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Water demand management in Syria: centralized and decentralized views

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Abstract

The countries of the Middle East are characterized by large temporal and spatial variations in precipitation and with limited surface and groundwater resources. The rapid growth and development in the region have led to mounting pressures on scarce resources to satisfy water demands. The dwindling availability of water to meet development needs has become a significant regional issue, especially as a number of countries are facing serious water deficit.

Syria is becoming progressively shorter of water as future demand is coming close to or even surpassing available resources. Syria had a population of 18 million in 2002, and its total renewable water resources (TRWR) is estimated around $16 \times 10^9\ m^3$ per year. In other words, the per capita TRWR is less than the water scarcity index (1,000 m^3 per person per year) which will make the country experience chronic stress that will hinder its economic development and entail serious degradation. Unfortunately, if water demand at current prices continues to increase in the same way, Syria will experience an alarming deficit between the available resources and the potential needs in the near future.

In Syria, until fairly recently, emphasis has been placed on the supply side of water development. Demand management and improvement of patterns of water use has received less attention. The aim was always to augment the national water budget with new water. The most popular way of achieving this aim was to control surface flows by building new dams and creating multi-purpose reservoirs (there are now around 160 dams in Syria with a total capacity of $14 \times 10^9\ m^3$). Irrigation schemes were also built and agricultural activities were expanded greatly to achieve self-sufficiency in essential food products and food security. However, this is no longer achievable with the limited water resources available; water demand is rapidly increasing and easily mobilizable resources have already been exploited.

The objective of this paper is to think of different possible ways to manage water demand in the agricultural sector of Syria. It mainly involves two main management options: taxation as a centralized option and water markets as a decentralized one. While water demand management refers to improving both productive and allocative efficiency of water use, this paper focuses on two allocative measures (taxation and water markets) and does not thoroughly cover productive measures such as rehabilitation and upgrading of irrigation schemes or improving operation. However, the paper does not attempt to settle the question for or against each option but tries to find some elements to determine under which conditions the option can lead to expected outcomes taking into account the history of management and the local conditions in Syria: political, social and economical. The paper also looks at other alternatives such as cooperative

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action and lifting subsidies and argues their possible association to the main management options that may help in reducing the difficulties of implementation.

Keywords: Syria; Taxation; Water demand management; Water markets; Water pricing

1. Introduction

There has been an extraordinary level of development of irrigated agriculture in the Middle East region in the last three decades. The objective of this development was to promote intensive agriculture with a high economic value, capable of satisfying part or all of the national food needs and achieving an exportable surplus while stabilizing production through mitigation of the negative effects of drought that make rainfed agriculture fragile and unreliable (Bazza & Ahmad, 2002). This development might have been pushed by at least two main institutionally determined factors. First, national governments have been largely engaged in the construction of water infrastructure of which the cost was, for the most part, sustained through the public budget. Second, agricultural policy in most of the countries of the Middle East, which has been based on subsidized prices paid to farmers in excess of the market value of crops, might have further inflated the incentives to irrigate.

Management of water in the agricultural sector generally comprises four groups of functions: water resources assessment and development to augment the availability of water; water resources allocation to meet the demands; water utilization; and environmental and pollution control. Managers try tirelessly to strike a balance between the available water resources and the demands on water by either supplying more water (supply management) to match the demand, focusing mainly on assessing and developing new water sources, or manipulating the demand (demand management) to match the available supplies, focusing mainly on water allocation, efficient water utilization and effective pollution control (Bakir, 2001, 2003).

Historically, water resources management was supply driven. This paradigm, however, has recently changed in the Middle East region. Two major drivers of change have been recognized: a shift in policy emphasis away from the supply side to more demand management, and the decentralization of water management institutions as part of the subsidiarity requirement for sustainable development. Since most of the managers of water resources are water supply engineers or techno-experts, their approach could not be other than technical. In "water conservation", solutions consist essentially in reducing technical losses (leakage and waste), promoting a better technical use of the resources and mobilizing non-conventional resources. The design of more appropriate management policy to restrain water demand has just recently started to be recognized.

