Water Resources: Use, Constraints and Potential for Cooperation in the Middle East

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INTRODUCTION

The Middle East is a prime example of a location where, although water scarcity seriously constrains human development prospects political borders and historical animosities constrain the ration development and management of the region's water resources—while accelerating population, expanding agriculture, industrialization, and higher living standards demand more fresh water. Drought and pollution limit water availability, and wars and mismanagement squander it.

Over 50% of the population in the Middle East and North Africa excluding the Maghreb, depend either on water from rivers which cross an international boundary, or upon desalinized water and water draw from deep wells. Millions of people face daily problems in obtaining, water for drinking, cooking, bathing, and washing. More than 25% of the population of Egypt, Sudan, Algeria, and Yemen are estimated to b without access to uncontaminated water, and an unknown but large proportion of people have to spend hours daily to collect water. Cholera and typhoid related to contaminated drinking water are common in Egypt. Sudan, and Yemen. Because the adverse consequences for productivity, health, and quality of life are both obvious and widespread, extensive efforts have been mounted to correct these problems, with increased emphasis since the inauguration of the UN's International Drinking Water and Situation Decade in 1981.

In many countries of the region, the data available are generally inadequate to establish a comprehensive water sector database for planning purposes. in some countries, programs to measure basic water-data from networks of meteorological, hydrological, and hydrogeological stations have not been undertaken yet. The existence of conflict situation adds another dimension to the problem: countries may not publish reliable water data on national security grounds or may publish data that serve their own geopolitical ambitions.

Lack of cooperation in managing and developing the major shared water resources is common in the region. Despite years of efforts, until now no formal protocols existed among all riparian states for the

Nile, Yarmuk, Orentes, Al-Kabir, Jordan, Tigris, and Euphrates rivers. If current circumstances persist, most of the downstream riparian shared will experience a severe deficit in the quantity and/or quality of water resources. Even under the best of circumstances, most of the end-user countries will be unable to generate sufficient capital to finance urgent, feasible, and critically needed water storage and management project without massive assistance from donor nations and lending institutions.

This paper prescribes a scheme of cooperation on water. The scheme is structured around the notion of risk-taking within the context of expected utility approach. The identified scheme evolves from diagnosing water profile; pattern of water use and determinants of water access. The proposed cooperation scheme delineates short-term "distributive" and "efficiency" measures that may substitute and/or complement long-term options which are capital and time intensive.

Water Profile

In the northern northeastern subregion of the Middle East, surface water resources predominate. Groundwater resources are well developed in Jordan, the Syrian Arab Republic, and to a lesser extent, in Lebanon and Egypt. In Iraq, the development of surface water resources is well advanced, yet groundwater resources are not developed or identified. Appreciable au-face water resources in the subregion include the Nile, Euphrates, Tigris and tributaries, Yarmuk, Orentes, Barada, Litani, and Hasbani Rivers, Jordan River, the Lebanon Rivers and others.

Regional water resource estimates based on various hydrologic and hydrogeologic investigations are given in Table I. The table displays the close relationship between water resources when balanced against its present and future water demands. Development in the region will be constrained by the year 2000 due to the acute water shortages, which are at present a reality in countries like Bahrain, Kuwait, the Republic of Yemen, Jordan, and Qatar. The available water resources for several countries may overestimate future availability due to ongoing water conflict among riparian states, the absence of registered riparian states' rights and water transfer schemes as the discussion below indicates.

Egypt

The main source of water supply for domestic, agricultural, and - industrial uses traditionally has been the Nile River. Current consumption rates in Egypt are about 61,000 mcm, but consumption is projected to reach 73,000 mcm by the year 2000. The increase is pushed by Egypt's rapid population growth and the resultant irrigation needs for expanded food production. Egypt might even encounter water shortages driven by (1) inefficient water use in irrigation (2) leaks in the water distributions system,

Table I: Estimated 'Water Resources Supply, Demand, and Balance in the Middle East (million cubic metres)

Water shortages may be exaggerated	Resources 1985	Use 1985	Water Demand 2000	Tentative Balance 1985	Tentative Balance 2000	Non-conventional 1985	Non-conventional 2000	Water Resources Total Available 1985	Water Resources Total Available 2000	Estimated Total 1985	Estimated Total 2000
Bahrain	153	223	302	-70	-149	87	186	240	339	17	31
Egypt	61350	60700	66000	650	-4650	1400	2200	62750	63550	2050	-2450
Iraq	43500	42350	60639	1150	-17139	-	-	43500	43500	1150	-17139
Israel	2150	1900	-	-							
Jordan	1086	893	1160	190	-74	35	116	1121	1202	225	42
Kuwait	247	329	675	-82	-428	356	547	603	794	274	119
Lebanon	7300	1036	2010	6264	5290			7300	7300	6264	5290
Oman	1483	580	1255	903	228	10	39	1493	1522	913	267
Qatar	100	145	235	-45	-135	198	274	298	374	153	139
Yemen R.	4177	916	2560	-	-	9	12	-	-	-	-
West Bank	175	110	-	-	-						
Gaza	145	-	-	-	-						
Saudi Arabia	5546	8670	14627	-3124	-9081'	1160	1534	6706	7080	-1964	-7547
Syria	25035	8095	17262	16940	7773	74	140	25109	25175	17014	7911
UAE	487	829	1700	-342	-1213	277	370	764	857	-65	-843
Region Total	150464	124769	168425	22434	-19578	277	5418	149884	151693	26031	14172

