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Real and ideal water rights:the prospects for water-rights reform in Israel, Gaza, and the West Bank

Peter Berck
University of California, Berkeley

Jonathan Lipow
University of California, Berkeley

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Existing water policies in Israel and the Disputed Territories are not characterized by an efficient set of water contracts. The system misallocates water over both time and space.

Current policies are driven by strategic and ideological objectives. With peace, reform of water policies will become politically feasible. The paper concludes with a proposal for a new water-allocation system.

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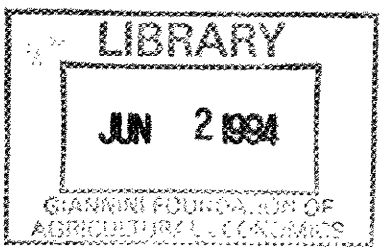

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REAL AND IDEAL WATER RIGHTS: THE PROSPECTS FOR WATER-RIGHTS REFORM IN ISRAEL, GAZA, AND THE WEST BANK*

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Peter Berck and Jonathan Lipow
University of California at Berkeley

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ABSTRACT

The ideal water contract for a heterogeneous population of users is a prioritized right that is fully vested and fully tradable. A set of tradable, prioritized rights contracts will span the same space as the Debreu contingent commodities. Therefore, they lead to a competitive equilibrium that is Pareto optimal. Equal sharing of water shortfalls does not have this property.

Existing water policies in Israel and the Disputed Territories are not characterized by an efficient set of water contracts. The system misallocates water over both time and space. Current policies are driven by strategic and ideological objectives. With peace, reform of water policies will become politically feasible. The paper concludes with a proposal for a new water-allocation system.

REAL AND IDEAL WATER RIGHTS: THE PROSPECTS FOR WATER-RIGHTS REFORM IN ISRAEL, GAZA, AND THE WEST BANK

1. Introduction

There are major differences between the theoretically efficient water-allocation models developed by economists and the actual water-sector policies pursued by governments. In practice, government water policies throughout the world seem biased toward agriculture. This bias results in artificial shortages and popular pressure to implement major supply projects that cannot be justified on economic or environmental grounds. Economists often explain this bias as the result of political phenomena, such as rent seeking and log rolling.

In Israel, the West Bank, and Gaza, the bias toward agriculture appears to be motivated by strategic and ideological objectives related to the long Israeli/Arab struggle. Standard explanations for the primacy of agricultural interests in water allocation seem only a secondary explanation for the policies formally articulated by Israeli water authorities and informally practiced by Palestinian farmers.

Should Israeli/Palestinian efforts to settle their conflict result in a robust peace agreement, there will be an opportunity for serious structural reform of water policy in the region. Given the scale of inefficiency in the Israeli/Palestinian water regime, such reform could play an important role in promoting the economic growth and development that most observers believe is necessary to assure the long-run success of any peace accord.

By far, the most important source of inefficiency in the Israeli system is the inherent lack of property rights. A meaningful property-rights regime would not, however, assure efficient water allocation. Not all water-rights regimes optimize human welfare. It is critical that Israeli (and eventually Palestinian) water authorities choose the best framework for the allocation of property rights for water resources.

This paper is divided into four sections including this introduction. In the second section of the paper, the current water situation in Israel, the West Bank, and Gaza is described. The pricing and allocation scheme is reviewed, and the political, strategic, and ideological logic of overallocation to agriculture is discussed.

In the third section, ideal water rights will be discussed. The major alternative rights regimes are (i) prioritized rights and (ii) equal-sharing rights. Current Israeli allocation policies incorporate elements of both rights regimes, with a bit of market pricing and legal ambiguity thrown in. In this section, received economic theory on efficiency is described: State-contingent claims are needed for a fully efficient market-allocation mechanism. It will be shown that tradable, divisible prioritized rights duplicate state-contingent claims and are, therefore, efficient. It will also be demonstrated that the equal-sharing claims advocated by Burness and Quirk (1979) are only efficient if all users are identical and do not specialize their activities. As a result, equal-sharing water rights should not be assumed to assure economic efficiency and are, in fact, unlikely to do so under realistic real-world conditions.

