WATER PRICE POLICIES AND INCENTIVES TO REDUCE IRRIGATION WATER DEMAND: JORDAN CASE STUDY

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SUMMARY - Water in Jordan is the single most critical natural resources, since most of all aspects of social, economical and political development depends on the availability of adequate water supply. Jordan is one of the most water scare countries of the world where the per capita share of water is about 175 cubic meter per year. Nowadays, demand is far exceeding the supply and the trend in continuing. The implies a growing deficit. One of the main options to control this deficit is by reducing water allocated for agriculture. This paper discusses the impact of water pricing policy as a tool in controlling and reducing agricultural water demand. The provision of water irrigation pricing policies in Jordan are based on the assumption that water prices should cover at least the cost of operation and maintenance and should be used as an incentive to improve on-farm irrigation use efficiency. The prices of irrigation water in the Jordan Valley was designed so that O & M cost (0.025 JD) would be completely covered. The recent water tariff structure has helped in improving irrigation efficiency in the Jordan Valley to 70% compared to 55% for the last decade. A differential pricing structure based on water quality has been recommended which is based on crop response to water quality. To control groundwater pumping and reduce over-abstraction above the safe yield, the government is now charging the extra amount on groundwater withdrawal exceeding 150,000 m^3/year. It is believed that this strategy will enhance water saving and control agricultural demand. Recent studies using groundwater for irrigation showed that water pricing policies based on volumetric charges could have little impact on water consumption as water demand is inelastic for higher price above O & M. Water consumption has decreased significantly only when water prices has exceed the 0.5 \$/m^3 limit.

Key words: irrigation, water pricing, demand curve, Jordan.

INTRODUCTION

Adequate water pricing in the agricultural sector is a key factor in maintaining the operational capacity of water supply systems. Making farmers pay for the costs they impose on them by the government as suppliers contributes to restraining short-term water demands, as well as the pricing policy can be used as a screening device for selecting irrigation projects which generate the highest social and financial returns. If prices paid by farmers incorporate at least some long-run marginal cost components, water demands will more easily be kept at sustainable levels.

Furthermore, adequate pricing implies that the charges paid by farmers approximate the social value of water, allowing society as a whole to capture any gains that might be derived from allocating water more efficiently. In despite the importance given to water pricing as a tool in Jordan — pricing policies alone cannot deliver the benefits that more comprehensive water policies in the agricultural sector are meant to accomplish. Unlike much of household and industrial water demands, agricultural demands are far from homogeneous. This heterogeneity implies the need to imagine of irrigation water supply as a multi-attribute service in which “cost” alone does not convey much information about water’s relative scarcity.

Water quality, supply reliability, frequency of accessibility, whether individual consumption is measurable, are other factors that considered as important as the prices paid by farmers. Agricultural water’s relative price should ultimately depend on how productive water is to irrigators. Efforts to draw agricultural water pricing comparisons across different countries will therefore be hindered by any deficiencies in information about the other (non-cost) attributes attached to the service of supplying water to irrigation units. In spite of these difficulties, price information, combined with information about underlying policies and industrial structures, can provide a useful *beginning* for comparing water management strategies across places and through time according to different water qualities.

Increasingly, water scarcity is described as a major challenge facing the world. However, its definition remains a controversial issue. For instance, water scarcity is not an absolute concept. Communities truly facing water scarcity are those where basic human requirements can only be satisfied by some very basic changes in life style and/or levels of living; only a limited number of countries fall into this category. A larger number of countries face water scarcity because they need to make some basic changes in their water management including, in some cases, infrastructural changes to facilitate management. Another group of countries have water scarcity and will need to make both management changes and infrastructural investments to develop their water supply.

This paper discusses the impact of water pricing policy as a tool in controlling and reducing agricultural water demand. However to satisfy the main objective the following specific objectives were addressed:

1. projections of the demand, the supply and the deficit of water for the year 2020,
2. discussion of water strategy and policy,
3. determine methods used by the government to decrease the demand for water and
4. finally deriving the demand curves for different water qualities.

BACKGROUND

In Jordan, water scarcity is the single most important natural constraint to economic growth and development, and the rapid increase in population and industrial development has placed unprecedented demands on water resources; Jordan's population approached 5.5 million in 2002 and is growing at a very high annual rate of 2.8% (DOS, 2002). As a consequence, total demand is approaching 1 billion m3 per year, a figure which approximates to the limit of Jordan's renewable and economically developable water resources. Indeed, for several years, renewable ground water resources have been withdrawn at an unsustainable rate and, consequently, groundwater quality in some areas is deteriorating.

At present, Jordan's water policy concentrates on satisfying the water requirements of municipal and industrial consumption, while the rest is left for agricultural use. Thus, in meeting Jordan's future demand for water, it is imperative that optimal and sustainable patterns of water use be established to meet the requirements of a growing population as well as Jordan's economic development objectives and need for basic agricultural foodstuffs. No single action can remedy the country's water shortages; rather many actions are necessary to increase overall water availability. One strategy is to focus on increasing the usable supply of water and the amount of wastewater reuse. Another strategy is to reduce water demand by adopting water conservation programs and improving water use efficiency, while yet a third involves a water pricing policy.

