Development of the Water Resources in the Eastern Slopes of the West Bank

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Abstract: The eastern slopes of the West Bank were targeted by Israel since the first day of occupation in 1967, therefore, they are now with the lowest population density in the Occupied Palestinian Territory, OPT. Palestinians were prohibited from exploiting their natural resources in this area especially land and water. On the other hand, many jewish settlements were established in this area. Following the recent political developments and the Palestinian-Israeli agreement, then it is expected that the Palestinians will have full control over their land and its resources within five years. The eastern slopes including the Western Ghore represent the most potential area for development.

This study shows that developing the eastern slopes of the West Bank requires full utilization of the water resources in the area. The Palestinian riparian share in the waters of the Jordan River basin is the key element for developing the eastern slopes. This share was estimated to be 257 mcm/year. Also, utilizing the ground water aquifers through constructing water wells will provide another 105 mcm/year. Utilizing runoff water through dams will provide additional 13 mcm/year. Thus, the total water available can be about 375 mcm/year. This study found that this amount of water will be sufficient to satisfy the future domestic, industrial and agricultural needs of the area. Agricultural needs included irrigating 210 square kilometers suitable or can be reacclimated for irrigated agriculture. Those will be cultivated to satisfy the local demands from irrigated agricultural crops for the Palestinians in the West Bank and Gaza in the next 20 years. Thus, developing the eastern slopes was found to be essential to provide self sufficiency of essential crops and open new job opportunities to the Palestinian people.

Introduction

The eastern slopes of the West Bank lie between the Central Uplands and the Jordan river. They are located between Grid North 210 and Grid North 130 and Grid East 205 and Grid East 180 (Figure 1). They are about 80 kilometers in length and about 30 kilometers wide. This region is considered the most arid and eroded region in the West Bank. Its average annual rainfall is about 250 mm in the higher areas, and about 100 mm in the Jordan Valley. The Eastern Slopes have been subjected to severe over-grazing and rainfall run-off which have resulted in soil erosion and deterioration of natural vegetation.

The Jordan valley or the western Ghore, has a total area of about 500 thousand donums is located at the foot of the eastern slopes and included as part of them in this study. It is considered the most important area for intensive cultivation of winter vegetables and citrus and banana trees. The Valley lies within 200m-300m below sea level, and enjoys a warm winter and hot summer climates suitable for the production of off-season crops. The valley has two terraces; the flood plain of the Jordan River, called Zhor, and the rest of the Valley, called Ghore.

Analyzing available contour maps, testing the soil for salinity hazards and through site visits of the eastern slopes, we found that there are more than 210 square kilometers of land suitable or can be reacclimated for irrigated agriculture. Figure 1 shows the distribution of these lands. Knowing that the total area suitable or can be reacclimated for irrigated agriculture in the West Bank is only 610 square kilometers (Haddad and Mizyed, 1993) gives the eastern slopes a vital importance in developing the irrigated agricultural sector.

Although the area irrigated in the West Bank is about 100 square kilometers (5% of the total area), it contributes about 35% of the agricultural input in the West Bank (Awartani and Judeh, 1989). Thus, developing the irrigated sector will be vital to the Palestinian economy.

Irrigated agriculture crops include vegetables and fruit trees. The eastern slopes area produces more than 59% of the vegetables produced in the West Bank. It also produces 100% of the banana produced in the West Bank and Gaza. The area planted with citrus trees is still 23 % of that in the West Bank. Table 1 shows the contribution of eastern slopes in the irrigated agricultural sector (Awartani and Judeh, 1989).