Sources:

- United Nations, Economic and Social Commission for Western Asia (ESCWA), 1992
- World Resource Institute in Collaboration with United Nations Environmental Program and United Nations Development Program. *World Resources 1990-1991* (Oxford: Oxford U. Press, 1991).
- el-Musa, "Dividing the Common Palestinian-Israeli Waters: An International Law Approach, Journal of Palestine Studies 22:3

(3) below standard use of fertilizers in agriculture, and (4) lack of cooperation between the Nile delta countries in addition to the accelerated demand propelled by population growth.

The Aswan High Dam has helped Egypt gain additional irrigation water, extend the area of rice farming for export, protect the country from floods, and augment the country's annual (hydro)electric power. But there are areas of malaise, including overwatering of fields because farmers are afraid they will not get enough water when they need it most and therefore take as much as is available. Overwatering has led to waterlogging, drainage, and salinity problems with a negative effect on land productivity and crop revenues.

The Tigris and Euphrates Basin

The Tigris and Euphrates Rivers are often treated as one basin because they unite in the Shatt–Al–Arab waterway shortly before emptying into the Arabian Gulf. The approximate annual discharge of the Tigris is 42,230 mcm and 31,830 mcm for the Euphrates.

In 1989 Turkey suggested the construction of two pipelines to supply the Middle East countries in Asia and the Gulf States with water from two unutilized rivers in Turkey. At an estimated $21 billion project cost, the pipeline would have carried water to two destinations: Mecca on the west side of the Arabian peninsula, and Sharjah and intermediate destinations on the Gulf. These seemingly expensive lines could deliver water at one third the cost of a similar desalinated quantity.

The Attaturk Dam, dedicated in 1992, will generate nine billion kilowatt hours of electricity per year. Turkey's Anatolia project (known by its Turkish acronym, GAP) includes building 22 dams and 19 hydro-electric power plants on the Euphrates and Tigris Rivers by the year 2005. Full development of the Anatolia project could reduce the Euphrates' flow by as much as 60%, jeopardizing Syrian and Iraqi agriculture. Filling the Attaturk reservoir curtailed water supplies in downstream Syria and Iraq, plus electric power in Syria, and both countries had to ration river water for domestic and farm use. This is a vivid example of how externality (third-party) effects result from transferring water from one use into another. Further, the Turkish hydro-power stations require additional water to generate electricity, showing that water usage technology could lead to *increased* water demand.

Israel, Jordan, and Palestine

Israel draws 65% of its renewable fresh water from two major aquifers a limestone aquifer under the mountains and a shallow partly saline one beneath the coastal plains including the Gaza strip. The rest comes from the Jordan River and its great reservoir, the Sea of Galilee. The Litani River in northern Lebanon has been a tempting potential water source, especially since Israel established its security zone eight years ago. In 1948 Israel's total water resources were 230 mcm. By 1964 water resources increased to 1288 mcm and by the end of 1980s the figure rose to well over 2000 mcm. In 1982, the water

resources of the West Bank were completely incorporated with Israel's water company, Mikarot. The diversion of the West Bank water into Israel represents about 80% of the West Bank reserves.

In the West Bank and Gaza, aquifers constitute the sole source of water for the Palestinians. They consist of two West Bank groups of wadis, the Jordan River, and numerous springs. Some wadis are "harvested" endogenously while others flow towards Israel and are "harvested" inside Israel. In Gaza, too, the chief source of surface water is wadis; the most important is Wadi Gaza whose water is impounded by Israel before it enters Gaza.12 The Israeli military administration limits the quantity of water which the Palestinians can withdraw from the aquifers to a total of 110 million cubic meters of water per annum. The water situation in Gaza is alarming due to increased demand, control by Israeli authorities, overdrawing of water, increased salinity, and drying up of fresh water strata."

In Jordan, rapid increases in the industrial and the agricultural sectors are expected to exacerbate water scarcity. Irrigation demands 70% of all water, which can no longer be provided by available resources. On the other hand, the 30% used by municipalities and industries produces waste water which, subject to adequate treatment, could be a valuable source of irrigation water.