Demand for water is increasing due to population growth, higher standard of living and industrial development. Water shortage has become of permanent nature, since demand is exceeding the supply and the trend is continuing. Water requirement was 1,205 MCM, water supply was 840 MCM, and the deficit was 365 MCM in 1999. It is expected that water requirement will be 1,746 MCM, water supply will be 1312 MCM and the deficit will be 434 MCM in 2020.

Jordan's water resources consist primarily of groundwater, base flow, and flood flow, which are considered conventional resources. Treated wastewater, brackish and desalinated water are considered non-conventional resources.

Surface Water Runoff

The water flowing in Jordanian Wadis (valleys) has three different sources: Direct runoff from heavy rainfall, base flow leaking out from groundwater bodies and the discharge from wastewater treatment plant

Direct runoff in Jordan lasts typically from less than an hour to very few days. Water made available from the existing "ordinary" reservoirs, is around 190 MCM/year for the year 2005. It is assumed, that the year 2020 all reservoirs currently under construction or study will be completed. Table 2 shows average surface water resources 2005-2020 (MCM/year). Total surface water is estimated around 621 MCM/year for the year 2020 as shown in Table 1.

Table 1. Average Surface Water Resources 2005-2020 (MCM/year) (Source: Ministry of Water and Irrigation, The National Master Plan, Jordan, 2003).

Years	*2005*	*2010*	*2015*	*2020*
Total base flow excluding reservoir inflow	142	128	128	118
Reservoir safe yield	188	240	264	292
Yarmouk base flow to KAC	120	126	126	126
Additional flood flow from Wahdeh dam	-	85	85	85
Total surface water resources	456	579	603	621

Groundwater

Groundwater is the major water resource in Jordan; it is the only water recourse in some areas of Jordan. Groundwater resources in Jordan are considered renewable in certain part and non-renewable in other. Groundwater is water that is stored underground in places of soil or rocks. Groundwater supplies are replenished or recharged by rainfall. Table 3 shows the annual mean water budget of renewable groundwater. The budget reflects the relationship between input-output of water.

The comparison of total inflow and total outflow shows that the outflow is greater than inflow, and that some of the discharged water is taken from storage. Thus at present time the groundwater budget is negative and ground water management is not sustainable. Besides renewable resources Jordan possesses limited resources of fossil-non-renewable-groundwater, is estimated to be about 125 MCM/year, originating from the Rom Aquifer in the Disi area.

Table 2. Annual Budget of Renewable Groundwater (Source: Ministry of Water and Irrigation)

Budget Component	*Quantity (MCM/year)*
Groundwater recharge from precipitation	390
Tran boundary groundwater inflow from Syria	80
Return flow from irrigation, leak from pipers, reservoirs, sewage plants	70
Total inflow	540
Groundwater abstraction (wells, springs)	440
Base flow	220
Total outflow	660
Charge in storage (inflow-outflow)	-120

International Water Rights

Jordan receives a large share of its water resources from trans-boundary water courses, namely Yarmouk River, Jordan River and from trans-boundary aquifers. In 1987, the government of Jordan and the government of Syrian Arab Republic signed the agreement on the utilization of the Yarmouk River. The agreement provides the legal basis for the construction of Wehdah dam on the Jordanian-Syrian border, this providing about 85 MCM/a of water to Jordan by the year 2005 after completion of the dam.

In 1994, the government of Jordan and the state of Israel had entered into a peace treaty. According to the said treaty, the parties agreed mutually to recognize their rightful shares of the Jordan River and Yarmouk River stream flow and Wadi Araba groundwater, thus protecting Jordan's share in interment water resources in the magnitude of at least 100 MCM/year.

Wastewater Generation and Reuse

Treated wastewater is a non-conventional water resource of increasing importance for Jordan's water budget. Almost 60% of the country's population is connected to the (sewer system). In 2002, 19 treatment plants were in operation, treating about 85 MCM of wastewater per year. It is estimated that the usage of wastewater inflow of treatment plants will be 231 MCM in 2020 of which 114 MCM will inflow to reservoirs.

Desalination

Desalination allows the utilization of Jordan's huge brackish groundwater resources, and unlimited seawater resources. At present 27 desalination plants are in operation and 7 plants are under construction. Twenty three plants with total capacity of 1000m^3/h are privately owned and operated by farmers for irrigation in the Jordan Valley. The Water Authority of Jordan operates four desalination plants for drinking water. Major desalination projects are planned. Brackish water for Wadi Mujib and Wadi Zara Main will be treated to provide and add 37 MCM/year of drinking water until the year 2005. In Aqaba, research development is foreseen to contribute 5 MCM of drinking water to water supplies by the year 2005.

Demand-Supply Balance

Actual water uses have actually exceeded the available Jordanian supply. Renewable ground water in the Jordan Valley (JV) and highland areas is being exploited at unsustainable rates and water quality is deteriorating. Current water demands are not being met satisfactorily throughout the country (both spatially and temporally), and the costs of developing new water resources are rising rapidly.