In the fourth an final section, the policy regime required for an efficient water-allocation policy in the region is compared with current practice. Some specific proposals for reform are presented. Central to any reform of the region's water regime is the introduction of secure, divisible, tradable, allocative property rights. The need for cooperation between Israeli and Palestinian water authorities is also emphasized, as well as the importance of an equitable distribution of water resources between the two communities.

2. The Israeli-Palestinian Water Situation in Brief

The water resources of Israel, Gaza, and the West Bank are indeed limited and, under the current allocation system, stretched close to their limits. Water shortages are largely artificial and mostly reflect uneconomic allocation to agriculture. While these allocations do not make economic sense, they do make political sense. Thus, the current situation is uneconomic allocation of water to serve political aims.

2.1. The Water Resources

There are four primary sources of water in the region: (i) the upper Jordan River/Lake Kinneret, (ii) the Yarmouk River and the lower Jordan, (iii) the Yarkon-Tannaim aquifer, and (iv) the Coastal aquifer. There are a number of smaller aquifers as well. The long-term sustainable water yield for the region is somewhat above 2,100 million cubic meters (MCM) per year. Current sustainable yield is roughly 1,900 MCM. Presently, Israel can recycle 100 MCM of wastewater each year. Long-term potential for wastewater reclamation is greater than 450 MCM (Kislev, 1990). This gives the region on the order of 2 million acre-foot, roughly the water resources of the Westlands Water District or one-fourth of the resources of the Central Valley Project in California.

The water consumption of Israel, the West Bank, and Gaza has been outstripping currently sustainable water yields, resulting in a drop in water tables and the infiltration of seawater into the aquifers. Annual water consumption in the mid-1980s totaled 2,049 MCM. Domestic consumption in Israel accounted for 325 MCM, industry consumed 125 MCM, and agriculture consumed 1,320 MCM. The West Bank was allocated 170 MCM. Palestinians consumed 30 MCM for household consumption and industry as well as 95 MCM for agriculture. Israeli settlers consumed 45 MCM for all purposes. In Gaza, total consumption was 103 MCM, with 23 MCM allocated to households and industry, 80 MCM allocated to agriculture, and 6 MCM reserved for Israeli settlers (United Nations, 1992).

The current allocation of water between Palestinians and Israelis was largely determined by prior use patterns. The West Bank and Israel share the Yarkon-Tannaim acquifer. Since Israel occupied the West Bank in 1967, it has allowed for expanded Palestinian access to water for household use, but not for agriculture. The remainder of the water in the Yarkon-Tannaim has been appropriated by Israel (United Nations, 1992). No reserved water rights for Palestinians, such as the reserved rights recognized by the United States for environmental purposes (e.g., the protection of salmon), are recognized in current Near Eastern practice, and there is no unexploited water left in the Yarkon-Tannaim

system for further growth. In Gaza, there has been no restriction of access to water, with consequent overpumping and salinization (Benvenisti and Khayat, 1988, and Soffer, 1992).

Given current conditions and allocation rules, the water situation in the region is very tight. For instance, if Palestinians were to consume water for industrial and household use at the current Israeli consumption rates, they would either need an extra 107 MCM or they would need to reduce agricultural allocations by more than half. Similarly, reasonable projections of Israeli growth lead to water "requirements" well beyond current safe yield or even the 2,550 MCM that can be achieved with vigorous reclamation. One solution to the water problem is to build large-scale projects. Among the current suggestions are diversions from Lebanon or even Turkey and a desalinization project that requires a diversion from the Mediterranean to the Dead Sea. Another solution would be to reform the water-allocation regime to allow the diversion of some of the 75 percent of water now used for Israeli agriculture to industrial and household use.

2.2. Water-Allocation Rules and Inefficiency

Reducing agricultural water use is a rational economic policy. Agriculture often produces too little value to pay for the marginal production cost of the water used. Nevertheless, in Israel and the West Bank, there is a price/quota system that blatantly favors agriculture.

