Towards a Palestinian Water Policy

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Table of Contents

Abstract

Palestinian entitlements for water include the underground water of the West Bank and Gaza aquifers and their rightful shares in the waters of the Jordan River as riparian. However, at present, Israel is utilizing 85 % of the water from the Palestinian

groundwater aquifers, and Palestinians are denied access to the waters of the Jordan River. This policy led to a severe water crisis in the Palestinian territory in general and the Gaza Strip in particular.

The task of articulating water policies is considerable. This paper highlights the complexities of the Palestinian water policy and calls the establishment of a central water authority in order to coordinate all water related issues. It highlights the options for a Palestinian water strategy to meet the water needs of the Palestinian population for agricultural, industrial and domestic purposes. Baseline consuption for 1990 which is about 225 MCM as a total for all purposes and demand projections for 2000, 2010 and 2020 which are estimated to be about 497, 826, and 1263 MCM, respectively.

Introduction

Following the signing of the Declaration of Principles in Washington, D. C in September 1993 1993 and Cairo Agreement in May 1994, Palestinians are taking up the formidable task of formulating policies in all sectors of development in the autonomous areas. After the Israeli Authorities prevented Palestinians from making any policies during the years of occupation, the options set forth here are the beginnings of policy formulations in the water sector for Palestine. This paper represents a draft description of elements of a water Policy.

The Israeli occupation of Palestinian land had adverse impacts on the West Bank, East Jerusalem and the Gaza Strip in many respects. In the water sector, these have included the illegal control, by Israeli military order, of all water resources in Palestine, including the licensing, operation, and administration of wells; prohibition of new well drilling without authorization; overextraction from and degradation of aquifers; inequitable allocation of water between Israeli Settlements and Palestinian municipalities; and seizure of the Jordan River waters. This is the backdrop against which Palestinians must formulate policy. The task of articulating policies is considerable. In these initial stages of policy development, the quantities allocated are yet unknown. Certain problems particular to the Palestinian case complicate the discussion of policy:

1. the Palestinian National Authority is not yet controlling all disricts of the West Bank, including East Jerusalem, and Gaza Strip.
2. lack of important water resources data, and the complexity of the basis upon which to build a cohesive policy drawing together with the household, industrial and agricultural sectors. Studies are still required to ascertain both the true quality and capacity of aquifers, to guide development of more efficient use in all sectors and estimating the costs of improving and installing supply and delivery systems. Despite the difficulties, policy priorities have emerged. Policies in the water sector must be made with a view not only to establishing the basis for Palestinian control of their natural resources and their equitable allocation, but also to the regional impacts of sustainable resource use and management. Protection of natural resources is a priority. At the same time, negotiations leading to selfrule bring with them the first opportunities for development in all sectors. The goals of independence and economic development must be made in concert with the goals of protecting

resources. An essential prerequisite for sustainable peace is sustainable development.

Several principles establish the basis for ensuring a safe water supply for the West Bank and Gaza and guide the development of Palestinian policy. These include observation of aquifers' maximum safe yields to avoid overpumping; the adequate provision of a secure domestic water supply; efficient and productive agricultural and industrial sectors; fair water pricing systems; and water exchange between both the West Bank and Gaza, and, in the longer term, between Palestine and Israel. Each point is necessarily interlinked with the others, as no singular option can solve Palestinian water needs. Between the West Bank and Gaza, differences exist with respect to the seriousness of the situation. Additionally, differences exist with respect to what can be accomplished over the immediate, short, and long terms. The options discussed below can be implemented in the short to medium terms, over the next ten to twenty years. While we must plan for the long term, beyond 2020, much remains to be negotiated.

Palestinian Water Resources

The water resources of Palestine include:

The Jordan River:

The Jordan river is 360 kms long with a surface catchment area of about 18,300 km2 of which 2,833 km2 lie upsream of the lake tiberias outlet. The eastern catchment area downstream of Tiberias is about 13027 km2, while the western catchment is about 2344 km2. The average annual flow of this river is about 1200 MCM (Abu Faris 1992). The Jordan river initiated from three main springs: the Hasbani in Lebanon, the Dan in occupied Palestine, and the Banias in the Syrian Golan Heights to form the Upper Jordan river basin. The water of this basin flows southward through Lake Hula towards the Lake Tiberias. In the absence of irrigation extraction, the Jordan River system would be capable of delivering an average annual flow of 1,850 MCM to the Dead Sea. The riparians of the Jordan River are Lebanon, Syria, Palestine and Jordan. Only three percent of the Jordan River's basin fall within Israel's pre1967 boundaries.

Average precipitation for Upper Jordan and Lake Tiberias averages 1,600 mm and 800 mm respectively. Lower basin, around the Dead Sea has a desert climate characterized by scarce rainfall. The Jordan River is progressively more saline and less usable towards the Dead Sea. The Jordan River system satisfies about 50% of Israel's and Jordan's water demand; Lebanon and Syria are minor users, meeting 5% of their combined demands via the Jordan.