In the mid-long term, with a growing population and an increasing water demand, Jordan will not be able to satisfy its increasing water demands from renewable water resources. Meeting Jordan’s future water demands, including delivery to major consumption centers, will require implementation of expensive development and conveyance projects. These projects will place a heavy burden on the national budget and will affect the national economy adversely. Financial constraints as well as the political difficulties of managing water demands clearly indicate that future water strategies must be selected carefully.

No single action can remedy the country's water shortages; rather many actions are necessary to increase overall water availability. One strategy is to focus on increasing the usable supply of water and the amount of wastewater reuse. Another strategy is to reduce water demand by adopting water conservation programs and improving water use efficiency. The agricultural sector in Jordan consumes about 65% of the total available water supply, where M&I sectors consumption was 35%, in 1999 (MWI, 2000).

In Jordan, the actual and forecasted supply and demand for M&I sectors is increasing in an increasing way due to the raped increase in population. Table 3 shows that the gape between supply and demand is expected to increase as seen in Figure 1.

However in the case of agricultural sector in seems that the there is gradual decrease in the consumption of water for irrigation due to the fact that the Ministry of water and irrigation is allocating water from agriculture to be used for M&I sectors (Table 4 and Figure 2)

Table 3. Total Supply and Demand (Requirements) for M&I sectors in MCM/year

Year	*M&I Supply*	*M&I Requirements*	*Deficit*
2000	276	375	-99
2005	357	462	-105
2010	473	537	-64
2015	575	654	-79
2020	647	783	-136

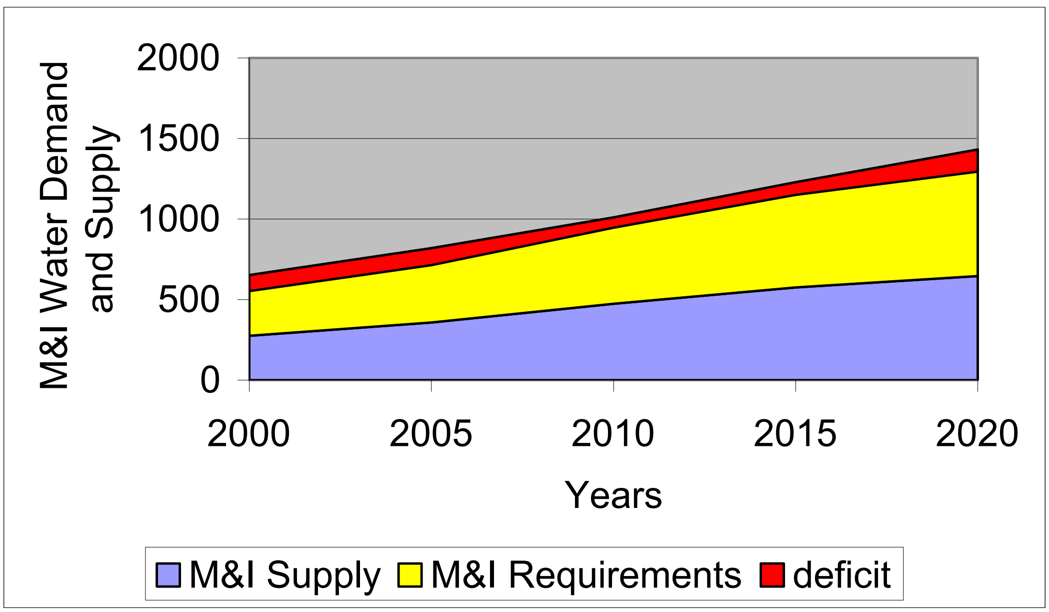

Fig. 1. Total Supply and Requirement for M&I sectors in MCM.

Table 4. Total Supply and (Demand) Requirement for Agricultural sector in MCM/year

Year	*Agriculture Supply*	*Agriculture Requirements*	*deficit*
2000	541	922	-381
2005	750	949	-199
2010	746	1001	-255
2015	704	991	-287
2020	665	963	-298

