Water Resources

West of the Jordan River

Problems & Solutions

prepared by

Dr. Avishay Braverman
Nehemiah Hassid
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1. Introduction

This paper describes the Israeli part of a coordinated regional study which sets out to formulate, appraise and evaluate alternative development programs. The study will contribute to an international effort, led by the World Bank, to achieve sustainable development in the region, on the premise that coordination between neighboring countries in the field of water development and usage could increase the total amount of available usable water for all. The net result of such coordination would thus be a "positive sum game" in which all players stand to gain. Political issues and the principles of allocating resources between countries are, however, beyond the terms of reference of this study.

Although the study in question was done in reference to the area between the Jordan River and the Mediterranean Sea, the problems it raises are common to many regions in the world. Hence, the solutions suggested could serve as a model to areas where water shortage exists or is anticipated.

Geographically, the study relates to areas and populations between the Mediterranean and the Jordan River, that is, areas in Israel within the "green line", the West Bank and the Gaza Strip. The study takes into full account the implications of urbanization processes, water quality and environmental considerations - and especially, water environment considerations.

The study, covering the period 2000-2040, examines Israel's projected water demand, existing sources, gaps between demand and supply and the possibilities of closing them.

Proposed solutions to the problem of closing the water supply gap will clearly tend towards programs incorporating wastewater reclamation and desalination of both brackish water and sea-water. It is estimated that up to the year 2010 the gap could be closed primarily by increased use of reclaimed wastewater. After this, the main solution to the water supply deficiency problem would be the gradual introduction of seawater desalination projects.

Notes

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The anticipated growth in the population of the urban regions will bring about an increase in the demand for fresh water and an increase in the production of sewage water. The population growth will also result in greater demand for agricultural produce. However, icreasing efficiency in agriculture will enable the supply of the needed produce without significant addition of water, and through utilizing reclaimed wastewater. The agricultural sector will be able to spare some of the fresh water for urban use.

As a result, the main utilization of fresh water will take place in urban areas, while its use by agriculture will decrease as the dependence on purified wastewater increases. That will be followed by a growing gap in the prices that the urban sector will be paying for the use of water and its removal, versus the average price of wastewater in agriculture.

Wastewater reclamation is considered not only a water supply stopgap but also a means of disposing of sewage in a manner appropriate to the ecological and environmental requirements of the twenty-first century.

The choice of seawater desalination as the ultimate solution rather than importation of water from other countries - amongst alternatives examined - was determined on the basis of the following considerations:

1. The engineering/economic parameters of water importation programs and evaluation of their cost are highly uncertain (except in the case of the canal from the Nile, on which engineering data is of a higher level).

2. A downward trend is foreseen in the cost of erecting new water desalination projects and maintaining those presently operating, due to technological improvements expected to appear in the next twenty years.

3. Seawater is the only existing quantitatively unlimited source of water.

4. Since importation of water depends on multinational agreements it may involve political dangers, as well as the possibility that the price charged for the water could be at least as high as the alternative cost of desalination.

5. In future water systems exploiting water of different qualities - including reclaimed wastewater - the mineral quality of the water will have to be ameliorated by dilution with high quality desalinated water.

Although the assumptions in a study of this nature may be expected to be somewhat uncertain, should the study's recommendations be accepted, the course taken will be in the direction of immediate implementation of treatment and reclamation projects, and entry into desalination towards the year 2010. An error in assumptions may involve adjustment of the year for starting desalination, making it earlier or later than 2010. If indeed the

assumptions lead to such an error, and if at the same time it is decided on immediate preparations for entry into the desalination age, the error can be corrected according to actual developments between the years 2000 and 2005.

The importance of neighborly coordination regarding water use and sewage disposal seems self-evident; it is in fact vital. A distinction has to be made, however, between the approach adopted regarding activities undertaken by Israel within the defined area between the Jordan and the Mediterranean Sea and activities undertaken involving coordination with Jordan. Integrated activity between Israel and the future Palestinian Autonomous Authorities in the planning and implementation of water projects, is clearly inevitable since this region constitutes an almost unified hydrological unit.

The progressing peace process in the area, will enable a discussion with the Jordanians based on a similar study done by them. This should result in the presentation of solutions based on the cooperation between all the elements in the area.