Downstream of Tiberias is the Lower Jordan river basin which joins Yarmouk and Zerka rivers originating from Syria and Jordan in the east. The outlet of this basin is toward the Dead Sea in the South. As a result of water diversion from the upper Jordan by the Israelis which is approximated to be about 650 MCM/yr (Salameh, 1993), there is no fresh water to flow downstream of Tiberias. Different riparians took

their needs from the Jordan River basin and the only small quantity that can reach the Palestinian riparian in the West Bank is of deteriorated quality. The deterioration of Jordan River water quality may be due to the upstream utilization by other reparians and Saline springs emerged at the bottom downstream of Tibenias as well as agricultural return flows and untreated wastewater practised by the Israeli settlements of Jordan Valley. Palestinian's share in the River's water cannot be used because they have no access to the Jordan River due to military closure by the Israelis since 1967.

U.N (1992) reported that an estimated 180-200 MCM/yr may be provided by surface runoff and from Jordan River for Palestinians in the occupied territories.

West Bank Mountain Aquifer

The Mountain Aquifer which was called so by Blake and Goldschmidt (1947) includes the area which was controlled by the Jordanian Administration before 1967 and since then became under Israeli Occupation. It is mainly composed of karstic limestone and dolomite formations of the Cenomanian and Turonian ages. It is mostly recharged from rainfall on the West Bank mountains of hieghts greater than 500 meters above mean Sea level. The annual renewable freshwater water of this aquifer ranges from 600 MCM to 650 MCM according to different Israeli and Palestinian sources. Figure (1) shows a schematic diagram of the Mountain Aquifer that illustrates the rain water's flow path to form different groundwater basins in the West Bank (Gvirtzman, 1993). According to that schematic diagram (Fig.1), the Mountain Aquifer can be divided into three main groundwater basins, each of which can be subdivided into subbasins. Figure(2) shows the distribution of groundwater basins and aquifers in the West Bank. There are two general directions for the groundwater of the Mountain Aquifer, east and west. The groundwater basins were recharged directly from rainfall on the outcropping geologic formations in the West Bank mountains (forming the phreatic portion), while the greatest part of the storage areas was located in the confined portions (Fig 1).

