WATER RESOURCES FOR THE STATE OF PALESTINE

BACKGROUND PAPER

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This paper aims at analyzing the water sector in the occupied Palestinian territory and assesing the future supply and effective demand in view of the anticipated regional political developments. Although some ideas about potential regional arrangements for addressing the water shortage are referred to, no attempt is made to articulate any detailed proposals for such arrangement. Instead, the emphasis is on the water rights of the Palestinian people and the need to regain control of Palestinian water resources as a pre-requisite for Palestinian development and regional stability.

HISTORICAL BACKGROUND

As a result of the war it waged against its neighbors in 1967, Israel has succeeded in extending its control over all the water resources of Palestine and the Syrian Golan Heights. In 1982 Israel also acquired control over the Litany water by occupying the southern part of Lebanon. Thus, Israel has completed the implementation of an additional phase of the old Zionist scheme which calls for controlling all the water resources in the areas surrounding the State of Israel.

Attempts at implementing the Zionist scheme began in 1919, two years after Britain issued the Balfour Declaration, when Chaim Weizman stated in a letter to British prime minister David Lloyd George, that " the whole economic future of Palestine is dependent upon its water supply for irrigation and for electric power, and the water supply must mainly be derived from the slopes of Mount Hermon, from the headwaters of the Jordan and from the Litany river". He also added that he " considers it essential that the northern frontier of Palestine should include the Valley of the Litany for a distance of about 25 miles above the bend, and the western and southern slopes of Mount Hermon" (3).

The borders proposed by Weizmann covered not only all of present-day Israel and the occupied territories of the West Bank, Gaza and the Golan Heights, but also significant proportions of Lebanon, Syria and Jordan, as shown in Figure 1.

In September 1921, the British Mandate Government in Palestine offered a seventy-year concession to the Jewish Rotenberg Company to generate electric power by exploiting the waters of the Jordan and Yarmuk rivers. The concession agreement permitted the Rotenberg Company to divert the Yarmuk river into lake Tiberias, to exploit the Auja river and to construct water canals necessary for the successful completion of the project. It also allowed for the construction of a power generating station on the Jordan River near Al Majami' Bridge and the construction of other stations as required (4).

In 1929, the British Mandate Government also offered a 75 year concession to the Jewish Palestine Potash Company for exploiting