All water users are metered and have nontransferable quotas. Following recent pricing reforms made necessary by drought conditions, agricultural users are charged 12.5 cents per cubic meter (CM) for the first 80 percent of the water allocated to them. The remaining 20 percent is priced at 20 cents per CM so as to encourage conservation. Water in excess of allocation is priced at 26 cents per CM. Industrial users pay a flat rate of 15 cents per CM. The prices charged for household consumption begin at 32 cents per CM and rise to as high as 123 cents per CM for those using in excess of 8 CMs per person over a two-month period (World Bank, 1990). These prices do not vary by location, nor do they vary across wet

and dry years. The price/quota system is changeable at will by the government. Individuals have no secure property rights over water.

The average variable cost of water production is 19.5 cents per CM. Incorporating imputed capital costs, the average total cost is 33 cents per CM. While marginal costs vary between 2 cents per CM and 50 cents per CM, over 40 percent of Israel's water is sold at less than its marginal production cost (World Bank, 1990). The range of marginal costs largely reflects the cost of transportation to remote regions.

To see what these figures mean for the profitability of agricultural production, consider cotton growing. Using international prices, Kislev (1990) found that the marginal-value product of water in cotton (which appears to be water's marginal use in Israel) had varied between 53 cents per CM in 1983 to -11 cents per CM in 1988, with an average return over 1980-1988 of 8.7 cents per CM. Based on Dinar and Letey's (1991) evaluation of the profitability of cotton production in California (a climatic and agronomic equivalent of conditions in Israel), and assuming a world price for cotton of 70 cents per pound, 12 cents per CM is the most that should be paid for water. University of California Cooperative Extension Service (1992) data sheets, in which a more water-intensive technology is assumed, lead to an estimated value of 8 cents per CM for water. The marginal-value product for water in cotton production, 8 to 12 cents per CM, is obviously less than the average cost of 19.5 cents per CM. For Israeli agriculture in general, a recent survey found that 25 percent of "high-yield" farms as well as 60 percent of "low-yield" farms failed to generate marginal-value product (at international prices) in excess of the marginal cost of water (World Bank, 1990).

Use at less than marginal cost implies that overexploitation of water resources constitutes an economic burden.[1] One visible attribute of this burden is that subsidization of water costs Israel's Finance Ministry $250 million per year (Kislev, 1990). Another attribute is that the cost of getting additional water for industry or households by reducing agricultural consumption is likely near zero.

As can be seen, the region's water crisis is really an agricultural crisis. Four-fifths of the region's water is devoted to irrigation. A large fraction of this water may be producing little, if any, value net of cost. This misallocation of resources makes no economic sense. Yet, the justification for this allocation lies—to a far greater extent than is generally appreciated—in incentives created by the continued state of war that exists in the region.

2.3. The Political Motivation for Israel's Water Regime

Israeli water policy is driven by the perceived necessities of warfare and ideology, rather than by concern for economic efficiency. Four factors figure most prominently in Israeli thinking regarding water and agriculture:

1. There is an emphasis on food security. As a nation besieged, Israel has pursued a variety of policies aimed at lessening its dependence on outside sources of vital products. These policies include the development, at great expense, of Israel's arms industry as well as the stockpiling of huge quantities of raw materials. The fear that food and fiber supplies could be disrupted helps encourage favoritism toward agriculture.

2. There is a need to assure the physical control of remote areas in order to combat infiltration and guerrilla operations. This has been a goal of Israeli agricultural settlement activity since the preindependence period. In the 1950s, increased settlement of the Jezreel Valley, the Northern Galilee, the Arava, and the Lachish region was promoted in order to limit the operation of the "Fedayeen" infiltration units. Israel's earliest settlements in the West Bank and Gaza were located in the Jordan River Valley and the Katif Bloc in order to secure infiltration routes that were commonly used by Palestine Liberation Organization units following the 1967 conflict. Israel's defense establishment is so convinced of the military value of agricultural settlement that a specialized unit of the Israel Defense Forces, the "Nahal" Brigade, is dedicated to the continual development of new agricultural settlements, although such operations disrupt training and impose financial burdens.

3. Israel also has sought to settle outlying regions in order to assert control over areas with Arab majorities (such as the Galilee and the Negev) and to physically separate the Arab population of Israel from the borders of other Arab states. It is feared that predominantly Arab regions of Israel are subject to separatist/irredentist pressures and that a strong Jewish presence is necessary to demonstrate Israel's permanence and the legitimacy of its borders.