Figure 1. Cross-section of the Mountain Aquifer and Coastal Plain

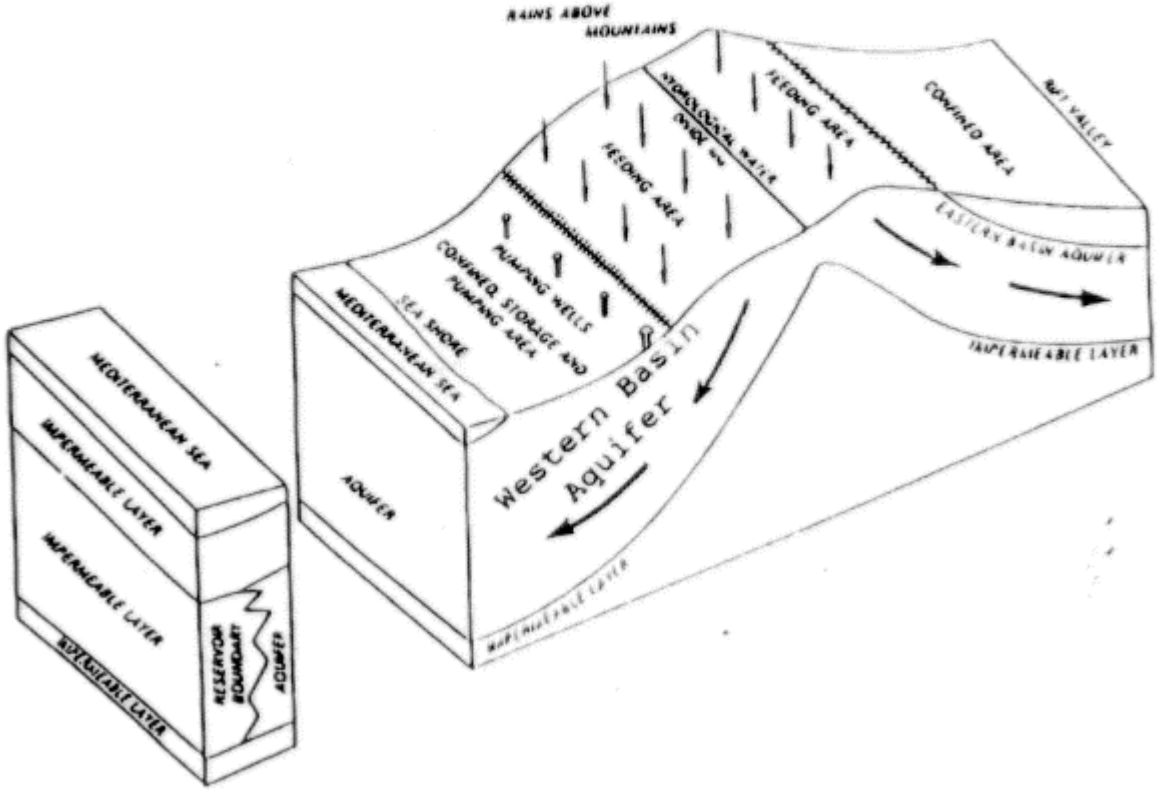

Figure (1) Schematic diagram of the Mountain Aquifer

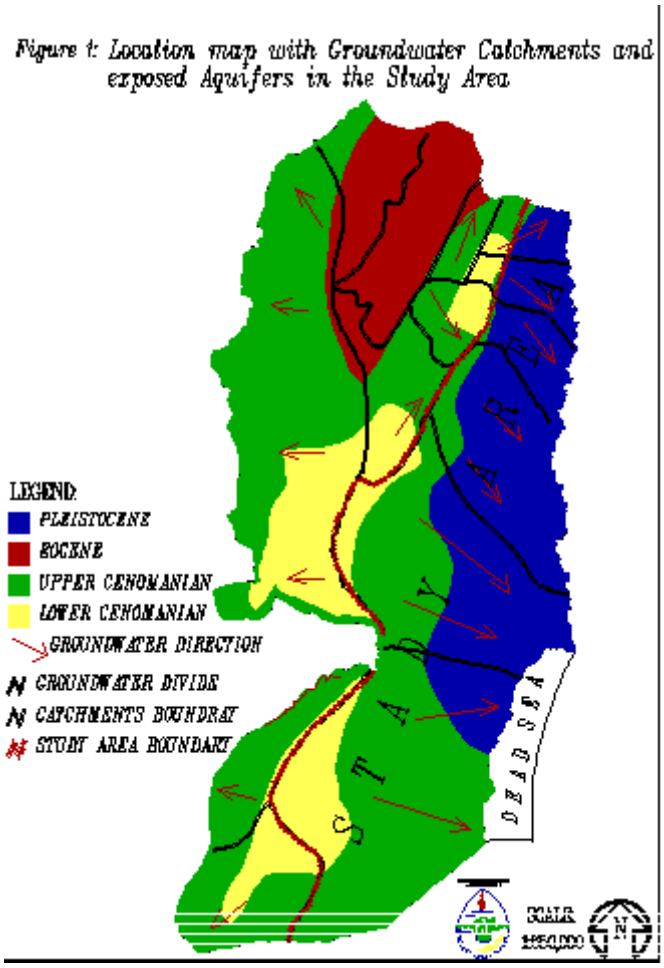

Figure 2: The distribution of groundwater basins and aquifers in the West Bank

The phreatic portions constitute the subsurface area under the West Bank mountains where the Palestinians dug their groundwater wells to tap the shallow unconfined aquifers. The Israelis, however, dug their wells to tap the confined aquifers whose quality and quantity are better. These groundwater basins are:

1. The Western Groundwater Basin:

   Consistuting the western part the Mountain Aquifer, it consists of two subbasins, Nahr el Auja A-Tamaseeh and Hebron- Beer Shava, that drain the Lower and Upper Cenomanian aquifers with a total pumpage and spring discharge ranging from 380-400 MCM/yr. The storage capacity of this basin is about 360 MCM/yr (Gvirtzman, 1993). 80% of the recharge area of this basin is located within the West Bank while 80% of the storage area is located within the Israeli borders.

   The groundwater flow movement is towards the coastal plain in the west. Though, in theory, it is a shared basin between both Israelis and Palestinians, the Israelis have overexploited the basin using

   333 MCM in 1992, while the Palestinians consumed in the same year about 27 MCM for all purposes. Palestinians pump their water from 138 wells for

irrigation and domestic purposes in Qalqilya, Tulkarm, and west Nablus, while the israelis overexploit this basin through thier 300 deep

groundwater wells to the west of the green line which are under artesian pressure (IPCRI, 1993). The tatal number of springs of this basin with an average discharge greater than 0.1 L/S in the West Bank is 35 with a total annual flow of about 7.7 MCM (Nuseiba, 1994).

2. Northeastern Groundwater Basins:

   Consisting of the Nablus-Jenin basin that drains the Eocone aquifer and the overlying Samarian basin that drains the Eocene and Neogene Aqifers, the basin's storage capacity is approximately 140 MCM/yr (Gvirtzman, 1993). While again this is a shared groundwater basin, Israelis in 1992 consumed about 115 MCM and Palestinians consumed about 25 MCM for both irrigation and domestic purposes from thier wells and springs in Jenin district and East Nablus (Wadi El Far'ah - Wadi El Bathan). In 1992 the total pumpage in these areas is about 12.3 MCM in addition to about 15 MCM from springs (Nuseiba, 1994). In total Palestinians have 86 wells tapping this basin. The general groundwater flow direction is towards the Bisan natural outlets (springs) in the north and northeast.