The beginning of the 1990s witnessed intensive immigration of Jordanians and Palestinians from the Gulf to Jordan, and Jews from Russia to Israel. This increased the water demands, while water resources have been continually depleting over time due to political conflicts, drought conditions, and misuse in addition to increasing demands. In Jordan, from 1947 to the 1990's renewable water resources dropped from 3000 to about 200 cubic meters per capita annual share.

Table 2: Water Use in the Middle East

Country	GNP Per Capita (1990-1991)	% of Total Water Resources (1970-1987)	Per Capita Agriculture Share (1970-1987) (cu. m.)	(%)*
Algeria	2020	52	1435	74
Bahrain	6910	N.A.	735	4
Egypt	620	97	1202	88
Iraq	N.A.	43	4575	92
Israel	11330	88	447	79
Jordan	1120	41	173	65
Kuwait	N.A.	N.A.	238	4
Lebanon	N.A.	16	271	85
Libya	N.A.	404	623	75
Oman	5650	22	561	94

Qatar	15817	174	234	38
Saudi Arabia	7070	106	321	47
Sudan	400	14	1089	99
Syria	1110	9	449	83
Tunisia	1510	53	325	80
UAE	19870	140	429	80
Gaza	681t	N.A.	160	75
West Bank	1518t	N.A.	127*	78
Yemen R.	540	147	127	94

* as a % of freshwater withdrawal only.

t United Nations Conference on Trade and Development (UNCTAD), *Selected National Accounts Series of the Occupied Palestinian Territory (West Bank and* Gaza) 1968-1987 (Geneva: UNCTADIRPDISEU/6,1991, 1991).

t Simple mean of Palestinian and Israeli estimates cited in El-Musa (1993).
Sources:

(a) World Bank Atlas, 1992 .
(b) World Resources Institute in Collaboration with UNEP and UNDP, *World Resources* 1990—1991 (Oxford: Oxford University Press, 1990).

WATER USE AND VARIABILITY

In Table 2 we present data on average per capita water consumption levels in the region. There are wide variations in the level of water consumption across countries—in Jordan the per capita annual water use is 173 cubic meters, compared with 447 cubic meters in Israel and 1202 cubic meters in Egypt. Water use as a percentage of total internal water resources varies, from nearly 10% in Syria to 97% in Egypt.

The correlation between water use and per-capita income is not particularly high, which suggests that consecutive increases in per-capita income do not lead to proportionate rise in water use and that beyond a certain threshold water use does not constitute a critical constraint on development as measured by temporal rise in per-capita income. The differential in use appears to result from structural factors such as water irrigation system efficiency, water availability, pricing, and management policies, among others.

Figure 1 traces the relatively weak correlation between variations in per-capita income and water for 55 developing countries. Wide intercountry fluctuations in income are not strongly associated with fluctuations in water use. A simple regression performed on international data revealed slight (approx. 0.65) income elasticity for water use, indicating that water demand is income inelastic.

Domestic Water Use and Access

While the macrodata is indicative, it is important to also examine the behavior of individuals (microdata) in order to create an efficient and just water system. For example, in Kuwait the richest decile uses twenty-fold as much water as the lowest decile, and over three-fold the household average (Table 3). Water is sold at a flat rate irrespective of the consumption level. Given that the production of water is heavily subsidized (the selling price constitutes less than 10% of the cost of producing water), the data suggests that existing pricing contributes to excessive use, burdens the public purse, precludes efficient allocation of internal water resources, and exacerbates social inequality by providing more subsidy to rich households.

The effect of differing water distribution and access policies is apparent in a comparison of the cases of Jordan and the West Bank. Access to water in Jordan is via kitchen or yard taps; public taps; water storage tanks; wadis (or wells); and other links. The great majority of Jordanians have access through kitchen or yard taps, regardless of income or distance from Amman. By comparison, access to water in the West Bank has been hindered by deliberate Israeli policies. In Jordan, per-capita water consumption for household purposes is twice that of the West Bank, and nearly all villages receive water.