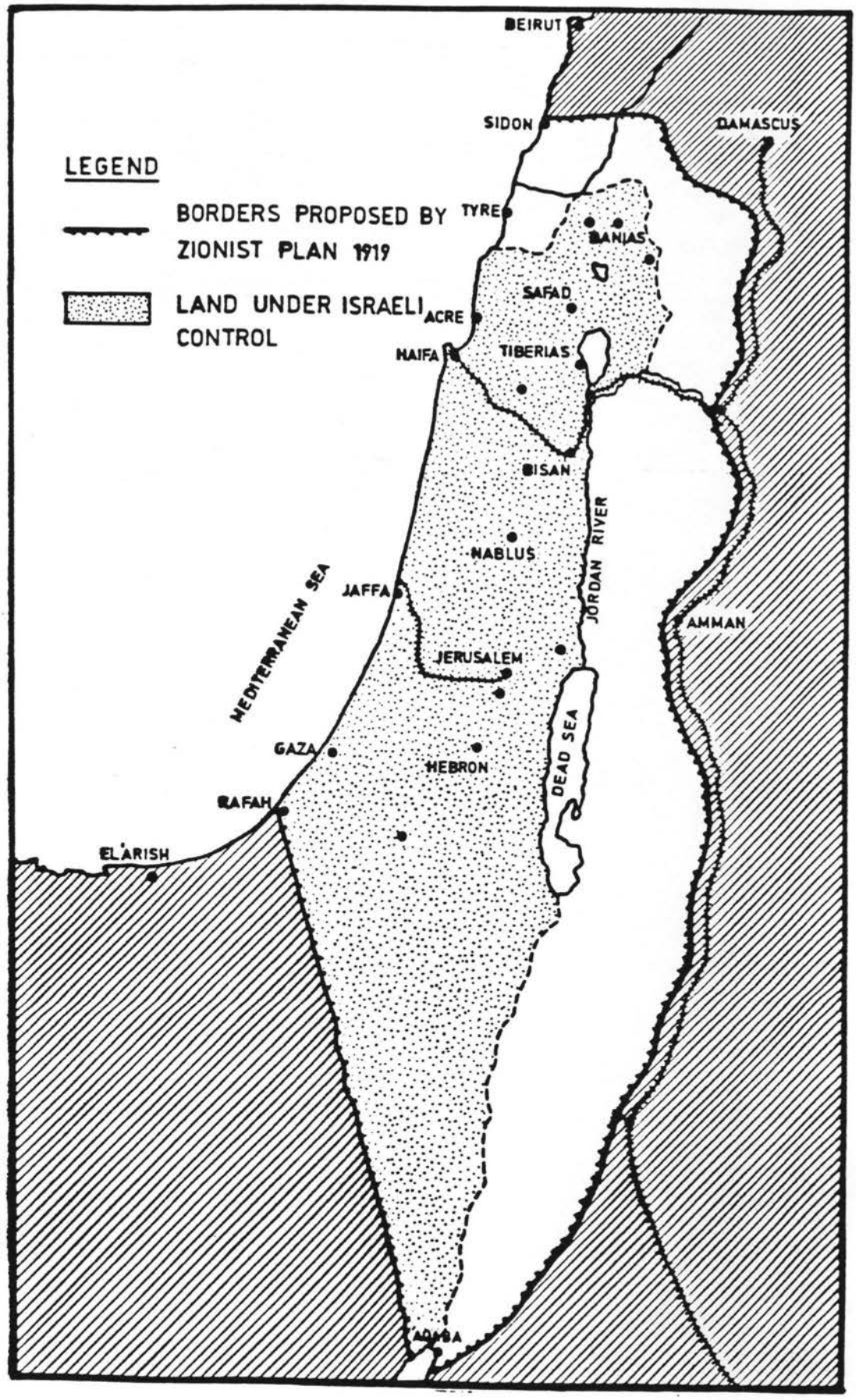

FIGURE 1: PALESTINE'S BORDERS ACCORDING TO THE ZIONIST PLAN OF 1919

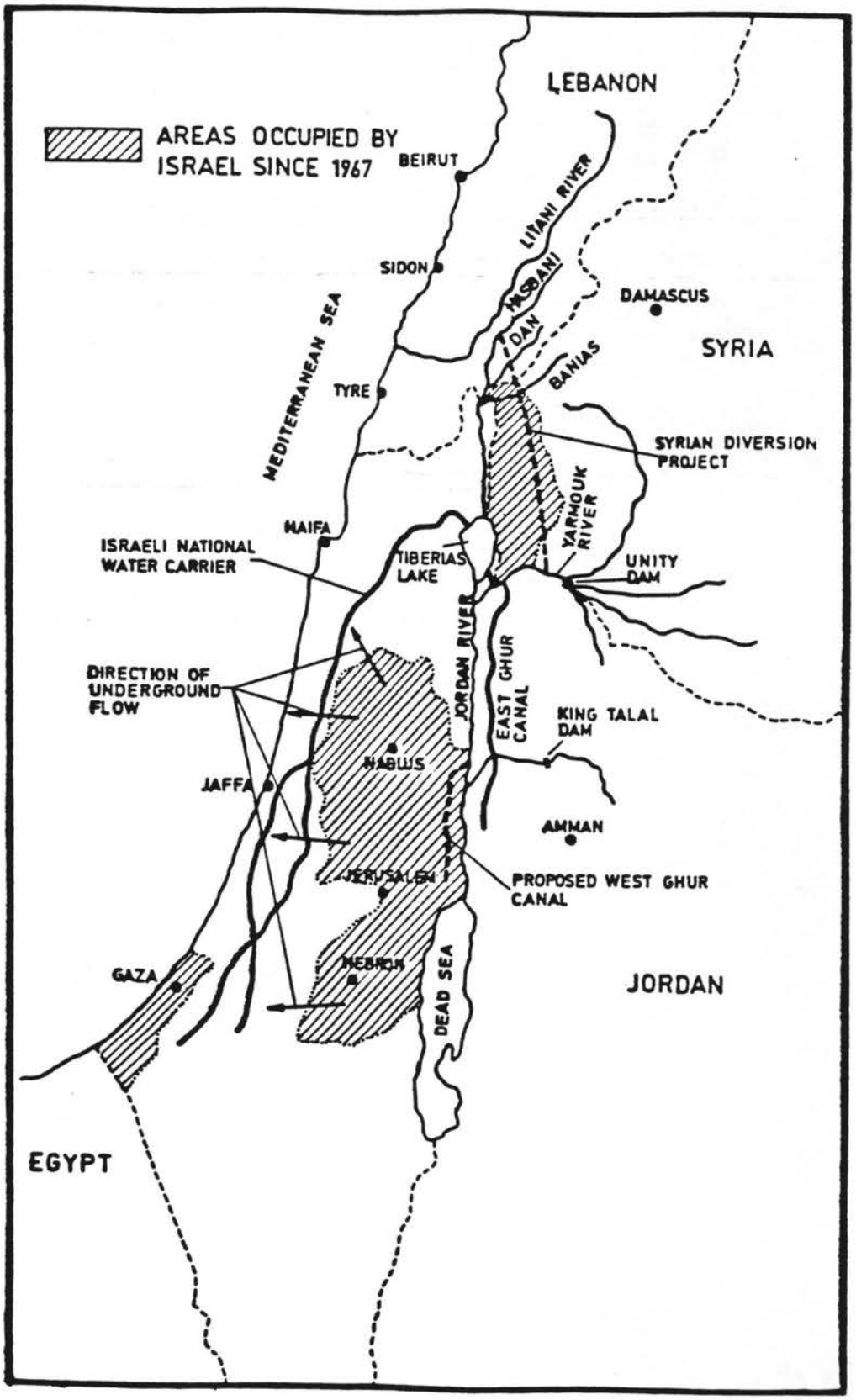

FIGURE 2: SCHEMATIC LAYOUT OF PROPOSED WATER SCHEMES FOR THE JORDAN RIVER BASIN

The connecting "corridor" has an area of around 136 square kilometers and extends from Idna in the south-west of the inland region to Beit Hanoun in the north-east of the coastal region. It has a total length of about 35 kilometers and an average width of 4 kilometers. The State's general location is shown in Figure 3.

2. Topography and Climate

The area of the State is divided into five distinct physiographic zones on the basis of topography and climate. The five zones are the Jordan Valley zone, the Eastern Slopes zone, the Central Highlands zone, the Semi-Coastal zone and the Coastal Plains zone.

The Jordan Valley zone extends along the western bank of the Jordan River from the point where the boundary intersects the River in the north to the northern tip of the Dead Sea in the south. This zone has an area of approximately 400 square kilometers and lies within 200-300 meters below sea level.

The Eastern Slopes zone lies between the Jordan Valley in the east and the Central Highlands in the west. It extends from the areas east of Jenin in the north to the Dead Sea in the south and includes the slopes along its western shore. This zone has an area of approximately 1500 square kilometers with altitudes varying from 800 meters above sea level to 50 meters below sea level.

The Central Highlands zone extends from Jenin in the north to Hebron in the south. It has an area of about 3500 square kilometers and altitudes exceeding 1000 meters above sea level.

The Semi-Coastal zone is an extension of the Palestinian Mediterranean coastal lands and comprises parts of the Jenin and Tulkarm sub-districts. It has an area of approximately 400 square kilometers, and altitudes ranging from 100 to 300 meters above sea level.