Practical solutions to the problems of water in the region from a comprehensive viewpoint will call for heavy investments and the creation of suitable financial mechanisms to carry programs forward.

2. The Geo-Urban Overall Plan

According to projections and Israel's present planning concept, most of the country's population will continue in the future to concentrate in the metropolitan area between Hadera and Gedera with Tel Aviv at its center. Within this area the thickest concentration will be in Tel Aviv and its satellites. This concentration will be "self-created" due to the dynamics of metropolitan development, which may be encouraged by the government out of transportation considerations (No efficient transportation system exists yet for daily commuting into the city of a large part of the population living in the metropolitan outskirts).

In addition to the Tel Aviv center, other urban centers such as Haifa, greater Jerusalem and Gaza are expected to grow in population. In parallel, smaller urban concentrations will grow up throughout the country, in towns like Beer Sheva, Carmiel, Kiryat Shmonah, Ramalla, Nablus and others.

The projected population growth will alter the relationship between amounts of water supplied to the urban and to the agricultural sectors. With the increasing shift to urban concentrations, the problems of water quality and disposal of sewage will be accentuated.

3. Water Quality

Population growth and density, water scarcity and heightened awareness in matters of health and environment, will place the subject of quality at the center of the problems of the water system in the years 2000-2040. Drinking water and water for some industrial purposes will have to meet very high standards, demanding appropriate raw water treatment (as long as there is no desalination).

This study presumes that removal and conveyance of water that has served various urban uses (domestic, industrial, etc.) will, in the future, only be permitted in closed systems, unlike the present situation in which sewage (some of it totally untreated) flows into sewage pits, wadis, river beds and the sea. The final aim of the treatment of wastewater removed in closed systems would be use in irrigation.

As part of the water system, agriculture will play an important role in the determining of water quality. The irrigation outlet will form an integral part of the wastewater treatment and removal system, while agriculture will have to adapt itself to a regime of balanced fertilization and controlled farming subject to soil and water source pollution prevention and food quality constraints.

4. Methodology of the Study

It follows from the above that the study is not confined to locating the water supply gaps and performing simplistic economic analyses of the feasibility of closing them. Water sources and uses have been examined along a time axis in an effort to bring into account the projected developments bearing on the various parameters, including classification of water sources according to geographical distribution and quality. The possibilities studied for closing gaps took into consideration existing sources, possible additional quantities from these sources, the whole subject of wastewater and two main categories of unconventional sources: a. water imported from other countries; b. desalination. Although, in the matter of source development, wastewater reclamation has been practiced for some time and was stepped up in the late 1980's, this may still be seen as an unconventional source in the overall future context, as regards engineering problems which remain to be solved, and, above all, the amount of finance required for its further development.

5. Planning Assumptions

5.1 Israel's population is expected to increase from 4.9 million in 1990 to 7.7 million in 2010 and 12.8 million in 2040.

5.2 The Arab population in the West Bank and the Gaza Strip is expected to increase from 1.6 million in 1990 to 3.2 million in 2010, and 6.3 million in 2040.

5.3 The per capita water demand in the urban and industrial sectors is almost inflexible and is expected to remain at its present level of an annual 120 cu.m. at the beginning of the period and decrease to 110 cu.m. per capita by 2040. The annual per capita demand in the West Bank and Gaza Strip is at present 35 cu.m. and will increase to 100 cu.m.towards 2040.

5.4 The demand for water in the agricultural sector is derived as a function of the projected development of agriculture and as relating to the role of agriculture in the water quality cycle.

6. Food Supply From Local Agricultural Sources and the Agricultural Crop Plan

The root question here is what price can agriculture afford to pay for water, and whether a future agricultural crop plan could be established to withstand water prices stemming from future costs and system considerations for overall water supply to the different users, and at the same time meet food demands defined in Israel as non-tradable.

The basis used in the study for designing a crop plan was the 1993-1997 agricultural production forecast prepared by the Israel Ministry of Agriculture Planning Authority. Among the above forecast's planning assumptions it was determined that food supply to the population of Israel with regard to vegetables, fruit and milk would come mainly from local agricultural sources. In a quantitative analysis it was assumed that this situation would prevail throughout the period, although the possibility was foreseen that some vegetables, fruit and milk would be imported in the future. This assumption, taken parallel with the calculated return for water from Israel's total agricultural crops, implies that most irrigated farming activity would concentrate on vegetable and fruit production and 25% of the dry fodder requirement for milk production.

