Managing Water for Peace in the Middle East

Alternative Strategies

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Abbreviations

International organizations and agencies

DTCD	Department of Technical Cooperation for Development (UN)
FAO	Food and Agriculture Organization of the United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNRWA	United Nations Relief and Works Agency for Palestine Refugees in the Near East
WHO	World Health Organization
WMO	World Meteorological Organization

Academic and professional associations

AGU	American Geophysical Union
AWWA	American Water Works Association
IDA	International Desalination Association
IHP/IHD	International Hydrological Programme/Decade
IWRA	International Water Resources Association
NWSIA	National Water Supply Improvement Association (USA)

Projects

EGMC	East Ghor Main Canal
INWC	Israel National Water Carrier

MDS	Mediterranean–Dead Sea (canal/conduit)
PG	Palestine Grid

Desalination technology

CA	cellulose acetate
ED	electrodialysis
EDR	electrodialysis reversal
ME	multi-effect evaporation
MSF	multi-stage flash evaporation
RO	reverse osmosis
VC	vapour compression

Units of measurement

gal.	(US) gallon(s)
GWh	gigawatt hour(s)
ha	hectare(s)
km^2	square kilometre(s)
km^3	cubic kilometre(s)
kV	kilovolt(s)
kVA	kilovolt ampere(s)
kW	kilowatt(s)
kWh	kilowatt hour(s)
m^3	cubic metre(s)
m^3/sec	cubic metre(s) per second
MCM	million cubic metres
mgd	million gallons per day
mg/l	milligram(s) per litre
mig	million imperial gallons
MW	megawatt(s)
MWh	megawatt hour(s)
μm	micrometre(s) (micron[s])
ppm	part(s) per million
psi	pound(s) per square inch

Miscellaneous

BOD	biochemical oxygen demand
CFU	colony-forming unit(s)
CIS	Commonwealth of Independent States (former Soviet Union, since 1991)
EDTA	ethylene diamine tetra-acetic acid
El.	ground elevation
JD	Jordanian dinar(s)
KD	Kuwaiti dinar(s)
M&I	municipal and industrial

O&M	operation and maintenance
PLO	Palestine Liberation Organization
TDS	total dissolved solids
UAE	United Arab Emirates

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Introduction

1.1 Background

Limitations on water, one of the scarcest resources in an arid region, are likely to have a significant impact on the economic development of all countries of the Middle East. Middle East water-resource issues are also likely to have a significant impact on the future political framework of the region in the aftermath of the Gulf war of 1990–91 and the peace agreements between Israel and the Palestine Liberation Organization of September 1993 and Israel and Jordan of October 1994. The scarcity of water and the high cost of its development have long been recognized in arid regions, especially in the Arabian Gulf countries, where neither surface water nor renewable fresh groundwater are available. The demand for water to serve expanding third-world populations continues to increase, however, while fresh-water supplies are finite, and it is becoming more and more difficult to develop them on a renewable basis. Almost all fresh and renewable waters such as rivers, streams, lakes, and groundwater, which are termed "conventional water" or "traditional water," have already been exploited or will be fully developed in the countries of the Middle East and North Africa by the end of this century.

Few regions of the planet offer a more varied physiography or a richer mix of ethnicities, religions, languages, societies, cultures, and politics than the Middle East. At the same time, no segment of the globe presents its diverse aspects in such an amalgam of conflicts and complexities. Out of this compound, one issue emerges as the most conspicuous, trans-boundary, and problematic—water. Its scarcity and rapid diminution are most keenly felt in places where there also happen to exist some of the fiercest national animosities. River waters in the Middle East in particular are a conflict-laden determinant of both the domestic and external policies of the region's principal actors. However, as one of the leaders of the Palestine Liberation Organization stated in the early 1990s, "Water is more important than oil or politics"; so politics may not remain a constraint to water development much longer.

As water shortages occur and full utilization is reached, policies tend to be framed more and more in zero-sum terms, adding to the probability of discord, and it would seem to be unavoidable that the severity of Middle Eastern water problems will continue to increase significantly. In the already overheated atmosphere of political hostility, the lack of sufficient water to satisfy burgeoning human, developmental, and security needs among all the nations of the Middle East has heightened ambient tensions. By the end of the 1990s Israel, Jordan, and the West Bank and Gaza, or Palestine, will have lost virtually all of their renewable sources of fresh water if current patterns of consumption are not quickly and radically altered. In these circumstances, the Jordan River system, which includes the Al-Wuheda dam scheme on a major tributary of the Yarmouk River, unquestionably holds the greatest potential for conflict.

