NOTES ET DOCUMENTS

THE LONG TERM WATER BALANCE EAST AND WEST OF THE JORDAN RIVER*

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This paper evaluates projections of the long term water balance in the region East and West of the Jordan River, including Israel, the West Bank and the Gaza Strip, and Jordan. Projections are based on a few assumptions about population growth in the region, water consumption per capita for urban needs, agricultural needs, etc... A basic scenario based on those assumptions is presented. Alternative scenarios are also analyzed: water balance in case of water reclamation as against no advance in the treatment of sewage water, in case of drought years, in case of investing in a desalination project, specifically a canal project between the Dead Sea and the Red Sea or the Mediterranean Sea.

Main results show that the fresh water supply is expected to increase at an insignificant rate while population in the region will double in the next 25 years. If no measures are taken, a severe water shortage will occur within a very short time, before the end of the century. This will mean a need to reduce the agricultural activity plans.

A few solutions are considered. The most important conclusion is probably that water reclamation measures should be taken very soon. Treatment of waste water should reach within a few years about half of the total urban use. Treated

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water would be in the long run the main source for irrigation in agriculture, and also for a few urban uses. In parallel it is recommended to begin a long term process of desalination of sea water. This can be done at desalination plants on the sea shore. Desalination within a Two Seas Canal project is considered as insufficient in relation to projected water demand.

It is finally recommended to reconsider the structure of agricultural activities, in light of the severe shortage of water and of its increasing prices.

1. THE PROBLEM

Water shortage is expected to be one of the major problems affecting the economic development in the Middle East. This also has been often mentioned as a potential trigger of political and security instability in this region.

This paper tries to offer a preliminary evaluation of the extent of this problem, of its time schedule, and of the solutions which are currently contemplated. It relates both to Jordan and to Israel, the West Bank and the Gaza Strip. A few tentative conclusions and recommendations are offered.

There is no doubt that the water question is a very major one, and deserves a full and extensive analysis. However, some of the implications of this problem may impose extremely urgent policy questions, which should be addressed even before a full analysis is completed.

2. SOME FORECASTS FOR RELEVANT PARAMETERS

Water balance is a result of demand and supply. Here are a few basic forecasts for parameters which influence them (see table 1 for detailed numbers).

2.1. Demand

There are two basic sources of demand for water: urban and agricultural. Urban demand is defined as the demand for drinking water (for all population, urban and rural), and for water used in economic activities, mainly industry. Urban demand is evaluated as a function of population size, and expected consumption per capita. Agricultural demand is evaluated as a function of agricultural growth potential and agricultural technology. The main assumptions are the following.

2.1.1. Population

Population growth West of the Jordan River, including Israel, the West Bank and Gaza Strip is evaluated on the basis of projections by the Central Bureau of Statistics and of the National and Economic Planning Authority. The rate of growth of the population is quite rapid in the first decade, between 1990 and 2000, as a result of the heavy immigration, and reaches an average annual rate of 3.1 %. It declines to a rate of 2.1 % in the next decade and stabilizes in the long run (until 2040) on a growth rate of 1.8 %. Then it will reach the level of more than 19 million persons, out of which about 11 millions in Israel and 8 millions in the West Bank and Gaza.

For the population in Jordan, projections presented at the Symposium held in 1991 by the Water Research and Study Center at the University of Jordan show an annual population growth at a rate of close to 3 % until 2010. Then the population will reach 6.5 millions. We assume a declining rate of growth in the future, reaching about 2.0 % in the longer run, and total population of 12.2 millions in Jordan at the year of 2040.

In total, the water sources will have to supply the needs of a growing population in the region, which will double until 2020 and triple until 2040.

2.1.2. Urban water consumption

Urban water consumption west of the Jordan River stands now at about 100 cubic meters per capita. It is expected to raise gradually, mainly as a result of an economic development process in the West Bank and the Gaza Strip, and stabilize in 2020 on a level of about 107 cubic meters per capita.

In Jordan, data from the University of Jordan Symposium show a prevailing urban consumption rate of about 60 cubic meters per capita, and a projected rate of 66 cubic meters in 2010. We expect this parameter to grow more rapidly in the future, as a result of an expected economic development. We assume it will reach 70 % of its value west of the Jordan River in 2020 (75 cubic meters per capita), and 80 % in 2040 (85 cubic meters).

2.1.3. Agricultural demand

Contrarily to the tendency of increase of the consumption per capita of urban water, the agricultural sector one tends to decrease. Agricultural development plans in Israel show a continuous decline of water consumption per capita, from about 175 cubic meters now to 115 in 2020 and 105 in 2040. Projections presented in Jordan at the Symposium show a quite similar picture for

the years until 2010. We assume that the same trends will continue in Jordan as in Israel and in the West Bank and Gaza.