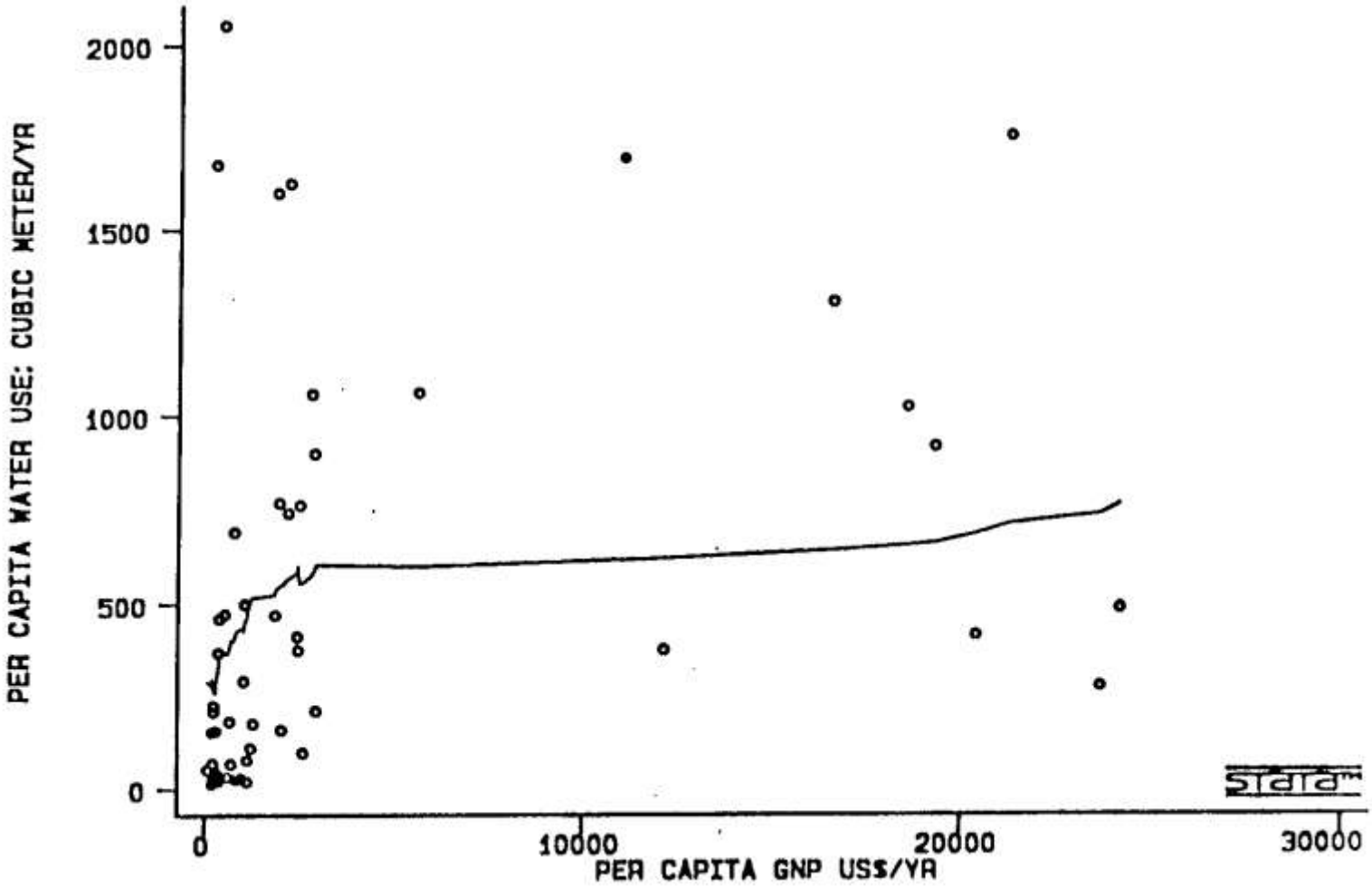

PER CAPITA WATER USE: CUBIC METER/YR
2000
1500
1000
500
0
0
10000
20000
30000
PER CAPITA GNP US$/YR

Table 3: Household Daily Consumption of Potable Water, 1986

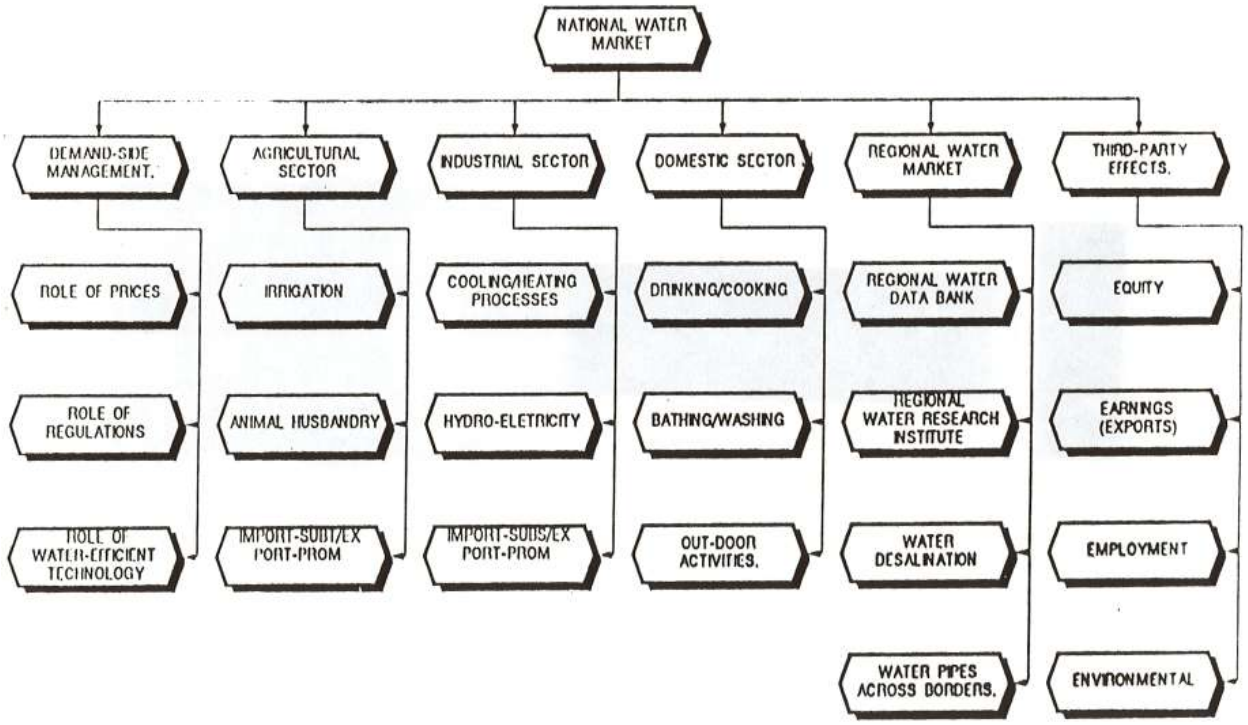
Decile Group	Average Use(gallons per day)
Lowest 10%	47
11—20%	95
21—30%	134
31—40%	177
41—50%	215
51—60%	255
61—70%	306
71—80%	391
81—90%	526
Upper 10%	1000
Average	315

