, economically unjustifiable, and leave the channel as the only alternative.

d[1]- Whenever one starts considering alternative means of increasing sweet water supplies, desalination is one of the first possibilities one thinks of. Up to about 1970 most of the larger desalination plants were of the multiple stage flash evaporation type. These are expensive.

After 1970 developments in semi permeable membranes allowed the construction of reverse osmosis (R.O.) plants in which hydraulic pressure was used to force the water component of a salt solution, through a membrane. Once suitable membranes were developed this type of plant proved to be lower in capital cost and required less energy to run than the multiple stage flash evaporation type.

As a result the proportion of R.O. type plants built with over 100 cum/day capacity has increased rapidly and about 70% of contracts for new large desalination plants in 1989 were for R.O. type plants.

(1) Contributed by J. Arregger

Even with the improved efficiency and a lowering of the cost of the flash evaporator, recent studies show that if a realistic value is placed on energy, i.e. $20 per barrel of crude, unit water costs will be 30% lower for R.O. plants, say about $0.5 to $1.0.

Further reductions in R.O. plants are possible using Brackish water as opposed to Sea Water. Here one can achieve costs of about $0.35 per cum (1990 $s) which should be of interest.

Other methods of desalination have been developed such as systems based on solar energy, wind and tidal energy. These methods have in general proved uneconomic due to the high capital cost required.

It is worth mentioning, however, one method which has so far failed for technical reasons. This is freeze desalting which is based on the fact that ice crystals deposited from salt water contain essentially no salt. The power requirements for this method are low but it has proved very difficult to wash the salt water mother liquor from the ice crystals.

e - Pipelines: These projects have received the greatest share of attention - especially the more recent ones from Turkey. Turkey and Egypt are effectively the only two candidate countries.

The writer proposed a pipeline from Egypt through Sinai in 1980. At the time the cost of transporting 1 cum for a flat distance of 100 kms in twin 2.0 m diameter pipes at the rate of 290 MCM/yr was 6 cents. For 100 kms on terrain rising to 100 m the cost was 10 cents per cum. For the purposes of this report costs for greater and higher distance may be taken by simple proportion. For example, twin 2 m Pipelines 500 kms in length carrying water to a height of 800 m would result in a transport cost of 65 cents per cum. (1980 $s)[1]

Ben-Shahar has also recently published a paper (1989) in which he outlines such a project. His project starts with a widening of the present Sinai canal, continues to link up with the national water carrier of Israel, and from there through several conduits to locations in the West Bank and Jordan. Ben-Shahar gives "exchange" cost of about 20 cents per cum for the project which appear optimistic. Nevertheless a realistic cost of about $0.80 per cum is probably achievable.

Even the long pipeline from Turkey has an estimated delivery cost of about $0.80 per cum, but this does not appear to include storage costs in Turkey or a price for the water itself. The project centers around the Geyhan and Seyhan rivers which flow into the Mediterranean at the Bay of Iskendarun in the South Western corner of Turkey. One pipeline destined for Syria, Jordan and Western Saudi Arabia will carry 3.5 MCM/day. The other moving ambitiously East proposes to supply Kuwait, Eastern Saudi Arabia, Bahrain, Qatar, UAE, and Oman with 2.5 MCM/day. The total cost of the two pipelines is estimated at around $21 Billion.

(1) Malouf

-The Eastern Pipeline proposed by Turkey and targeting the Persian Gulf seems to carry more than one inherent contradiction. On the one hand waters of the Euphrates are cut off by building Dams on it (The Ataturk Dam in Turkey and the Al-Thawrah in Syria). Then an offer is made to send water in a pipeline. If one must go through a pipeline, then why not use a much shorter pipe run to the Euphrates and use the natural river channel - a God created conduit - for the rest of the way? Furthermore in this connection one cannot technically ignore Iraq as a supplier in view of its very convenient proximity to the Persian Gulf States. In spite of the worsening quality in the Shaff-el-Arab waters (partly due to upstream Dams!), adequate surpluses exist, and it does not make sense to pipe water from a source which is 1000 kms farther away.

-The Western pipeline from Turkey which is much shorter does have some merit. The total distance is not much longer than that from the Nile Delta, but the pipeline has to cross two countries before reaching its destination. The choice of a supplier must therefore remain with Egypt and the adjacent Nile waters. The total requirement is less than 20% of the amount now being wasted in overirrigation. Strangely enough the average combined flow of the Geyhan and Seyhan rivers is the same - about 13200 MCM/yr.

f - Israel has always considered water from the Litani in Lebanon as a convenient source. One proposal is to divert Litani water below the Karoun Dam through a tunnel into the Hasbani, then through a hydro-electric power plant into Lake Tiberias (Sea of Galilee). Other alternatives are considered and presented as quite viable projects.(1) The projects probably are both feasible and viable, but they all deprive the South of Lebanon of its natural source of water supply. Israel has also been accused of diverting Litani waters surreptitiously into Israel, but the writer does not know of any solid evidence to support this. With a remaining flow of no more than 300 MCM/yr below Karoun, and about 100 MCM/yr taken by the Kasmieh project, the question is whether there is sufficient water in the Litani for South Lebanon as well as Israel? And in the very doubtful event that there is, the supply would be completely insignificant with respect to the future requirements of Israel.

g - In addition to the continuous supply of fresh water in large quantities there maybe a need to consider smaller perhaps even isolated communities.

One possible solution is the use of DRACONE Tankers. These are sausage shaped rubber tanks which are towed behind a ship and were originally developed for transporting oil and petroleum products in areas inaccessible to larger ships such as rivers and estuaries.