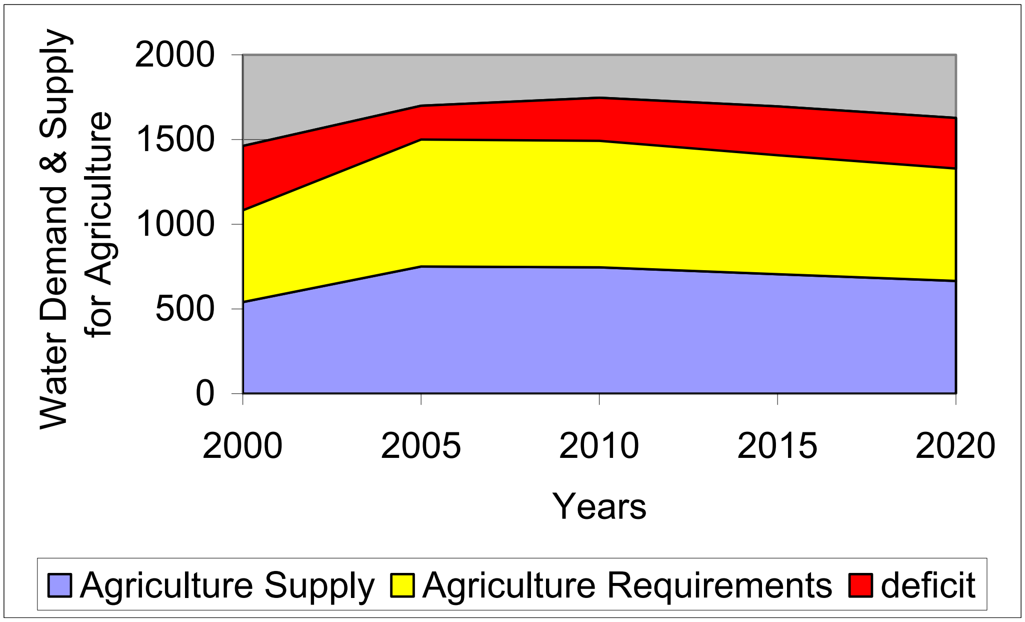

Fig. 2: Total Supply and Requirement for Agricultural sector in MCM.

However when summing up the demand and supply quantities for all sectors together Table 5 and Figure 3 show that due to reallocation between sectors in Jordan (from Agriculture to M&I) that the gape in increasing again but in lower rate compared to the M&I growth rate alone.

Table 5: Total Supply and Demand of water for all sectors in MCM/year

Year	Total Supply	Total Requirements	Deficit
2000	817	1297	-480
2005	1107	1411	-304
2010	1219	1538	-319
2015	1279	1645	-366
2020	1312	1746	-434

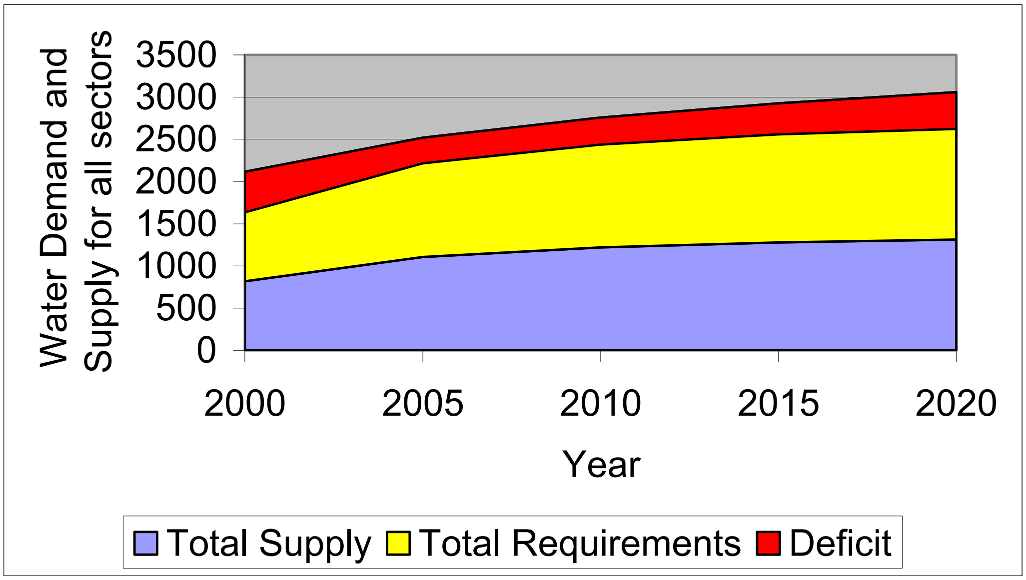

Fig. 3. Total Supply and demand for all sectors in Jordan in MCM.

JORDAN'S WATER STRATEGY AND POLICIES

A water strategy has been formulated by the Ministry of Water and Irrigation (MOWI), and was adopted by the Council of Ministries in 1997. The strategy stresses the need for improved resource management with particular emphasis being placed on the sustainability of present and future uses. Special care shall be given to protection against pollution, quality degradation and depletion of resources.

The water strategy ensures the rightful shares of the kingdom's shared water resources shall be defended and protected through bilateral and multilateral contacts, negotiations and agreements. Peace water and wastewater projects, including the schemes for the development of the Jordan Rift Valley, shall be accorded special attention for construction, operation and maintenance.