4. Agricultural development has been integral to Israel's approach toward settlement of the region since the very inception of the Zionist movement. Many Israelis, particularly older ones, have a romantic attachment to agriculture and to the communal/cooperative settlements that dominate agriculture in Israel, viewing them as the "soul" of the Jewish state and living testimony to the struggles that helped establish that state.

As a result of these military and ideological considerations, Israel has pursued policies intended to favor agriculture at the expense of other economic sectors. There have been price subsidies, trade barriers, quotas on production, marketing boards, and input subsidies. Inordinate scientific resources have been devoted to the development of agricultural technology. Finally, agriculture has enjoyed the lion's share of Israel's water resources, at prices that fail to reflect the marginal cost of supply, not to mention the recouping of capital expenditure. Allowing the trading of water rights or charging a marginal cost for water would lead to water being traded away from the target regions and would undermine these political aims.

Palestinians of the West Bank and Gaza have powerful motivation to favor the agricultural sector as well. Although Israel does not seek to promote or subsidize agriculture in the West Bank and Gaza, Palestinian farmers reap considerable benefits from Israeli policies. Israel has shielded its local agricultural sector from competition through trade restrictions and quotas, leaving local prices for many products far higher than international rates. Much of the agricultural produce of the West Bank and Gaza slips through the porous

"Green Line" and ends up being sold in Israel at higher prices. Thus, subsidization of Israeli agriculture results in the subsidization of Palestinian agriculture as well.

Setting aside these economic incentives, Palestinians have strong ideological and military reasons to pursue agriculture. We believe that there are three motivations behind Palestinian willingness to pursue even unprofitable agricultural activities:

1. There is a fear that Israelis will "starve" Palestinians into submission. This has grown more acute since the intifada and has spurred a mass movement aimed at local self-sufficiency. Over the past five years, "victory" gardens have sprung up throughout the West Bank and Gaza.

2. Agriculture is one of the few sectors in which Palestinians are able to exercise economic control and act as entrepreneurs. Industrial development has been hampered by political uncertainty and by policies pursued by Israeli administrators. As a result, agriculture serves the political goal of Palestinian self-reliance, which makes local agriculture more appealing than the otherwise low returns would suggest.

3. Few Palestinians hold formal title to the land or water that they use. Poorly delineated property rights are detrimental to the efficient allocation of water resources in the Near East (and nearly everywhere else in the world). Under laws applied originally by Turkey, but followed by Britain, Jordan, and Israel, land that is not actively tilled and water that is not consumed can be subject to expropriation. Israel has, indeed, laid claim to large tracts of West Bank land and much of the Yarkon-Tannaim aquifer through this approach. Failure to use water could result in loss of both effective land ownership and the water rights associated with that land. Since both land and water have option value, even marginal farming operations may seem attractive (Benvenisti, 1986). Thus, the Palestinians also have political reasons to support the existing allocation of water between agriculture and urban uses.

In addition to strategic motivations for current water-allocation policy, there is no reason to believe that Israelis and Palestinians are immune to the political rent seeking that

characterizes water policy in much of the rest of the world. Maintaining agricultural allocations satisfies influential political constituencies at a relatively low political cost. For example, assume that growth increases industrial and urban water demand by 20 percent. A new desalinization plant would cost approximately 60 cents per CM (World Bank, 1990). There are currently 450 MCM used for urban and industrial uses, so a desalination plant that would increase supplies to these sectors by 20 percent could be financed by an additional charge of 10 cents per CM for all 540 MCM then available. In terms of an individual water bill, this would be about $8 per person per year. Such a price increase is not likely to have a large political effect. In contrast, a reduction in allocation to farmers would target a relatively small population for a relatively large loss. As argued in Stigler (1971) and Peltzman (1976), a small loss to a large population may be more politic than a large loss to a small population, because the small losing population will have the incentive to organize political opposition and contribute money to opposing political candidates. In the Israeli system, this pressure would be particularly effective because the water authority is under the minister of agriculture, who is largely answerable to agricultural interests. Thus, the political-economic system makes the political costs of the current system fairly small.

In the absence of peace, neither Palestinians nor Israelis have any motivation to reform the current allocation of water, most particularly the overallocation to agriculture. Conversely, with the onset of peace, there are gains to both Israelis and Palestinians in revising the water-allocation system.