(1) Ben Shahar

These DRACONE Tankers are now also used to transport water to islands etc. Some of the Greek Islands are a good example. The tanks can be towed by a supply vessel and detached at the destination providing local storage and avoiding unloading operations. When empty they can be rolled up and returned as deck cargo.

Sizes up to 1100 m^3 are available. The additional horse power required for towing this size of DRACONE is 165 H.P. while its capital cost is about $450,000.

If it can be assumed that the ship will be making the journey anyway to supply the community, the incremental cost of towing the DRACONE and depreciation on the capital can be calculated.

For a journey of some 250 nautical miles this value comes out at $0.70 per cum. Unfortunately this appears to be only valid for normal supply vessels making the trip anyway. If a 100% dedicated ship is to be used, the cost becomes prohibitive for anything but very short distances.*

h - Ballast water is really a peripheral project at the other end of the spectrum. Normally crude tankers use sea water as ballast on their return journeys to the oil exporting countries as sea water is available at the ship at no cost. However, many of these return journeys are made from ports which have an abundance of fresh water.

Large crude oil tankers are provided with some segregated water ballast tanks with volumes of 8-20% of the cargo volume. These tanks could be used for fresh water transportation. The only additional requirement being reception facilities at the oil loading port. Water carried in cargo tanks would of course require some treatment on arrival but contamination can be minimized by the use of tank cleaning systems during the voyage.

To give an idea of the order of magnitude we are talking about, a country like Saudi Arabia (1990 production of 327 million tons) will have 80 MCM as ballast or sweet water per year. This may not be a very sizeable amount of water , but the idea deserves further study if only for the quite obvious environmental advantage it possesses.

* This is probably not the place to make the remark because this particular project is not really relevant to the present problems. But the writer considers that if there is no alternative, the question of cost should lose its priority. No one ever thinks of criticizing the Dutch for the very expensive dykes they build.

6. Afterthoughts

-Whether Peace for Water or Water for Peace a lot is going to be heard about the two in the immediate future. There are those who will continue to make noises about Water and War, and a minority who will make gentle gestures of water offers. Irrespective both PEACE and WATER are the key inseparable words for the area. Hopefully the 'hydraulic imperative' will help to accelerate the Peace process, and the fact that the most acute water shortage is in Israel (and, of course, the West Bank-Gaza) may turn out to be an asset.

-With respect to water as a resource, the need is there; even a conflicting need is there; the required technology is probably there; the question therefore is only a matter of cost. Can the water be transferred from where it is to where it is not at an acceptable price? What would be the acceptable price?

-With respect to water as a commodity the implications are much more far reaching and take on a completely different context.

Water is no ordinary resource and certainly no ordinary commodity. Once there is an agreement between two parties, where one agrees to sell and the other agrees to buy, the two parties will become bound like siamese twins or worse. It is therefore difficult to imagine such an agreement or actual transfer without the presence of some world body or agency with the necessary authority to control, monitor, and arbitrate. An infringement on national sovereignty? In a way of course, but the writer can not think of another way. Even under a Peace umbrella, even on a bilateral basis between two contiguous states, the writer can not see water being traded without future problems arising, except in the presence of a World Agency created specifically with the authority to oversee and control the operation.

-At present International Law does not provide for such an Agency. Laws for it may have to be formulated.

-As a matter of fact, there is as of now no single project in the area affecting a transboundary river which really satisfies the basic elements of existing International Law. As examples

-The Jordan River Scheme was placed on the table by the emissary of the U.S. President. Some discussions took place. No formal agreement was signed.

-The High Aswan Dam is based on an agreement between Egypt and the Sudan only. There are seven other riparians. As the farthest country downstream, Egypt is in the most vulnerable position.

-The Ataturk Dam in Turkey was built without any consultations (or perhaps even warnings) to Syria and Iraq.

-Syria has been building on tributaries of the Yarmouk without any reference to Jordan.

-Israel has on more than one occasion flexed its military muscle to stress one or another 'hydraulic imperative'.

-All across the board double standards are applied. Even 'good neighbourliness', a primary but vital principal of international relations, has been sadly lacking in the area for many, many years. It still is.

-It should be noted that the Law governing transboundary rivers is a 'soft' Law which to date can not be enforced through regular Legal procedures. Laws governing the exploitation of sub-surface waters flowing across national boundaries are to all intents and purposes non-existant. Hence the 'Good Neighbourliness' principal in International Law takes on a greatly increased importance. If the infant Peace Process grows to maturity, good neighbourliness should follow. When it does, it would hopefully eliminate the need for elaborate and futile legal arguments.

Perhaps it would be appropriate to close with the two main themes of this report:

PEACE

- There must be serious misgivings among large masses of ordinary people all over the area when they see certain Arab Countries talking peace with Israel, while some Arab Countries are still enemies. This is unhealthy, and anything unhealthy does not bode well for the future. In due course a New World Order should try and achieve an 'Overall' Peace covering the Eastern as well as the Western extreme of the area.

-WATER

-If countries in the area continue to waste water in the manner they are presently doing, they will not be only harming themselves by destroying the Land which feeds them; they will not be only harming their neighbours; they will be criminally abusing the rights of their children's children and all future generations.

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APPENDIX A

WATER RESOURCES AND USE IN INDIVIDUAL COUNTRIES

A.1 Egypt

Egypt is a narrow oasis stretching 1250 kms between Lake Nasser in the South and the Mediterranean in the North. Attempts to broaden the strip or increase the number of Lakes have had limited success to date.

The Nile, however unique, remains Egypt's only source of water and its present water use may be summarized as shown in Table A-1.