The Government of Jordan has adopted the following water strategies:

- On Resource Development: A comprehensive national water bank data bank will be established; wastewater shall not be managed as waste; marginal quality water and brackish water sources shall be enlisted to support irrigated agriculture; a revolving five-year plan; the priority criterion for project implementation shall be based on economic, social and environmental consideration.
- On Resource Management: Priority is given to the sustainability of use of developed resources and mining of renewable groundwater aquifers; a dynamic regime of demand and supply; minimum cost of operation and maintenance.
- On Legislation and Institutional Set-Up: Institutional restructuring; update legislation; enhance the participation of stake holders; cooperation among public and private entities.
- On Shared Water Resources: The rightful shares of the kingdom shall be defended; peace water and wastewater projects shall be accorded special attention; bilateral and multilateral cooperation with neighboring states will be pursued.
- On Public Awareness: The public shall be educated about the value of water; challenges in the water sector; use of water saving and recycling systems.
- On Health Standards: Enforcing national health standards; concerns for public health and the health of workers; laboratories for controls.
- On Private Sector Participation: Management contracts; the concepts of BOT/BOO shall be entertained; the private sector role in irrigated agriculture shall be encouraged.
- On Financing: Recovery of operation and maintenance cost shall be a standard practice; cost recovery shall be linked to the coverage per capita of the GDP and its level.

Water Management Policy

Jordan's Water Strategy was supplemented with a set of policies and measures to help achieve its objectives. Three policies have developed. These policies are:

- Groundwater Management Policy
- Irrigation Water Policy
- Wastewater Management Policy

Groundwater Management Policy

Government's policy concerning groundwater management aims at the development of the resources, its protection, management and measures needed to bring the annual abstraction from the renewable aquifers to the sustainable rate. Specific policy statements are:

- On Resource Exploration: Plans for the exploration of groundwater resources; assessment of the sustainable yields; a comprehensive program to assess the potential of brackish groundwater.
- On Monitoring: A network of observation wells; advanced technology shall be employed in the monitoring process; a special monitoring network of industries and olive presses will be installed.
- On Resource Protection, Sustainability and Quality Control: Protection of recharges areas of aquifers; wells licensing; withdrawal from wells shall not exceed the abstraction permit rate; cooperate with the Ministry of Agriculture to regulate the type and application rate of fertilizer and pesticides.
- On Resource Development: Well fields distribution with a proper distance; deep groundwater aquifers shall be carefully made; groundwater reservoirs shall not be allowed without a license; groundwater mathematical models shall be developed for all regional aquifers of the basins.
- On Priority of Allocation: Priority of allocation of groundwater shall be given to municipal and industrial users, to educational institutes and to tourism; priority shall be given to the sustainability of existing irrigated agriculture where high capital investment had been made.
- On Regulation and Control: Campaigns shall be waged against illegal drilling of tube wells; water meters installed on groundwater wells shall be read on quarterly basis; prohibition of wells licensing for agricultural purposes.
- On Private Sector Participation: The private sector shall be encouraged to develop aquifers of marginal water quality; desalination of brackish ground water

Irrigation Water Policy

The policy addresses water related issues of resource development: agricultural use, resource management, technology transfer, water quality, efficiency, cost recovery and other issues. Specific policy statements address:

- Sustainability of Irrigated Agriculture: Existing areas of irrigated agriculture shall be accorded the chances for sustainability; sustainability of agriculture shall be compromised only if it threatens the groundwater; surplus surface water during the wet season shall be provided to farmers free of charge to leach soils.
- Resource Development and Use: Wastewater is considered a resource; maximum use shall be made of rainfall for crop production; the use of brackish water in irrigation shall be pursued with care; a revolving development plan for water resources shall be adopted.
- Technology Transfer: Higher agricultural yields; modern advanced irrigation methods; plant varieties developed as a result of genetic engineering.
- Farm Water Management: Crop water requirements shall be determined; automation of farm irrigation networks.
- Irrigation Water Quality: Water quality shall be monitored; improving wastewater quality; testing water salinity.
- Management and Administration: The Jordan Valley Authority is responsible for the operation and maintenance of irrigation facilities; piped irrigation network shall be the standard method of irrigation conveyance and distribution; abstraction from groundwater wells shall be metered.
- Water Pricing: Irrigation water shall be managed as an economic commodity has an immense social value; water price shall at least cover the cost of operation and maintenance, it should also recover part of the capital cost; differential prices can be applied to irrigation water to account for its quality.

- Regulation and Controls: Planting of crops with high water requirements shall be discouraged; planting of perennial crops shall be allowed only with permits.

Wastewater Management Policy

The policy addresses the management of wastewater as a water resource including development, management, collection and treatment, reuse and standards. Specific policy statements are:

- On Resource Development: Wastewater is an integral part of renewable water resources; collection and treatment of wastewater becomes mandatory to protect public health.
- On Resource Management: A basin management approach shall be adopted; effluent quality standards shall be defined; industries shall be encouraged to recycle part of its wastewater.
- On Water Collection and Treatment: Wastewater shall be collected and treated; priority shall be given to protecting public health and water resources; treatment plants shall be located away from any potential population growth.
- On Reuse of Treated Effluent and Sludge: Priority to agricultural use for unrestricted irrigation; accumulation of heavy metals and salinity shall be monitored; farmer shall be encouraged to use modern irrigation technologies.
- On Pricing: Treatment fees shall be set to cover at least the operation and maintenance costs; appropriate criteria in order to apply the “polluter pays” principle shall be established; different charges for different areas may be applied.