In the present study it was assumed that during the planning period a rise in efficiency in agricultural production generally and specifically in water exploitation could be expected. In the years 1993-1997 the cumulative increase in efficiency is expected to be 5%; for the period 1997-2040 the cumulative rise in water-use has been assumed at 15%, and it is suggested that efficiency coefficients will rise even higher. This subject and the validity of other basic assumptions are dealt with below.

The agricultural crop plan views Israel, the West Bank and the Gaza Strip as one economic system with free movement of goods and services. Where food supply is concerned, the agricultural system in these three areas should satisfy the vegetable, fruit and milk requirements of the whole population.

Based on the aforementioned 1993-1997 agricultural crop forecast, and subject to the above assumptions, an agricultural crop plan for 2000-2040 was drawn up for this study, indicating the agricultural sector's water demand and the cost of water it should be able to afford.

7. Balance of Sources and Uses (including West Bank and Gaza)

7.1 Conventional sources (MCM - millions of cubic meters)

	2000	2010	2020	2040
Groundwater	1,090	1,100	1,100	1,100
Jordan Basin	670	670	670	670
Floods	50	70	80	70
Effluents	198	198	198	198
Gaza	87	87	87	124
Losses	(40)	(30)	(25)	(25)
Total	2,055	2,095	2,110	2,137

7.2 Forecast water demand for years 2000-2040 (cumulative MCM - millions of cubic meters)

Year	Population (thousands)	Urban sector water demand	Agri. sector water demand	Total demand	Existing sources	Cumulative gap	New sources **	
							Wastewater	Other
2000	8,900	903	1,250	2,153	2,055	98	98	---
2010	10,900	1,151	1,317	2,468	2,095	373	288	85
2020	13,400	1,440	1,542	2,982	2,110	872	453	419
2040	19,100	2,041	2,017	4,058	2,137	1,991	873	1,048

** In addition to the amounts mentioned in 7.1 above.

8. Additional Water Development Sources

8.1 The possible sources for obtaining additional quantities of water are:

a. Additional wastewater reclamation
b. Importation of water by conveyance from a neighboring country
c. Desalination (of brackish and/or sea water)
d. Increased water-use efficiency

8.2 Wastewater reclamation

Reuse of water after suitable treatment serves several purposes:

a. It solves the sanitation problem of sewage removal, at the same time preventing environmental nuisances and hazards.

b. It prevents pollution of surface and ground water sources (safeguards the water environment). This subject is particularly important in the West Bank because of the rate of expected urban development and also the area's karstic structure.

c. It is an important and reliable source for solving the water resource gap problem.

As explained in the study, by the year 2000 an annual quantity of about 300 MCM of reclaimed wastewater will be in use (See accumulated figures in 7.1 and 7.2 above). Use over and above this quantity is termed "unconventional" due to the leap required from the point of view of scope of activities and accelerated growth rate and allowing for the fact that development of wastewater treatment technology and irrigation technologies to combat agriculture-related health risks still has a long way to go.

In line with Israel's policy and according to a long-range program, all sewage will be transported to suitable reservoirs and treated to the appropriate level to enable its use for crop irrigation.

From the water balances it may be learned, inter alia, that by 2020 reclaimed sewage will constitute 46% of the total irrigation water supply, and by 2040 this will have increased to 58%. The extent of investments needed to achieve this program is $ 550 million up to year 2010, a further $ 450 million up to 2020 and another $ 770 million up to year 2040, amounting to a total 1.8 billion (thousand million) dollars in the next 40 years.

The water and sewage system in Israel's non-agricultural sector is planned to be based on statutory authorities set up throughout the country, whose functions will include overseeing the general supply of water of the required quality, collecting sewage and raising it to a standard appropriate to environmental and irrigation quality demands. The cost of treating the water and conveyance of the effluent is estimated at between 26 and

52 cents per cu.m. The authorities will function on a business basis and as a closed economy. Investments will come from the authority's profits and the capital market.

This subject necessitates a unified approach and, hence, cooperation between Israel, the West Bank and Gaza. The terrain, geographical distribution of population, environmental requirements and the distribution of agricultural areas justify coordination of use of water and reclaimed sewage between the three elements.