2.2. Supply

2.2.1. Fresh water

In Jordan, prevailing sources of fresh water are evaluated today at about 883 million cubic meters a year (as compiled by Dr. Daniel Freeman, in a position paper prepared for the National Economic Planning Authority, "*The Two Seas Canal*", 1995). They include about 277 MCM (million cubic meters) from ground water aquifers (as compiled by Garber and Salameh in "*Jordan's Water Resources and their Future Potential*", 1992), and 606 MCM from flow water (an extra quantity of about 150 MCM has been used from non-renewable fossil water). Improvements in the capture of flow water are expected to bring in the longer run the total supply of natural water to about 1150 MCM a year.

West of the Jordan river, the annual supply of clean water is evaluated at about 1900 MCM, out of which 1100 MCM are from ground water aquifers.

2.2.2 Reclaimed water

Water treatment for agricultural use is a major source which has to be considered in the future. Quantities of reclaimed water today are quite limited, both in Jordan and in Israel. A tentative assumption is that by year 2000 Israel and Jordan will treat 30 % of the urban consumption water. The proportion will gradually grow to 45 % in 2020 and stabilize on 50 % by 2040.

3. WATER BALANCE PROJECTIONS

Table 1 shows the results of the calculations of water balance based on the described projections for demand and supply factors, for the region as a whole, and separately for Jordan and for Israel, the West Bank and Gaza Strip. For all calculations, it is assumed that fresh water can be used both for urban and agriculture use, and that reclaimed water can be used only for agriculture, although non-potable water can be used for some urban purposes. It is also assumed that urban use has the highest priority, and only surplus from urban use is channeled to agriculture use. Main results are shown in the last three rows of each part of the table. It should be remarked that all the calculations at this stage are based on annual averages of demand and supply of water. Significant variations in rainfall may change the picture. At a later stage, the implications of drought years will be

analyzed.

1) Water regional balance is expected to be negative already by 2003. Assuming the given parameters above, Israel, the West Bank and Gaza will confront water shortage by 2000, while Jordan will theoretically see first signs of shortage soon after 2010. In fact, Jordan experiences already today a shortage of water, principally due to a severe leakages in urban supply (evaluated at 29 %), and of inefficient use in agriculture. The implication of water shortage at this stage will be the inability to fulfil the agricultural activity plans. By this time, about a third of all water needs in agriculture will be supplied by treated water (if infrastructures for treatment of waste water are installed as assumed).

Table 1: Water Balance Projection, Basic Scenario, East and West of Jordan River

year	1990	2000	2010	2020	2040
population (thousands)	10254	13749	17400	21617	31329
total demand (MCM)	**2684**	**3157**	**3648**	**4540**	**6389**
urban	984	1218	1577	2056	3082
agriculture	1790	1939	2071	2484	3303
total supply (MCM)	**2876**	**3192**	**3578**	**3971**	**4587**
drinking water	2741	2827	2947	3046	3046
reclaimed	135	365	631	925	1541
water balance (MCM)	**192**	**35**	**-70**	**-569**	**-1799**
% of agriculture	**111**	**102**	**97**	**77**	**49**
balance of drinking water (MCM)	**1847**	**1609**	**1370**	**990**	**-36**

Israël, West Bank and Gaza

year	1990	2000	2010	2020	2040
population (thousands)	6558	8900	10900	13417	19129
total demand (MCM)	**1804**	**2153**	**2468**	**2982**	**4058**
urban	664	903	1151	1440	2041
agriculture	1140	1250	1317	1542	2017
total supply (MCM)	**1955**	**2128**	**2357**	**1560**	**2933**
drinking water	1857	1857	1897	1912	1912
reclaimed	98	271	460	648	1021
water balance (MCM)	**151**	**-25**	**-111**	**-422**	**-1126**
% of agriculture	**113**	**98**	**92**	**73**	**51**
balance of drinking water (MCM)	**1193**	**954**	**746**	**472**	**-129**

Jordan

year	1990	2000	2010	2020	2040
population (thousands)	3696	4849	6500	8200	12200
total demand (MCM)	**880**	**1004**	**1180**	**1558**	**2328**
urban	230	315	426	616	1041
agriculture	650	689	754	942	1286
total supply (MCM)	**921**	**1065**	**1220**	**1411**	**1655**
drinking water	884	970	1050	1134	1134
reclaimed	37	95	170	277	521
water balance (MCM)	**41**	**61**	**40**	**-147**	**-673**
% of agriculture	**106**	**109**	**105**	**84**	**48**
balance of drinking water (MCM)	**654**	**655**	**624**	**518**	**93**

Source: 1. Central Bureau of Statistics, Israel. 2. Symposium of the Rater Research and Study Center at the University of Jordan, 1993. 3. Daniel Freeman, "The Two Seas Canal", 1995. 4. Projections of the National and Economic Planning Authority.