Water Pricing Policies in Jordan

Irrigation water is managed as an economic commodity that has an immense social value. Water price is set at least to cover the cost of operation and maintenance, and also to recover part of the capital cost of the irrigation project. Differential prices are applied to account for irrigation water quality, the end users and the social and economic impact of prices on the various economic sectors and regions of the country.

In the case of wastewater, due to the increasing of marginal cost of collection and treatment, wastewater changes, connection fees, sewerage taxes and treatment fees shall be set to cover at least the operation and maintenance costs. It is highly desirable that part of the capital costs of the services shall be recovered. Differential changes for different regions may be applied.

Water is relatively expensive in Jordan because of its limited availability and the cost required abstracting from deep wells, pumping it and conveying it for a long distance from its source.

The actual costs of delivering water to consumers are estimated at \$ 1.14 / m^3 for municipal purposes and \$ 0.32 / m^3 for irrigation in the Jordan Valley. Cost analysis suggests that the government of Jordan has been subsidizing these water services in amount exceeding \$ 70 million annually because of low tariff structures.

Water charged in Jordan Valley according to the principle of price discrimination. Water block structure is divided into four slides depending on the level of water usage. The farmer's payment depends on total water consumption; it ranges from \$ 0.0114 / m^3 to \$ 0.05 / m^3. The farmers pay in average \$ 0.027 / m^3. To control groundwater pumping and reduce over-abstraction, above the save yield, the government is now charging the extra amount on groundwater withdrawal exceeding 150,000 m^3 / year.

The government of Jordan and the Ministry of Water and Irrigation has undertaken a package of measures and policy reforms to enhance the water sector and assure financial viability. The following financial measures were undertaken:

- A new tariff for groundwater abstraction for agricultural use has been implemented. This will generate annual revenue of \$ 5.7 million.
- Implementation of additional surcharge on all water bills issued by Water Authority of Jordan. This will generate annual revenue of \$ 4.0 million.
- Treated wastewater will be sold at \$ 0.0143 /m^3.

- Implementing a surcharge of $ 23.0 per year per customer in all agricultural water bills in the Jordan Valley.

The purpose of these policies was to generate revenue which covers the cost of operation and maintenance.

Policies Implemented to Reduce Water Consumption

The government implemented a range of policies to reduce water consumption in irrigated agriculture. The following are the major policies:

- Enforce limits on planting crops with high water requirements.
- Prevention of planting summer crops in the Jordan Valley, due to the high water requirements.
- Discourage planting fruit trees and limit planting of banana trees.
- Encourage advanced methods as drip irrigation, spray irrigation and micro-sprinkler irrigation.
- Installation of pressure pipe network for irrigation water conveyance and distribution.
- Penalty is introduced to face those who are violating the regulation of water exploitation.
- The government hired a number of agricultural farm units in the Jordan Valley and put it out of the irrigation system temporarily to save water consumption.
- The government encouraged the farmers to construct desalination plants.
- The government reduced the amount of water supplied to the farmers in the Jordan Valley to 60% compared with the normal practice.
- No more agricultural credits to irrigated agriculture (olives) in the highlands area or to cultivate Banana in the Jordan Valley.

DEMAND CURVE FOR WATER

The relationship between the price of water and the quantity demanded, can be shown using economic technique called the demand curve. The water demand is inversely related to price. Prices perform two essential roles in a market system: rationing water and production motivation. The demand for water is partly a function of its own price. An efficient water price leads consumer to consume, and producer to produce, an appropriate amount of water. Under pricing water can lead to underproduction and over consumption. Prices that are too high can lead to overproduction and under consumption.

The demand curve slope is determined with the magnitude of its elasticity. Two demand curves are shown in figure 4: a and b. These typical water demand curves demonstrate that price and quantity are inversely related.

These demand curves were developed in the context of perfect market. The recently published study by Fortin *et al* (2001) contains a more accurate illustration of the nature of the demand curve for water as shown in figure 5, where three "zones" of water demand are depicted.

a. demand curve relatively inelastic

b. demand curve relatively elastic

Fig. 4. Typical Demand Curves:

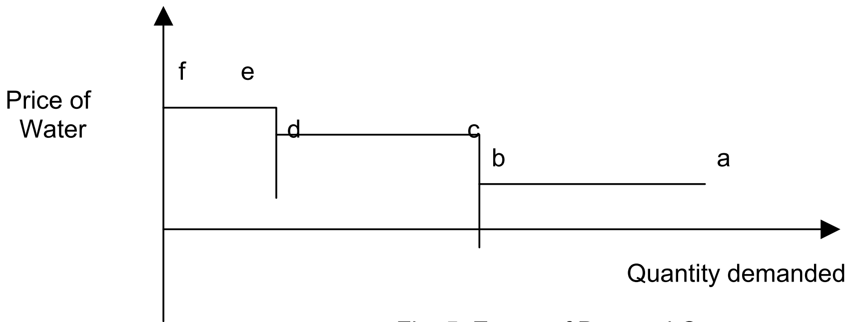

Fig. 5. Zones of Demand Curve

Starting from the right side of the figure, the first zone (a-b) has low prices, no metering and high demand. The second zone (c-d) has lower demand, higher prices and water use stable. The third zone (e-f), conservation programs rationale begins, and water price is high. The demand curve shown here is a stepped function of water use against price, indicating that water demand responds to significant measures.