Table 1 Areas irrigated in 1989 (thousands of donums):

Area	Vegetables &melons	Citrus	Other fruits
Tulkarm	12.1	16.3	0.8
Jenin	17.4	2.5	0
Nablus	3.7	1.7	0.2
Jericho	32.8	2.9	4.5
Ramallah, Beit-lehem and Khalil	2.1	.3	.1
West Bank Total	68.1	23.7	5.6
Contribution of Eastern slopes	40	5.4	4.7
% of West Bank production	59	23	84
Gaza	41.6	63	13
Total	109.7	86.7	18.6

Rainfall, Temperature, Humidity and Evapotranspiration

The total annual rainfall has a large range of spatial and temporal variations in the West Bank. For the eastern slopes, a variation trend is observed along the Jordan Valley and from the Jordan River toward the mountainous lay. The annual rainfall levels along the Jordan Valley drop from 270 millimeters in the north to less than 100 millimeters in the south with an overall annual average of 150 mm. The annual average rises from less than 100 mm to 500-600 mm in the mountainous lay (Haddad, 1990). The rainy months are usually October to April. Figure 2 shows average monthly rainfall in Jericho for the period of 1980 to 1986 (Rural Research Center, 1986).

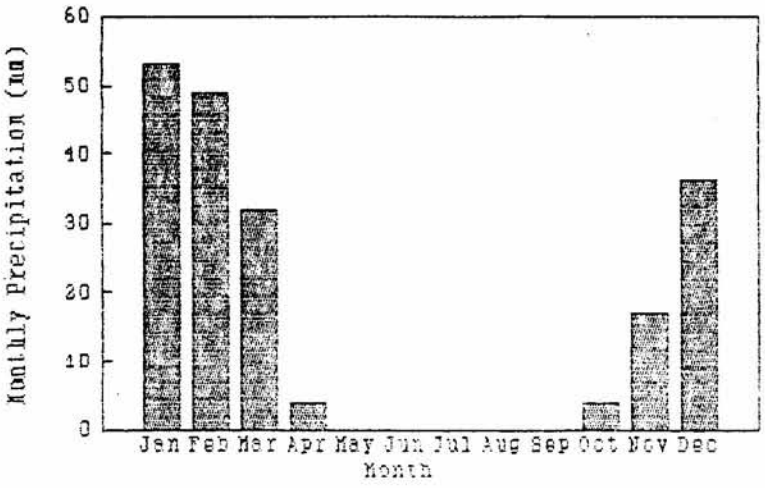

Figure 2 Average monthly precipitation in Jericho for the period 1980-1986.

Temperature ranges from 13-17 °c in winter months to 36-40 ℃ in summer. The annual average temperature for the Jordan Valley of the Western Ghore is 24°C. Figure 3 shows average monthly temperatures in Jericho for the period of 1980 to 1986 (Rural research center, 1986).

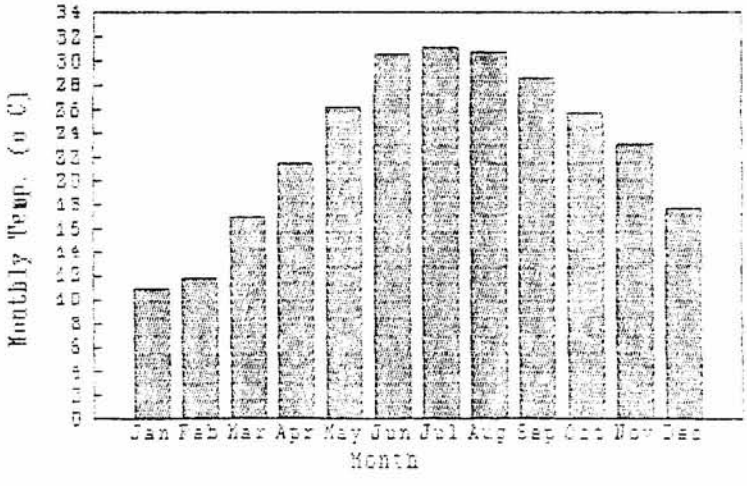

Figure 2 Average monthly temperature in Jericho forthe period 1980-1986.

The average measured relative humidity in the Jordan valley of the Western Ghore is ranging from 50% near Jericho and the Dead Sea to 60% in the Northern parts near Bardala. Another variation is that the minimum humidity occurs in June while the maximum humidity occurs in January.

No direct measurement for evapotranspiration is available in the West Bank (Mizyed and Haddad, 1993). Using temperature data for the period 1980-1986 measured at Jericho monthly evapotranspiration for grass reference crop were estimated using Blanney-Criddle method (James, 1988). The annual evapotranspiration for grass reference crop was estimated to be 1577 mm while monthly values are shown in Figure 4.