3. Ideal Water Rights

An ideal economic solution to the water problem is to permit the market to work (i.e., permit urban interest to buy water rights from agricultural interests). An obvious difficulty with the market solution is that there is currently no well-defined property right that can be traded. Therefore, the first step toward a market solution is the definition of the right to be traded in the water market. The basic types of underlying water rights are sharing rights and

prioritized rights, similar to the appropriative rights common in the American West. Real water systems often combine elements of both types of rights as well as rules limiting transfer of rights. In this section, the basic types of water-rights regimes (sharing rights and prioritized rights) are analyzed and we will show that the prioritized rights are the better choice for a tradable instrument.

The most common prioritized right is an appropriative right. An appropriative right is often summarized as "first in use, first in right." First in use refers to the date when the user first diverted the water. A user who diverted water before another user is said to be a prior appropriator or senior to the other user. Rights are only established by diverting water for a beneficial use. Beneficial use includes agricultural and urban uses, but not gross waste. First in right refers to when a user receives water. When the supply of water is limited so that not all water rights can be exercised, senior appropriators are given all of their water allotment before junior appropriators. Thus, the most senior appropriators receive their allotments no matter how dry the weather, and the most junior appropriators receive theirs only when the weather is favorable. A prioritized right is one in which senior rights holders receive their allocation before junior rights holders, but the right may be established in a manner other than first in use. In contrast, sharing rights give each user a fixed share of available water.

A prioritized rights regime can be formalized by assuming that there are a finite number, I, of different states of water availability. Let W_i be the amount of water available when condition i occurs. The Ws are in increasing order so that the larger is i, the larger is W. There are J holders of prioritized rights. The rights holders are ordered by seniority. Therefore, a lower numbered right is senior to a higher numbered right. The *j*th rights holder has the right to receive up to quantity A_j of water, if the more senior rights holders have not taken all of the water first. Consequently, the *j*th user receives at least part of his allotment in state i whenever

$$a_j = W_i - \sum_{k=1,j-1} A_k \geq 0.$$

That is, whenever the water available, W_i, exceeds the water taken by the rights holders senior to j, $\sum_{k=1,j-1} A_k$. Thus, a_j is the water available for rights holders j and junior. Assuming that $a_j > 0$, the *j*th user receives either A_j or a_j, whichever is less. If $a_j < 0$, there is no water available after the first j - 1 users have taken theirs and the *j*th rights holder receives nothing.

A simple example of prioritized rights has two users and two states of nature. In the dry state of nature, there is just enough water for the first farmer and, in the wet state, there is enough for both. The prioritized right with the first farmer senior allocates all the water to the first farmer and no water to the second farmer when it is dry. In wet years both farmers receive water. Such a state would presumably come about, because the first farmer began farming and diverting before the second farmer and the stream in question only has enough water for one of them in dry years.

In sharing rights, the available water is split between the claimants. Assuming equal sharing, each user would receive W_i/J units of water in state of nature i. In terms of the two-state, two-farmer example, each would receive half of their allotment in the dry year and all of it in the wet year.

3.1. State-Contingent Claims

Debreu (1959) has shown that, in an economy with uncertainty and state-contingent claims, a competitive equilibrium is a Pareto optimum. In our case, the unknown is the availability of water and we have limited ourselves to the finite number of states, W_1 ... W_I. A claim contingent on state i is a contract that provides for water delivery only if amount W_i of water is available. An example of a claim is 10,000 MCM if there is between 1,800,000 to 1,900,000 MCM available. The state-contingent claims are the I contracts for water delivery, one for each state of nature. The contracts are made in advance of the state of nature being known and are carried out after the state is known. Thus, a competitive equilibrium that includes these state-contingent claims as tradable goods will be a Pareto optimum.

There is a system of tradable, prioritized rights that duplicates the state-contingent claims. Let there be as many prioritized rights as there are states. The rights of type i provide A_i units of water, when it has not been claimed by senior holders. Define A_i as $W_i - W_{i-1}$ with $W_0 = 0$. Therefore, A_i is the difference in water availability between two consecutive states of nature. Let the senior prioritized rights have the lowest cardinal numbers (i.e., 1 is senior to 2). In state of nature i, the needs of holders of class i and less are met. For instance, in state 2, holders of seniority 1 and 2 rights receive water. Since $A_1 + A_2 = W_2 - W_1 + W_1 - W_0 = W_2$, there is indeed just enough water to satisfy these claims holders. The A_is, together with the rule that low-number holders are senior, is an appropriative water right.