3. Eastern Groundwater Basin:

   Constituting the eastern flank of the Mountain Aquifer, the general groundwater flow direction in this basin is to the east (Jordan Valley). The available potential resources of this basin ranges from 100 MCM/Yr (Tahal, 1990) into 150 MCM/yr(IPCAI,1993). This basin drains the Neogene, Pleistocene, Lower Cenomanian, and Upper Cenmanian Aquifers and can be divided into six subbasins (Fig.2). It is an unshared groundwater basin as both recharge and storage areas are located within the boundaries of the West Bank. It is unexploited completely because of water quality problems in the upper shallow aquifers in which Palestinians dug thier wells. It needs extensive hydrogeological study to identify its actual potential resources, safe yield, the hydrogeological proberties, groundwater quality, and flow pattern of each aquifer.

   The most important springs in the West Bank belong to this basin. The total number of springs with average discharge greater than 0.1 L/S is 79 which participates in 90% of the total annual spring discharge in the West Bank (Jad Isaac, 1994). The total number of Palestinian groundwater wells in this basin is 122 used for irrigation and domestic purposes. The Israelis have 19 deep wells, located in Jewish settlements in the upstream of the Jordan Valley areas to extract water before it becomes saline. These Jewish settlement wells are located under artesian pressure and tap the lower Cenomanian aquifer with both good water quality and quantity.

Gaza Coastal Aquifer

The main Gaza Aquifer is a continuation of the shallow sandy/sandstone coastal aquifer of Israel (shared aquifer) which is of the Pliocene-Pleistocene geological age. About 2200 wells tap this aquifer with depths mostly ranging between 25 and 30 meters. Its annual safe yield is 60-65 MCM (Tahal, 1990), but the aquifer had been overpumped since before 1967, resulting in a lowering of the groundwater table below sea level and saline water intrusion in many areas. The main sources of salinity are deep saline water intrusion from deeper saline strata, sea water intrusion, and return flows from very intensive irrigation activities. Since 1967, the aquifer has been overpumped by a rate of 90-100 MCM/Yr in order to meet both Israeli settlers and Palistinian water needs.

Water Policy under Occupation

One of the major impediments to developing a sound Palestinian water policy has been Israeli control over the water resources in Palestine which has affected adversely the development of a consistent supply, maintenance of quality, and improvements in systems. The Palestinian water status against which policy will be made includes the following considerations:

1. Water Authority and Institutional Capacity

   At present, Palestinian district water authorities operate independently of each other without coordination of policy, data, or expertise. Under the control of the Israeli Water Department and Mekorot, the municipal departments, serving municipalities, villages, and some refugee camps, act as individual utilities. The following are responsible for providing service according to the guidelines of the Civil Administration, Water Department and Mekorot: Jerusalem Water Undertaking in Ramallah District, Bethlehem Water Authority, Nablus Municipality Water Department, Hebron Municipality Water Department, and Gaza Municipality.

2. Well Drilling and Efficiency of Operation

   In addition to the closure of wells belonging to Palestinians, many wells operate at inefficient levels and are in need of rehabilitation or replacement. Civil Administration restrictions on the drilling of new wells and testing wells, and the length of time required to obtain permission for well operations prohibits upgrade in the quality of operation and volume of water supplied.

3. Limited Access to Piped Water

   Between 26 and 40% of the population in Palestine has yet to be connected to household water distribution systems. By comparison, Israeli and Jordanian citizens have service levels of domestic piped water of close to 100%.

4. Intermittent Water Supply and Quotas

   Israeli settlements receive continuous water supply, largely from wells in Palestine, and are provided service of greater quantity per capita than that

received by Palestinians in the West Bank and Gaza. When the low monthly quota levels for Palestinian municipalities and towns are approached, the remaining supply is constricted, and communities may be without water for extended periods of time. Heavy fines are imposed by the Israeli Civil Administration for pumping beyond low quota levels.

5. Deteriorated Water Quality

   At present, most of the water extracted from the Gaza aquifers is of poor quality, falling below health standards set by the World Health Organization. However, there are a limited number of water lenses under Gaza which are of freshwater quality. These lenses are situated around the Israeli settlements in the Gaza Strip and thus are not accessible to the Palestinians even after Autonomy. Overpumping of the Gazan aquifers has resulted in seawater intrusion and high salinity levels. Chemically contaminated water runoff seeping into aquifers has resulted in high nitrate levels. The same water quality Problem is located in the eastern groundwater basin of the West Bank Mountain aquifer.

6. Distribution Networks

   Currently, water distribution networks are in poor condition. Unaccountedfor-water and system losses are between 2540% due to leaky pipes, inadequate maintenance, unmetered consumption, and pirated water.