The concept of water demand management generally refers to the implementation of policies or measures which serve to control or influence the amount of water used (Lallana *et al.*, 2001). However, a comprehensive and more sophisticated working definition of water demand management was quoted, after the Forum on Water Demand Management in the Mediterranean Region that was held in Fiuggi, Italy, in October 2002, as follows:

If water demand consists in the sum of water use (use and losses), Water Demand management consists in the body of interventions and organization systems that societies and their governments can implement to increase technical, economic, social, institutional and environmental efficiency in *water management. Complementary to supply-side policies (development of new water sources and supply facilities), Water Demand Management, therefore, tries to reduce physical and economic loss and better satisfy economic, social and environmental demands. Its implementation relies on a host of tools (economic, technical, institutional and the mobilization of stakeholders) that it is advisable to adapt to each situation. The Water Demand Management policies, therefore, aim to intensify water use, optimize water usage, provide more products and services, greater value and ultimately more sustainable development for each unit of water received (rains), extracted (pumping) or produced from salt or brackish water (desalination). The recycling of treated wastewater is on the border between supply and demand. Water Demand Management implies accepting the specific costs in equipment or actions.*

Indeed, such a definition does not look very "snappy" but it does show how complicated water demand management is, particularly in the Mediterranean region.

This paper, however, does not intend to explore the theory of water demand management but to look carefully at its dominant implementation tool (economic tool) and try to find in theory some elements to determine under which conditions this tool can lead to the expected outcome taking into account the history of management and local conditions in Syria. The article is structured as follows. The following section presents water supplies against use and the pressure on water resources for agriculture in Syria. Section 3 sketches the experience of water pricing in Syria. Section 4 discusses the different possible ways to manage water demand in Syria, evolving two management options: taxation as a centralized option and water markets as a decentralized one as well as the collective option as an alternative, and argues their appropriateness for the agriculture sector of Syria. Finally we summarize and present our conclusions on the adequate choices.

2. Pressure on water resources for agriculture in Syria

In Syria, the total estimated water use volume is about $15 \times 10^9\,m^3$. The Euphrates and Orontes basins account for about 50% and 20% of the water use, respectively. Table 1 shows water availability and use in the various basins of Syria. As shown in this table, water balance in some basins has already been in deficit. This will be exacerbated further especially in those basins encompassing large urban areas such as Damascus and Aleppo.

Agriculture is the largest water consuming sector in Syria accounting for about 87% of water use. Domestic and industrial water use stand at about 9% and 4%, respectively. While urban water demands are rapidly increasing as a result of strong population growth rate (about 3% per annum) and industrial growth, new water sources are becoming scarce and extremely expensive to develop. Water deficits are expected to worsen placing additional stress on all uses. Since drinking water needs are given top priority in the government's policy, water availability for agricultural use could face severe constraints.

Pressure on the country's water resources comes from all sectors of the economy with highest demand from the agricultural sector. In 2000, the cultivated land area in Syria was estimated at 5.5 million hectares, which accounted for about 30% of the total area. 20% of the cultivated land area (1.2 million hectares) was irrigated. The Euphrates and the Orontes basins account for the major share (Figure 1). The total irrigated area increased from 650,000 ha in 1985 to 1.3 million ha in 2002 (Somi *et al.*, 2001,

Table 1. Water availability and use.

Basin	Irrigation ($m^3 \times 10^6$)	Domestic ($m^3 \times 10^6$)	Industrial ($m^3 \times 10^6$)	Total use ($m^3 \times 10^6$)	Renewable water resources ($m^3 \times 10^6$)	Deficit ($m^3 \times 10^6$)
Yarmouk	360	70	10	440	500	60
Aleppo	780	280	90	1,150	500	−650
Orontes	2,230	320	270	2,730	3,900	1,170
Barada/Awaj	920	390	40	1,350	900	−450
Coastal	960	120	40	1,120	3,000	1,180
Steppe	340	40	10	390	700	310
Euphrates	7,160	250	110	7,520	N.A.	N.A.
Total	12,750	1,390	570	14,700	–	–
% Share	87	9	4	100	–	–

Source: adapted from World Bank (2001).

2002). This rapid expansion of irrigated agriculture is mainly attributed to the government policy objective of achieving food self-sufficiency and the remarkable increase in groundwater irrigation.