Despite the many political complications in the Middle East, there is a recent history of tacit, although limited, cooperation over multinational river development even among the bitterest opponents on the Nile, Euphrates, and Jordan Rivers:

» Egypt and the Sudan created a model of cooperation in their 1959 Nile Waters Agreement, which not only governs the sharing of the Nile's waters but contains an instrument for settling controversies by negotiation. This could serve as a model for other river systems in the application of technology to alleviate water problems.
» Turkey has often threatened to cut the flow of the Euphrates. But Iraq and Syria managed to arrive at an arrangement over the operation of the Tabqa dam in 1975. Turkey agreed with Syria on the operation of the Ataturk dam in 1987, by releasing 500 m^3/sec

(15.8×10^9 m^3 per year) of water to the Syrian border. However, the water was used as a political weapon to force Syria to curtail its support for Kurdish activists in south-east Anatolia.

» Israel and Jordan—before Israel's invasion of Lebanon and her troublesome stand on clearing out obstructions to the intake of Jordan's East Ghor canal—had more or less informally agreed to share the Jordan River system within the framework of the 1955 Johnston Plan (Naff and Matson 1984).

Multinational river development has been a keen concern of water-resource planners throughout the world, especially in developing countries in arid regions. One example has been Turkey's ambitious proposal for the "Peace Pipeline" project in 1987, to transfer water from the Seyhan and Ceyhan river systems in south-eastern Turkey to the Euphrates basin and to other countries downstream. This project would require the construction of a series of dams, water tunnels, and the world's longest international water pipeline system, with a total length of about 6,550 km and a capacity of 6 million cubic metres a day (Gould 1988). It has been shown to be technically though not yet economically feasible. The project would involve the crossing of several political boundaries, however, and is likely to be postponed until some of the most pressing political issues of the Arab world, including international water-rights problems between Turkey, Syria, and Iraq, have been solved. Transboundary river development may not take place this century, but planning and the easing of water disputes will certainly form an important part in political discussions to determine the future pattern of boundaries to be redrawn in any future peace settlements.

In arid regions, the potential resources of fresh and/or good-quality water are limited because of the scantness of rainfall and the very high potential evaporation, exceeding the potential rainfall by ten times or more. Further, as is becoming increasingly apparent, salinity pollution resulting from irrigated agriculture, which is not a recent phenomenon but an age-old problem, has an important indirect effect on water quality.

Scientists of the former Soviet Union have reported that the Caspian and Aral Seas are in retreat because excessive irrigation withdrawals are reducing inflow from their catchments. The Aral Sea has already shrunk dramatically in size; the water level has dropped by three metres since 1960, reducing its size by some 18,000 km^2. In the mean-time the reduced inflow from the two major rivers, the Sir Darya and the Amu Darya, with enhanced salinity from irrigation returns, has already increased its salinity up to 1,000 ppm of total dissolved solids (Meybeck et al. 1990).

Basin irrigation has been practised on the flood plain of the Tigris and Euphrates Rivers since 4000 B.C. Lack of drainage has repeatedly caused a build-up of salts in soil and water that has inhibited food production and indeed that contributed to the decline of Sumerian culture. More recently the modern development of irrigation in arid regions has suffered from a variety of salinity-pollution problems. Problem areas have included the Indus River basin in South-West Asia, the Tigris-Euphrates basin in the Middle East, the Nile in North Africa, the Murray River in Australia, and the Colorado River in the United States (Meybeck et al. 1990).

Since the 1950s the Colorado River has been seriously contaminated by irrigation return flows and highly saline pumped drainage water from the Wellton-Mohawk irrigation project in south-western Arizona. By 1961 the salinity of the river had reached a level that was unacceptable to the government of Mexico. In 1973 the International Boundary and Water Commission required the US government to improve, enhance, and protect the quality of water available in the Colorado River for use in the United States and Mexico. The agreed-upon salinity level could only be attained by either bypassing saline drainage or desalting the brackish water before it returned to the river. Since water is a precious resource in the semi-arid areas of southern Arizona, a decision was made to reclaim a major portion of the Wellton-Mohawk drainage by a desalination plant—the world's largest reverse-osmosis desalting facility, with an installed capacity of 72.4 million gallons, or 274,000 m^3, per day (Applegate 1986).