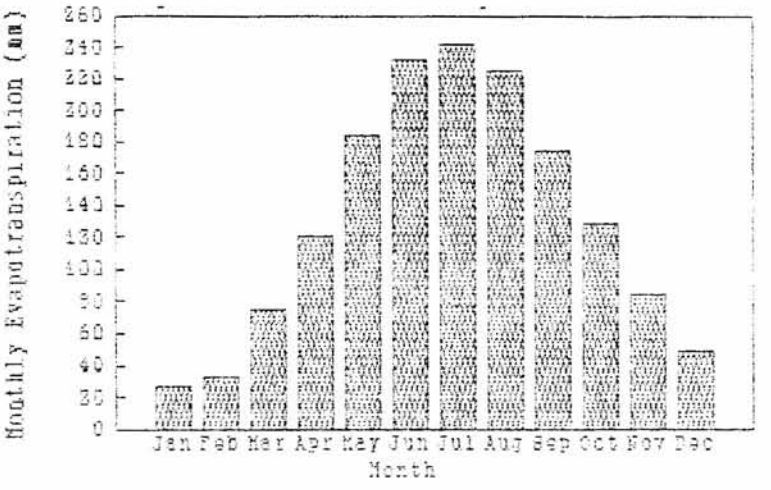

Figure 4 Average monthly evapotranspiration for a grass reference crop in Jericho.

Available Water Resources in the Eastern Slopes

1. The Jordan River Basin

The Jordan river flows from north to south from an elevation of 2200 meters above mean sea level at mount Hermon to about 395 meters below mean sea level at the Dead sea. The Jordan river passes a distance of about 140 km with a length of about 350 km (Al-Dabagh, 1965). Table 2 shows the average annual discharge of the Jordan river tributaries as estimated by different sources (Ali, 1964; Naff and Matson, 1984; Gwyn, 1984; Al-Dabagh, 1965; and the Natural Resources Authority of Jordan (NRA), 1964).

The whole catchment of the Jordan and Dead Sea basin comprises of an area estimated at 40650 km^2. Table 3 (compiled from Ionides, 1939) shows the contribution of the catchments in the riparian states of the Jordan-Dead Sea

system. From this table, we see that although the West Bank has 7% of the total catchment area of the basin but it has 11% of the catchment area with more than 300 mm of annual rainfall. With Israel, the area of its catchments is 19% of the total catchment area of the basin but Israel has only 12% of the catchment with rain more than 300 mm a year.

Table 2 Annual discharge of the Jordan River system (different sources).

Description	Ali	Naff & Matson	Gwyn	Al-Dabagh	NRA	Average
Ash-Shriaa						
- Hasbani	157	138	125	157	157	147
- Banias	157	121	125	157	157	143
- Dan	258	245	250	258	285	259
- Springs & Wadis	329	340	---	300	200	292
Total	900	844	---	872	799	841
Lake Tiberias						
- Evaporation	-300	-270			-251	-274
Total	600	574			548	567
Jordan River						
- Yarmouk	475	500	500	473	450	478
- Zarqa	---		80	92	54	75
- Wadis	232			1578	149	191
Total (Dead Sea)	1307				1201	1311

Table 3 The contribution of the Jordan river riparian states in the catchment of the Jordan and Dead Sea basin (data taken and compiled from Ionides, 1939).

Country	Area		Average annual rainfall over basin mm	Average annual supply from rain		Average area covered by isohyets over 300 mm		Rainfall on area with over 300 mm		Area covered by isohyets over 300 mm	
	km²	%		MCM	%	km²	%	MCM	%	km²	%
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Syria and Lebanon	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	
Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Areas are given in km², rainfall in mm, volume of water in millions of cubic meters.

Palestinian use of the Jordan river water before 1967 was through 140 water pumping units installed and used to irrigate the area next to the Jordan river known as Az-Zhor to the north western of the Western Ghore. This use was suspended only by Israeli military occupation authorities which destroyed, demolished, or confiscated the pumping units after occupation of the West Bank in 1967. Since then, Israeli military authorities prohibited by force local Palestinians from withdrawing any water from the Jordan river. In addition to large areas of the Ghore, Az-Zhor, the land area that was irrigated and used by Palestinians, was confiscated or closed as a military zone and later given to Jewish settlers.