Cereal and cotton production has been encouraged by the government at a policy level as a mechanism for ensuring the country's self-sufficiency. The notion of self-sufficiency has been recently redefined into a more flexible concept oriented to increase production of certain crops that profit from comparative advantage; thus exports of these products can counterbalance the need to import other commodities (Sarris, 2001). The production of selective crops, especially wheat and cotton, has shown marked improvement when comparing consumption. The ratio of production/consumption for wheat has increased from 0.51 in 1989 to 1.41 in 1997 while, for cotton, it increased from 1.56 to 1.74 during the same period (World Bank, 2001). The high level of self-sufficiency and the increase in the production of selective crops appear, however, to have come at the expense of unsustainable water use patterns.

Groundwater use, particularly for irrigation, has increased dramatically over the last two decades (Table 2). 60% of the irrigated area in Syria is currently irrigated by groundwater. Most sources are privately developed and operated.

A substantial portion of the increase in groundwater use is related to increases in irrigation for wheat, cotton, citrus and sugar beet. Area increases have been substantial in the last decade in sugar beet (32%), cotton (75%), irrigated wheat (40%) and citrus (40%). Much of the expansion in wheat has been driven by rapid expansions of its price while water cost has remained low. Farmers from public irrigation

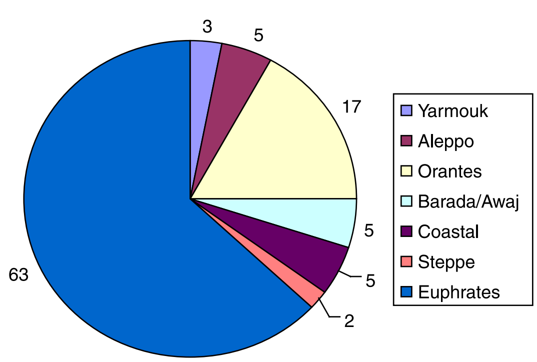

Fig. 1. Irrigated area distribution by basin (%). *Source*: adapted from World Bank (2001).

schemes obtain water at a highly subsidized rate, and groundwater costs do not reflect their real value because the energy required for pumping is also subsidized (Rodriguez *et al.*, 1999).

Government policies have contributed to the tremendous increase in groundwater irrigation. Wheat supported prices which have been higher than the world prices for several years, coupled with subsidized energy costs have proved to be strong incentives for farmers to take up groundwater irrigation in many areas.

This great expansion of groundwater-irrigated agriculture has, however, resulted in groundwater being overexploited in most basins of the country. Continuous decline in groundwater tables has been identified, affecting some surface sources such as spring flows and causing seawater intrusion in land areas adjacent to the sea.

Traditionally, surface water has been developed widely in most basins and a large share of the surface water is supplied by dams. Though there still remains some potential for further development of dams and augmentation of storage volume, the cost for such exploitation is considered extremely high.

With the exception of the Euphrates, most of the distribution system for the irrigation schemes has a low conveyance efficiency that does not exceed 40–50%. Even with the concrete lined canals of the irrigation schemes in the Euphrates basin, the conveyance efficiency still does not exceed 60–70% because of evaporation and poor maintenance (Salman *et al.*, 1999). In order to improve the conveyance efficiency and to provide more reliable water supply to the fields, the Ministry of Irrigation has planned to convert the old, open surface distribution system into a pipeline system and rehabilitate new, lined canal systems.

The surface gravity system is the prevailing irrigation system at field level covering about 95% of the irrigated area in Syria. Basin irrigation is the predominant method used for wheat and barley. On-farm water use efficiency is in general low (40–60%) owing to over-irrigation by the traditional basin irrigation method. Even with cotton and vegetables, which are irrigated by furrows, the efficiency is still low owing to the lack or inadequacy of land levelling. Thus, there seems to be considerable scope to increase the efficiency of water use at field level by introducing advanced on-farm irrigation techniques such as drip and sprinkler irrigation or by improving on-farm water management and water conservation.