In some of the more arid parts of the Middle East, in particular the Gulf states, where good quality water is either not available at all or is extremely limited, desalination of seawater has been commonly used to solve the problems of water supply for municipal and industrial (M&I) uses. Owing to the rapid increase in demand for water in the Arabian Gulf countries—Saudi Arabia, Kuwait, the United Arab Emirates, Qatar, Bahrain, and Oman—where the potential for development of conventional water resources such as fresh surface water and renewable groundwater is extremely limited, other alternatives such as waste-water reclamation and desalination processes have been developed since the 1960s. Saudi Arabia, Kuwait, Qatar, and Bahrain are using non-renewable groundwater resources in large quantities, causing depletion of these valuable resources. Although conventional water resources such as renewable groundwater and surface run-off are available in Oman, the United Arab Emirates, and Saudi Arabia, these resources have yet to be developed sustainably in an integrated water-resources planning context.

A huge amount of non-renewable or fossil fresh groundwater is stored in the Palaeozoic to Mesozoic-Neogene (Nubian) sandstones which underlie wide areas in the Arabian peninsula in Saudi Arabia and Jordan and in the eastern Sahara desert in Egypt and Libya. The dominance and importance of the non-renewable groundwater reserves in national water planning may be seen in the 1985–90 development plans of Saudi Arabia and Libya.

Saudi Arabia is one of the world's leaders in the production of wheat for self-sufficiency in food, but is heavily dependent on the use of non-renewable groundwater. Agricultural water demand in Saudi Arabia in 1985 amounted to 8×10^9 m^3 per year, while the demand for water for urban, rural, and industrial (M&I) use was 1.6×10^9 m^3 per year (MAWSA 1985). It was estimated that the total annual demand will increase to 16.5×10^9 m^3 by the year 2000, of which 14×10^9 m^3 will be for agriculture and 2.5×10^9 m^3 for M&I use. The huge water demand for agriculture is based on the kingdom's policy of self-sufficiency in food and on the use of non-renewable groundwater for growing grain, which generally requires 2,000–3,000 tons of water per ton of grain (Akkad 1990; SWCC 1990).

Groundwater development and/or mining in the Nubian sandstones of the inland desert depressions of Libya for the "Great Man-Made River" project will be a key element in Libya's development strategy for the twenty-first century. The Libyan government began construction in 1984–1986 (first and second phases), with the aim of abstracting groundwater in the inland desert at a rate of 2×10^9 m^3 per year (66 m^3/sec) in total. The water is to be conveyed over 600 km north to farms on the Mediterranean coast by the world's largest water pipeline system, with a total length of 4,000 km (Beaumont et al. 1988). The life of the Nubian sandstone aquifer can only be estimated to be between 20 and 200 years, owing to the lack of data for estimating groundwater recharge through wadi beds and/or depressions during occasional and temporary flash floods. The total pipeline system is therefore designed on the assumption of an aquifer life of 50 years.

The Egyptian government began non-renewable groundwater development in the Nubian sandstone aquifer in the inland Sahara desert in the mid-1950s with the New Valley project, which aims to expand the cultivated area in the Kharga and Dakhla oases. The construction of deep production wells in the Dakhla oasis was completed by 1966, which increased the combined installed capacity of shallow and deep systems up to 190 million m^3 per year, but the yield had decreased to a level of 159 million m^3 per year by the end of 1969. The Egyptian authorities are planning to augment the extraction till it reaches 2,400 million m^3 per year by the year 2000 (Shahin 1987). The extraction of the target volume will lead to further decline of the piezometric head and cessation of the artesian flow. The project is also faced with the human problem that many of the managerial staff do not like living in such isolated areas.

Desalination of brackish water and seawater is a key element of non-conventional water-resources development. The ocean holds 1.34×10^9 km^3 of seawater, which accounts for 96.5% of the earth's total water reserves of 1.39×10^9 km^3. In some of the drier parts of the Middle East, in particular the Arabian Gulf states, where conventional good-quality water is not available or is extremely limited, desalination of seawater has been commonly used to solve problems of water supply arising from increasing demand for municipal and industrial uses. The cost of desalting brackish groundwater is competitive, while for seawater it is invariably high, being largely influenced by petroleum prices. Two-thirds of the world's desalting plants are located in the oil-rich states of the Middle East, which can afford the price of massive quantities of desalting equipment.