Source: Ministry of Electricity and Water Micro-data Files, Kuwait, Private Communication.

Water Policy Issues

This section focuses on major regions' internal and external policy issues and suggests a scheme of water policy tools and measures that would improve efficiency and promote equity. Since water policy issues are time specific and prescriptives are time consuming, the suggested scheme distinguishes between short and long term measures. Figure 2 provides a schematic view of the relationships among major domestic and external water policy issues and suggests instruments to deal with them.

Figure 2: National and Regional Water Issues



At the domestic level, water issues include per-capita use by sector and activity, usage determinants, and measures to conserve water. A major policy tool in this regard is demand-side management (DSM), which has three components. These are market signals (prices), regulation, and water-efficient technologies. If properly applied by all parties in the region, these tools would lead to discernible improvement in domestic and regional water profiles, particularly in the short and intermediate runs—five to seven years.

External water issues involve more than one party and require the political will to compromise in order to mutually coexist. This recognition will push parties to a process of confidence building, as described below. One of the elements of the process is the establishment of a Regional Water Data Bank (RWDB) and its sister organization, a Regional Water Research Institute (RWRI). The purpose of these institutions is to collect, analyze and maintain data on water supply and demand and examine the technical and economic feasibility of long-term water projects, including regional desalination plants and water transfers. The remainder of the chapter elaborates on the components of the internal and external policy issues and areas of cooperation.

MANAGEMENT OF A SCARCE RESOURCE

Many writers warn of a pending "water crisis" in the region. According to some forecasts, by the year 2000 Israel will need 30% more water, Syria and Iraq, 60%, and by the year 2010 Jordan will require twice as much as it uses today. According to a 1987 U.S. State Department study, at the present rate of population growth, by the year 2000 Egypt will run out of water.

For economists the question is not shortage per se, but how the "balance" between demand and supply is affected by pricing structures. In other words, the water balance is primarily an issue of the price at which supply and demand equilibrate. At a higher price of water, the demand would decline and recycling (e.g., of urban sewage) would become more attractive. There is much potential for reducing agricultural water demand. At the current subsidized prices for agricultural water, farmers profit while society wastes valuable resources.

When a strategic resource is scarce, the issue is not whether to engage in demand management but how to do it most effectively. Demand management in the context of Middle East water resources can be divided into three components: (1) transferring water among alternative uses, (2) encouraging conservation, and (3) protecting instream flows and water quality.

Many countries in the Middle East maintain policies of food self-sufficiency. While the notion appeals to the masses, it makes little sense from an economic efficiency perspective. For instance, Saudi Arabia's drive to stimulate the agricultural sector led to remarkable increases in the output and value of agricultural produce. Overall, Saudi fanners produced by the early 1990s nearly 35% of the country's food, up from 15% in 1984. But the increase was largely the result of heavy subsidization: farmers were provided free land and free water pumped from aquifers deep beneath the desert. Moreover, farmers received interest-free loans for equipment and seeds. In the case of wheat, the government's support price was in 1987 $933 per ton. Some of this wheat was then exported at world market prices of $80 per ton 22 Perhaps more significant, the farm sector is a voracious user of water. It is estimated that Saudi Arabia used about 20,520 million cubic meters of water in 1988. Agriculture used about 90%, with wheat accounting for about 35% of agricultural water use.

