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EFFICIENCY AND DISTRIBUTIONAL EQUITY IN THE USE AND TREATMENT OF WATER: GUIDELINES FOR PRICING AND REGULATIONS

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Even though we may consider these recovery ratios low, they are probably much higher than the average recovery ratio for comparable projects not financed by the World Bank. That is, pressure from the Bank towards fiscal self-sufficiency of individual projects probably had some effect.

Economists favour fiscal independence for different reasons than does the banker. It contributes to better investment decisions in the future. If users know that they will be paying for a project then they will participate more actively in the decisions regarding that project. Also, if decision makers know that they will be paying for a project then they also will participate more actively in decisions. Also, if decision makers know that users will have to pay for a project then they will study more seriously the actual benefits to the users in order to predict actual usage. More important perhaps is the concern that charges for water be based on the "marginal cost pricing" principle, which requires knowledge of the quantities (volumes or shares) of water actually used.

2. Israel: Moving towards an efficient allocation of water

Water management in Israel provides an example of a situation in which water has high value and useful lessons have been learnt on how to use it efficiently. Most of the material below has been condensed from a paper prepared initially for the meeting of the Ad hoc Group of Experts on the Achievement of Efficiency in the Use and Reuse of Water, held in Israel in 1974, and updated later as a thematic paper for the United Nations Water Conference (Arlosoroff, 1977).

(a) Water pricing

Internal political pressures and a great deal of trial and error have led to the tariff structure described in table 7. Most water is sold under the uniform tariff structure for municipalities given in section A.1 of the table. Increasing block rates are used in which the households have three rates, sharply increasing from $2.46 per m3 under 8 m3 per month to $6.16 per m3 for any amount above 16 m3. Agriculture, industry, hotels and services have two prices: low prices for water within the official allocations and higher prices for any water purchased in excess of these quotas. Hospitals, educational institutions and security installations have about the same penalty (marginal) charge as households, $6.16 per m3.

The rates for exceeding quotas are less for agriculture, public gardens, industry and hotels than for the others listed. Commercial establishments such as laundries and restaurants have flat rates for all the water they use.

There are plans to use more treated waste water from the cities for crop production in the future. There may be a need to establish special incentives to encourage full use of this water by farmers and induce efficiency in the process. Large users could make contracts with cities to manage waste treatment plants and make specific contracts to handle industrial wastes, including provisions for limiting the discharge of toxic substances.

Table 7. Water rates in Israel, effective 1 October 1977

A. Water tariffs for municipalities with own source of supply a/

Types of use	Block rates	Block rates within official allocations	Block rates in excess of allocations	Flat rates applied to commercial firms without allocations
	(dollars per m^3) b/			
Household use per dwelling, per month c/				
Under 8 m 3	2.46			
8 - 16 m 3	3.89			
Above 16 m 3	6.16			
Agriculture, industry, services and public institutions				
Agriculture		0.85	1.80	
Public gardens		1.33	2.28	
Industry		2.32	3.27	
Hotels		2.46	3.32	
Educational institutions		3.14	6.18	
Hospitals		3.15	6.18	
Security installations		3.16	6.19	
Laundries				3.18
Fish mongers				3.19
Swimming pools				3.19
Restaurants				4.46
Construction				5.69
Shops and offices				6.02
Other				4.41

(continued)

Table 7 (continued)

Types of use	B. Water tariffs for users supplied by others d/		
	Tax on low-cost water	Ceiling price = cost plus tax	Minimum price of subsidized water
	(dollars per m^3)		
Agricultural	0.9	0.57	0.95
Industrial	0.28	1.04	1.37
Other	0.43	0.85	0.95

a/ Rates are uniform throughout the entire country for those municipal authorities that have their own sources of supply, except in the desert town of Eliat. When a municipality purchases water, the charges are as follow$: for agricultural uses, the cost of purchase plus $0.28 per m 3; for industrial uses, the cost of purchase plus $0.57 per m 3.

b/ Exchange rate: $US1.00 = 1.05 Israeli pound.

c/ Any family of more than four persons occupying a single dwelling unit is entitled to an additional 3m3 per month at the base rate per additional person.

d/ Buyers are taxed is suppliers have low costs and are subsidized if they have high costs.