TABLE A-1 Estimated Present Water Use[1]
(cukm per yr)

INFLOW		
Aswan Release	55.5	
WATER USE		
Municipal and Industrial		2.4
Evapotranspiration (irrigation)		33.6
Evaporation from water surfaces		2.0
Sub-total		38.0
OUTFLOW		
Edfina to Sea		3.5
Canal tails to seas		0.1
Drainage to sea		13.2
Drainage to Fayoum		0.7
Sub-total		17.5
GRAND TOTAL		55.5

Egypt at present suffers from two major ills in as far as its water is concerned; over-irrigation and industrial pollution, with all of their resulting problems.

Without going into details, it is essential for the well being of the nation and the area as a whole that Egypt tackles and SOLVES these problems. The job is very difficult but it must be done. It can be done if it is given the right priority by the Government.

The present report will therefore assume that this will be achieved, and that the present flow of the Nile at Aswan continues undiminished. Both

(1) Chesworth

of these are not as improbable as they appear at first glance. In connection with the inflow it should be mentioned that any increase or decrease will depend predominantly on natural phenomena. Major projects upstream are more likely to increase the flow - not decrease it. This may even apply to the very expensive series of dams proposed on the Blue Nile in Ethiopia[1]. As can be seen from Table A-2 all other projects, if implemented, will contribute to the flow.

In as far as the writer is concerned, however, the "dark horse" in Egyptian water resources is Ground Water. The writer remains convinced that this resource has considerably larger potential than most people seem prepared to accept.

In support of this contention the following points may be mentioned:-

- A UNESCO[2] sponsored Russian study gives an overall water balance for the Nile Basin showing a surplus of 116 cukms. This is a sizeable amount of water by any standards, and the writer is convinced that at least part of it must be recoverable. The table is reproduced as Table A-3 in this text.

- Seepage losses (unlike evaporation) should be at least partly recoverable.

- Given the geology of the area, there is no way to avoid the conclusion that a 90 m depth of water at the Aswan Dam is definitely going to produce infiltration - some of which must reappear as ground water further downstream. In further support of this the writer also finds that reported seepage losses at Aswan Dam are questionably low.

- There are proven ground water resources in Northern Egypt and wells are in operation[3].

- According to Stoner[4] storage available as ground water is perhaps 400 cukm (vs 130 cukm in the Aswan high dam).

Farmers should therefore be encouraged to operate shallow wells (15-25 m) to irrigate small farms and then duplicate such schemes all over the area[4].

We may thus conclude that the Water Resources of Egypt, when properly managed, can provide a fair surplus for a long time to come. (Refer to Table A-2.)

(1) Whittington
(2) World Water Resources
(3) Kinawi
(4) Stoner

TABLE A-2 Sources and Projects for Additional Water in Egypt[1]

Project or Source	Location	Total Gain cukm/yr	Possible Distribution		
			Egypt	Sudan	Upstream Riparians*
A - Possible Immediate Implementation					
1-1st Stage Ground Water Development	Egypt	5.7	5.7	-	-
2-1st Stage Jongeli (Sudd Swamp reclamation)	Sudan	4.8	2.4**	2.4	-
3-Water Recycling (or more efficient irrigation)	Egypt	12.0	12.0	-	-
Sub-Total(A)	-	22.5	20.1	2.4	-
B - Future Projects Swamp Reclamation - Bahr-el-Ghazal	Sudan	20	10**	10	-
- Machar Marsh	Sudan	8	4	4	-
- Lake Kioga	Uganda	6	-	-	6
- Remainder of Sudd	Sudan	7	3.5**	3.5	
- Dams in Ethiopia	Ethiopia	+?	(2)	(2)	4***
TOTALS (A & B)	-	63.5	35.6	17.9	10

* Can not be further subdivided due to lack of International Agreements
** Measured in Sudan
*** Assumes series of 4 Dams. Probably partly compensated by reduced flooding (and evaporation) in the Sudan.

(1) Malouf

TABLE A3 NILE RIVER BASIN OVERALL WATER BALANCE*

RIVER STATIONS	AREA OF DRAINAGE BASIN BETW. STATIONS 1000 SQ.KMS	RUN OFF CU. KMS.		WATER BALANCE DRAINAGE AREA BETWEEN STATION CU. KMS				
		IN THE BASIN	AT STATION	PRECIPI-TATION 1	RUN-OFF 2	RUN-OFF LOSS BY VAPORA TION 3	TOTAL VAPORA TION 4	NET (1)-(2) -(4)+(3)
1. SOURCE	—	—	—	—	—	—	—	—
	262	—	—	344	75.1	54	290	+32.9
2. VICTORIA NILE AT LAKE VICTORIA OUTLET		75.1	21.1					
	236	—	—	253	15.9	10	223	+24.1
3. BAHR-EL-JEBEL AT MONGOLA		91.0	27.0					
	480	—	—	449	15.0	27.6	411	+50.6
4. WHITE NILE BELOW SWAMPS (BEFORE SOBAT JUNCTION)		106.0	14.4					
	350	—	—	282	13.5	0.0	280	-11.5
5. WHITE NILE AT MALAKAL		119.5	27.9					
	331	—	—	251	3.3	5.3	172	+81
6. WHITE NILE AT KHARTOUM		122.8	25.9					
	305	—	—	463	51.5	0.9	213	+199.4
7. MAIN NILE AT KHARTOUM		174.3	76.5					
	762	—	—	53	14.5	2.3	152	-111.2
8. NILE RIVER AT WADI HALFA		188.8	88.7					
	144	—	—	0	13.0	29.1	36	-19.9
9. NILE AT MOUTH		202.0	72.6					
TOTALS	2870	—	—	2095	201.8	129.2	1777	+245.4

*DRAWN FROM UNESCO'S WORLD WATER BALANCE AND WATER RESOURCES OF THE EARTH, 1978.