Other examples abound. In Egypt, water-intensive crops such as rice and vegetables receive water more frequently than others. The extremely small size of land-holding and operational units makes it extremely difficult to deliver a specified amount of water to a particular crop. There is no metering of this water and no charge for its use.24 Similarly, because of Israel's policy of subsidizing water to farmers, nearly 70% of the state's water is used to grow crops that account for a minute value of the state's income. It is cheaper to import bananas to Israel than to grow them. Oranges and grapefruits which are grown in Israel and sold abroad are essentially exported water. In Jordan, it is estimated that a quarter of the country's water resources are used illegally, that is, without payment.

With any stretch of the imagination it is reasonable to conclude that the above cases demonstrate the potential gain if countries were to increase water prices. Even though it might be thought that water has no perfect substitute, more careful consideration shows that an increase in water prices may induce domestic users to economize. For instance, individuals may replace water-using lawns with gravel, bricks, and other paving material. Higher water prices may also result in the use of more plumbing services (personal or professional) to repair leaky faucets and other water-using equipment. Farmers may also be induced to use water more prudently.

Economists generally recommend the use of an inverted-block pricing structure where successive units of water are sold at increasing prices. The price structure would thus be better able to align prices with costs of production and concurrently induce users to conserve water. Moreover, this pricing structure is appropriate from the social equity perspective.

The selected pricing structure should reflect inter- and intra-sector differences in water use. For example, within the agricultural sector, it ought to differentiate between types of crop irrigated and farmers' ability to pay. Specifically, crops that could be imported more cheaply from the international market should be provided with water at higher prices than crops that are economically feasible. If such a pricing structure is followed, cross-sector subsidization would be is, farm subsidies from urban consumers and taxpayers would be reduced.

Domestic water management policies should also embody programs that encourage conservation and technologies that reduce the amount of water required in domestic, industrial, and agricultural activities. One example of such anagricultural technology is the drip irrigation system, which conserves water use relative to the farrow system used by farmers in many countries. Similarly, it is possible to devise industrial processes that reduce water consumed per dollar's worth of industrial output. Israel, for instance, managed to reduce its industrial water usage from 20 to 7.8 cubic meters per S100 worth of production between 1962 and 1975.27 The water-scarce Gulf Countries have used brackish water to irrigate temperature resistant crops and have succeeded in certain cases in bringing production costs to competitive levels.

Demand-side management can be an effective tool in conserving the region's scarce water. Several countries' water systems need maintenance and repair. Both Jordan and Israel lose 25% of their water through pipe leaks. One quarter of Jordan's daily pumped water is lost from corroded, leaky pipes; leaks in Israel's national water system pipes account for 25% of the total water deficit.

Likewise, Syria is estimated to lose 30% of its water supply as a result of old, leaky pipes. In Egypt, up to two thirds of the water supply allocated to cities and towns is lost through inefficient use. Farmers in the fertile Nile Delta are estimated to be using twice as much as necessary because of primitive irrigation techniques. If these pipes are repaired, the "recovered" water would be equivalent to a new supply source for the countries of the region.

Undoubtedly, water conservation is apt to be an important "source" to tap in future regional plans. Growing water demand, due to population growth and other structural transformations, will press policy officials to explicitly address demand management strategies. Rate structures together with methods of education and conservation programs can be applied simultaneously in order to achieve a temporal balance between water availability and water demand.

WATER COOPERATION: POTENTIAL AND OBSTACLES

We focus here on two major potential areas of cooperation in the Middle East (1)the creation of a regional data bank and a regional water research institute and (2)tension reduction and confidence building. Substantial gaps exist in statistics pertinent to water use and its determinants. In view of this, we suggest that countries of the region collectively develop a regional data bank of information on sectoral and activity-specific water use. For instance, within the farming sector various crops have different water usage rates and command different cash values in the local or international market. Similarly, indoor and outdoor activities within the residential sector require different rates of water use per unit of activity. The data bank will collect, maintain, electronically store, and update a water data base that can be retrieved and accessed easily for policy-making and research objectives.

Once data is collected, a regional research team, housed in a regionally-developed water research institute, would study and monitor the pattern of water use and establish robust causal relationships and baseline data sets. For instance, within the domestic sector, the team would model the determinants of water use and its variations. Countries of the region would share and exchange the data, computerizing it for quick retrieval and analysis. Multinational and bilateral agencies could help the region establish such a data bank and research institute by providing technical expertise and financial support.

To address the second broad potential area of co-operation we pose a simple question: Why does a rational person refuse a fair gamble—even a gamble whose expected value is positive? Economic theory tells us that refusal of a such a gamble derives from consumers' preferences; sociologists suggest a whole set of factors including emulation, peer advice, historical experience, information networks, common knowledge, affect preferences, among others and that preferences change.