Many water plans, projects, and studies were evolved and presented by foreign governments and international experts on water conflicts. One of the most important plans was "Johnston plan" prepared by Charles Main in 1954. This plan allocated 394 mcm for Israel, 774 mcm for Jordan, and 45 mcm for Syria. Although both Israel and the Arabs rejected the plan, but they followed its principles. It should be noted that at the time of Johnston plan, the West Bank was part of Jordan. Therefore, its share in water was considered as part of the Jordanian share (774 mcm/yr). In Johnston plan, the western Ghore canal was proposed to irrigate 160000 donums in the western Ghore with 257 mcm/yr and the eastern Ghore canal to irrigate 353000 donums with 517 mcm/year. Thus the proposed, by Johnston plan, Jordanian and West Bank shares would be 517 and 257 mcm/yr, respectively.

2. The Ground Water Aquifer System

The ground water aquifer under the eastern slopes has annual recharge of 105 mcm (Awartani, 1992). According to hydrological year book issued by the Israeli Authorities in 1978, there are 115 wells used in irrigation by local Palestinians in the Western Ghore withdrawing about 12.13 mcm/yr. There are also 7 wells located in the eastern slopes and used for municipal purposes with a capacity of about 7 mcm/yr. The Israeli military authorities drilled about 19 wells (1990 estimates) for the needs of the Jewish settlements in the eastern slopes (including the Western Ghore).

Several major fresh water springs are located in the eastern slopes. These springs include: Auja, Sultan, Diyuk, Nuweimeh, Fara, and Baddan springs. These springs produce about 44 mcm/year (Haddad and Mizyed, 1993). However, most of them require improving the methods of conveying water from them to the farms. They also need storage facilities (dams) to store their extra water (during winter)o summer months.

3. Water Harvesting

Although about 50 mcm of water are lost every year through runoff to the east (Haddad and Mizyed, 1993). It is possible to harvest about 13 mcm/year through constructing dams on five main Wadis. These are Wadi Al-Maleh-Biquia, Wadi Al-Fara'-Badan, Wadi Al-Ahmar-Fassayel, Wadi Al-Auja, and Wadi Al-Qilt. Figure 5 shows the preliminary locations of these reservoirs. The proposed locations are subject to detailed investigations. Soil-water conservation

practices should be introduced to reduce the amount of water lost through runoff and its erosion hazards. These practices might include constructing small harvesting projects on the farm level, introducing new crops to conserve soil and water, and constructing conservation terraces.

Total Available Water

The total water that can be made available within the Western Ghore as discussed in the previous sections can be summarized in the following:

Description	Water available, mcm/yr
Jordan River	257
Ground Water	105
Run-off Harvesting	13
Total available	375

Development Plan

The proposed development plan of the Eastern slopes is based on the following principles and/or assumptions:

1) Political solution, full Palestinian control of land and resources in the area.

2) Development aiming toward self sufficient Palestinian community in the West Bank and Gaza Strip.

3) Maximum of absorbance of Palestinian returnees from diaspora (housing, jobs, and food supply).

4) Re-distribution of population density in the newly formed entity.

Plan Description

One major factor which will affect the development is the number of Palestinian returnees who will return to their homeland and the population growth. The population of the West Bank and Gaza were estimated to be 1211 and 588 thousands in the year 1992, or 1899 thousands (the statistical abstract of Israel, 1992). With a 3.5% natural annual increase, the population of the occupied territories will increase to 2.1 millions by 1995. Adding 300 thousands for returnees will bring the number to 2.4 millions in 1995. This number will increase naturally to 2.86 millions by the year 2000. With 0.5 million returnees, the number will reach 3.36 millions in the year 2000. By the year 2010, the population of the new Palestinian entity will reach 4.5 millions (assuming 3% natural increase annually).