At present there are about 26000 sqkms under irrigation, and agriculture will continue to be a major Egyptian activity. This in spite of the fact that, with its present population of 52 million projected to reach 86 million in the year 2010, the Country will probably never be able to feed itself. The constraint is land not water.

A.2 Israel, Jordan and the West Bank & Gaza

The Jordan and Yarmouk rivers have Lebanon, Syria, Jordan, Israel and the West Bank as riparians. Syria at present draws 160-170 MCM/yr from the upper Yarmouk. The water resources of the other three are so interrelated that it is easier to treat them under the same heading.

The division of the Jordan river waters between Syria, Israel and Jordan was first proposed by the Jhonson Scheme in 1954, and initially adhered to. The present overall use is approximately as shown below:-

TABLE A-4 Present Apportioning of Water (MCM/yr)

Resources and Remarks	Total Supply	Israel	West Bank and Gaza	Jordan
1. Surface Waters				
- In flow into Lake Tiberias				
(Sea of Galilee)	840			
Evaporation from above	300			
Net into Galilee	540	540	-	-
- Yarmouk 475 (165 to Syria)	310	180	-	130
- Wadi Zerka	95	-	-	95
- Dead Sea & Other Wadis	675	-	-	675
Sub-Total	1620	720	-	900
2. Ground Water				
- Main West Bank Aquifers & and Other Supplies	600	490	110	
Gaza Aquifers & Other Supplies	80	60	20	
Sub-Total	2300	1270	130	900
3. Additional Resources				
- Beisan Springs & Reduction in Galilee evaporation (est.)	180	180	-	-
- Deep wells in Israel (est.)	550	550		
Grand-Totals	3030	2000	130	900
4. Estimated Deficits				
Present (1990)	195	150	75	(30)
Future (2010) (est.)	2550	1810		740

It should be noted that the estimated deficits for Jordan include the present shortfall of 70 MCM/yr from its "share" of the Yarmouk waters. The fact that it is making do without it should not be taken against it.

The West Bank-Gaza deficits include the overpumping of the sandy aquifers on which the area depends for most of its water supply. Present over exploitation runs at between 60 & 90 MCM/yr. There already must be some salt water intrusion, but the extent of the damage is not known. (See Ben-Shahar in list of references)

All three countries depend a lot on Agriculture, but Israel has the lowest percentage employment (6%) in that field. Dry farming is practised in the West Bank, but the highlands of Jordan are mostly irrigated by pumping from wells.

Israel at present has 2100 sqkms under irrigation; Jordan 500 sqkms; and the West Bank and Gaza around 150 sqkms. Any future expansion in all three areas will depend on availability of water supplies.

The future requirements of the West Bank & Gaza are more difficult to assess under a Peace scenario. The West Bank has a substantial area of good irrigable land. But an appreciable part of it lies at higher elevations that could make pumped ground water expensive. Nevertheless, some provisions must be attempted, and the future demand in Gaza & the West Bank may be assessed as follows:

Irrigated Area:	740 sqkms at 1 m/yr = 740 MCM/yr
Domestic:	4.2 M at 125 lpcpd = 190 MCM/yr

i.e. Total Demand in 2010 = 930 MCM/yr

This will cover the above projected requirements under a Peace scenario and is not out of line. It is to be noted that Domestic water consumption was taken as 34 lpcpd in 1990, which is factual but ridiculously low by any standards. Also a water duty of 0.8 m was assumed which is dictated mostly by present restrictions of supply.

Furthermore, within the context of a Peace scenario, one must look at all riparians and assess the overall deficit for the group. We are after all looking at essentially transboundary flow of both surface and ground waters.

Politically it will probably make a lot of difference between:

(1) Israel disengaging herself from the waters which belong to her neighbours and being allocated another source of supply.

or

(2) Israel keeping the present set-up as is and having her "wronged to" neighbours allocated water from an outside source.

From the engineering point of view, however, there is no important difference between the above two, and the second alternative may even prove less expensive.

With respect to Israel it is presently living on borrowed resources, both by overdrawing on its own resources and by taking from its neighbours about 550 MCM/yr. Overexploitation is a dangerous procedure and could lead to irreparable harm. It can not possibly be justified by the short-sighted argument of need.

Over and above that Israel is using the supplies in a way which is harmful to Jordanian waters downstream due to the very high resulting salinity. The total annual renewable water resources of Israel may therefor be taken as follows:

- From Surface Waters	720 MCM
- From Springs & Wells	480 MCM
- Total Safe Renewable	1200 MCM
- West Bank-Gaza Water to be returned or replaced	550 MCM
- Reduction in pumping to a safe level (estimate)	250 MCM
Total Shown in Table A-4:	2000 MCM

With total projected Domestic water demand of 645 MCM/yr in 2010 and an irrigation demand of not less than 1680, this would imply a minimum deficit of about 1125 MCM/yr in 2010. However, one should perhaps also provide Israel with water for an additional 400 or 500 sqkms of irrigated land over the 1990 total. This will make the total demand for 2010 about 1500 MCM/yr. We will thus have a total theoretical deficit of about 300 MCM/yr but a total real deficit of 1100 MCM/yr which has to be dealt with somehow. (NB. This figure includes the 250 MCM provision for reduction in pumping).