Moreover, urban water demand has rapidly increased in the country during the last decade as a result of strong population growth (around 3%) and industrial growth. The primary objective of the national water policy has always been the provision of safe drinking water. 95% of the population in urban areas and 80% of the population in rural areas have access to safe, potable water. Urban and rural water supply and sanitation facilities have been enlarged and upgraded regularly to accommodate the expanding population. However, the water balance in most basins has been in deficit. This will be exacerbated in those basins encompassing large urban cities such as Aleppo and Damascus, putting more pressure on water use for agriculture. The Barada/Awaj basin, where Damascus is located, has no significant water sources, neither surface nor groundwater, other than the Barada and Figeh Springs which supply

Table 2. Irrigated area by source of irrigation.

Year	Surface irrigated (1,000 ha)	Groundwater irrigated (1,000 ha)	Total irrigated area (1,000 ha)
1985	334 (51%)	318 (49%)	652
1990	351 (51%)	342 (49%)	693
1995	388 (36%)	694 (64%)	1,082
2000	512 (42%)	698 (58%)	1,210
2002	583 (43%)	764 (57%)	1,347

Source: adapted from Somi *et al.* (2002).

drinking water to the inhabitants of Damascus. As most of the water resources of the basin are being dedicated continuously to support Damascus's increasing demand for drinking water, internal conflict over water has risen. Farmers in the Damascus countryside, who have been using groundwater for irrigating their lands for years, have protested about the drying up of their wells caused by the massive groundwater extraction.

3. Water pricing in Syria

Water pricing is viewed as an economic instrument to improve water allocation. Water has two sets of prices: the supply cost and the economic cost. The supply cost may cover the costs arising from the operation and maintenance of water utilities to which one can add investment cost, interest and depreciation on borrowed capital to obtain the full supply cost. The economic cost may include the opportunity cost relating to the fact that water should be allocated to its highest value uses in order to maximize social welfare, adding to that the resource cost arising if water is economically scarce. In addition to supply and economic considerations one can integrate the fact that a certain use of water may impose costs on other users (social costs) and the fact that environmental damage costs arise if water is used (environmental damage costs), in order to present the full cost pricing. Almost nowhere do farmers pay anything near the supply cost of water, let alone its economic cost (Roth, 2001; Bazza & Ahmad, 2002).

Because water in general and irrigation water in particular often require initially large capital investments in infrastructure development, governments are often required to allocate water resources using various mechanisms, some more efficient and some easier to implement than others (Dinar, 1998). Decision makers generally involve water pricing of one sort or another. Yet, and against any rational expectation, irrigation water prices in most of the countries of the Middle East are low and reflect neither the scarcity of the resources nor the important investments required in the mobilization of water. In fact, since the 1960s and 1970s, economic and urban development has compelled public authorities to promote irrigated agriculture as the unique way to satisfy the food needs of explosively increasing populations. This policy considered essentially providing water at low prices, largely less than mobilization costs and with increasing subsidies.

This situation has become unsustainable. First, water demand at such low prices is increasing so rapidly that it will soon be hard to satisfy with only mobilized resources. Second, easily mobilizable resources have already been exploited and the development of new resources would be possible only at high costs. The threat of such a situation, however, has pushed governments to realize the necessity of shifting their policy to demand management as the key instrument to improve agricultural water utilization and conserve precious resources.

In Syria, beneficiaries from public irrigation systems are subject to service charges which intend to recover some of the investment made as well as the cost of operation and maintenance of public networks. This makes Syria one of the few countries in the developing world where an attempt to collect capital costs is being made. The capital cost of construction of irrigation and drainage projects and rehabilitation is recovered by the government from farmers taking into consideration the development cost for an amortization period of 30 years with no interest charged nor corrected by inflation. The amounts paid range from the equivalent of US$40 to 120 per hectare. The capital costs are calculated as average costs in each basin, and the users cannot sell part or all of the reclaimed land before all the 30-year payments are made.

Table 3 provides the cost of irrigation development in selected basins. The capital cost payments are funnelled into the National Debt Fund which is autonomous within the Ministry of Finance.

Like in many other developing countries, operation and maintenance costs of irrigation and drainage systems in Syria is charged as a flat rate per unit area. The charge is based on average rather than marginal costs of supply and does not include provisioning for depreciation. According to the Ministry of Irrigation, Syrian farmers pay about 80% of the operation and maintenance costs. As of December 1999, farmers have been charged for the operation and maintenance costs the equivalent of US$75 per hectare while the estimated average total regular operation and maintenance costs of the delivery of water up to farm gates, excluding dams, are estimated at about US$90 per hectare. The fee is only for irrigated areas and is outlawed when no irrigation water is available.