Theories of expected utility and observations of preference changes are useful guidelines for analyzing water conflicts in the Middle East and suggesting a tentative scheme to overcome existing impediments to cooperation. The long history of wars between Israel, the Palestinians, and other Arab neighbors, exacerbated by public media and other mechanisms, have created antagonistic feelings reaching deep into the "selves" of Israelis, Palestinians, and Arabs on both sides. Collective preferences have come to include suspicion and distrust of the motives, goals, and plans of others. In this environment of mutual distrust, people on both sides have generally revealed "preferences" of "dislike" for one another.

Actions became motivated by passion rather than by interests, and wars with their disastrous human and economic toll have erupted.30 Each party to the conflict has developed water-related schemes that are seen as detrimental to the interests of the other parties, and the situation has been a zero-sum game.

Now under consideration are several proposals that attempt to create water cooperative schemes among the region's economies. Most of these schemes entail water transfers across borders. They focus on the economic calculus, cents per KWH, or cents per cu. m. of water, and devote remarkable volumes and efforts to demonstrate the feasibility of the advocated water projects. These capital-intensive water projects embody complex third-party effects. Such effects lessen the potential regional gain promised by advocates of water transfer schemes. Transfers of irrigation water to other destinations reduce the ability of rural areas to control their future and will result in less economic opportunity, a diminished tax base, reduced fishing potential, and losses to wildlife, natural areas, and recreation in the water-exporting country. These are generally overlooked by studies that focus strictly on the "private" or country-specific costs of water transfers.

Another concern is that the legal and administrative hurdles imposed to protect these third-party interests may block socially desirable transfers by unduly increasing the time, cost, and risk associated with a proposed water transfer. The potential benefits of a transfer would have to be large and equitable to justify the cost and risks associated with overcoming these hurdles. The appropriateness of water transfers and the type of institutional arrangements for incorporating third-party impacts depend on the values that are at stake. The challenge is to develop institutions that take account of impacts on third parties without imposing high transactions costs.

Furthermore, these studies suffer from the benign neglect of the very essence of expected utility and consumer preferences on both sides. No matter how economically or financially attractive the expected pay-offs of these projects may appear on paper, the chance is they may not be implemented for a protracted time. Worse yet, if developed, they might be sabotaged or destroyed by conflicting parties in the future. For instance, although the Unity Dam between Syria and Jordan has been heralded as economically feasible, Israeli leaders have vowed to destroy it if it is ever built. The dam, if constructed utilizing the Yarmuk River, will regulate the water supply, ensuring sorely needed water for the Jordan valley and vital municipal and industrial water for the Amman-Zarqa urban complex. Israel has contended that the project could seriously affect its ability to meet growing water demands even through the Yarmuk contributes a very insignificant proportion (3%) of Israel's national water supply.

We propose that, prior to discussing projects that commit exorbitant and irreversible investments and require years to build, what is needed are simple confidence-building gestures that will make a substantial difference in implanting the spirit of cooperation. In essence, confidence-building would help change attitudes on both sides and remold, adapt and adjust individual and collective preferences in a manner that would reduce distrust and hatred and re-institute tolerance, trust, and, eventually, willingness to become less risk averse. If the seeds of such trust are planted, the current and future generations can reap the fruits of cooperative schemes.

But where and how do we plant the seeds of mutual trust and start the process of confidence-building? The fertile ground, in my view, could lie in water redistribution schemes. Among the-territories seized by Israel during the 1967 war is the Gaza strip and the West Bank of the Jordan River. A large aquifer under the limestone mountains in the West. Bank provides at least one fourth of Israel's water. Its importance to the country is such that one of Israel's first acts after the 1967 war was to declare the water maces of the West Bank and Gaza strip a strategic resource under military control. The Israeli occupation administration strictly controls Palestinian water use in the West Bank by licensing artisan wells on a limited basis and restricting pumping from other wells through the use of meters. Some 51% of Palestinian villages in the West Bank do not have running water while all Israeli settlements have that service. It has been estimated that Israelis utilize approximately 83 % of the water from the West Bank aquifers.

The net result of Israel's unlimited action is a substandard level of consumption for Palestinians in the occupied territories as well as a wide water gap between the Palestinians and the Israelis: Palestinian consumption is a meager 15–20 gallons per day. Israel's consumption on a per-capita basis is three to four times more than that of Palestinians. Furthermore, Palestinians in the West Bank are charged three times more per unit of domestic water than are Israelis. Stated in terms of relative GNP per capita, Palestinians pay a minimum of fifteen times more than Israeli consumers do—a phenomenal difference for water systems managed by the same company.

In the agricultural sector, disparities are also pronounced. The total area cultivated by Palestinians amounts to 2.3 million acres (.43 million hectares) with a total of 624,000 acres (260,000 hectares), irrigated accounting for 6%. This small percentage is due to Israeli restrictions. The total area cultivated by Jewish settlers is 337,800 acres (140,750 hectares), with 69% of it irrigated. Within Israel proper, only 45% of cultivated land is irrigated.