Jordan is the county whose voice is the least heard in this respect. Perhaps this is partly due to the fact that it has been living under a regimen of water scarcity since the 1940s, and the Jordanians have therefore learned to make do with what they have with minimal complaints. Figures for Jordan were drawn primarily from E. Salameh's paper (see references). These result in a total present water us of 800 MCM/yr including Industrial Consumption - hence an elegant 30 MCM surplus! Forecasts for the year 2010 place the total demand at 1570 MCM, including industrial consumption, and thus a make-up supply of 740 MCM/yr will be needed.

The net results of the preceding discussion are summarized in Table A-4, and show total requirements of water to be provided from outside and/or additional sources as 2550 MCM/yr for Israel, Jordan, the West Bank and Gaza. The total demand for Israel and the West Bank-Gaza (1810 MCM/yr) has been shown as one figure.

Since this subject will be a major topic in any Peace talks, it would be well to bear all of the above mentioned points in mind.

A.3 Lebanon

Lebanon is blessed with an annual rainfall of 9 cukms per year, but the disadvantage is that about 80% of this quantity falls within a period of six months. Storage thus becomes difficult. Only one sizeable dam has been built on the largest national river. (The Karaoun Reservoir on the Litani.) A number of other dams were planned but could not be implemented mostly due to political disturbances.

The main rivers were listed in Table 3.1 and provide a total surface flow of about 1940 MCM/yr. To these should be added several smaller rivers and streams (e.g. Nahr Beirut, El-Joz, etc.), totalling about 290 MCM/yr. With an estimated use of 25 MCM/yr from the Orontes, this will bring the total annual surface flow in Lebanon to about 2255 MCM.

It is doubtful whether an accurate figure exists for how much of this amount flows into the sea, but the present writer estimates it to be around 860 MCM/yr.

Cultivation in Lebanon is widespread with even the high mountainous slope transferred to small fruit gardens by terracing. If one is to include such terracing, the total cultivated area could well reach the suggested figure of 31% of the total area or 3225 sqkms[(1)]. At the moment, in view of the still fluid political situation, it is difficult to make any accurate forecasts.

The total irrigated area at present is about 850 sqkms, and for the purposes of this report, the area forecast for the year 2010 will be taken as 2850 sqkms, although it would be difficult to achieve.

At an estimated present water duty of 1 m the above translates to an irrigation water requirement of 850 MCM/yr. For the future improved efficiency in water use should bring the water duty to say 0.80 m. Hence the annual requirement in 2010 will be for 2280 MCM of irrigation water.

A figure of 150 lpcpd will be used for domestic water consumption, although it is doubtful that more than 40% or 50% of this will reach the consumer until the distribution networks have been repaired. This will result in an annual demand of 165 MCM and 275 MCM for the years 1990 and 2010 respectively. Representative figures for industrial consumption can be taken as twice these figures.

It is of interest to note that with such a high ratio of suitable irrigable land the future estimated water requirements already exceed the total surface flows. The first obvious additional source is, of course, to reduce the amounts draining into the sea. But, in view of the given hydro-geography, this will be both difficult and expensive.

Future water resources policy planning will therefore require very careful formulation. The choices lie in deciding what balance to strike between

(1) Leeden

(1) how much of the full agricultural potential to try and realize - and at what expense, and (2) what other uses can be made of available water resources and what are the broad economics involved.

Another fact which may be at least of hydro-political interest is that Lebanon becomes progressively drier as you go further South. A large part of the area occupied by Israel at the time of writing is in reality quite short of water - especially as a major part of nearby water resources is being diverted elsewhere.

A.4 Syria

Two transboundary rivers provide the major part of the surface flow:

- The Assi (Orontes) rises in Lebanon and is fed mainly by the Ain Zerka Spring. It flows northwards into Syria and eventually passes through what is now a south-west part of Turkey before flowing West into the Mediterranean. Lebanon makes little use of the flow, and Turkey appears unlikely to claim much of a share in the near future. 90% of the entire flow of 500 MCM/yr has, therefore, been assigned to Syria, with Lebanon and Turkey being allotted 5% or 25 MCM/yr each.
- The Euprates springs in Turkey and flows through Syria to Iraq. This river has already been the cause of some tension. No formal agreement yet exists between the three countries. The writer has used the projected figures of J. Kolars for the year 2010 in allocating the future Euphrates waters between Turkey, Syria and Iraq.

The Euphrates used to carry about 30300 MCM/yr into Syria, including about 1700 coming from the Khabur and Balikh springs. When construction of the Ataturk Dam was nearing completion in 1990, Turkey cut off the entire flow to start filling up the reservoir, and there was a brief period of very tense relations between Turkey on the one side and Syria & Iraq on the other side.

A make-shift agreement resulted in an undertaking by Turkey to provide 500 cum/sec on a continuous basis through the Dam. The agreement also stipulated a minimum amount of 100 cum/sec. It appears that Turkey has honored its commitment to date and kept the flow at 500 cum/sec or 15770 MCM/yr.

With a population expected to reach 17 million by the turn of the century, Syria's uncertain role in the Euphrates - its only major stream - leaves it rather badly placed with respect to its two neighbouring riparians - water rich Turkey and oil rich (though shattered) Iraq. The situation of Iraq, however, is considerably worse in as far as water is concerned. (see section A-6).

Other than the above two rivers Syria has only about 1800 MCM/yr in additional water from a number of springs, and it is presently drawing about 165 MCM/yr from the Yarmouk river in the south. (See Table 3.1.)

The total renewable water resources of Syria will therefore be taken as 7415 MCM/yr for the year 1990 and 9415 MCM/yr for the 2010 distributed as follows:-

5000 to 7000(1)	From the Euphrates
1800	Misc. springs (see Table 3.1)
450	From the Orontes (estimate)
165	From the Yarmouk

(1) Kolars (year 2010)

Irrigation in Syria is mainly in the north of the country in the area from the Khabur in the north east to the Euphrates, Orontes and the Mediterranean Coast westwards.