8.3 Importation of water from neighboring countries

The following possibilities of water importation are discussed in the study:

a. Water importation from Turkey by sea in vinyl sacks.

b. Water importation from Turkey from the Seyhan-Cheyhan rivers, to Syria, Jordan and Israel, the West Bank, Gaza and the Arabian Peninsula.

c. As in b., but without the Arabian Peninsula.

d. Water importation from the Litani River to Lake Kinneret by an overland carrier.

e. Water importation from the Nile, by overland carrier.

The conclusion reached in the present study was that importation of water is not very promising. The necessary degree of economic/engineering knowledge required for such projects is lacking, and despite the peace process the political aspect may present a problem. All the countries involved, it should be remembered, may have their own water problems and it may be safely assumed that a country which plans to supply water to its neighbor will charge a price which, together with the cost of transportation, may equal the cost of desalination. If the question of water quality and the rising necessity of diluting water in the system with high quality desalinated water are also taken into account, the conclusion that the water importation solution is inferior to desalination is further strengthened.

8.4 Brackish and sea-water desalination

The need for significant quantities of desalinated water will arise in 2010. The period until then allows time for development of technological solutions and preparations regarding water-pricing. Water desalination is extremely important not only as an additional water source but also, and especially, as a means of water environment quality protection.

The intensive system discussed above, exploiting water from conventional sources to the last drop, treating wastewater and conveying it for agricultural use, calls for amelioration

of water by adding high quality water from an outside source. The most favorable source for this is desalinated water.

Logistically too, this source has obvious advantages. The large urban centers lie along the coastal plain (Haifa, Tel Aviv, Gaza), the source of water for desalination will be the Mediterranean, hence the desalination installations can be erected close to the large consumer areas.

According to calculations starting from the year 2010, the gap between water demand and supply is about 375 MCM per year. The most favorable solution at present for closing it is desalination. The investment required in order to close this gap until 2040 (excluding the needs of the Kingdom of Jordan) is about $3.3 billion in addition to the $1.8 billion needed for the reclamation of wastewater. The production cost per cu.m.of desalinated water is estimated at $ 0.72.

An interim stage in the subject of desalination is the use of brackish water. The per cu.m.cost of desalinating this water is only $ 0.35 to $ 0.50.

Sea-water desalination is essential to the solution of the region's water problem towards the year 2010. The subject demands timely preparedness, from the technological and planning aspects and regarding cooperation agreements and sources of finance. It demands the involvement of governments and industries, including investments in R&D and planning studies.

8.5 Marginal and average return for water, and water charges policy

The added production and conveyance cost of the extra water needed is $0.26 to $0.52/cu.m, for wastewater, and $0.72/cu.m. for desalinated water.

Analysis of the crop plan arranged in diminishing order of marginal return for water shows a wide range of return per cu.m.of water, starting from $4.0 and decreasing to $0.10.

Taking average values (for the year 2010 for example), the following picture emerges:

Marginal return for water ($/cu.m)	Quantity of water (MCM)	Average (cumulative) return per cu.m
>1.0	593	1.58
1.0 - 0.5	285	0.83
<0.5	318	0.27
TOTAL	1,196	1.11

The total gap that year is 375 million cu.m. Assuming that this gap withstands irrigation needs and taking marginal return as against marginal water, then the last 318 million cu.m.will yield an average return of $ 0.27 /cu.m.while its cost is $0.72/cu.m.

From a purely economic viewpoint it would seem unprofitable to produce the aforementioned quantity of water - 318 million cu.m.- if there were importation alternatives for the same price. If the cost of importation alternatives were higher, then the marginal return per cu.m.would rise making production of marginal water worthwhile. The decision affecting production of this quantity of water would have to be reached in the years 2000-2003, and by then the question of profitability would be clearer. Other considerations are also liable to appear, regarding population composition and distribution, and agriculture as a value, etc., which may indicate a need to preserve a certain amount of agriculture. On this question two important points should be noted: a. the average return per cu.m.is higher than one dollar; b. all water deriving from wastewater and supplied freely to agriculture - excluding conveyance costs - is water whose treatment costs the urban user would have to bear.