2) If no action is taken beside water treatment, the situation will continue deteriorating. By 2020, on a global regional basis, the supply of water after urban use will be sufficient for the implementation of only 77 % of the projected agricultural activity. At this stage, even this will be possible only if about 45 % of the waste water coming from urban consumption is reclaimed.

3) The ultimate crisis will occur before 2040, when drinking water will not be sufficient for the growing population. If the growth of urban water consumption per capita in Jordan follows the assumed path, the crisis in Jordan will happen after 2040, if water is used efficiently. In Israel, the West Bank and Gaza it will be felt at about 2035. At this stage, agriculture uses only reclaimed water, which is sufficient for the implementation of only 49 % of the plans.

The implication of those results is that water shortage is a very concrete and close danger, given the long time which is needed to prepare infrastructures for solutions. Solutions which are mentioned are the construction of a Canal to the Dead Sea, which can be used for the production of electricity and for desalination, the establishment of desalination plants on the Mediterranean Sea or on the Red Sea, or the importation of water from other countries (such as Turkey).

We shall see next the influence of the construction of a Canal.

4. IMPLICATIONS OF A CANAL SOLUTION

The Ministry of Energy and Infrastructure of Israel has published in January 1995 an "*Economic Reassessment of the Dead Sea Hydro Project*", in which a few options of canals are analyzed. A major assumption there is that the maximum quantity of water which can be desalinated by any canal cannot be higher than 800 MCM a year, in order to enable the Dead Sea to keep a stable level on the long run. Feasibility studies, construction, and operation until full capacity may take many years. We shall assume here that the plant will gradually achieve full capacity by 2010. Table 2 shows for the whole region the quantitative implications of the immediate construction of such a canal. In addition, graph 1 presents a demonstration of the projected water balance, with and without the canal solution. The graph shows the balance between supply and demand for drinking water.

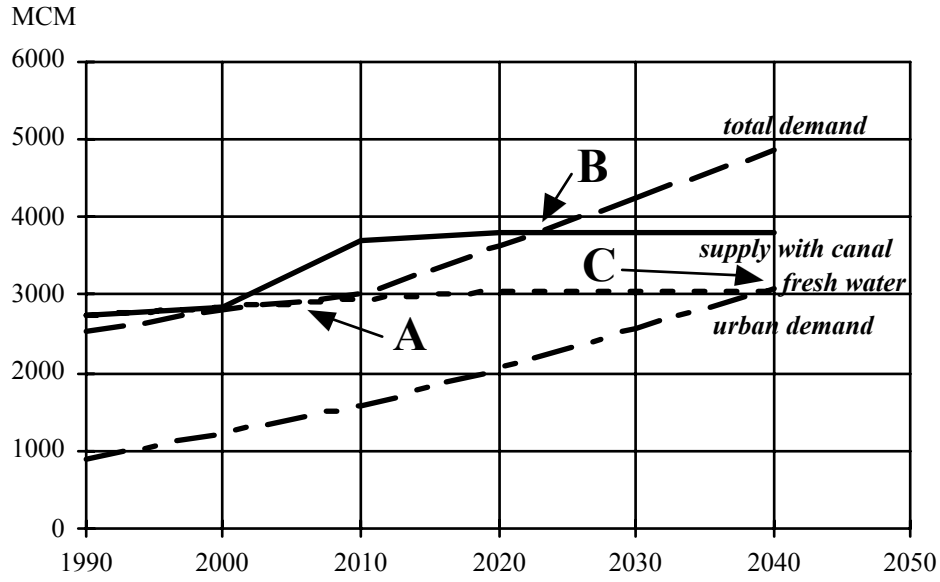
Total demand includes urban consumption, and demand for agricultural consumption above the supply of reclaimed water. Supply is presented before and after the installation of a canal. The results show:

1) While the crisis shortage of water for agriculture is expected to happen at about 2003 in regular conditions (point A in graph 1), if we keep the assumption that the process of water reclamation is accelerated, and if a canal is

Table 2: Water Balance Projection, With and Without a Canal, East and West of Jordan River

year	1990	2000	2010	2020	2040
total demand (MCM)	**2684**	**3157**	**3648**	**4540**	**6386**
drinking water	*2549*	*2792*	*3017*	*3615*	*4845*
total supply (MCM)	**2876**	**3192**	**3578**	**3971**	**4587**
drinking water	*2741*	*2827*	*2947*	*3046*	*3046*
water balance (MCM)					
without canal	*192*	*35*	*-70*	*-569*	*-1799*
with canal	*192*	*35*	*730*	*231*	*-999*
% of agriculture					
without canal	*111*	*102*	*97*	*77*	*49*
with canal	*111*	*102*	*135*	*109*	*70*
balance of drinking water (MCM)					
without canal	*1847*	*1609*	*1370*	*990*	*-36*
with canal	*1847*	*1609*	*2170*	*1790*	*764*

Graph 1: Projected Drinking Water Balance



operated, the crisis will be postponed for about 20 years, to about year 2024 (point B in graph 1). Postponing the crisis to this year will be a result of the addition of

800 MCM a year of drinking water by the canal, and the addition of about the same quantity of reclaimed water.

2) From this year on, the agriculture suffers from a continuously increasing shortage, and at year 2040, it can supply only 70 % of the expected production.