In terms of our discussion about block pricing above, Israel is de facto implementing a decreasing block pricing structure where ethnicity (Palestinian versus Israeli) and not rates of water use is the deciding factor. Existing discriminatory water pricing schemes impose a disproportionate burden on Palestinians, who not only use the least water but are least able to pay. The striking inequities in water use concomitant with inefficient use of water in Israel suggest that a relatively easy approach towards confidence-building might be redressing the inequalities by redistributing water more equitably between Palestinians and Israelis. Such a pragmatic approach to solving water disputes would give momentum to the overall peace process by demonstrating how redistribution could succeed in tension reduction. The relative gains parties achieve may well provide an effective example. It would further help convince people that peace is more than just a piece of paper.

CONCLUSIONS

To sum up, water proposals within the framework of a lasting peaceful solution to regions' problems must be structured around the principles of efficiency, equity and co-operation. Specifically, at the domestic level this chapter suggests the following guidelines:

a) Study the dollar value lost when some portion of the water normally applied to water-intensive crops such as bananas, rice, and cotton is withheld. With this information in hand, water authorities might pay irrigators to use less water.
b) Introduce demand-side management programs combining technical and economic factors that encourage water conservation at the sectoral and activity levels. At the generation and distribution levels, water authorities must devote appropriate resources in order to reduce distribution losses by fixing water leaks and lining canals. A key conservation concept, particularly in the agricultural sector, is to intercept drainage water for reuse just before it goes into the sea. At the end-use level, water users must be encouraged (induced) to adopt water-efficient systems that enable them to maintain the same services with less water (e.g. households installing water-conserving showerheads, toilets, and faucets).
c) Encourage conservation through price incentives and regulations lest it become forced by shortages. Prices provide the primary signal to use or conserve a resource. Available empirical evidence suggests that. the price elasticity of water demand is small in the short term, which implies prices have to be increased substantially in order for users to respond appreciably. However, user response depends on the activity type (indoor versus outdoor) and varies according to economic sector. Moreover, in the long term the price elasticity is much higher than over the short term, thereby inducing a rising pattern of curtailment over time. Revenues raised from higher water prices can then be used to compensate disadvantaged groups including poor farmers and households. And while development and income growth would certainly be accompanied by increased demand for water, the increase is proportionately less than the corresponding income growth.

At the regional level, this chapter recommends the following guidelines:

a) Water is a mutual, interconnected need that must be shared fairly. Work needs to be done to convince countries of the region that it is in their broader self-interest to view water as a part of a system governed by the laws of nature rather than as an aspect of territorial sovereignty. The region must seek just and equal distribution of the natural resources among the West Bank, Gaza, and Israel, and among Israel, Jordan, and Syria. Authorities in international law as well as the practitioners in most peace-loving nations have rejected the doctrine of absolute sovereign rights of an upstream country over shared international waterways. Likewise, downstream countries do not have immutable sovereign rights over water based on historical use of water flowing through their territories.
b) A proper assessment of the damage one party has imposed on another must be conducted and externality estimates generated. For instance, Turkey's unilateral water transfer projects have already affected those downstream by forcing contraction of their normal water use. This loss of

use should be compensated. Likewise, a constructive step would be an Israeli demonstration of willingness to allow Palestinians access to the Jordan river waters concomitant with release of sufficient quantities of fresh water into the river to supply their minimal needs. Furthermore, schemes to compensate the Palestinians for their water shares, lost since 1967, must be worked out

c) Countries of the region should be encouraged to co-operate in establishing a regional water data bank and a regional water research institute at which parties would continuously monitor the water situation, share and exchange water-related information, and conduct studies to determine the social costs and benefits of long-term regional schemes and capital-intensive technologies, for example water-efficient farming technologies. In this area, Israel has introduced major innovations, including drip irrigation and computerized automation systems which allow such refinements as high-frequency pulse irrigation.

d) Accept the principle of equal footing in decision-making by all parties, as the water problem is regional, and solutions will require co-operation by all parties. Existing shared water entities (the Undugu Group for the Nile, the Technical Committee for Yarmuk, the Trilateral Commission for the Euphrates and Tigris Rivers) have been unable to meet periodically to defuse conflicts among the riparian. Such conflicts cannot be defused without the formulation of joint comprehensive water resources management plans. These plans should include explicit agreements on water allocation among the concerned riparian for each river basin or exploitation rights for the major aquifers within the region.

e) Neither forced solutions nor illegal use of others' natural resources can be used as a basis for any just or lasting peaceful cooperation.. Collective efforts are urgently needed to break away from the zero-sum game in water sharing, towards a multilateral cooperation in basin management where there will be net gains for all parties.42 Third-party effects must be internalized and accounted for and necessary compensatory schemes must be drawn up and debated--and approved by all parties.

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