The question asked is whether the return for water derived from Israeli economic statistics also applies to an economy which includes the West Bank and Gaza, bearing in mind that the present standard of living and, to some degree, the present standard of agriculture in the West Bank and Gaza, are low. The present study is concerned with very long-term planning and the assumption is that being one economic unit, the standard of living in the West Bank and in the Gaza Strip will rise rapidly and in the years considered for introduction of desalination, 2010-2020, will approach that in Israel.

9. Validity of Assumptions

In a study covering a planning horizon of 40 years, the question of validity of assumptions arises. No doubt, changes can occur over the years in each of the parameters affecting assumptions, namely, the rate of population growth, technological advances, trade conditions, the food basket composition, etc.

From the study itself and, on the face of it, subject to assumptions, two main conclusions are arrived at. The solution to problems of quality and deficiency in water supply will be achieved through appropriate preparations for wastewater reclamation and sea-water desalination. An error in assumptions and in the model could, it seems, lead to erroneous decisions. Further analysis shows that the subject of wastewater is not affected by assumptions. The technological and physical infrastructure for sewage collection, reclamation and disposal, has been established over the past decade in the Dan Sewage project and other local projects. Expanded activity in this subject is a function of resources to be budgeted year by year.

10. Cooperation on a Regional Level

Inter-state cooperation could in the future reach all the countries of the region (Turkey, Iraq, Syria, Lebanon, Jordan, Israel, the West Bank and Gaza, Egypt and the Gulf States). This study, however, deals with Israel, the West Bank, Gaza and Jordan only.

The area of Israel, the West Bank and Gaza appears in calculations as one entity regardless of political and institutional aspects.

With regard to cooperation with Jordan, the basic assumption is that even in the analysis of sources and future uses, conclusions reached in Jordan as to the need for maximum use of wastewater and seawater desalination will be similar to those in Israel, although their timing may be different.

Population concentrations in Jordan are some distance from sources of sea water for desalination, but closer to the natural sources of the Jordan basin. Thus, the Jordanians may be interested in joint projects, such as:

- Bringing sea water sources closer to Jordan for the purpose of integrating them with an Israeli or joint "Two Seas" (Mediterranean Sea - Dead Sea or Red Sea - Dead Sea) Canal project; or

- Seawater desalination along the Mediterranean coast and conveyance of the treated water to Jordan.

- The "Two Seas" Canal project could contribute to solving the water shortage problem if desalination plants were built along it in the Jordan Valley or the Dead Sea, exploiting the water drop to below sea level as a source of hydro-electrical energy and/or a conservational source of energy in the reverse osmosis process.

11. Conclusion

This study is intended to examine urban and agricultural water requirements in areas west of the Jordan as a basis for providing appropriate answers to these requirements and future coordination with Jordan.

The study has devoted careful thought to the subject of the quality of the water to be supplied to the population and the question of reclamation and disposal of wastewater.

Regarding the water system as a whole, from the year 2000 gaps appear between water demand and supply which, up to year 2010 can be closed by reclaimed wastewater. After

2010 the need arises for production of water from unconventional sources. The study proposes that desalination should be considered the primary source of this water.

Taking the urban sector water demand as inflexible, including the system's obligation to supply the treated effluent to consumers and on the assumption that food requirements in vegetables, fruit and milk will be supplied by local agriculture, the urban sector appears able and obliged to pay the costs of sewage treatment and desalination.

Future coordination between all the areas west and east of the Jordan in the subject of water and economics is most important, if not vital.

12. Recommendations

12.1. Main Points

Where solutions to water problems are concerned, Israel, the West Bank and the Gaza Strip should be regarded as one planning unit.

The main technologies capable of meeting future water problems are wastewater reclamation and desalination of brackish water and sea water.

Solutions to water shortage problems should ensure:

a. Compatibility of water sources and water supply with demands in the various periods by: continued development of existing sources; development of unconventional sources; adoption of new and innovative technologies; implementation of innovative projects; demand management and an appropriate pricing policy.

b. Appropriate water standards for all types of use: drinking, industrial and agricultural.

c. Safeguarding of general environment quality and of water environment quality.

12.2. Existing Water Sources

The main conventional water sources should be exploited to the maximum, thereby increasing the area's annual water supply by 145 million cu.m. This will be achieved, inter alia, by addressing the subjects of floodwater storage, reduction of water losses and, especially, demand management and pricing policy, to prevent water wastage generally and discourage use of water to irrigate crops which give a low return for water.