Some good agricultural soil exists in the South where limited dry farming is practiced and where Syria has access to the Yarmouk, but once again Israel has 'borrowed' part of the land - the Golan.

Syria appears to have a major problem in and around the Euphrates basin. Here it is plagued by such poor soils that one author[1] considers that an absolute maximum irrigable area of only 3750 sqkms exists. For the purposes of this report presently irrigated areas in Syria have been taken as 5000 sqkms distributed as follows:

2000 sqkms	Aleppo Area
1400 sqkms	Upper Khabur Basin
1200 sqkms	Orontes Basin
270 sqkms	Other Areas
130 sqkms	Yarmouk Tributaries

Bearing in mind that the Syrian Government has itself cut back on some irrigation programs because of the poor soils encountered,the area developed for irrigation in 2010 was estimated at 6000 sqkms. A water duty of 1.25 m was also set, and maintained constant up to the year 2010. It may be well to bear yet another point to mind: the Euphrates waters flowing into Syria will become progressively worse in quality as increasing return flows from irrigation waters in Turkey are diverted to the river.

Domestic water consumption in the three major cities is estimated at about 175 lpcpd. An average for the whole country was taken as 150 lpcpd, resulting in a total domestic consumption of 685 MCM/yr for 1990 and 1360 MCM/yr in the year 2010.

(1) Kolars

A.5 Turkey

Turkey enjoys an abundance of rainfall over the whole country (about 500 cukms). Here evapotranspiration losses are very high and only about 30% of rainfall remains as stream flow.

Oil-poor but water-rich, Turkey has plans for ambitious schemes for utilizing its waters in irrigation and hydroelectric development. The recently completed Ataturk Dam project on the Euphrates is one example.

The resulting problems due to this dam with the two downstream riparians - Syria and Iraq - have been temporarily defused; but, in the absence of a formal agreement between the 3 riparians, the situation will remain unhealthy.

Rivers are spread all over the country. These represent surface flows of about 119000 MCM/yr. When withdrawals from the Tigris, Euphrates and Orontes are added, the total renewable surface flow in Turkey will amount to 137000 MCM/yr, made up as follows:-

- 119000	Total of 24 Rivers (see Table 3.1)
- 25	Orontes, estimated withdrawal
- 8000	Tigris, estimated withdrawal by 2010
- 10000	Withdrawal by 2010 as forecast by Kolars

Ground water supplies could add to the above figure at least 1000 MCM/yr.

About 16250 sqkms are presently under irrigation and this figure is expected to nearly double (to 33000 sqkms) after completion of the GAP project. (Guneydogu Anadoly Projéssi).

At an initial water duty of about 1 m total irrigation requirements will amount to 16250 MCM/yr. Future requirements for a total irrigated area of 33000 sqkms should have a slightly lower water duty assigned, say 0.85 m, resulting in a total demand of 28000 MCM/yr.

Domestic water consumption in Turkey should show the usual large difference between urban and rural areas. An average of 100 lpcpd will be used in 1990 and 120 lpcpd in 2010. (Equivalent figures for Egypt were taken as 90 and 110 lpcpd respectively based on Chesworth.) This will result in alotted domestic consumption of 2050 MCM/yr in 1990 and 3540 MCM/yr in 2010.

A.6 Iraq

Iraq is the downstream riparian of the Tigris and the Euphrates. Unlike Syria and Turkey, however, the major part of its population is concentrated in the valley formed by the two rivers and the many tributaries of the Tigris.

This demography has not changed since ancient times when Mesopotamia witnessed the birth of the first organized agricultural communities, the first urban developments, and the inventions of writing and the wheel.

Iraq maintained its agricultural momentum in modern times and a large number of projects since the early 1900s bear testimony to that fact.

Under its present shattered condition it is difficult to make any assessments both for the present and the future, but the rough estimates of Table A-5 will be used for the purposes of this report.

It shows the country to have had total surface run-off resources of about 71000 MCM/yr in 1990 (excluding the Karun which is purely navigational).

However, it should be noted the water balance for the year 1990 has now been superceded due to the gradual filling of the Ataturk Reservoir.

As mentioned earlier (Section A-4) the present flow of the Euphrates entering Syria from the Ataturk Reservoir is supposed to be 15770 MCM/yr. It has also been affirmed that this is only a transient situation which will end when the reservoir attains its full capacity of 48000 MCM around 1993. The Euphrates will then resume its normal flow of around 32000 MCM/yr with the added advantage of being spread evenly throughout the year.

This appears rather improbable if only due to the year to year variation in flow(1). Table A-5 has therefore continued to show the situation at the time of writing as extending up to 2010 in as far as the Euphrates is concerned. Even this is probably optimistic.

It will be seen therefore that Iraq's renewable surface water resources have now fallen to 58000 MCM/yr and are likely to dwindle further to below 48000 MCM/yr by the year 2010. A worsening in quality is bound to accompany that drop.

Total water use for all purposes will therefore have to drop from 52000 to 48000 MCM/yr by 2010. In as far as irrigation is concerned, this may be a blessing in disguise.