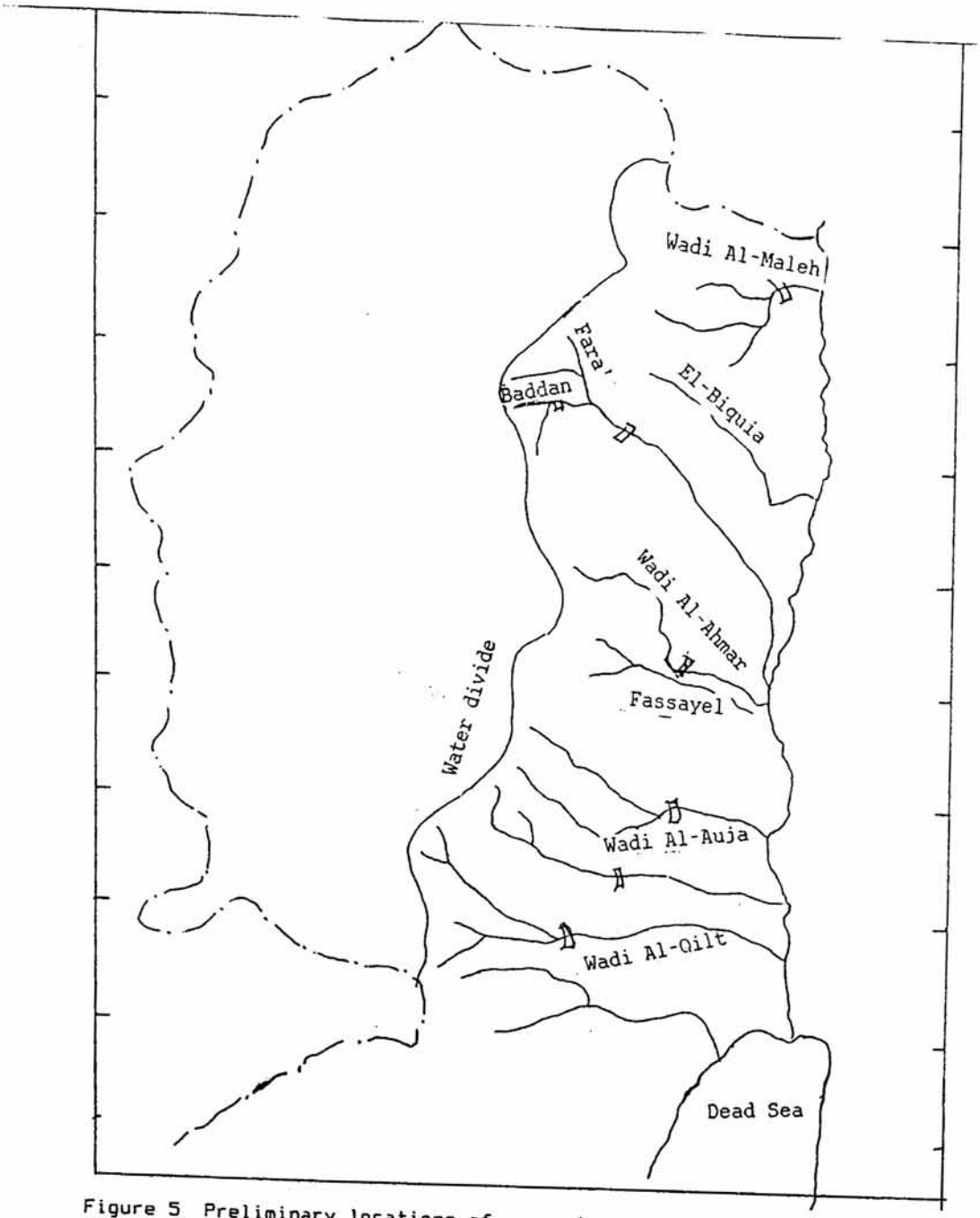

Figure 5 Preliminary locations of suggested reservoirs.