12.3. Other Sources for Closing the Water Gap

a. Water quality

The 2000-2040 water development setup should be seen as one entity, responsible both for supply of the required water and the treating and disposal of the used water. Thus, at all points of the water cycle the quality of water supplied to urban and agricultural consumers and the treatment and removal of sewage can be scrutinized, ensuring prevention of any general environmental damage and in particular water environment damage.

b. Wastewater Reclamation

The setting up of a sewage treatment and removal system, the first stage in environmental treatment, will mean that no untreated sewage will be allowed to drain off to sewage pits, the sea, wadis and streams. The treated water will be used mainly for irrigation purposes, with irrigation acting as the final stage in the water reclamation cycle.

The subject of sewage, its treatment and removal has reached an advanced stage of development in Israel, but has not yet been applied sufficiently in the West Bank and the Gaza Strip. To advance the subject, about $ 550 million will be required until 2010. Up to the year 2020 a further $575 million will be needed and another $ 1,050 million by 2040. Overall investments amounting to $ 2.2 million dollars would yield an additional 970 million cu.m.of water per year.

In view of the importance of this subject it is recommended that the World Bank assist in the funding of these developments.

c. Desalination

As the findings of the study show, a deficiency of water, exceeding the conventional sources between the Mediterranean and the Jordan, will appear in 2010 (if until then the water used in agriculture is reclaimed wastewater, as per the study data). The answer to this deficiency, in addition to reclamation of all sewage water, will be provided by desalination plants.

If future desalination plants are to be reliable and their setting up, operation and maintenance not too expensive, applicable and specific research must be carried out in both the basic technology and in the planning of the plants themselves. Subjects for more research include: improvement of durability of membranes and other materials, problems of heat transfer (the problem of furring), improvement of pump efficiency, computerized control developments, etc.

It goes without saying that Israel's technological ability built up over the last 30 years, especially in the arms industry, could provide a basis for the advancement of desalination technologies.

In order to be able to supply the reclaimed water at a reasonable price, starting from the year 2010, it is recommended that parallel with the technological development work, desalination plants should go into operation from the year 2000; the resulting feedback would stimulate and contribute to the R & D.

The investment required in order to set up desalination plants up to the end of 2040 would amount to $ 3.3 billion. This investment would yield an addition of 1.1 billion cu.m.of water per year by the end of the period.

d. **Demand management and pricing policy**

Israel has amassed wide experience in the field of demand management. This should be exploited to the maximum by encouraging methods of efficient and economical water use in agriculture, industry and for municipal purposes.

Where pricing is concerned, a new approach will be needed: users will be required to pay a price based on the following economic considerations:

The main addition in water demand in the years 2000-2040 will arise from urban population growth, and it is this population which will have to pay for the cost of technological development of innovative water sources, as well as sewage removal and its reclamation to a standard suitable for agriculture.

Agriculture will have to pay only the cost of conveyance of the reclaimed water, and the adoption of this policy will bring about a reduction in the average price of water intended for agricultural purposes.

Agriculture will assume a new role of "water treater" and "environmental quality preserver" and this role will be expressed in the price paid by the agricultural sector for water.

The price of water for agriculture will be determined not on the basis of subsidies, but on the basis of an economic calculation as shown above. The change in the price of water and in its quality for agriculture will call for changes in the agricultural production plan. An agricultural plan can be designed which would withstand water prices higher than those in force today.

"CREATING NEW WATER: A MIDDLE EAST PERSPECTIVE"

A significant converging of the world's geopolitical and economic concerns is taking place over the needs and rights of people to a significant water supply. The Earth's nearly six billion population will balloon to nearly 10 billion by the year 2050. Vast new quantities of water will be required by urban centers in China, India, Latin America and even the U.S. Southwest. Therefore, it is to the benefit of all countries that accords being hammered out in the volatile Middle East -- a region of 95% desert, intense sun, exploding population and water scarcity -- become a viable model for the international community.

This year has seen significant breakthroughs towards peace treaties between Israel and its Arab neighbors. However, if the social and economic benefits on which their success largely hinges are to be realized, one major obstacle has to be tackled. That is the scarcity of water, an issue which some believe is more likely to cause the next war in the Middle East than oil.