3) Shortage of drinking water, which is expected close to year 2040 (point C in graph 1), is not expected in that time range if a canal is installed.

5. BALANCE IN DROUGHT YEARS

The analysis above is relevant for average years. In years of drought, the results may be completely different, and it is important to allow for such a risk in any plan for the future.

The following assumptions are made for the case of a drought year:

- The supply of fresh water is limited to 1100 MCM in Israel, the West Bank and Gaza, and to about half the regular supply in Jordan (around 500 MCM).

- The allocation of drinking water for agricultural use is limited to half the quantities available during the drought year. In addition, reclaimed water is used in agriculture.

- No significant change is made in urban consumption during drought years.

Table 3: Water Balance Projection in Drought Years, East and West of Jordan River

year	1990	2000	2010	2020	2040
population (thousands)	10254	13749	17400	21617	31329
total demand (MCM)	**1800**	**2376**	**3020**	**3815**	**5457**
urban	894	1218	1577	2056	3082
agriculture	906	1158	1443	1759	2375
total supply (MCM)	**1677**	**1950**	**2256**	**2592**	**3208**
drinking water	1542	1585	1625	1667	1667
reclaimed	135	365	631	925	1541

demand for drinking water	**1665**	**2011**	**2390**	**2890**	**3916**
supply of drinking water	**1542**	**1585**	**1625**	**1667**	**1667**
water balance (MCM)					
without canal	*-123*	*-426*	*-765*	*-1223*	*-2249*
with canal	*-123*	*-426*	*36*	*-423*	*-1449*
% of agriculture					
without canal	*86*	*63*	*51*	*53*	*65*
with canal	*86*	*63*	*102*	*76*	*65*
balance of drinking water (MCM)					
without canal	*648*	*367*	*48*	*-389*	*-1415*
with canal	*1448*	*1167*	*848*	*411*	*-615*

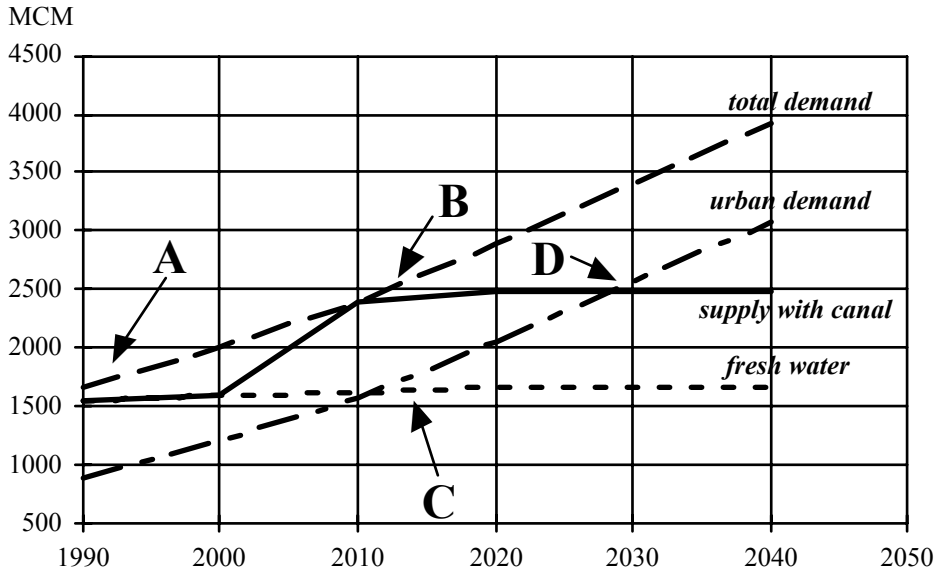
Table 3 and graph 2 shows the results in drought years, with and without a canal:

1) The problem of water shortage is already acute now in case of a drought year. This means that there is no possibility to afford the limited amounts of water in Israel and in Jordan. Soon, by the year 2000, a year of drought will mean a reduction of agricultural use of water to 63 % of the already limited allocations.

2) If no additional source of water is supplied, by 2011 a drought year may mean a shortage of water for urban consumption (point C in graph 2), while agriculture survives with only reclaimed water, at less than half of its emergency level. By 2020, a drought year may imply a reduction of 20 % of urban water consumption.

3) A canal hardly provides a solution for drought years. By 2010, if it reaches full capacity by then, it would provide all needs. But within a couple of years, it would already fail to secure the minimal needs of agriculture in case of drought. By 2028, the canal would not secure even the needs for urban water consumption in case of drought (point D in graph 2).