With these numbers in mind, two major responsibilities lie ahead on the Palestinian authority. The first responsibility is to provide food for this population and the second will be to find jobs for the large labor force arising. Providing food will be the responsibility of the agricultural sector. Producing more agricultural crops requires more intensive agriculture especially irrigated agriculture. Thus, developing the irrigated agriculture sector is essential to increase available products for local consumption. Also, irrigated agriculture requires more labor work and thus it can absorb more jobs. There is a possibility to increase the participation of this sector in the Palestinian economy as the area used in this sector has been frozen since 1967 in the West Bank.

Forecasted local consumption of irrigated agricultural products:

Looking at the estimates of local consumption of irrigated agricultural products during the last 10 years, we find that the average consumption of vegetables and melons, citrus and Bananas is 220, 50 and 15 Kg per person per year (Haddad and Mizyed, 1993). From these estimates, the local consumption of these crops is estimated in Table 4.

There are 80 thousands tons of vegetables and melons produced from un-irrigated agriculture in the West Bank. This amount can be hardly raised to 100 thousands tons because of the low productivity of un-irrigated areas and the high demand on other un-irrigated crops. Thus the increase in vegetable and melon production should be the responsibility of irrigated agriculture.

Table 4 Forecasted local consumption of irrigated agriculture products.

Year	Forecasted population (thousands)	Forecasted local consumption is thousands tons		
		Vegetables & melons	Citrus	Bananas
1992	1899	418	95	28
1995	2405	529	120	36
2000	3357	739	168	50
2010	4511	993	226	67

The areas to be irrigated are estimated in the following tables based on the assumption that average production of vegetables, citrus and bananas is 3, 3.35 and 3 tons per donum respectively.

Table 5 The areas to be irrigated in thousands of donums

Year	Vegetables and melons	Citrus	Bananas	Total irrigated
1992	106	28	9	143
1995	143	36	12	191
2000	213	50	17	280
2010	298	67	22	387

Comparing the above table with table 1, we see that there will be a need to increase the area planted with vegetables and melons significantly. There will be no need to increase the area planted with citrus trees but there will be a need to increase the area planted with other fruits. Bananas are planted only in the Ghore area, thus the whole increase in the area planted with bananas should be in the Ghore.

The increase in area irrigated will be mainly in the West Bank as the natural resources of Gaza have been over exploited. The Ghore will be responsible for all the increase in bananas production, or 22 thousands donums of bananas are needed to be planted in the year 2010. With citrus, the current area about 5000 donums is not expected to increase even if a lot of citrus trees are uprooted in Gaza. In that case, we expect that the costal areas in Jenin and Tulkarm will be responsible for planting new citrus trees to compensate the reduction in their area in Gaza. Some other crops are expected to be planted in the Ghore such as Date palms, grapes and flowers. Grapes are produced in the Ghore at an earlier time in the year before those produced in the mountains. Flowers can also be produced for commercial purposes during winter in the Ghore area.

The required increase in the area planted with vegetables and melons is about 190 thousand donums. Most of this should be planted in the Ghore as it will have the climate, the soil and the water to produce these vegetables. With 40 thousands donums currently planted in the area, the total area of vegetables and melons will be 230 thousand donums. As we can use a crop intensity of about 1.5 in the Ghore area, the field area planted with vegetables and melons will be about 160 thousand donums.

We have seen before that the area suitable for irrigated agriculture within the study area is about 210 000 donums. In 2010, this area will be planted as: 22000 bananas, 30000 other irrigated crops and fruits (5000 citrus and the rest will be grapes, date palms and flowers), and the rest is 158,000 donums will be planted by vegetables and melons, with an average crop intensity of 1.45 crops per year or 229,000 donums of vegetables and melons.

The other 69,000 donums of vegetables and melons needed to satisfy local demands can be those currently planted in Gaza, Tulkarm and Jenin areas. If more water is made available in these areas, then the irrigated area can be increased to export specific types of irrigated crops.

Water Requirements and Resource Development

This development plan anticipate the development of 210 thousands donums in irrigated agriculture and a forecasted population of 260 thousand people in the Ghore by the year 2010. The water requirements for all purposes are presented in the following sections:

1) Domestic Water Requirements: The total domestic water requirement was estimated assuming that the per capita water consumption in the West Bank by the year 2010 will equal the present Israeli water consumption of 250 liters per day. The unaccounted for water is assumed to be 15%. Accordingly the

total water demand for domestic purposes will be about 28 mcm/yr.