The Coastal Plain zone extends along the southern part of the Palestinian Mediterranean shore to the north and south of Gaza city. It has a total area of 365 square kilometers and altitudes ranging from 20-40 meters above sea level.

Palestine has a Mediterranean climate characterized by long, hot, dry summers and short, cool, rainy winters, which are modified locally by altitude and latitude. The climate is determined by Palestine's location between the subtropical aridity of Egypt and the subtropical humidity of the eastern Mediterranean. January is the coldest month, with temperatures ranging from $5^{o}C$ to $10^{o}C$, and August is the hottest month, with temperatures ranging from $18^{o}C$ to $38^{o}C$.

About 70 percent of the average rainfall in Palestine falls between November and March. The months of June through August are generally rainless. Rainfall is unevenly distributed, generally decreasing to the south and east and varies from season to season and from year to year. Precipitation is often concentrated in violent storms, causing flooding and erosion. During January and February, it may take the form of snow at the higher elevations of the central highlands, especially around Jerusalem.

Climate in the Jordan Valley zone is characterized by hot summers and warm winters with an annual rainfall ranging from 350 millimeters in the north to 100 millimeters in the south. The Eastern Slopes zone suffers from aridity and erosion with an average annual rainfall of around 250 millimeters. The Central Highlands zone enjoys good rainfall ranging from 700 millimeters in the mountains to 400 millimeters at the foothills annually. The Semi-Coastal zone has relatively high rainfall ranging from 500 millimeters to 600 millimeters annually. The Coastal zone has an average annual rainfall ranging from 400 millimeters around Gaza in the north to 200 millimeters around Rafah in the south. The mean number of rainy days per year ranges from 55 in the mountain range to 25 in the Jordan Valley and the coastal zones.