7. High Water Prices

   Because water prices include tariffs assessed at every level of administration, costs are high due to the transfer of water from the Israeli Water Department to the municipalities before it is sold to the consumer. Prices are therefore higher than would be the case if only one Palestinian Water Authority's administrative charge were assessed rather than the two presently charged by both the Israeli Water Department and the municipalities.

Palestinian Water Rights

The Palestinian water rights issue is a very sensitive and crucial issue. Despite rights outlined by the Helsinki Rules and the International Law Commission, Palestinians have been denied their riparian rights to several surface water and seawater resources, in contravention of international water law. Israel is utilizing most of the resources of the West Bank aquifer, the recharge area of which is mainly in Palestinian land. At the same time, Israel is pumping water from the coastal aquifer, preventing the replenishment of the Gaza aquifer. The current water allocations have not been negotiated, but rather taken by force. Palestinian claims for reinstatement of riparian and groundwater rights include the following:

1. Jordan River.
   Although Palestinians are full riparians to the Jordan River, they have been denied rights to its water. Under the Johnston Plan, the proposed West Ghor

Canal would have supplied 150 mcm from the River to the West Bank, but plans were never carried out. The Jordan's River waters have been diverted for transport via the Israeli National Water Carrier to irrigate areas in the Negev. Israel is also using the lower Jordan River as a dumping site for saline water from around Lake Tiberias, as well as for polluted and industrial wastewater. Treatment and use of the Jordan are important for household consumption, irrigation, transport, industry, and tourism.

2. Yarmouk River Tributaries.
   Palestinians have riparian rights to the Yarmouk River.
3. Storage and Fishing Rights in Lake Tiberias.
   Lake Tiberias is part of the Jordan River Basin. According to international law, Palestinians have storage and fishing rights because of their status as riparians to the Jordan River.
4. Groundwater Aquifers.
   Palestinians' claims for groundwater aquifers underlying the West Bank and Gaza must be under the sovereign control of the Palestinian Administration since the recharge areas are within Palestinian borders. Under Israeli control, inequitable groundwater allocations between Israelis and Palestinians are as follows: from the Northeastern Basin, the Israeli share is 115 MCM whereas the Palestinian share is 25 MCM; from the Western Basin, the shares are 325 MCM and 25 MCM; and from the Eastern Basin, the shares are 65 MCM and 60 MCM, respectively.
5. Wells and Springs.
   Control of well pumping and spring flow, drilling of new wells and proper maintenance, must be under a Palestinian water authority, though pumping levels for shared aquifers could be equitably negotiated.
6. The Mediterranean and the Dead Sea.
   Rights of access to the Mediterranean for fishing, port development, and shipping is essential for the development of the fishing industry and for international trade. The Dead Sea represents an important natural resource and area for tourism for Palestinians who are full riparians.

Institutional Authority, Management, and Regulation

To effectively manage Palestinian water allocation once, access rights are determined, a central water authority should be created which will be responsible for the coordination of policies and activities. The present district departments, under the umbrella of the central water authority, will also be responsible for regulations, including pumping quotas and well licensing, instituting pricing systems, and interdistrict transfers. Institutional development will require the development of staff training and expertise in order to fulfill the functions of the authority. One of the most important priorities of the Palestinian Central Water Authority should include the water resources planning. The following items should be considered in the Palestinian water resources planning policy:

Hydrological, hydrometeorological, and hydrogeological studies

Observation gauge stations should be established in all parts of Palestine in order to obeserve and monitor different hydrological, hydrometeorological, and

hydrogeological parameters such as: rainfall, evapotranspiration, streamflow, floodflow, baseflow, sediment load quality and quantity, and surface and groundwater quality. The processing of the above data in the form of hydrographs, duration curves, and groundwater contour maps can lead to the application of mathematical modelling methods using digital computers for simulation of streamflow and groundwater flow in different reservoirs (Al- Labadi, 1989). Mathematical modelling can be applied in hydrogeology in order to predict the drawdowns and pumping lifts for various well field schemes. It can also provide us with a valuable information about the time of lowering of the water levels as a result of continuous withdrawal from well fields at constant discharge. As groundwater is the main water resource in Palestine, mathematical groundwater flow modelling should be used to set up the Palestinian water strategy. In order to do so, the following hydrological and hydrogeological studies are required:

Evaluation of water budget depending on measurements of the above mentioned gauge stations.

1. Evaluation of different aquifer proberties and execution of aquifer pumping tests to identify permeabiliy, transmissivity, storage coefficient, and safe yield.
2. Estimation of natural and artificial recharge and evaluation of the leakage coefficients between lower and upper aquifers.
3. Geological and Geophysical well logging studies should be executed in order to identify the thiknesses and boundaries between different aquifers.
4. Environmental isotope hydrology study for a carefully selected number of water samples from floods, wells, and springs of the upstream and downstream portions of different aquifers. These samples should be analysed for Deterium, Oxygen-18, Tritium, and Carbon-14 in order to determine the confined and unconfined portions, recharge areas, and groundwater ages of different aquifers in Palestine. This tool could also povide us with a valuable explanation about water quality problems such as sources of high saliniy and the points of mixing between different groundwter sources.
5. Complete hydrogeochemical studies should be conducted for floods and production wells and spring systems in order to determine water quality parameters and correlate them with groundwater flow pattern in different aquifers.