Buying one unit of right i and selling one unit of right i + 1 gets one unit of water only when there are W_i units available. For instance, a unit of right 2 gives one water in all states of nature numbered two and above. A unit of right 3 gives one unit in all states numbered three and above. Consequently, buying one unit of right 2 and selling one unit of right 3 gives one the right to water only when there are exactly two units of water available. Since, by buying a unit of right i and selling a unit of right i + 1 one can get exactly the same contract as buying one unit only when there is W_i units, the prioritized claims contracts can be used to duplicate the state-contingent claims. Since there is a way to use the prioritized contracts to get exactly the same economic effect that would be derived from the state-contingent claims, the tradable, prioritized rights are an efficient set of water rights. A competitive equilibrium with prioritized rights is a Pareto optimum.[2]

The classic analysis of appropriative water rights was by Burness and Quirk (1979). They concluded that equal sharing was the efficient right. They considered the case of identical farmers each with a concave payoff (restricted profit) function, $\pi(w)$. It is straightforward to show that the efficient outcome in such an economy (even with payments made before the state of nature is known, such as investment in trees or facilities) is for each agent to consume the same amount of water. In terms of the discussion above, the efficient

allocation is that each agent hold the same number of shares of each of the prioritized rights.[3] While the equal-sharing rule works well for equal agents, it is easy to find cases where it does not produce the optimal allocation.

Consider a region that produces two crops—a nut crop (pistachio) and cotton. The yield per acre for both crops is described by the concave function $y = \min(a^j w, b^j)$, where j is n for nuts for c for cotton. Let c^j be the nonwater costs, which we take as constant, and let the price of water be the numeraire. These are linear-response and plateau-yield functions, and they tend to describe crop response better than polynomial functions (see Berck and Helfand, 1990, for an extended discussion). Since the marginal product of water is constant at a^j until b^j/a^j units of water are used and is zero thereafter, the profit-maximizing amount of water to be used is either b/a or zero. Assuming that water is used on a crop, the profits from growing that crop are $\pi = p^j b^j - b^j/a^j - c^j$, where p is price.

Water should be allocated between the two crops to maximize profits. Profits are maximized when water is first allocated to the crop with higher profits. Only when that crop has b/a units of water should any water be allocated to the other crop. In our example π is greater in the nut crop, so all of the dunams of nuts should be irrigated before any water is used for cotton. This rule is just the rule for a prioritized right, and it is different from the equal-sharing rule. It also corresponds to real practice: High-valued crops are grown when water is scarce, and land that would produce low-valued crops is then left fallow.

The prioritized rights are relevant as long as there is specialization or heterogeneity or both. Specialization can be a purely technical issue: Given the same type of land, one farmer learns how to grow nuts and the other learns how to grow cotton. They buy the appropriate equipment and learn the appropriate skills for their crop but not for their neighbor's crop. In technical terms, the production function is transray convex. Heterogeneity in soils, which is common, will also lead to great differences in cropping patterns and marginal values.

3.2. Location

Water is similar to manufactured goods. Like an ordinary manufacture, it is produced at a source, stored in a reservoir rather than a warehouse, cleaned rather than packaged, and then piped rather than trucked to the end user. The economics of efficient water use are also similar to those of manufactures. The cost to the consumer should be the marginal cost of production plus the marginal cost of distribution. Water rights are the right to water at its source. To their price, one needs to add the transport, storage, and cleaning costs in order to find the efficient price to charge consumers. Therefore, tradable, prioritized rights are only part of the story for achieving an efficient system. Charging marginal costs of distribution is the other part. The statistics quoted above for Israeli distribution costs, from 2 to 50 cents per CM assure that marginal cost pricing would have a major impact on use.

In conclusion, choosing the right type of tradable water right and charging for transportation assures efficiency and, as argued below, makes the transition from agricultural to urban use much easier.