Deriving Water Demand Curves for Different Water Qualities

This part of the paper has drawn heavily on a paper written by Salman, *et al, 2001.* An inter-seasonal agricultural water allocation system (SAWAS). A principal feature of SAWAS is the use of demand and benefits from water together with costs, and optimization within the agricultural sector to specify the optimal usage of different water quantities.

The postulated model was used to evaluate the response of water quantity (of different water qualities) to a wide range of water prices. The demand curves were derived for surface water, brackish water and recycled water. To obtain observations on the demand curve for surface water, the prices of the two of the other water quality prices (brackish and recycled) were held constant, while systematically changing the price of the remaining one (surface). The results of systematically changing the surface water price are presented in Table 6. When the price of the surface water rises from $ 0.20 to 0.25 per m^3, the quantity of the surface water demanded is reduced by 13 MCM. They are graphically presented in Fig 6. At the midpoint of the range of surface prices studied, the own-price elasticity of surface water is -0.91. This means that an increase of 1% in the price of the surface water will decrease the quantity demanded by about 0.91% so the demand is slightly inelastic.

Table 6. Responsiveness to incremental increase in surface water price

Price	Water Use (MCM)	
[$/$m^3$]	Total	Surface
0.05	234.1	162.9
0.15	233.0	151.7
0.20	214.0	131.5
0.25	207.1	118.5
0.30	206.0	117.4
0.40	203.5	114.8
0.45	203.5	114.8
0.55	182.7	94.1
0.65	173.0	83.2
0.75	156.7	65.1
0.85	122.9	34.2
0.95	119.5	30.9

1.05	119.5	30.9
1.10	118.2	29.5

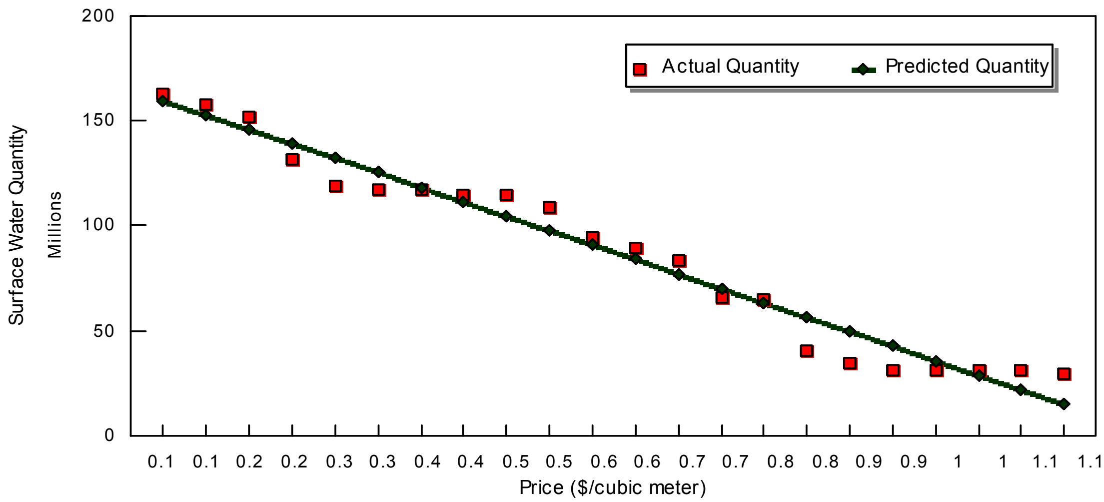

Fig. 6. Surface Water Demand Curve

Following the same procedure as for the surface water, the results of varying the brackish and recycled water prices are presented in Tables 7, 8, respectively.

The best fitting demand curve for brackish water is linear as shown in fig 4, whereas in the case of recycled water the semi-log form fits best Fig 5. The price elasticities of demand of brackish and recycled water, at the respective midpoint prices of $ 0.3 and $ 0.017 per m3 are -1.01 and -1.21 respectively, so that demand is almost unitary elastic for brackish water and elastic for recycled water.