Extensive groundwater studies should be conducted on Gaza Coastal Aquifer and on the Eastern Groundwater Basin of the West Bank Mountain Aquifer in order to evaluate and monitor quantity and quality there.

Supply Management

Although the amounts of water used by Israel and Palestine are not yet allocated by formal agreement, the general quantities available are estimated at 60-65 MCM from the Gaza aquifer and 600-650 MCM from the West Bank aquifers. Once rights to these quantities are established and the resources come under the control of a central water authority, individual well operation rights must account for the fact that water is a communal and limited resource. Given its value as a commodity, as well as a social,

political, and security resource, its management will require implementation of the following supply programs:

1. Specific Yields of Palestinian Groundwater Aquifers

   The condition and yield capacity of the Gaza aquifers requires priority action to prevent further deterioration. Measures to prevent similar deterioration in the West Bank must be taken. In Gaza, estimated yields are 60-65 MCM annually, but extraction rates are at approximately 90-100 MCM. Of this, approximately 43 MCM are estimated to be extracted from the Gaza Aquifer from the Israeli side. Overpumping of the aquifer is occurring presently at a rate of approximately 30-35 MCM per year. Clearly, this is not sustainable, given that the resulting salination of the aquifers' waters is above safe consumption levels. Table(1) shows the 1990 baseline estimates and projections of total water demand for different sectors (ARIJ, 1994). Projected consumption for Gaza is at 163.8 MCM by the year 2000, exceeding the natural capacity of the aquifers by 100 MCM, approximately 60 MCM over 1990 figures. The projected 2020 figures are even more ominous at 366.4 MCM. Where these rates to be extracted, the aquifers in Gaza would eventually show salinity rates well above acceptable agricultural use levels.

   The West Bank Mountain aquifers' maximum specific yield is 650 MCM, depending on annual recharge from rainfall and potential artificial recharge. Extraction levels should account for annual variations in recharge, and then set just below the maximum specific yield levels. The West Bank water consumption in 1990 was 123.1 MCM which is much closer to the current water consumption and is projected to grow to 333.5 MCM by 2000, 578.8 MCM by 2010, and 896.5 MCM by 2020 (Table (1)).

2. Treated Wastewater for Use in Agriculture and Industry

   The establishment of wastewater treatment plants will be an important element in shifting freshwater resources to domestic use and in helping solve the problem of waste contamination and disposal. It is estimated that 70% of domestic wastewater could be treated to levels appropriate for use on fruit trees and for industry.

3. Desalination and Mixing Water of Differing Salinities

   Because of the dangerous salinity levels of the Gaza aquifers, the option of desalinating brackish water and mixing waters will be an important alternative water source. Although the cost to desalinate seawater is clearly prohibitive, the prospects for desalinating brackish water in the West Bank and Gaza should be further explored. The costs for desalinating vary according to the salinity level of the volume processed and the end salinity level desired. Costs vary also according to the desalination method used. For brackish water, costs per each cubic meter may range as low as US$. 30, and for seawater, as high as $1.70. The option of mixing desalinated brackish water with other brackish water supplies to produce water of safe salinity levels is being tested in Gaza and presents one option. Another option is that of mixing supplies of naturally

differing salinities, without treatment. The northern aquifer in Gaza shows lower saline contamination levels than do the central and southern aquifers. While the southern aquifer salinity levels are generally too high for agricultural or safe household use, the northern aquifer may be too valuable a freshwater resource to continue using it for agriculture. One option may be to pipe lower salinity (100 ppm) water from the northern aquifer south, mixing in higher salinity water (600 ppm) from the southern aquifer to produce water of acceptable salinity levels appropriate for both agricultural and household use.

4. Natural and Artificial Recharge of Aquifers

   Unsustainable rates of groundwater extraction beyond natural recharge rates lead to drops in the groundwater table, creating conditions for seawater infiltration into coastal and mountainous aquifers. In years when rainfall is low and extraction exceeds natural recharge, storm water collection and artificial recharge are two methods used for controlling further contamination. Artificial recharge is also an effective method of storing water when there is excess. The principle of artificial recharge is especially relevant for Gaza's aquifer system in order to prevent contamination. The shallow Gaza aquifer could potentially be used as a storage aquifer for winter rains. Excess water runoff from the Hebron Mountains transported via several Wadis, estimated at 50 MCM, though currently diverted by Israel, can be collected in lagoons or catchment systems and injected through wells into the aquifer. An additional 35 MCM could be similarly stored and injected. Alternatively, water may be transported via a pipe from the West Bank or the Israeli National Water Carrier, recharging the aquifer. Water could then be extracted in the summer for various purposes. The option would require careful monitoring. In the West Bank also, runoff waters may be effectively contained and used to recharge aquifers through injection wells. Catchment projects can be undertaken in areas of high soil permeability such as in the Wadi EL Qilt and Wadi El Fara'ah areas.