POPULATION AND URBANIZATION

No population census was conducted in Palestine during the last twenty five years. Therefore, population and demographic information for the regions comprising the State of Palestine are often based on official Israeli statistics. These statistics are estimates based on the Census of Population which was conducted by the occupation forces in September 1967, and updated annually by adding the reported births, subtracting the estimated deaths and adding or subtracting the balance of movement of population at the crossing points to Jordan and Egypt. Thus, the Israeli estimates are based on "de facto" population, including only those people who are actually present during a certain year, and, therefore, represent an underestimation by at least the number of people who do not return to Palestine during that year.

Furthermore, these statistics represent a more gross underestimation as they are based on a census which was conducted when a significant proportion of the population was not accounted for in the census, either because it happened to be outside the country when the war broke out, or because it was forced out of the country as a result of the war. Except for a very limited number of people who returned under the "family reunion" arrangements, the majority of the "absent" population has not yet been allowed to return and enjoy full citizenship in its homeland. In addition, the Palestinian population of Jerusalem and the surrounding villages are not accounted for in the Israeli statistics as a result of the annexation of these areas in 1967.

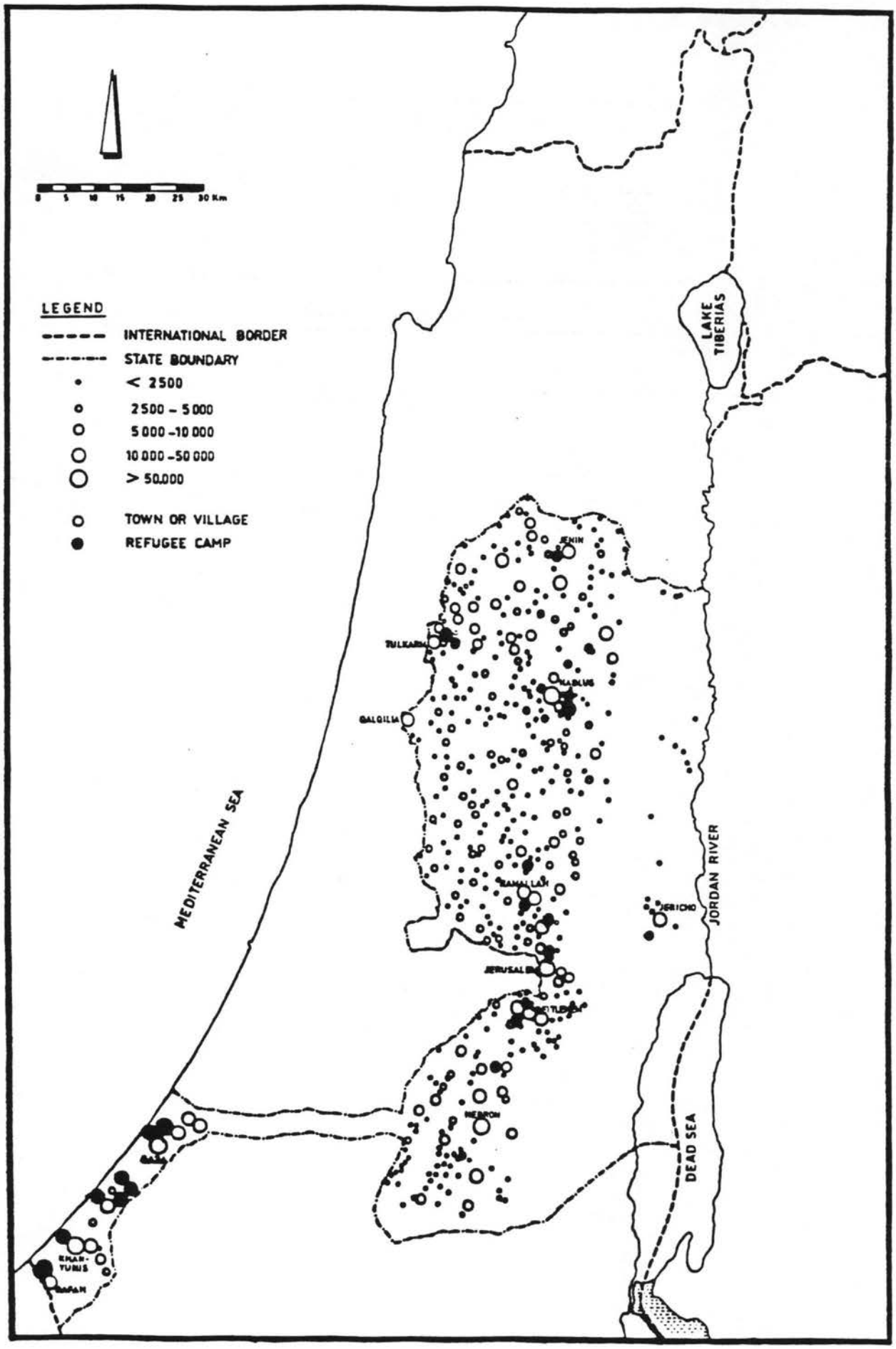

FIGURE 4 : SPATIAL POPULATION DISTRIBUTION, 1990

TABLE 1

POPULATION DISTRIBUTION, 1990
(THOUSANDS)

TYPE OF COMMUNITY	REGION									
	STATE		NABLUS DISTR.		JERUSALEM DISTR.		HEBRON DISTR.		GAZA DISTR.	
	POPULATION	%	POPULATION	%	POPULATION	%	POPULATION	%	POPULATION	%
Urban	978	43	157	23	319	55	95	40	407	53
Semi-Urban	125	5	60	9	19	3	24	10	22	3
Rural	782	35	395	59	205	35	110	46	72	9
Refugee	380	17	57	9	41	7	10	4	272	35
TOTAL	2265	100	669	100	584	100	239	100	773	100

Most of the usable surface water is available through some 295 springs and seeps which drain the various groundwater basins at the foot of the mountain range in the western inland region. Only about 120 of these springs and seeps have permanent discharge, while the rest flow only in the winter season and dry up in the summer.

The total annual discharge of all springs and seeps is estimated at 90-110 million cubic meters. Of this amount, fresh water annual discharge is estimated at 50-60 million cubic meters. The remaining 40-50 million cubic meters are brackish water discharged through springs and seeps located along the northern and western shores of the Dead Sea.