In the past, the water problem was commonly seen as one of allocation. Fair allocation, it was thought, would solve the problem. But a recent study which I directed of the region west of the Jordan river, commissioned by the World Bank, concluded that this view is wrong. (A separate study of the region east of the Jordan also indicated that demand is outstripping supply). Given the expected population growth and economic development, demand over the next 50 years in Israel, Jordan and the autonomous areas will exceed supply by a substantial margin. It is expected to reach 6.5 billion cubic meters annually by 2040 while conventional sources at that time will supply only 3 billion cubic meters leaving a gap of 3.5 billion cubic meters a year. Any effort to allocate these sources in accordance with any criteria whatsoever cannot possibly provide a solution to the problem except for the very short run. The only way to bridge the gap will be to create a new water supply.

Today, more than seven million people live west of the Jordan river -- close to 5.5 million Israelis, and 2 million Palestinians. This will rise to a total of 11 million by 2010, and 18 million by 2040 -- 12 million Israelis and more than 6 million Palestinians.

The area west of the Jordan is very small. The population density in Israel (omitting the Negev desert) is already higher than that of Belgium or the Netherlands, the most densely populated countries in Europe. With the Palestinian population added, the density is even higher.

At present, the water supply in the area west of the Jordan is about 2 billion cubic meters a year. We estimate that by 2040, demand would be about 4 billion cubic meters a year. If acceptable standards of living are to be maintained in the area, improved water management, though vital, cannot constitute a satisfactory solution on its own.

The first task is to preserve the quality of the existing aquifer, which is deteriorating because of the massive increase in wastewater generated by the rapidly growing urban population. This can be done by investing in better treatment of wastewater which would not only protect the aquifer, but also provide more than 1 billion cubic meters of water per year by the year 2040, suitable for agricultural use.

This would still leave a shortfall of about 1 billion cubic meters for urban and industrial uses needing higher quality of water than can be provided by treating wastewater. There are only two solutions: to import water or opt for the desalination of seawater.

In the past, it has been suggested that an overland carrier (a canal or a pipe) could transfer water from the Nile to Gaza. But Egypt has a huge rate of population growth, most of the country is arid or semi-arid, and the Nile is shared by Sudan, Ethiopia and other countries. These facts rule out that option. An alternative would be to import water from the rivers of Turkey, either by overland carrier or by sea. The technical feasibility is not proven yet, and given the complexities of the peace process, may be too risky. The price could also be higher than seawater desalination.

That leaves the desalination option. Experience to date indicates that the cost is normally US $1.10 per cubic meter of water, but the study calculates that operational improvements could soon reduce this to about $0.70 per cubic meter by the year 2000. A major research and development effort could reduce the cost even more, making desalination the most attractive option. The required investment for the reclamation of wastewater would total about $3 billion over the next 50 years. Desalination would require another $3.3 billion.

East of the Jordan, a solution for the water shortage is required even sooner. The total investment needed for generating new water for the entire region east and west of the Jordan during the next 50 years, is probably less than the total defense expenditure of countries in the region in one year. So why not use the goodwill created by the peace process to mobilize the resources necessary to eliminate the shortage of water for the entire region.

What is required is a plan of action. The more innovative solution -- desalination -- requires a massive effort, including investment in improvements in technology. This is urgent, since the shortage of water is rapidly increasing and becoming critical.

One of the critical questions to be resolved soon is whether the desalination solution should include only plants constructed along the seaside, or the construction of canals or pipes connecting, alternatively: the Mediterranean to the Dead Sea, the Red Sea to the Dead Sea, or the Mediterranean to the northern part of the Jordan river. The rationale for this is the utilization of the height differential (e.g. `0' meters for the Mediterranean and -400 meters for the Dead Sea). Such major undertakings must be assessed in the most professional and objective manner.

While the upcoming Economic Summit in Casablanca will focus on the Middle East and North Africa -- and feature the pivotal role of water creation in one of the planet's most war-torn regions -- the compelling, urgent issue is global.

Launching a visionary program for the Middle-East and North Africa would be a most fitting way to celebrate this year's 50th anniversary of the Bretton Woods conference, and would provide a valuable model for confronting the worldwide water supply problem as populations continue to expand.

Dr. Avishay Braverman is President of Ben-Gurion University of the Negev and a former Senior Economist with the World Bank.