2) Agricultural Water Demand: The agricultural water demand for this area is estimated according to the areas and crops planned to be planted by the year 2010 is presented in the following:

Area(1)	Crop Type	Water/Area(2)	Total Water Demand(3)
22	Bananas	2000	44
10	Grapes	1100	11
10	Flowers	1000	10
10	Palm Trees	1500	15
158	Vegetables	800	183
Total 210			263

Notes:
(1) Areas in Donums
(2) Water needed per unit area per cropping season in m^3
(3) Total water demand in million cubic meters per year, mcm/yr
(4) vegetables are planted 1.45 crop a year or 229,000 donums a year.

3) Industrial Water Demand: The industrial water demand was estimated assuming that the share of industry (including recreation and tourism) in the eastern slopes from the total water demand by the year 2010 will equal about 10%. This amount might be a conservative figure because the whole area will be under new development (completely new infrastructure will be built for the whole area). According to the previous estimates of domestic and agricultural water demand, the industrial water demand will be about 32 mcm/yr.

4) Water Balance: The water balance for the eastern slopes by the year 2010 would include the water requirements for the development plan plus the water will be pumped to urban areas in Nablus and Ramallah districts.

a- The total water demand for the eastern slopes by the year 2010 is about 323 mcm/yr.

b- The water that will be pumped to urban areas in Nablus and Ramallah districts was estimated at 21 mcm/yr based on the following assumptions:

- The present water withdrawn now from the eastern slopes aquifers for this purpose of 7 mcm/yr,

- The expected increase in water demand follow the socio-economic development in the area,

- The possible number of returnees to these districts during the period 1993-2010,

- The possibility of drilling new boreholes and withdrawing water from the Mountainous aquifers of the West Bank.

- and assumed continuation of present population growth rates.

c-The total available water for eastern slopes as discussed in the is about 375 mcm/yr.

Accordingly, therefore, will be a surplus in available water of about 52 mcm/yr if all of our water resources are being utilized for the local needs of the Palestinian people.

Implementation Strategy

The Implementation of this development plan can be done through the following steps assuming that the political solution to the Palestinian-Israeli conflict is reached and consists of a transitional period under which Palestinians will have control over most economic resources, decision making and some Palestinian returnees are expected, and a Palestinian sovereignty under which Palestinians will have full control over all economic and social resources with returnees are allowed to the territories.

-During the transitional period:

1) The establishment of the Western Ghore Water Authority as part of a National Water Authority which upon its formation will take the responsibility of a transitional take over of duties and responsibilities of all aspects of water resources in eastern slopes from the Israeli military authorities. For this purpose it is recommended that a committee or board which consists of a group of experts in the field be formed and take the responsibility to perform the following duties:

- immediate take over and administration of all Palestinian water resources related institutions in the West Bank. This will include the development of the existing West Bank water department as part of the National Water Authority and in a way that can perform the duties of: water resources development, management, extraction, exploitation, distribution, monitoring, and regulation. Monitoring and research laboratories should be established as soon as possible to support the work of various sections in the department (hydrology, hydrogeology, water quality, water harvesting, water supply, and others).

- Gradual and planned take over of all the duties and responsibilities given to Israeli Companies in the West Bank. This will include the water infrastructure (wells, pumping stations, distribution networks, etc.).

- Collect and verify available information related to the availability of water resources in the eastern slopes, existing water distribution systems, and all other related issues (e.g. water demand and population

estimates) . Also and when needed, conduct all necessary field and/or research work in the field.

- Develop; plan and design; a regional water supply master plan for the eastern slopes with detailed designs for local urban and rural areas. This would include the project of the Western Ghore Canal which will transport the Palestinian share in the Jordan River Basin (water from the Yarmouk and/or lake Tiberias to the Western Ghore) and the full exploitation of the eastern aquifers and management of wadis run-off. These projects will serve the Western Ghore from the northern border to the city of Jericho and from the Jordan River to the foothills of the eastern slopes.