About 3-4 million cubic meters of the fresh spring water are used for domestic purposes, while the rest is utilized for irrigation. Brackish water is partially utilized for irrigation of palm trees and for recreation in sites along the western shore of the Dead Sea. No spring water is available in the coastal region.

3. Groundwater Sources

The source of groundwater in the coastal region is the aquifer which is composed of sub-aquifers made up mainly of sand, sandstone and pebbles. The sub-aquifers overlay each other in certain places and are separated by impervious and semi-impervious clayey layers. The upper aquifer lies closest to the sea and extends up to two kilometers inland, at a depth mainly below sea level. Middle sub-aquifers are situated below the upper aquifer near the coastline, but rise in an eastward direction according to the general slope of the geological layers. The lower sub-aquifers extend further inland. Total thickness of the aquifer ranges from 120 meters near the coast to 10 meters in the east, where it has relatively higher salinity. The top of the aquifer consists of sand dunes in the west and of finer continental deposits, interbedded with paleosols in the east. Deeper permeable strata are present at depths of 200-300 meters and consist of carbonates and sandstones, with salinity levels reaching around 2000 mg per liter.

The inland region of the State contains six major underground aquifers. The pleistocene aquifer consists of unconsolidated sands and gravels of varying sizes separated by impermeable layers of saline marls. It extends along most of the Jordan Valley between Jericho in the south and Marj Na'ja and lower Wadi Fara'a in the north. This aquifer is believed to be fully exploited through some 100 pumping wells extracting water with chloride contents ranging from 100 mg per liter to over 200 mg per liter. Further exploitation would increase the salinity levels and may destroy the fresh water zone in the Jordan Valley unless fresh water artificial recharge is introduced.

The Neogene aquifer consists of well-cemented conglomerates containing relatively small quantities of fresh water. It is situated at the northern part of the Jordan Valley near Bardala

In the rural areas of the inland region only about 175 villages have water distribution networks. About 38 percent of the rural population is not serviced by water distribution systems. Around 53 percent of the total water supply is from sources controlled directly by the Israeli authorities.

In the Jerusalem district, the Israeli Jerusalem Municipality supplies water to the Palestinians in Jerusalem and its suburbs. There are two Palestinian regional water authorities in the district. The Ramallah Water Authority and the Beitlehem Water Authority supply more than 45 urban and rural communities in the Ramallah and Beitlehem sub-districts. They either have their own water wells or buy water from the Israeli authorities. In Jericho, the municipality provides partial supply of water, as some of the residents have their own private sources.