The operation and maintenance charge is regarded as a property tax since the amount to be paid is notified by the Ministry of Finance to each governorate based on the irrigated area for each landhold and is paid at the local branch offices of the Central Bank. No penalties are imposed if the user fails on a payment. Surcharges are applied on late fees in accordance with the laws governing late payments of taxes in the country. However, fee collection rates have exceeded projections in the last few years as shown in Table 4. This may be due to errors in the preparation of lists of users at the governorate level because the Ministry of Irrigation has under-estimated the number of farmers, compounded by inefficiencies in the billing and collection processes (World Bank, 2001).

According to the Ministry of Irrigation, the operation and maintenance budget in 2000 was US$31.12 million, about 9% of the total budget of the Ministry. However, there is no linkage between the collected operation and maintenance fees and the actual budget for the operation and maintenance activities. Farmers, therefore, do not perceive that the charges they are paying are associated with the actual operation and maintenance activities.

It has been reported that about 60% of the irrigated area in Syria gets water from wells, most of which are privately developed and operated (Somi *et al.*, 2001; Bazza & Ahmad, 2002; Salman & Mualla, 2003). Where water is pumped from wells, farmers bear all the cost. Operation and maintenance costs are the entire responsibility of farmers. They amount to the equivalent of more than US$110 per hectare.

4. Mechanisms to manage water demand in Syria

The primary objective of this paper is to think of different possible ways to manage water demand in the agricultural sector of Syria. While water demand management refers to improving both productive and allocative efficiency of water use, this paper will focus on two allocative measures: (1) taxation of groundwater as a centralized option, and (2) water markets as a decentralized one. The paper also looks

Table 3. Cost of irrigation development in selected basins.

Basin	Cost (US$/ha)
Tigris and Al-Khabour basin (Al-Hasakeh)	2,740
Euphrates basin (Maskeneh Gharb)	3,560
Euphrates basin (Beer Al-Hashem)	1,230
Yarmouk basin	1,210
Coastal basin	1,092

Source: FAO-MAAR (2001).

Table 4. Operation and maintenance fees for 1996–2000.

Year	O&M projected fees (million US$)	O&M fees actually collected (million US$)	Collection as % of projections
1996	1.2	2.72	227
1997	1.8	2.98	166
1998	2.4	3.58	149
1999	2.4	2.90	121
2000	3.0	3.50	117

Source: World Bank (2001).

at other alternatives such as cooperative action and lifting subsidies and argues their possible association to the main management options that may help in reducing the difficulties of implementation. What follows briefly discusses all alternatives as a starting point for their feasible implementation in the Syrian agricultural sector.

4.1. Taxation

As with other common resources, groundwater is often overexploited. Without regulation, it may run to a level of depletion that could be a source of serious economic, social and environmental consequences.

Considering the case of Syria, groundwater is probably the most prominent water management challenge of the country. Private groundwater wells represent an “on demand” source for irrigation that provides a more reliable supply of water to farmers in contrast to the government irrigation schemes which provide either too much or too little water when farmers need it. However, water balance analyses made by the Ministry of Irrigation indicate that groundwater resources in all basins except the coastal and steppe basins are fully, and in some cases over, developed. Mining of non-renewable groundwater is particularly evident in the Barada/Awaj, Orontes and Khabour basins. This has a major impact on the sustainability of groundwater irrigated agriculture and on some of the surface sources such as spring flows in critical basins. Farmers in the Damascus countryside who have been using groundwater for irrigating their lands for years, have protested about the drying up of their wells caused by the severe groundwater extraction in the basin (Mualla & Salman, 2002). It is also reported that groundwater extraction near Ras-al-Ain, where the headwaters of the Khabour river are located, has caused the spring flows to decline severely.