- Rehabilitation of the existing water infrastructure in the eastern slopes (wells, irrigation canals, water distribution systems and others).

- During Full Palestinian Control

The Water Department and the National Water Authority will begin in the period beyond the interim phase by:

- Continuing the work on funding and implementing the planned water supply master plan for the eastern slopes.

- Upgrade the technical capabilities of the Water Department and the National Water Authority using Palestinian human resources returning back to the territories from the diaspora.

- Enhance cooperation with neighboring and other countries in the region in water resources management, research and development, water conservation, and technology transfer.

- Develop a center for public education and information using a computer-based system and the data collected by the sections of the Water Department (e.g., monitoring laboratories, hydrology section, meteorology section, etc.), National Water Authority, statistical bureau or department, and any other needed sources and information.

Discussion and conclusions

We have seen that developing the eastern slopes is vital for the Palestinian food security an economy. However, this development is possible only if the Palestinian will be able to control and exploit there natural resources including land and water. A plan for this development was shown. However, the plan will face the following problems that should be addressed:

1. Acknowledging the Palestinian rights in the Jordan river system. These rights should be acknowledged within the agreement for the final settlement of the Palestinian problem.

2. The existing jewish settlements where about 40000 donums of most fertile land are cultivated by jewish settlers. This issue should be resolved based on international legitimacy which considered jewish settlements illegal. Palestinians should insist that those settlements should be evacuated and given to the Palestinian refugees as compensation for their right to return according to UN resolution 194.

3. The financial cost of implementing the above projects will be high. However private investments should be encouraged. International financial aid is expected to help such projects go through.

4. The distribution of lands in the area as large areas are considered Mesha' or public domain areas. The Jordanian experience in the eastern Ghore should be studied and used as a guide in this aspect.

References

Al-Dabagh, Mustafa Al-Dabagh, 1965. Biladuna Falastin (in Arabic), Dar Al-Talia'a, Beirut, 1965, pp 15-23.

Ali Mohammad, 1964. Jordan River and the Zionist Conspiracy (in Arabic). National Publishing and Printing House, Cairo, 1964, p 25.

Atlas of Israel, 1970. Published by the Ministry of Labor and Elsevier Publishing Company, Amsterdam, 1970.

Awartani, 1992. Artesian wells in Palestine: Present Status and Future Aspirations. Palestinian Hydrological Group, Jerusalem.

Awartani and Judeh, 1989. Irrigated agriculture in the West Bank. Rural Research Center, An-Najah National University, Nablus.

Gwyn, R., 1984. Israel into Palestine, Mansel Publishing Limited, London, 1984.

Haddad, M, 1990. The Environment in the Occupied Palestinian Territory. A Preliminary Report; Sponsored by the Center for Engineering and Planning-Ramallah; Prepared for the Conference on the Management of the Environment in the Mediterranean, Nicosia.

Haddad, M., and Mizyed, N., 1993, Status of Irrigated Agriculture in the West Bank, Journal of Palestinian Studies, Beirut.

Ionides, M.,G., 1939. " The Water Resources of Transjordan and their Development. Government of Transjordan, Crown Agents for the Colonies, 1939, p 262.

James, Larry, 1988. Principles of Farm Irrigation System Design. John Wiley and Sons, New York, U.S.A.

Mizyed, N. and Haddad, M., 1993, Water Harvesting in Green Houses, IAHR Symposium on Water Systems: Water the Life Blood of Africa, Zimbabwe.

Naff, Thomas and Matson, Ruth, 1984. "Water in the Middle East- Conflict or Cooperation". A Westview Replica Edition of a Study Published in cooperation with the Middle East Research Institute, University of Pennsylvania, 1984 pp 1-14.

Natural Resources Authority of Jordan, NRA, 1964. Review of Stream flow Data. Technical Paper No. 33. December 1964.

Rural Research Center, 1980-1986. Statistical Bulletin for the West Bank and Gaza for the years 1980 to 1986. An-Najah National University, Nablus.

Statistical abstract of Israel, 1992, Jerusalem: Central Bureau of Statistics.