In the Nablus district, the local authorities supply water from their own sources, private wells or from the West Bank Water Department. Most of the rural communities in the district lack water distribution systems and utilize private collection wells or nearby springs.

In the Hebron district, urban areas are supplied with water mainly from Israeli authorities, but receive a small share of their water requirements from municipal sources. In the rural areas, the percentage of population served by water distribution systems is limited and is supplied by water from the West Bank Water Department.

In the Gaza district, the municipal and village councils supply water from their artesian wells. Residents of refugee camps are mainly supplied from wells administered by UNRWA. The district suffers from serious shortage of water supply, coupled with a deteriorating water quality due to increased salinity.

In general, consumption does not reflect demand. Water demand is estimated to be 55 percent higher than water consumption, indicating a serious deficiency in the amounts of supplied water.

Water losses due to leakage and inefficiency of pumping systems are estimated at 30-50 percent of the total water supply.

Geographic distribution of water networks is shown in Figure 5.

a. Domestic and Industrial Use:

The total amount of annual water consumption for domestic and industrial purposes is estimated at around 60 million cubic meters (27 mcm in the Gaza district and 33 million cubic meters in the inland districts). Most of the water for domestic and industrial use is supplied from some 87 artesian wells which account for about three quarters of the total supply. The remaining one quarter is obtained mainly from the Israeli network, local springs and, to a lesser extent, from cisterns used to collect and store rainwater especially in the rural areas