At present, governmental responses to groundwater depletion appear to be limited. Generally, they emphasize the supply-side approach along with limited regulatory roles focused on licensing and metered supply. The Ministry of Irrigation has banned the drilling of new wells in all basins except in the coastal basin. According to recent governmental regulations, all drilling rigs must be placed under a specific depositary controlled by the government. Drilling contractors are required to get permits for moving the rigs for any new job. All existing wells in the country are to be equipped with discharge meters and a maximum extraction level will be specified for each well. The Ministry of Irrigation is also in the process of regularizing all illegal wells. Farmers and other citizens must register with the proper authorities any illegal well within their properties, and apply for a licence. A committee is set up in each basin to study each application and decide whether to grant the licence or to close the well. In case a license is granted, a discharge meter is installed and a maximum extraction is specified depending on well location, irrigated land area and other factors (Table 5).

First, the preceding actions are usually a response to an emergency situation and do not represent a long-term plan to resolve the problem. When these actions are taken, it is generally "too late". Second, though the Ministry of Irrigation is proposing various regulatory activities to control drilling and using wells, it has little or no authority nor a clear mechanism for enforcement from the management perspective. Poor enforcement has resulted in a large increase in the number of illegal wells in recent years (almost 50% of the total number of wells), which has contributed to the groundwater table decline in many areas. The Ministry of Irrigation has presented to parliament a comprehensive water law that supersedes and replaces the existing fragmented nature water laws and matches the development of irrigation and land reclamation projects. The new law confirms established rights on public water but gives the government the authority to nullify them in return for adequate compensation. It specifies that a licence must be obtained for digging wells or installing pumping equipment. Each licence specifies the extent of water use. The law requires a meter to be installed to monitor extraction level. The Minister of Irrigation has the right to nullify any licence if allowed extraction levels are exceeded. Licences for wells are renewed every year, while licences for the installation of pumps are valid for ten years. A fee is prescribed for issuing or renewing every licence while irrigation tariffs are based on irrigated land area not on metered water consumption. However, it may be noted that the new law establishes a high degree of centralization in regulating and managing water resources as well as enforcement actions, i.e. allocating management decisions to higher levels. The new legislation contains no indication of how it would be implemented nor does it specify who would have responsibility for enforcement.

Without stopping these actions, it is wiser to plan the exploitation of groundwater for the long term. Taxation is one way in which to do so. Taxes are frequently suggested in economic literature to avoid resources degradation and regulate the extraction of groundwater. Looking at the case of Syria, it is

Table 5. Regulated wells since August 2000.

Governorate	Number of regulated wells
Damascus countryside	2,367
Al-Sweida	354
Qonaitra	83
Daraa	830
Homs	1,193
Hama	1,596
Al-Ghab	206
Idlib	1,337
Aleppo	4,577
Tartous	300
Latakia	30
Al-Raqa	551
Al-Hassaka	2,680
Deir Al-Zour	321
Total	16,425

Source: Ministry of Agriculture.

apparent that, even with the bill for the new water law drafted by the Ministry of Irrigation, taxation as an option to limit groundwater exploitation has not been taken into consideration. Evidence has shown that energy pricing can have a significant impact on the farmers' pumping behaviours. The increases in the price of electric energy and diesel fuel in the early 1990s affected many farmers in the country and forced them to reduce their total volume of groundwater pumping. The implementation of groundwater tariffs would have the same impact.

Enthusiasm must not hide the difficulties in implementation of such an option that, in the case of Syria, can be greatly affected by two main factors: the appropriate taxation rate that reflects the true value of the groundwater, and the enforcement mechanisms required to regulate exploitation. First, the question is how to design an adequate taxation rate. The question is theoretical and practical at the same time. A number of criteria need to be considered according to which the planners fix the permitted level of extraction and set the taxation rate to be applied. These criteria may include: the observed level of water table, the safety level of water table below which serious irreversible problems of depletion may appear, the environmentally desirable level and the expected natural recharge. The planners, when calculating the level of extraction and the taxation rate, must not forget the social factor that represents the well-being of all agents. Second, the implementation of meters and monitoring on wells are in reality unavoidable with taxation. The problem necessitates centralized interventions implying high cost and strong enforcement. As with the surface irrigation system, the cost can be recovered through a system of tariffs aimed at maximizing both economic and social benefits. However, ambiguity is likely to remain in relation to enforcement.