Sectoral Demand Management

With the expected increase in population will come a significant increase in water demand. While household service levels are presently far below what is required to improve service to international standards, conservation of the precious commodity must also be a primary consideration.With increases in service levels must come programs targetting conservation and awareness. Lowflush or no-flush toilets, for example, can significantly reduce water volumes consumed. Even with conservation and awareness campaigns, to meet projected demands and to maintain access to supply over the long term, efficiency must be stressed in every sector. Distribution system improvements, changes in agricultural production, observation of aquifers' maximum spesific yields, desalination of brackish water, mixing of water of higher and lower salinities and use of treated wastewater will all be required.

Household Consumption

Supplying drinking water for household use, is the first priority in making Palestinian policy. Estimated water consumption in this sector was 81.55 MCM in 1990.

Projected demand estimates are for the year 2000, 176.2 MCM; for 2010, 321.96 MCM; and for 2020, 452.13 MCM (Table 1). West Bank aquifers are of excellent quality and, if used judiciously, can provide enough water to sustain the projected household requirements approximately over the next thirty years, supplementing supplies in areas where resources are of insufficient supply or quality. For example, water for household use can be transferred from the West Bank to Gaza via a water carrier system, or from Israel to Gaza through trade.

Agricultural Consumption and Efficiency

Agriculture represents approximately one third of the Gross National Product of the West Bank and Gaza. Development of the sector is essential for several reasons: it requires low capital investments, the technology is easy to absorb, and rural populations rely heavily on agriculture. The sector will also act as an important area in which Palestinian returnees will work. Such an important component of the economic base of Palestine requires attention to improving its efficiency for the maximum benefit and for sustainable development. Estimated water consumption in this sector was 140.1 MCM in 1990. Projected demand estimates are for the year 2000, 216.5 MCM; for 2010, 304.5 MCM; and for 2020, 415.2 MCM (Table 1). The use of treated wastewater for certain crops, and use of brackish watertolerant crops will be necessary in restructuring the sector for sustainable development and efficiency. Intensive agriculture, however, must be undertaken with regard to careful use of pesticides and agrochemicals. For example, intensive agriculture should be avoided in the West Bank Mountain Aquifer recharge area. Similarly, the soil type in Gaza is highly absorbent and chemical use there must be made with great care to prevent aquifer contamination.

Industrial Consumption

While industrial consumption of water is presently low, significant expansion of the sector is expected, particularly over the long term. Estimated water consumption in this sector was 7 MCM in 1990. Projected demand estimates are for the year 2000, 18.2 MCM; for 2010, 37.4 MCM; and for 2020, 61 MCM (Table 1). Expansion is first expected to occur in the areas which presently make up the sector: food, quarrying, and textiles. Over the longer term, however, investment opportunities, rises in income levels, and lifting of restrictions will open the sector to a wider range of production. Schemes for efficient use of water in the industrial sector should emphasize recycling water for certain processes, such as cooling, and treating water for reuse onsite. As the industrial sector is relatively undeveloped, efficient use and water conservation measures should be implemented early on. Beyond the conservation concerns, broader environmental concerns also affect greatly the issue of water quality. Heavy metals, for example, easily seep into clay soils such as are present in Gaza. Seepage of heavy metals and mercury into the aquifers are unacceptable.

Table(1): Total Water Demand in Palestine-Middle Senario 1990 Baseline estimate and Projections for 2000, 2010, and 2020 (MCM)(Isaac et al, 1994)

Sub-district	Household (MCM)				Agriculture (MCM)				Industrial (MCM)				Total (MCM)			
	1990	2000	2010	2020	1990	2000	2010	2020	1990	2000	2010	2020	1990	2000	2010	2020

West Bank	**53.05**	**114.6**	**208.69**	**339.9**	**69.9**	**146.3**	**234.3**	**345**	**5**	**13**	**26.7**	**43.5**	**123.1**	**333.5**	**578.8**	**896.5**
Gaza Strip	**28.5**	**61.59**	**113.27**	**186.39**	**70.2**	**70.2**	**70.2**	**70.2**	**2**	**5.2**	**10.7**	**17.4**	**102.2**	**163.9**	**247**	**366.4**
Total	**81.55**	**176.2**	**321.96**	**452.13**	**140.1**	**216.5**	**304.5**	**415.2**	**7**	**18.2**	**7.4**	**61**	**225.3**	**497.3**	**825.8**	**1263**

Market Demand Management

Pricing System

Water should be both fairly and efficiently priced. While water for household use should be available to all, its pricing should reflect its value as a limited resource to be utilised carefully. Several districts already use a block rate policy, by which several volume levels correspond to a different tariff. The lowest bracket of water used is priced so that minimum per capita household water requirements can be met reasonably. By this system, homes are equitably supplied with the basic requirements for drinking, cooking, and hygiene, while incurring higher costs for use beyond that which is considered the minimum daily requirement.