This tariff structure contributes to the twin goals of redistributing income and promoting efficient use. The most favoured sector is clearly agriculture. The highest rate for agriculture ($0.85) is less than the starting rate for all other users except public gardens. Swimming pools, fish mongers, laundries and industry also receive preferential rates. Greater efficiency in water use could still be encouraged by adopting a uniform penalty rate based on opportunity cost or price rationing to achieve full use of the available water.

(b) Use of water in agriculture

Water allocation for agricultural purposes is based on a system of annual licenses. These are norms and maximum quantities of consumption related to the various agricultural crops. The allocated water quantity is the sum of the appropriate norms times the cultivated areas. The norms are calculated on the basis of economic and efficient use. If the farmer is wasteful he will find himself unable to sustain his whole farm on the annual quantity of water available to him. Thus, the allocation provides the main incentive for efficiency. Over-consumption is also discouraged by payment of a penalty rate.

In addition, the Minister of Agriculture, by power of his legal authority, has issued regulations restricting the use of water in fish ponds, poultry houses and orchards (the largest consumer of water in Israel). The purpose of the regulations concerning water use in orchards, for example, is to encourage and promote efficient methods of water utilization, both in the engineering and economic contexts. A study of water consumption in orchards indicates that the use of various devices has resulted in saving considerable quantities of water. In order to provide the incentive for this form of water saving, the regulations stipulate that water saving achieved through the use of the said methods and devices shall not reduce the right of the consumer to receive the full quantity of water originally allocated to him including use on another site.

The activities of the Water Commission in this programme consist of developing efficient irrigation methods and systems, fostering their introduction by the farmers, granting loans at attractive interest rates, reducing market prices of water saving appliances, and of education projects. The co-operation of the farmer can be best secured by bringing about an increase in his income. However, the farmer must be given guidance and information as well as financial incentives. He must be induced to improve his systems of irrigation and thus save money and labour in addition to water.

Of the 200,000 hectares of land under irrigation in Israel, 90 per cent is irrigated by sprinkler and drip methods. This is the result of deliberate steps taken by the authorities to finance and otherwise encourage the replacement of gravity irrigation by closed-pipe systems over the past two decades. The national water system is capable of supplying water at suitable pressure for sprinkler and drip irrigation without the need for boosting. It is an integrated national system, with farms working to an "on-demand" schedule within a preset over-all water quota. The following considerations influenced the selection of this system:

(a) Sprinkler and drip irrigation systems make it possible to control the rate, amount and timing of water application and improve the over-all uniformity;

(b) The sprinkler and drip systems can be better adapted to the topography of the land and the shape of individual plots, while the irrigation rate can be easily adapted to soil type, climate and crop age at each plot;

(c) Sprinkler and drip systems are easy to operate; this is particularly important when land is being developed and farmers have little experience.

Drip irrigation is widely used for cultivating vegetables and vineyards and has recently been applied in cotton fields. Being stationary, drip irrigation systems lend themselves to the use of automatic water-control devices and a high degree of irrigation efficiency can be achieved.

The inevitable result of labour and/or water shortages, increasing costs, rising food prices and decreasing water quality, is an increasing need for and development of automated irrigation systems.

It is quite simple to set the automatic metering valve to deliver any prescribed volume of water, so there is no fear of excess discharge due to pressure fluctuations or forgetfulness. This device increases irrigation efficiency; and though it does not eliminate manual labour, it does reduce it.

Agriculture can enjoy the benefits of outside initiative in the development of electronic data-processing and control equipment, but most of the sensing devices are specific to agriculture and, apart from any problems regarding the profitability of automation in relation to labour costs and the value of additional production, they must activate and stop irrigation according to sound principles. Fully automated sprinkler and drip irrigation systems are in operation. Water applications are done by computerized scheduling based on considerations of water availability, climatic conditions, soil properties and marketing factors. Among the main problems in this regard are the great efforts needed to develop the data requirements for sound computerized scheduling and the desire to update computer programmes based on experience.

3. Mexico: evidence relating irrigation efficiency to the method of charging

One of the few studies that documents the relation between the method of charging for water and irrigation application efficiency was made by Schramm and Gonzales (1967) in Mexico. The study demonstrates that charges based on volume or the number of irrigations makes farmers more careful in their use of water (thus contributing to application efficiency), whereas flat rate charges per hectare or per season give no incentive to conserve water.

Table 8 shows the great variety of rate schedules in use in Mexico, a situation typical of many countries. The schedules are of three general types: charges related to volume of water use, fixed charges not related to volume of use, and a third type that includes elements of both types.