Nevertheless, implementing such taxation without any preliminary preparation will certainly result in a real conflict between the farmers and the irrigation authorities and may put a large number of persons out of the agricultural sector without any alternative source of income. The association of taxation with other management options such as the collective solution or the adjusted subsidies on energy may mediate the direct impact of implementation and efficiently manage the resource.

Collective action is suggested by several authors as an alternative to privatization or state regulation to ensure the conservation of common resources (Wade, 1987; Bardhan & Dayton-Johnson, 1996). However, a wide variety of international experiences related to groundwater exists and should be harvested before a country finalizes its own approach.

Review of the few experiences Syria has with groundwater participatory management and well consolidation could provide insights for future consideration of this approach. The existing community-based approach to groundwater management in the Nabk area near Damascus is notable. The government proposal of well consolidation as an alternative to well closures is indicative. This involves the closure of private wells and the provision of water to farmers through a much more limited number of collective wells. This reduces well interference problems and allows wells to be carefully located where resources are sufficient. In addition, it establishes clear points where control could be exerted over extraction levels and water use efficiency could be encouraged. This approach has been used in Aleppo. However, conflicts amongst farmers for the use of water have arisen because of the lack of proper social assessment, showing the complexity of implementing such an approach and the need for a clear institutional and regulatory framework. Overall, Syria may benefit from a careful review of the international experience on group operation of community wells with regard to the institutional designs for the management aspects. It is also important for Syria to recognize that one single option may not be the optimal solution while a joint option such as the association of taxation with community-based operation may be the best practice. However, an institutional framework to regulate such an approach is of utmost importance.

Finally, another association may also be a good option to reduce the drawbacks and the difficulties of implementation. This is to apply adjusted subsidies on electric energy and diesel fuel that are commonly used to operate groundwater extraction in Syria in association with a groundwater tariffing system taking into account the well-being of all users. Care must be given to both financial attributes to avoid any possible backlash.

4.2. Water markets

In its most basic definition, a water market is an arrangement in which holders of water rights trade them between each other or to outside parties (Kemper, 2001). Users sell their water rights based on their historical uses at the historical price and an exchange is allowed leading to a water price better reflecting water scarcity. Since the pioneering work of Gardner & Fullerton (1968), Hartman & Seastone (1970), it has long been recognized that markets provide a means to allocate water according to its opportunity cost, resulting in efficiency gains. Indeed, water markets, making users realize the real value of water, are expected to result in positive consequences in terms of water conservation: (1) immediately, users are incited to reduce waste and leakage to save a precious resource that they may sell at a higher price; (2) in the short term, the possibility of selling their use rights incites the least efficient farmers to transfer the resource to the most efficient ones; and (3) in the long term, farmers will improve their productivities through adequate investments in water saving irrigation techniques (Lahmandi-Ayed & Matoussi, 2000).

Several water market experiences have come to light in several regions around the world. However, the conclusions from these experiences are contradictory. Chile is amongst the few countries that have created a formal water market. According to the World Bank conclusions, the experience was successful and positive consequences were achieved: (1) The irrigation sector has experienced an important boom without recourse to new costly investment in mobilization infrastructure; (2) farmers are generally satisfied with their traditional water rights; and (3) farmers sell in general part of their use rights which allows them to invest in new irrigation techniques that better conserve the resource (Hearne & Easter, 1995). According to another study by Bauer (1997), however, there has been almost no private investment in irrigation technology for the purpose of selling rights to the water saved and transfers of water rights are uncommon in most of Chile. The claim for the success of water markets in Chile rests on political or theoretical beliefs rather than empirical support (Bauer, 1997). This critical position towards the success of water markets in Chile as well as the negative results in other regions have partially reflected the scepticism towards water markets in general. Nevertheless, there is a general consensus for which theoretical results are consistent with empirical observations that water markets will be active when water is scarce and heterogeneity between farmers is large (Bauer, 1997; Lahmandi-Ayed & Matoussi, 2000; Montginoul & Strosser, 2000).

As is the case with water markets, adequate centralized pricing can ensure better allocation of water amongst uses and generates economic efficiency. However, the implementation of such pricing encounters at least three major problems. First, the implementation of meters is unavoidable necessitating centralized intervention and high costs. Second, the design of adequate pricing requires accurate information on demand that only users hold and may not be easy to disclose spontaneously.