No Direct Subsidization

This policy does not provide for direct subsidies of water in household, agricultural or industrial use, but makes it possible for the minimum water requirements for household use to be acquired at reasonable rates. The availability and market value of water will be the determinant of price and consumption rather than a government policy to provide lower prices for encouragement of agricultural production.

Indirect Agricultural Subsidies

Some assistance in the form of capital and technology inputs may be important in the beginning stages of restructuring and managing crop growth in the agricultural sector. Other means might include negotiating for the opening of international markets for certain crops. A third is assistance in capital investment through loans and grants.

Transfer from the West Bank

Because the West Bank and Gaza are one political unit, transfer of water between areas is an important means of solving water crises where present. Because of the limited ability of the Gazan aquifers to provide household water at safe contaminant levels, and because of the high costs required to desalinate brackish water and seawater, it may be more cost efficient to provide the Gaza domestic water supply via a water carrier pipe. The costs of piping water from the West Bank, from high elevations to sea level, would certainly be lower than the maximum estimate for seawater desalination and will be considered in the cost estimates of providing household sector water to Gaza. The Gaza aquifers would then be left for agricultural and industrial use, observing the nooverpumping rule and artificially recharging in order to rehabilitate the aq uifer to reasonable salinity levels. Because the pipeline would have to pass through Israel to reach Gaza, carefully made agreements would be required to avoid disruption of the pipeline .

Trade between Palestine and Israel

As a longer term option, it may prove more cost efficient to negotiate trade between Palestine and Israel. Such an agreement could be effected only after water rights have been established and recognized. A trade agreement would likely include two elements:

- Israel would provide Gaza with its household water supply, and the West Bank in turn would provide Israel with water from the north; and
- trade would be established in wastewater for recycling and use in the Negev.

Were these to prove cost efficient options, the trade would create a mutual dependence on the traded supply of each side, theoretically securing that supply. Matual confidence in and good relations between trading partners would need to be built.

Summary and Conclusions:

It is clear that the water situation in Palestine deserves urgent attention. To avoid disasterous consequences of misuse, policies which will lead to sustainable use of water must be thought out and implemented as soon as possible. However, arid and semi-arid climatic conditions and rainfall variability are compounded by an abnormal political status whereby Palestinians lack legal control over almost all natural resources within their legitimate national boundaries. In developing water policy the following issues will need to be addressed.

1. Palestinians continue to face political/legal complexities in formulating water policy, including:
    - the Palestinian Authoriy does not yet have control over all the West Bank, including East Jerusalem, and the Gaza Strip;
    - important water resources data is lacking, making it much harder to build a cohesive policy which incorporates the household, industrial and agricultural sectors.
2. Palestinian water policy should include:
    - establishing the basis for Palestinian control and equitable distribution of their natural resources;
    - sustainable management, use and protection of water resources, specifically from pollutants such as irrigation and industry runoff or seepage.
3. Several provisions have been established as a basis for providing guidelines for the development of Palestinian water policy and safe water supply for the West Bank and Gaza, including:
    - observation of aquifers' maximum safe yields to avoid overpumping;
    - the adequate provision of a secure domestic water supply;
    - efficient and productive agricultural and industrial sectors;
    - fair water pricing systems;
    - water trade between both the West Bank and Gaza, and, in the longer term, between Palestine and Israel.

    All of these points are interlinked and must be taken together to solve Palestinian water needs.

4. Shared water resources between Israelis and Palestinians include the Jordan River, West Bank Mountain Aquifer, and Gaza Coastal Aquifer.
5. The water policies carried out under occupation have led to a complication and deterioration in the water situation, and resulted in a reduction of piped water for the population, losses in the distribution network, and problems in the water quality.
6. According to the International Water Law, Palestinians have the following rights:
    - the Jordan River Basin including Yarmouk River
    - the Mediterranean and Dead Seas
    - the groundwater aquifers of the West Bank and Gaza Strip
    - storage and fishing rights in Lake Tiberias
7. The creation of the Palestinian Central Water Authority is recommended once access and riparian rights are established. It will be responsiple for the coordiation of policies and activities including all the district water authorities under its umbrella. The main function of the Palestinian Water Authority will be water research and planning including: hydrological and hydrogeological studies: developing supply and demand management scenarios: and market demand management.
8. Extensive groundwater studies should be conducted on the Gaza Coastal Aquifer and on the Eastern Groundwater Basin of the West Bank Mountain Aquifer to deteremine their capacities and development priorities.

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