Table 7. Responsiveness to incremental increase in brackish water price

Price	Water Use	
[$/m^3]	Total	Brackish
0.01	234.1	18.1
0.015	234.1	18.1
0.02	231.6	14.8
0.025	231.2	14.3
0.03	231.2	14.3
0.035	231.2	14.3
0.04	227.8	9.7
0.045	225.4	6.6
0.05	224.3	5

0.055	220.5	0

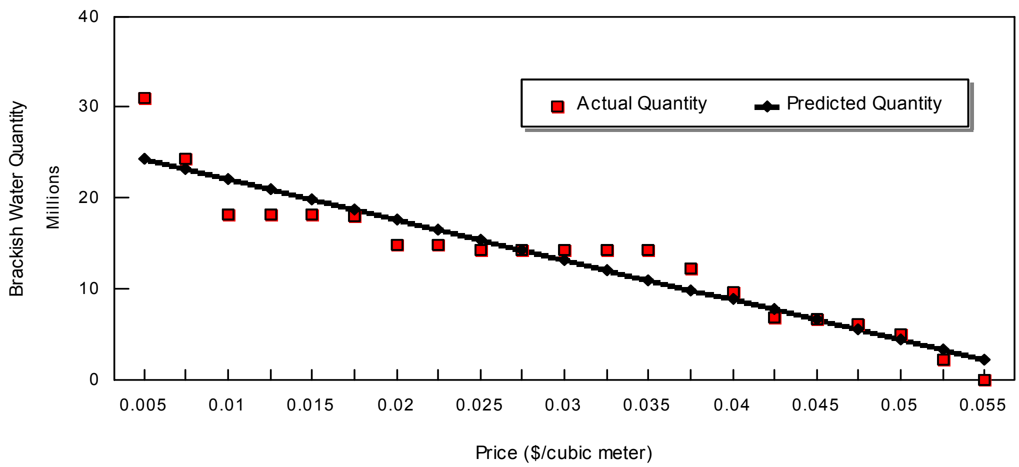

Fig. 7. Brackish water demand curve

Table 8. Responsiveness to incremental increase in recycled water price

Price	Water Use	
[$/m^3]	Total	Recycled
0.01	234.7	61.5
0.03	232.4	51.3
0.05	230.3	48.5
0.09	210	21.5
0.11	202.6	11.5
0.13	199.7	9.3
0.17	199.7	7.6
0.19	199.7	7.6
0.23	196.9	3.9
0.25	196.9	3.9
0.29	194.4	0.6
0.31	194	0

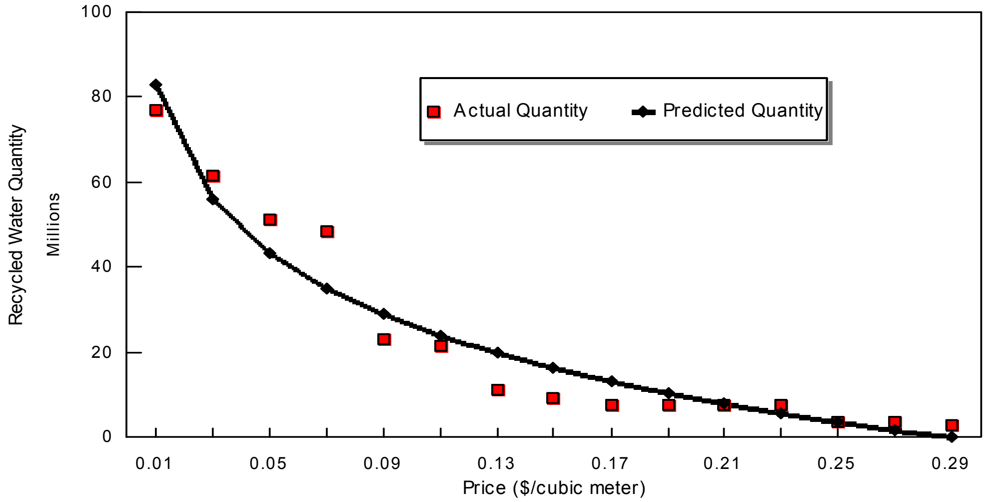

Fig. 8. Recycled water demand curve

CONCLUSIONS

The water demand from agriculture reacts to increasing water prices quite inelastic over a long interval; however, even marginal increases of the water price change the production structure, reduce agricultural production and initiate thus negative impacts on the supply situation of markets and the living standard of the local rural population.

Specifically the demand for surface water is slightly inelastic, while for brackish water is almost unitary elastic, and for recycled water is elastic, this means that if the price of water increase for low water qualities, the farmer would reduce his water consumption for low water quality. The current water pricing policies do not always send the right signals to consumers and users to ensure that water resources are used efficiently.

There are other factors that influence water demand and supply as well; these factors are Water quality, supply reliability, frequency of accessibility, and whether individual consumption is measurable. These factors should be considered by any planner.

As said before Agricultural water's relative price should ultimately depend on how productive water is to farmers. And should be differentiated according to different water qualities and different crops, some crops are more profitable than others, This would create rich and poor farmers, and the government would subsidize the rich people where poor people would pay and rich would consume.

Efficient water pricing policies have a demonstrable impact on the water demand of different uses. As a result of changes in water demand, efficient water pricing reduces the pressure on water resources. This suggests that farming communities can be expected to adapt to certain price increases that would result from a stricter recovery of the costs of water services. Furthermore, water pricing will need to be integrated with other measures to ensure environmental, economic and social objectives are met cost-effectively.

Finally, to play an effective role in enhancing the sustainability of water resources, water pricing policies need to be based on the assessment of costs and benefits of water use and to consider both the financial costs of providing services as well as environmental and resource costs in addition to social dimension.

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