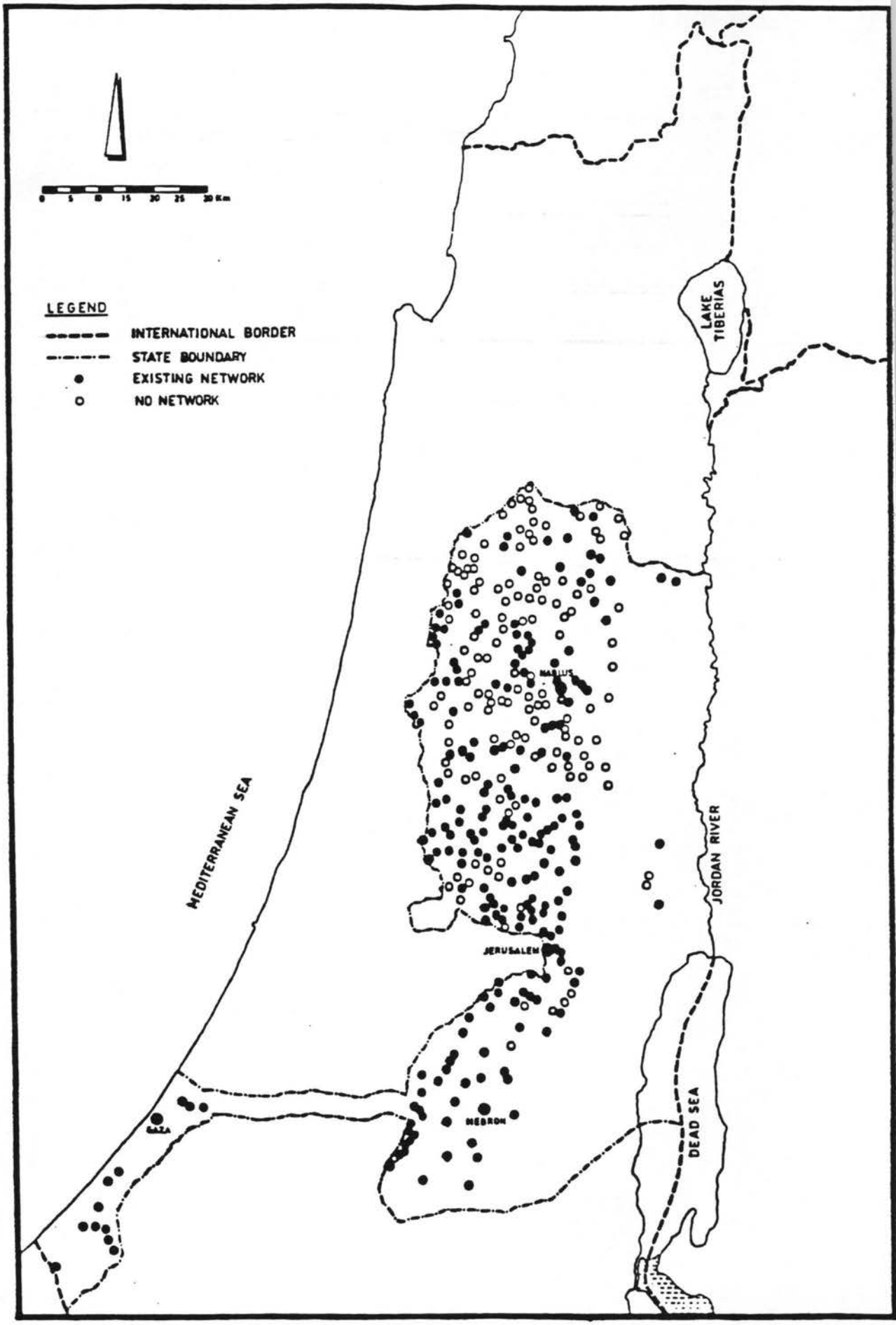

FIGURE 5: EXISTING WATER DISTRIBUTION NETWORKS

5. Estimated Future Demand

The components of future water demand in the State of Palestine will largely depend on the national development policies adopted by the State, especially those related to agricultural, industrial and urban development. Allocations for domestic uses will mainly depend on the size of the population and living standards.

If the State adopts an agricultural development program based on expanding irrigated agriculture to all irrigable areas, the total amount of annual water demand for irrigation in the year 2010 is estimated at around 590 million cubic meters. This would leave some 490 million cubic meters for domestic and industrial uses per year. If the consumption for domestic and industrial purposes is assumed to increase from its current level of 26 cubic meters per capita per year to 65 cubic meters per capita per year, the remaining available water supply would be able to support a total population of about 7.5 million. If, on the other hand, the adopted urban and industrial development programs require a higher allocation than 65 cubic meters per capita per year, then the water remaining for agricultural development will be less, resulting in reduced irrigated areas, unless much more efficient irrigation systems are employed. The estimated water consumption rates for all purposes until the year 2010 are shown in Table 5.

TABLE 5

ESTIMATED WATER CONSUMPTION FOR ALL PURPOSES (1990-2010)

ITEM	YEAR				
	1990	1995	2000	2005	2010
Land Area (km2)	6015	6183	6183	6183	6183
Population (million)	2.3	2.7	3.9	5.5	6.8
Cultivated Land (km2)	2165	2200	2600	2800	3200
Irrigated Land (km2)	215	250	325	500	700
Water Consumption(mcm/year)					
Domestic and Industrial	60	81	156	330	442
Irrigation	160	186	260	500	590
Total	220	267	416	830	1032
Per Capita (m3/year)	96	99	106	106	152

prevented the effective use of the few existing water treatment plants.

Finally, the lack of accurate and detailed information on the underground water sources and the lack of a water development master plan based on such information represent the biggest constraint on the proper and effective development of the water sector.

Regaining control over its potential water resource base is a prerequisite for any meaningful development of Palestine's water sector. It is estimated that over one third of Israel's water supply originates in rainfall over the western slopes of the inland region of the State of Palestine and is drawn from the same aquifer system that supplies the State's water requirements. Moreover, the riparian share of Palestine in the Jordan River basin waters has been intercepted through upstream diversion schemes.

Furthermore, the Palestinian people have, as a result of the prolonged occupation, been denied the opportunity to conduct a reliable assessment of their water resource base which would allow proper planning of water use requirements.

As a result of this situation, the top priority in Palestine's water development strategy is to regain control over the available water resources and prepare a detailed assessment study of these resources which may be used to prepare a national water master plan. This plan should identify Palestine's water resources in terms of location, quantity, quality and the economic viability of extraction and use. The plan should also define criteria for inter-sectoral allocation and pricing, outline the institutional framework for planning, managing, regulating, operating and maintaining the water resources and projects; identify medium and long-term development priorities and describe major projects for irrigation, domestic and industrial uses.

7. Strategy for the Development of Palestinian Water Resources

In the short-term, the development strategy should focus on actions which aim at alleviating some of the pressing problems that have resulted from the occupation and preparing for meeting the future development requirements. These actions may include and promote the following activities:

a. Repairing and maintaining existing water supply and distribution systems for domestic use and irrigation, with the objective of preserving these systems, improving their efficiency and reducing losses through leakage.

b. Extension of domestic piped water supply networks to deprived communities, especially in the rural areas.