(1) Clawson (e.g. Between 1937 and 1964, maximum and minimum annual flow varied from about 1350 to 485 MCM, with an average of 850 MCM)

TABLE A-5 Approximate Water Balance - Iraq (MCM/yr x 1000)

Description	1000 MCM/yr		
	Yr 1990	Yr 1991	Yr 2010
- Tigris at Mosul	18.5	18.5	18.5
Withdrawal in Turkey (estimate)	-	-	(8.-)
- Euphrates at Hit (natural flow)	31.8	17.5	17.5+
Withdrawal in Turkey	(1.5)	-	-
Withdrawal in Syria	(5.-)	(5.-)	(7.0)
- Euphrates at Hit after upstream withdrawals	25.3	12.5	10.5
Sub-Total	43.8	31.0	21.0
- Tigris Tributaries (Mosul-Baghdad)	27.0	27.0	27.0
Sub-Total	70.8	58.0	48.0
- Irrigation	(49.2)	(49.2)	(39.0)-*
- Industrial & Domestic	(2.8)	(2.8)	(9.0)**
Sub-Total	18.8	6.0	NIL
- Return Flows Less Evaporation esp. in Swamps & Lakes (estimate)	5.0	5.0	5.0
- Discharge of Karun and Dez Systems (estimate)	20.-	20.-	12.-***
- Flow of Shatt Al-Arab to Gulf	43.8	31.-	17.-

* Increase of 2000 sqkms (estimate) in irrigated area but with water duty of 1 m instead of 1.33 m

** After cut-back. Could also be a cut-back in irrigation water

*** After possible withdrawal in Iran

APPENDIX B COMPARATIVE CRITERIA OR INDICATORS

B.1 Water 'Duty' and 'Per Capita' Consumption

These are the most commonly known criteria used by irrigation and water supply engineers.

a. Water Duty or water need refers to the amount of water required to grow a certain crop. It is most simply expressed as a total depth of water to be applied to the land. (i.e. meters or feet and hence cubic meters or acre-feet or any other unit of volume to give the total requirements for an irrigated area).

It is not easy to set a 'yard stick' for water duty or water need because of the number of variables involved - type of soil, quality of water, ambient temperatures, type of product to be grown, etc. However, it may be necessary to assign guide-line or optimum use figures in order to determine whether water is being efficiently used or wasted.

The tabulation below gives some figures for the area.

TABLE B-1: Selected Values of Water Duty

Description		Water Duty	
		Meters	Feet
North Israel - UNRWA Report, 1953		.89	2.92
Western Ghor - UNRWA Report, 1953		1.44	4.72
Average forecast for Lebanon - Fawaz, 1967		1.0	3.28
Arid areas[1]	Primitive methods	2.0	6.56
	Modern methods	1.0	3.28
Rainy areas[1]	Primitive methods	1.0	3.28
	Modern methods	0.5	1.64

In the body of this report a water duty of about 1 meter has been used (0.85 to 1.33 m)

(1) Ben-Shahar

b. Per Capita Consumption

This is very simply expressed as the quantity of water consumed by an individual in a given time (usually one day). Per capita consumption varies greatly across the world, from 40 litres or less to 500 or more per person per day. Sample cities are given below:

TABLE B-2 Per Capita Consumption - Selected Examples (Lpcpd)

City, Country or Agency	Consumption Lpcpd
Baghdad (1969)	172 (1)
Damascus	180
Paris (1948)	145 (2)
Major European Cities	250
Tokyo (1965)	490
Beirut (1965)	125-220 (depending on area)
Egypt (1976)	45 rural, 180 Urban
Tel Aviv	280
WHO minimum subsistence level	40
IWES (1983) minimum for piped water	90
West Bank (1990)	30

With WHO setting a figure of 40 lpcpd as the minimum subsistence level, a figure of 100 to 150 lpcpd appears a fair average for the area under discussion.

(1) Leeden
(2) IWES

B.2 Competition Levels Index

Ms. M. Falkenmark, a consultant to the World Bank, has proposed what she terms 'competition levels' which is simply defined as "the number of people competing for a supply of one Million Cubic Meters per year". The following limits are mentioned, (Table B-3).

TABLE B-3 Water Competition Levels

Number of People competing for one MCM/yr	Comment
< 100	e.g. Sweden
100 - 500	Dry season problems
500 - 1000	Water stress
1000 - 2000	Absolute water scarcity
> 2000	"Water barrier" beyond manageable capability

There appears to be a basic contradiction in the above tabulation with accepted norms. At the lower end, with 2000 persons competing for 1 MCM/yr, the allowance comes out at 1370 lpcpd which is a "paradise of plenty" not an unmanageable "water barrier".

WHO sets a minimum subsistence level of 40 lpcpd. This is 34 times less than the above, and yet there is one country in the area where the present supply is 30 lpcpd.

One explanation which comes to mind is that the source the writer used has misquoted Ms. Falkenmark and the competition level should be for 10000 cum/yr Not 1000000. This results in a consumption of 275 lpcpd for Sweden (which is luxurious, and one country in our area enjoys it) and a figure of 14 lpcpd as the "Water Barrier" (and which is probably representative of some Palestinian refugee camps in the area under discussion).

Irrespective of the above, the concept is so simple that it will be used as a comparative criterion. Sample calculations for 1990 based on Table 3.2 show Iraq and Turkey as having dry season problems; Egypt under water stress; Lebanon and Syria with absolute scarcity; and the remaining three countries as beyond manageable capability. The relative rankings, however, appear more realistic:-

Egypt:	956	(3rd)	Syria:	1687	(5th)
Israel:	2300	(6th)	Turkey:	406	(2nd)
W.B-Gaza:	15380	(Poorest)	Iraq:	255	(Richest)
Lebanon:	1327	(4th)	Jordan:	5060	(7th)

B.3

The preceding criteria are all expressed as a function of one variable - water. If we consider this as taking care of 'drinking' water needs, it may be advantageous to add a factor which would reflect 'food'. If these two can be combined, then the result would take care of 'food' and 'drink' and hence should be more representative.