Graph 2: Projected Drinking Water Balance In Drought Years



6. WHAT IF - NO RECLAMATION

The projections above are made on the assumption that a rapid process of water reclamation is started. Today, waste water treatment plants still provide only a small portion of the needs for agricultural irrigation. In Israel, quantities of reclaimed water reached 98 MCM in 1990, and about 198 MCM in 1995. In Jordan, the evaluated quantities of reclaimed water are about 37 MCM. The projections made above assumed that the process of waste water treatment will gradually increase the recycling up to 30 % of urban consumption water in 2000, 40 % in 2010, 45 % in 2020, and 50 % in 2040. Reclaimed water is used mainly for agricultural purposes, but some urban uses have also been considered. Daniel A. Okun, in the paper "The Role of Water Reclamation in Addressing Water Needs in the Jordan Rift Valley" (in *Jordan Rift Valley Development Symposium*, April 24-26, 1995, Amman, Jordan), suggests a few options for non-potable reuse: landscape irrigation, cooling for industry and thermal power plants, toilet-flushing, cleansing, construction, fire protection. Water treatment is also an efficient measure for the preservation of ground water aquifers from pollution.

Table 4: Water Balance Projection in Case of No Water Reclamation
East and West of Jordan River

year	1990	2000	2010	2020	2040
total demand (MCM)	**2684**	**3157**	**3648**	**4540**	**6386**
drinking water	*2549*	*2922*	*3413*	*4305*	*6151*
total supply (MCM)	**2876**	**3062**	**3182**	**3281**	**3281**
drinking water	*2741*	*2827*	*2947*	*3046*	*3046*
water balance (MCM)					
without canal	*192*	*-95*	*-466*	*-1259*	*-3105*
with canal	*192*	*-95*	*334*	*-459*	*-2305*
% of agriculture					
without canal	*111*	*95*	*77*	*49*	*10*
with canal	*111*	*95*	*116*	*82*	*30*
balance of drinking water (MCM)					
without canal	*1847*	*1609*	*1370*	*990*	*-36*
with canal	*1847*	*1609*	*2170*	*1790*	*764*

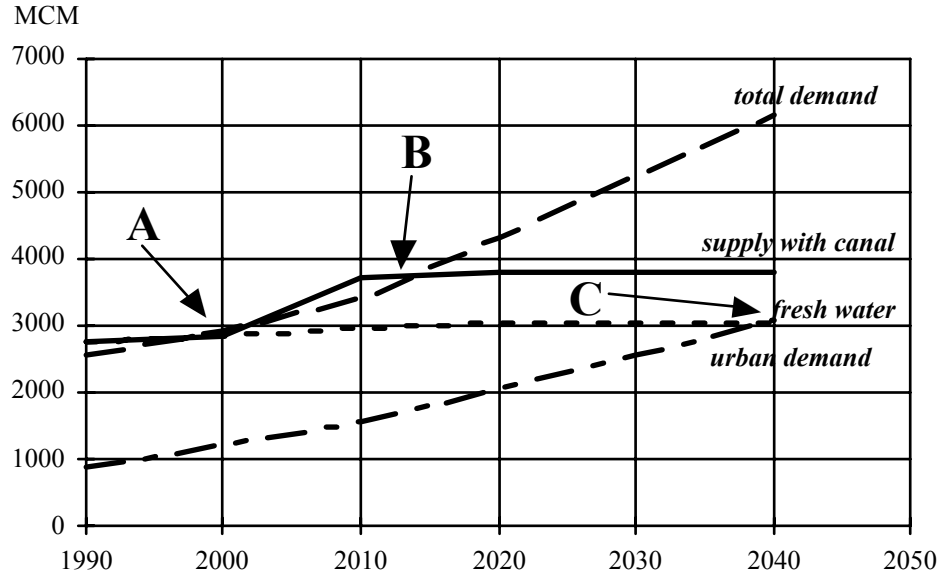
If no reclamation measures are taken in the future, the quantities of treated water are expected to stay at the present level of 37 MCM in Jordan and 198 MCM in Israel. Consequently, if no changes are made in agricultural activity programs, this limitation of reclaimed water will induce a growing demand of agriculture for drinking water. Table 4 and graph 3 show the consequences:

1) Water shortage for agriculture will occur very soon, at about 1997 (point A in graph 3).

2) Even if the canal is operated and reaches full capacity in year 2010, the solution will be for a quite short term: already in 2014, four years later, shortage of water for agricultural irrigation will be felt.

3) From 2015 and on, the situation of agriculture worsens very rapidly: water allocation is gradually decreased because of higher urban demand for the growing population (when reclamation takes place, part of this growing urban use, up to 50 %, is channeled back to agriculture). By 2040, only 30 % of the agricultural needs can be met if a canal is built (10 % in case of no water desalination).