Surface water utilization may be enhanced by improving spring efficiencies, harvesting rainwater and diverting river water for irrigation use.

There are twelve main springs located at the foothills of the Eastern Slopes zone, with an estimated total annual discharge of some 35 to 40 million cubic meters. Additional 127 smaller springs, with year-round flow are scattered throughout the inland region with individual annual discharge rates ranging from 0.5 to 0.6 million cubic meters. Most of these springs are used for limited irrigation of village lands employing traditional methods.

Large quantities of water run through the four major wadis of Al Maleh, Al Fara'a, Al Quilt and Al Auja and a number of smaller ones along the Eastern Slopes zone and discharge into the Jordan River. In addition, a number of wadis along the western hills discharge rain water across the western boundary into Israel before they can be utilized in Palestine.

The construction of collection dams on the four major wadis and of smaller earth dams on most of the other wadis will substantially increase the amount of surface water available during the dry season and help recharge the local aquifer, thus improving the quality and discharge capacity of artisan wells, which supply water for irrigation and domestic uses. Similar advantages may be obtained through the implementation and proper operation and maintenance of rainwater collection from urban cities and towns with relatively large built-up areas.

In addition to spring discharges and wadi flows, surface water is potentially available through Palestine's riparian share in the Jordan River and its tributaries. This share is estimated at some 320 million cubic meters per year. In the Johnston's water sharing plan for the Jordan River Basin of 1953 it was proposed that part of Palestine's water share would be provided through the construction of an irrigation canal along the western flank of the Jordan River. The planning and implementation of this project would provide the Jordan Valley zone with the irrigation water supply required for its proposed substantial agricultural and agro-industrial development.

The quantity and quality of groundwater supply may be enhanced by rehabilitating and improving the performance efficiencies of existing wells and the construction of new ones at selected locations with extraction capacities compatible with the yield potentials of the aquifer systems. It is believed that substantial water losses often occur due to bad bore-holes, obsolete pumping equipment and deteriorating water distribution networks in many of the operating wells. Although it is believed that, on the basis of available information, a number of wells for domestic and irrigation uses may be dug with a relatively high probability of success, it is recommended that a thorough and extensive assessment of the actual conditions of the national aquifer systems be conducted immediately in order to identify the

the present population and the return of around 1.5 million Palestinians. Jordan's population is expected to increase to around 5 million, while that of Israel is expected to increase to over 6 million if the anticipated immigration of one million Russian and other Jews is realized. Thus, the projected total population of the three states may by the turn of the century exceed 15 million. By 2010 the total population of the three states is estimated to exceed 20 million, which is almost double the current level of the combined population of the three states.

This situation will certainly result in continuining water shortages and over-exploitation of water supplies. At the same time, neither known natural sources nor available or potential water technologies have the capacity to generate new usable water to meet the projected demand at an affordable cost.

It has, therefore, been anticipated that Palestine, Jordan and Israel may face acute and progressively worsening perennial water shortages and degradation of quality bordering on complete depletion of all renewable sources of fresh water, unless immediate drastic remedial actions are taken. Proposed actions include basin-wide sharing and administration, alterations in crop patterns and irrigated agriculture, application of water saving technologies and controlled population growth. In addition, arrangements for importing substantial fresh water supplies into the region from external sources must be seriously considered.

Palestine's present annual water consumption for all purposes is estimated at around 210-220 million cubic meters, representing only about one fifth of its renewable water sources. Future annual consumption levels are expected to increase to slightly over 1000 million cubic meters by 2010. At the same time, Jordan's current annual demand for all purposes of about 800 million cubic meters, which already represents an annual deficit of 100 million cubic meters is expected to increase to about 1850 million cubic meters, while Israel's annual demand for all purposes is expected to rise from about 2250 million cubic meters, with an annual deficit of some 1000 million cubic meters, this deficit is being met by over-exploiting the water sources of the inland region of the State to around 2500 million cubic meters.

The critical water situation arising from rapidly increasing demand and diminishing sources can only be addressed through effective local water-conservation policies and measures, the provision of additional water supplies from external sources, and riparian arrangements based on the equitable allocation of the available and potential water resources. Such arrangements should guarantee for the new Palestinian State access to all its riparian water share and compensation for exploitation of its water resources during the past twenty five years. If geo-political considerations do not readily allow the direct exploitation by the State of all its surface and underground water sources, then the proposed riparian arrangements should

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