The writer would therefor like to propose adding the area under irrigation (or the total irrigable area in the ultimate) as a third variable to 'Population' and 'Water Resources'. This may be tackled in two possible ways:

a. If a 'viable' area of land for sustenance can be determined, then a country will be deemed to be self-sufficient in food if it has an adequate irrigable area for its population and the water with which to irrigate it.

   Perhaps a good example to use as a basis would be Lebanon. This is a small mountainous country where farmers have learned to get the most out of their land.

   In Lebanon an average of 70% of land holdings were less than 0.5 hectars (5000 sq m) in 1967 [(1)], and this has not really changed. With a family size of 5 to 6 persons, this gives a round figure of 1 dunum (1000 sq m) per person. This figure of 1000 sq m of irrigable land may be adopted as the viable average area for the purposes of this study. Limits may be assumed to vary between 500 sq m and 1500 sq m. This may now be treated in the manner proposed in B.2 to give a "Food Competition Level", i.e. the number of people competing for 1 sq km of irrigable land. On the basis of the proposed viable plot of 1000 sq m per person, the number of people competing for 1 sq km of irrigable land should therefore not exceed 1000.

   Resulting figures for the area can be shown to be as follows:-

Egypt:	2125 persons	Syria:	2500 persons
Israel:	2190 persons	Turkey:	3345 persons
W.B.-Gaza:	13335 persons	Iraq:	490 persons
Lebanon:	3530 persons	Jordan:	840 persons

   The above figures perhaps are of theoretical interest only, although they do reflect some degree of truth when they lead to the conclusion that six out of the eight countries in the area are not able to feed themselves. With the exceptions of Lebanon and Turkey, where a considerble increase in irrigated area is forecast, the 'Food' situations (or Food Competition Levels) in the year 2010 are expected to be considerably worse than in 1990.

(1) F.A.O.

b. The writer prefers to use the irrigation or 'food' criterion jointly with domestic consumption to give what will be called the Water Sufficiency Index (WSI). As proposed it is simply defined as the ratio between the total renewable water resources as determined herein (Table 3.2) and the total water consumed in irrigation and domestic water supply. It is obvious that a ratio of 1.0 implies sufficiency and anything greater than 1.0 a surplus, and vice versa.

Since the intention is to establish a comparative criterion between the countries concerned general norms will be applied to all. The simplest way to do that would be to use a common water duty and per capita consumption. A value of 1 m will be used for the first and 100 lpcpd for the second across the board. The results are summarized in Table B-iv below. It should be noted that in view of the common values applied, the total Irrigation and domestic requirements will differ slightly from those of Table 3.2.

TABLE B iv WATER SUFFICIENCY INDEX 1990

(1) Country	(2) Total Renewable Water MCM/yr	(3) Water Use MCM/yr		(4) WSI (2) ÷ (3)
		Irrigation	Domestic	
Egypt	55000	24750	1920	2.062
Israel - Pre 67	1200	2100	168	0.529
- Present	2000			0.882
West Bank & Gaza	130	150	73	0.583
Lebanon - Total	2260	850	110	2.354
- Net	1400			1.458
Syria	7410	5000	456	1.358
Turkey - Total	138000	16750	2045	7.342
- Net	53000			2.820
Iraq 1991 - Text	70800	37000	660	1.880
- FAO		18000		3.794
Jordan - Actual	830	500	153	1.217
- Theoretical	900			1.378

Values for the year 2010 are summarized in Table B-v below, using the same common values for Water Duty and Per Capita Consumption.

TABLE B v WATER SUFFICIENCY INDEX 2010

(1) Country	(2) Total Renewable Water MCM/yr	(3) Water Use MCM/yr		(4) WSI (2) ÷ (3)
		Irrigation	Domestic	
Egypt	55000	28300	3139	1.749
Israel	2000+	2500	230	0.733
West Bank-Gaza	130+	740	153	0.146
Lebanon	2260	2850*	182	0.745
Syria	7410+	6000	909	1.072
Turkey	138000	33000	3212	3.811
Iraq	48000	39000	1186	1.194
Jordan	830	650*	303	0.871
Overall For Area	253630	113040	9314	2.073

* Could be less for Lebanon and more for Jordan.

It may be of interest to note that approximate water deficits for the area can be easily extracted from Tables B iv & B v. Thus in 1990 two countries have a Water Sufficiency Index of less than one with a combined deficit of 361 MCM/yr (268 + 93). In 2010 the total deficit for the four countries with water "insufficiencies" (WSI under One) is 2388 MCM/yr.

APPENDIX C - CONVERSION TABLE

UNIT	ABBREVIATION	MULTIPLY BY	TO OBTAIN
centimeter	cm.	0.3937	inches
meter	m.	3.281	feet
kilometer	km.	0.621	miles
square meter	sqm.	10.764	square feet
square kilometer	sqkm.	1,000,000	square meters
" "	"	247	acres
Dunum	Dnm.	1000	square meters
"	"	10,764	square feet
"	"	0.247	acres
"	"	0.1	hectar
Cubic meter	cum	35.315	cubic feet
" "	"	264.2	U.S. gallons
" "	"	219.97	Imperial gallons
" "	"	0.0008107	acre-feet
cubic kilometer	cukm	1,000,000,000	cubic meters
" "	"	270,000,000	U.S. gallons
" "	"	810,700	acre-feet
cubic meter/second	cum/sec	15,850	U.S gallons/minute
" "	"	25,563	acre-feet/year
" "	"	86,400	cubic meters/day
" "	"	31,536,000	cubic meters/year
1 Million cum/yr.	MCM/yr	1.12	cuft./sec
1000 cum/day	cumpd	183.47	U.S. gallon/min

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