Graph 3: Projected Drinking Water Balance With No Water Reclamation



7. ASSUMING A RAPID GROWTH OF JORDAN URBAN CONSUMPTION

The assumptions adopted here from the University of Jordan Symposium are based on a quite slow growth of urban water consumption in Jordan. However, if economic development occurs in the Middle East, and specifically in Jordan, at an increasing rate, this assumption may be too conservative. Economic growth naturally brings an increase in urban water consumption, both for household purposes and for economic activities. We now analyze a scenario in which the per capita urban water consumption in Jordan increases which brings it to equality the rate in Israel, the West Bank and Gaza at 2020. This would mean that the per capita would raise in Jordan from the prevailing

Table 5: Water Balance Projection With Rapid Growth of Jordan Consumption, East and West of Jordan River

year	1990	2000	2010	2020	2040
population (thousands)	10254	13749	17400	21617	31329
total demand (MCM)	**2684**	**3206**	**3807**	**4804**	**6646**
urban	894	1267	1736	2320	3343
agriculture	1790	1939	2071	2484	3303
total supply (MCM)	**2876**	**3207**	**3555**	**3974**	**4383**
drinking water	2741	2827	2947	3046	3046
reclaimed	135	380	608	928	1337
water balance (MCM)	**192**	**1**	**-252**	**-830**	**-2263**
% of agriculture	**111**	**100**	**88**	**67**	**40**
balance of drinking water (MCM)	**1847**	**1560**	**1211**	**726**	**-297**

Israel, West Bank and Gaza

year	1990	2000	2010	2020	2040
population (thousands)	6558	8900	10900	13417	19129
total demand (MCM)	**1804**	**2153**	**2468**	**2982**	**4058**
urban	664	903	1151	1440	2041
agriculture	1140	1250	1317	1542	2017
total supply (MCM)	**1955**	**2128**	**2300**	**2488**	**2728**
drinking water	1857	1857	1897	1912	1912
reclaimed	98	271	403	576	816
water balance (MCM)	**151**	**-25**	**-168**	**-494**	**-1330**
% of agriculture	**113**	**98**	**87**	**68**	**40**
balance of drinking water (MCM)	**1193**	**954**	**746**	**472**	**-129**

Jordan

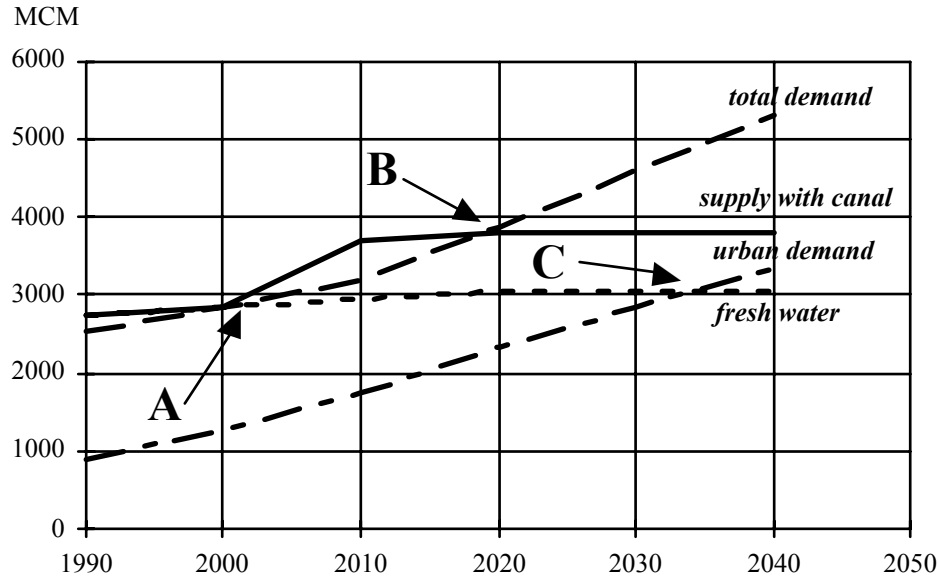
year	1990	2000	2010	2020	2040
population (thousands)	3696	4849	6500	8200	12200
total demand (MCM)	**880**	**1053**	**1339**	**1822**	**2588**
urban	230	364	585	880	1302
agriculture	650	689	754	942	1286
total supply (MCM)	**921**	**1079**	**1255**	**1486**	**1655**
drinking water	884	970	1050	1134	1134
reclaimed	37	109	205	352	521

water balance (MCM)	**41**	**26**	**-84**	**-336**	**-933**
% of agriculture	**106**	**104**	**89**	**64**	**10**
balance of drinking water (MCM)	**654**	**606**	**465**	**254**	**-168**