4. Proposed Reforms of the Water Regime in Israel, the West Bank, and Gaza

Since the political motivation for the current water system is rooted in the Israeli-Palestinian conflict, peace will provide an opportunity for reform of the water system. The current system fails to allocate water efficiently over space and time. The consequences of not charging transportation costs are well known: Much of Israeli agriculture does not cover water transport costs. The consequence of nontradability of rights is also obvious: Water is in short supply for urban use.

The consequences of lack of sufficient prioritization are somewhat more subtle. While there are broad clues regarding the sectoral impact of water cutbacks in a time of drought, the distribution of cutbacks within the industrial, urban, and agricultural sectors is unknown. For Israeli agriculture, where 80 percent of the water is used, the drought rationing system currently in effect is to dramatically raise prices for the last 20 percent of each farmer's

allocation. In effect, agricultural users with low marginal-value products were required to cut their use by 20 percent, while others had no cutbacks. That is, within the agricultural sector, there was very close to equal sharing of the water shortfall. For economic efficiency, the shortfall should have been more narrowly targeted at the low marginal-value product users.[4]

The lack of prioritized rights is also a problem for capital-intensive agriculture, such as floriculture. The current system threatens to idle greenhouses and plant production laboratories during dry periods. Given the threat of interrupted water supplies, it may not be prudent to build capacity much greater than that required to exploit the water likely to be delivered under drought conditions. With prioritized rights, capital-intensive farming operations can purchase the high seniority rights. These rights eliminate the uncertainties of supply that discourage capital-intensive farms from investing in new capital and equipment.

The direction of reform should be to move toward efficient allocation over time and over space. In the long run, this can be most easily accomplished by restructuring the underlying water rights. Such a restructuring should solve four problems: (i) the water rights are not tradable, (ii) the price of water does not reflect its marginal transport and processing costs, (iii) the rights are not prioritized, and (iv) the allocation to Palestinians may not be sufficient for the economic development that will assure the success of the peace process. The first three problems are problems of efficiency. On an economic level, they are solved by creating a practical rights system that has the properties described earlier for efficient rights. On a political level, solving these problems also requires reducing the pressure for water from agriculture. That is, some institutional reform is needed to make the economic reform politically practical. The problem of allocation of rights between Palestinians and Israelis is strictly one of equity and practical politics. We have four recommendations:

1. To solve the economic problem, water rights should be transferable, divisible, and prioritized and water users should pay marginal transport costs These are necessary preconditions for a market in water to perform. While the current block-pricing system does not properly respond to changes in water availability, it could provide the basis for a tradable,

prioritized right system. Existing rights should be divided into classes. Perhaps 40 percent of the original allocation should be characterized as firm or class I, 40 percent as class II, and the remaining 20 percent as class III. All class I rights would be satisfied before class II, and class II rights would be satisfied before class III. These rights would be tradable. When there was water beyond the allocated amounts, the government would be in a position to auction the surplus.

Since such a system would be pegged to water availability, it would automatically result in higher prices for water in drought years than in wet years. This would permit high-valued crops to be produced in all years, while low-valued crops were being rationed out in drought years. Put a little differently, flower producers and other specialty crop producers would buy the class I rights from grain and cotton producers. In addition, a tradable rights system would allow market forces to move water from agriculture to urban use, as urban consumers see fit to pay for it.

The most immediate effect of a market-based system would be the requirement that rights owners pay marginal transport costs to get their water from source to its point of use. Given that the marginal product of water for 40 percent of low productivity users is insufficient to pay transport charges, it can be presumed that the value of class II and class III water would be near zero. Users of these classes would be likely to pay only transport costs. This proposal for tradable rights would almost certainly result in a decrease in agricultural activity in what are now strategic (and remote) locations. Only with peace could the Israeli government tolerate this decrease in activity in strategic locations.