A hydro-power scheme for a Mediterranean–Dead Sea canal, with multiple socio-economic and political ramifications, was proposed by Israel in 1980. The plan was to convey water from the Mediterranean to the Dead Sea via canals and tunnels, utilizing the difference in elevation of almost 400 m to generate 600 MW of electricity. In addition, it was proposed to use the water to cool nuclear power stations rated at 1,800 MW, and to investigate the feasibility of generating 1,500 MW from the Dead Sea as a solar pond (Naff and Matson 1984). However, there has been no provision for sharing resources with other countries and no effort at joint development. The project was soon put aside, owing to strong opposition from Arab states and others, and following the confusion and drop in world oil market prices in 1984. Recently, however, discussion of the Mediterranean–Dead Sea canal or a Red Sea–Dead Sea canal has been revived by worldwide attention to the need for clean energy and safeguarding the global environment and the peace negotiations among Israel, Palestine, and Jordan.

Israel has experienced much difficulty in making additional water supplies available since the late 1960s, when it was using as much as

95% of the total renewable water sources available in its territory (Beaumont et al. 1988). Almost half of Israel's total water supply is dependent on water that has been diverted or pre-empted from Arab sources outside its pre-1967 boundaries (Naff and Matson 1984). The main effort has to be shifted to making more efficient use of available supplies rather than increasing the capacity of hydraulic structures.

In neighbouring Jordan, almost all the renewable waters will be fully exploited by the mid or late 1990s, when the ongoing Al-Wuheda dam project on the Yarmouk River is completed. This is the largest tributary not yet fully developed in the Jordan River system. After construction of the diversion tunnel in late 1989, the project was stopped by strong opposition from the Israeli government, which is the administrator of occupied Palestine, or the West Bank.

Priority in water-resource development in each state is still given to developing its own resources, not only conventional fresh-water resources such as renewable groundwater and surface water but also non-conventional water resources such as fossil groundwater, brackish groundwater, seawater, saline drainage water, and treated sewage effluents. The potential contribution of marginal waters to meet the anticipated water demand in Israel and Jordan will be a unique initiative. Another option will be the diversion of water from the existing system from one use to another—from agriculture to M&I, as has been done in large population centres in Arizona in the United States, and in some cases from general M&I to domestic drinking water—to make the best use of scarce resources.

Non-conventional water resources need to be developed properly in an integrated planning context such as a national water master plan. By the first decades of the twenty-first century almost all states in arid regions will be facing severe water shortages in urban centres as populations continue to grow. Water-resources planning for the twenty-first century in arid regions may therefore include the following techno-political alternatives:

- » water conservation and diversion of existing water systems from one use to another;
- » development of non-conventional water resources—including desalination of brackish water and seawater and the use of treated sewage—and water-energy co-generation, such as
  - — the lower Jordan River brackish-water reclamation scheme with RO desalination (the Peace Drainage Canal),
  - — the Mediterranean–Dead Sea Conduit scheme,
  - — the Aqaba seawater pumped-storage scheme for co-generation;

» multinational fresh-water transfer or importation by pipeline, tankers, barges, or floating water bags, including
  — the Ceyhan/Seyhan–Middle East Peace Pipeline, including a smaller pipeline or canal to the Jordan watersheds (Kolars and Wolf 1993),
  — diversion of the Nile to Gaza and Israel,
  — Manavgat–Mediterranean, using tugs and bags as carriers (Savage 1990),
  — other bilateral options, including diversion of the Euphrates from Iraq to north Jordan, diversion of the Shatt al-Arab from Iraq to Kuwait, and diversion from Iran to Qatar,

» other marginal non-conventional measures, including weather modification, dual distribution systems, and rain harvesting.

There are now several changes in the political situation since the Iraqi invasion of Kuwait in 1990 and Israel's peace agreements with the PLO and Jordan that may form part of a comprehensive resolution of the Israel-Arab problem. This may make integrated development not only technically and economically feasible but politically desirable and urgent.

1.2 Objectives, concepts, and scope

This study attempts to evaluate some new non-conventional approaches to water resources which need to be taken into account in building the new peace in the Middle East. These new approaches, including techno-political alternatives, offer the opportunity to introduce new applications of well-tried technology to solve long-standing water problems which are at the centre of many of the potential sources of conflicts.

It introduces the following five concepts:

(1) *integration of development alternatives in the context of a water master plan*, including applications of non-conventional water resources for arid regions;

(2) *co-generation of clean energy and water*, including solar-hydro, groundwater-hydro, and hydro-powered reverse-osmosis desalination;

(3) *the strategic use of non-conventional water resources for sustainable development*, including brackish water, seawater, and reclaimed waste water;

(4) *techno-political alternatives and joint development with the sharing of resources for the multinational development* of the Jordan River and Dead Sea basin;