Table 6: Water Balance Projection With and Without a Canal With Rapid Growth Of Jordan Urban Consumption, East and West of Jordan River

year	1990	2000	2010	2020	2040
total demand (MCM)	**2684**	**3206**	**3807**	**4804**	**6646**
drinking water	*2549*	*2826*	*3199*	*3876*	*5309*
total supply (MCM)	**2876**	**3207**	**3555**	**3974**	**4383**
drinking water	*2741*	*2827*	*2947*	*3046*	*3046*
water balance (MCM)					
without canal	*192*	*1*	*-252*	*-830*	*-2263*
with canal	*192*	*1*	*548*	*-30*	*-1463*
% of agriculturewithout canal					
without canal	*111*	*100*	*88*	*67*	*40*
with canal	*111*	*100*	*126*	*99*	*56*
balance of drinking water (MCM)					
without canal	*1847*	*1560*	*1211*	*726*	*-297*
with canal	*1847*	*1560*	*2011*	*1526*	*503*

Graph 4: Projected Drinking Water Balance With Rapid Growth of Jordan Urban Consuption



evaluated 65 cubic meters to 75 in 2000, 90 in 2010, and stabilize on 107 in 2020, as in Israel.

Table 5 shows the detailed data in this case, and the water balance without a canal separately in Jordan and in Israel, the West Bank and Gaza. Table 6 draws the summarized picture of demand and supply of drinking water for the region as a whole, as presented in graph 4. Main results are:

1) Jordan will experience a shortage of water for agriculture at about the year 2000. If no measures are taken for the provision of water, a shortage of water for urban use will be felt by 2032. At this stage, no fresh water is allocated to agriculture.

2) The canal will offer a solution only for a quite short term of 9 years if it reaches full capacity in 2010: by 2019, additional measures have to be taken for the provision of water, in order to prevent hindering agriculture activity.

8. A GLOBAL OVERVIEW AND MAIN CONCLUSIONS

Since it is assumed that urban water consumption is considered as the use with highest priority, the quantity of surplus water which can be allocated to agricultural use, as a percent of agricultural needs, is a good measure of water

shortage. Table 7 and graphs 5 and 6 show the percent of agricultural use in each year, at different assumed scenarios.

Table 7: % of Agriculture at Different Scenarios,With and Without a Canal, East and West of Jordan River

Without a Canal

year	1990	2000	2010	2020	2040
basic scenario	111	102	97	77	59
drought year	86	63	51	53	65
high urban consumption in Jordan	111	100	88	67	40
no reclamation	111	95	77	49	10

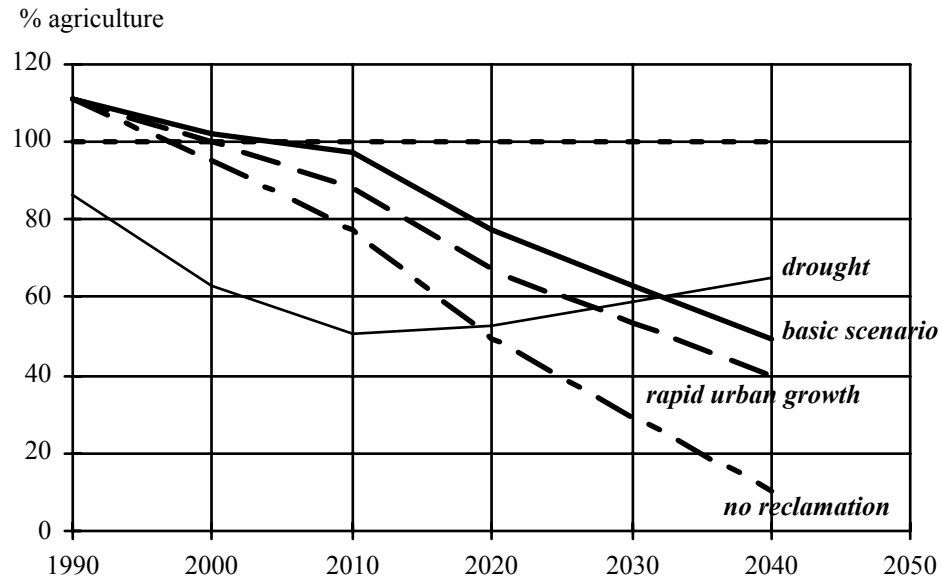
With a Canal

year	1990	2000	2010	2020	2040
basic scenario	111	102	135	109	70
drought year	86	63	102	76	65
high urban consumption in Jordan	111	100	126	99	56
no reclamation	111	95	116	82	30