2. In order to reduce the pressure from agricultural interests for cheap water, the thicket of regulatory mechanisms and market interventions that protect agriculture in Israel should be dismantled. Once again, steps in this direction have already been taken, but a great deal remains to be done. Israel has already eliminated its Citrus Marketing Board, resulting in a 30 percent decline in local prices for citrus. There continues to be considerable intervention in markets for vegetables, poultry, and dairy products. In an informal survey of

supermarket prices conducted in March, 1993, it was found that Israelis pay 15 percent more than Americans for edible oil, 33 percent more for whole milk, 50 percent more for eggs, and 333 percent more for chicken. By way of contrast, sugar (the production of which Israel abandoned long ago) is 17 percent cheaper in Israel than in the United States. This situation is hardly unique to Israel. The distortion of internal prices results in a distorted picture of the value of water. With high internal prices, the region has a high apparent marginal-value product of water. The high apparent marginal-value product becomes part of the justification for new water projects and for avoiding structural reform.[5]

3. In order to create the political climate in which transferable rights can succeed, nonagricultural institutions should be given a voice in water policy in both Israel and the Territories. Even with tradable rights, there would be important administrative and regulatory issues in water allocation. The allocation and pricing of water should be relieved of institutional pressure that favors agriculture. Israel's Water Authority is currently part of the Ministry of Agriculture. The Water Authority should be made into an independent administration, supervised by a committee composed of the Ministers of Commerce and Industry, Environment, Health, and Agriculture. This reform would give proper voice to the industrial, health, and environmental concerns that should dominate water policy in the long run. The nascent self-governing authority of the Territories should structure its water authority in much the same fashion.

The authority or authorities that monitor and enforce water rights will have to cope with the binational nature of some of the water supply. The aquifers underlying the West Bank and, most particularly, the Yarkon-Tannaim aquifer, will (with peace) belong both to Palestinians and Israelis. For an agency to successfully adjudicate disputes about rights on these aquifers, the agency will need to be binational.

4. As a purely pragmatic political matter, the West Bank/Gaza water districts should be awarded rights to half of the Yarkon-Tannaim aquifer's sustainable yield as well as half of the water yield of a smaller aquifer shared by Israel and the West Bank. Failure to grant

Palestinians access to sufficient water to support their economic development could dangerously undermine any peace, as did the onerous economic conditions that were imposed upon Germany at Versailles.

The cost of giving Palestinians rights over an additional 100 MCM would be minimal for Israel. Even if the value of water net of cost was 10 cents per CM for marginal uses, which is most unlikely, the value of that water to Israel would be $10 million, hardly worth noting in a $60 billion economy. If, as we suspect, the marginal value of water net of cost is close to zero or even negative for Israel, award of the additional 100 MCM of water to Palestinians may actually save money for Israel.

Although nontradable water rights are a detriment, they are not the only problem standing in the way of efficient water use. The orientation of water institutions to development, defense, and agricultural goals is at least as serious a problem. The subsidization of agriculture provides a real force driving water away from efficient use. Without reform of the whole complex of agricultural and water institutions, and the achievement of Peace in the Mideast, there is little hope that transferable tradable, prioritized rights will exist, much less that they will lead to an efficient use of water.

Footnotes

[1]Anecdotal evidence that increased water consumption is not a prerequisite for economic growth is provided by examining Israel's recent economic performance. In the past three years, Israel's gross domestic product has grown from 5 percent to 7 percent per annum, while water consumption has been sharply cut back in agriculture and the agricultural product has declined by as much as 10 percent. It would seem that the linkage between water supply and economic growth is more tenuous than many observers appear to believe (Israel Yearbook and Almanac, 1991/1992).

[2]The description is in terms of the rights, and it does not matter how many appropriators there are of each type or who among them is senior. If one appropriator of type i receives water, they all receive water.

[3]An aside for the technically minded: Any appropriative right can be shared if it can be subdivided. The right to A acre-foot is divided by creating z new rights—the odd-numbered rights to one individual and the even-number rights to the other individual. Each right is of size A/z, and the priority is the number. As z approaches infinity, the rights of each individual approach equal sharing. Thus, equal sharing is a limiting form of appropriative right.

[4]The value of the right prioritized rights can be very high. Hamilton, Wittelsey, and Halvorsen (1989) provide an example where selling dry-period water increases the present value of water by a factor of nine.

[5]Alternatives must be found to compensate farmers for lost income. Considerable revenue could be raised for compensation through the sale of valuable real estate currently reserved for agriculture in Israel. Much of this land is of far greater value in the form of subdivisions and shopping malls.

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