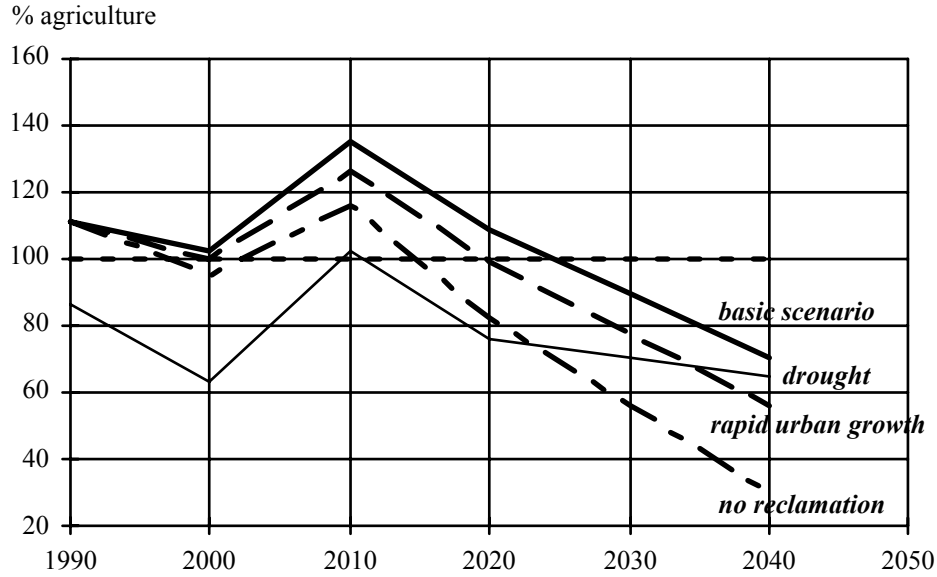
Some main results:

1) There is an urgent need to take measures for the provision of water in the region. The following regional time schedule for an average year should be kept in mind:

Graph 5: Ability to Maintain Agriculture Without a Canal



Graph 6: Ability to Maintain Agriculture With Canal



-1997: water shortage will occur if no measures are taken for the additional treatment of waste water and for desalination.

-2003: water shortage will occur if measures are taken for waste water treatment, but no measures are taken for desalination.

Measures, such as the canal project or other desalination projects require a long time until they reach full capacity: the time for taking a decision is already now.

2) Another aspect of the emergency of the situation is the risk of a drought year. Already today, the region is not prepared for a drought year, and agricultural activity may suffer and have to pay a much higher price than that paid up to now. This means that the minimal amount of agricultural activity will be unreachable, unless water long term sources are damaged.

3) A canal, which can supply a maximum quantity of 800 MCM a year, would reach full capacity only by 2010. Water shortage is expected to occur already by 2003, and therefore this is only a short term solution:

- Within 14 years after the canal reach full capacity, by 2024, and assuming that measures of water reclamation are taken, the canal solution will not be sufficient

anymore.

- If water reclamation measures are not taken, shortage will occur very soon: only 4 years after the canal reaches its full capacity, in 2014.

- A minimal level of security for years of drought will be supplied by the canal only for a couple of years after full operation. Most of the time the danger of drought years will not be solved by the canal.

9. SOME PRELIMINARY RECOMMENDATIONS

1) The problem of projected water shortage in Jordan, Israel, the West Bank and Gaza Strip is extremely urgent and urges for decision making by all parties in the region already now. It is recommended to establish a joint committee to address this question in the very near future, and suggest an agreed joint policy.

2) Independently of the cost considerations of a canal (any of three considered options) or of plants for water desalination, it seems that the canal cannot be the only solution, since it can provide only short term answer to the needs. The option of desalination plants has to be considered in any case.

3) Treatment of waste water is a major and crucial measure both for the short term and for the long term support of agricultural activities. It is imperative to give a highest priority for investments in plants for the treatment of waste water and accelerate water reclamation, even before taking measures for water desalination. Main reasons are:

a) Since urban use has a higher priority, shortage in agriculture is expected very soon. If agricultural needs are not considered, shortage of drinking water is expected only on the long term, by 2040.

b) The surplus quantities of drinking water which can be allocated to agriculture decline very rapidly because of economic development and of a growing population. On the other hand, the quantities of reclaimed water grow as a function of the growth of population and urban use. On the long term, reclaimed water will be the main if not the only source of water for agricultural use.

c) The treatment of waste water provides long term benefits, by decreasing the dangers of pollution of ground water.

d) The supply of reclaimed water to agriculture is not subject to fluctuations and to

the risks of drought years.

e) Reclaimed water can be considered also for many urban uses such as industrial uses, car wash, garden watering, etc...

4) On the demand side, the following measures should be taken:

a) Savings in urban consumption can generally hardly be considered. However, it is recommended to take immediate measures for the reparation of severe leakages in water pipelines, causing a lost of an evaluated 29 % of urban water in Jordan.

b) Agricultural use of water should be reconsidered. Production factors for agriculture, water and land, are severely limited, and the economic viability of a few products is due only to heavy incentives to those factors. Agricultural policy should be reconsidered, in the light of the growing shortage of water (and land), and of the ability of various agricultural products to pay the increasing prices of those production factors.