Third, readjusting prices when necessary may imply substantial increases that may conflict with the willingness of users and may create some backlashes. Though with water markets there will still be a high transaction cost for implementation, the other two problems associated with the centralized pricing option would be avoided.

It is generally recognized in the agricultural sector that managers do continue to prefer water pricing and water conservation techniques in spite of all the advantages that water markets can offer. This can be mainly attributed to their fear of losing control of the situation. Indeed, centralized management policies such as pricing foster the power of the sector managers while the promotion of water markets or other decentralized policies entails a substantial disengagement of the state and the weakening of the power and the privileges of its managers.

In Syria, mention of water markets is rather rare and as such does not appear in any official statement. Water is defined by Syrian law as a "public good" that is not treated according to market forces. Even with the new water law, the process of water rights is based on land not on water. The new law confirms established rights on public water but gives the government the authority to nullify them with compensation if required. The compensation must exceed the difference between the value of land before and after development.

An informal water market has been operating in Syria. Farmers who have excess water sell it to their neighbours at a rate of US\$0.12 m^{-3} (Bazza & Ahmad, 2002). However, the fact that a water market is not common in Syria does not necessarily mean that it is not feasible or will never be so. The necessary infrastructure such as the distribution network and quotas is already in place. Water scarcity and heterogeneity amongst farmers do exist in most basins in accordance with theory and empirical evidence on the appropriate environment for an active water market. Lastly, an evolution of mentalities towards an acceptance of the idea of a water market has been observed in the agricultural sector of Syria. However, careful preparation for implementing such a mechanism must be done since effects are not predictable. Legal and institutional frameworks to ensure the success of implementation as well as enforcement are inevitable. Further investigations and assessment studies on a piloting basis must be conducted before making a decision on the implementation of such a policy.

In contrast with the development of water markets as an alternative policy to manage water demand in the agricultural sector in Syria, we propose here what we call an "optimal centralized policy", which relies on the integrated reform of the country's current policy and includes the following major components:

- Design and implement a water pricing mechanism that represents an "adequate" cost recovery system taking into account the full cost and the local socio-economic factors by applying a differentiated approach, i.e. varying water prices according to region. Indeed, it may be difficult to assess the full cost of investment since, in many cases, it has been made a long time ago or its facilities may be shared with other stakeholders, e.g. drinking water. Comparative assessment with new developed projects can be helpful for estimating adequate cost recovery.
- Use market-like instruments such as volumetric prices or quotas instead of the fixed charges on a flat-rate basis to create incentives for water saving. Using such instruments requires the installation of a metering system, which may be difficult to achieve at farm level but can be substituted by one covering a command area, charges can then be distributed amongst farmers based on cropland and intensity of cultivation.
- Re-assign the agricultural commodity prices, in particular the current subsidized crops (wheat, cotton, sugarbeet), to the world market level and encourage the growth of diversified high value and/or less water

intensive crops as a primary avenue for increasing water availability. For a transition period and to counter the reluctance of farmers to adopt water saving and high value crops, selective subsidy allowing public support for both high value crop products and water saving technologies can be adapted.

Indeed, such an optimal centralized policy can only be effective if it is embedded into an integrated set of measures that create the synergy necessary to achieve the anticipated objectives (technical, institutional, legal, economic and social).

5. Summary and conclusions

The choice of an adequate option to manage water demand in the agricultural sector is highly dependent on the type of water source: whether it is ground or surface water. It also depends on the history of management as well as the local conditions: social, economic and political. Taxation, perhaps associated with other management alternatives, may be well adapted for the management of groundwater. In the case of Syria where groundwater is probably the most prominent water management challenge of the country with significant levels of depletion and possible future unsustainability, taxation may be the wiser way to plan the exploitation of this resource for the long term. However, this option, standing alone, may experience implementation problems starting with imposing a high rate of taxation that may conflict with the well-being of users, and ending with the clear need for enforcement. The contribution of taxation in conjunction with other options, such as a community-based approach to groundwater management, or the adjusted subsidies on electric energy and diesel fuel that are commonly used to operate groundwater pumps, may be more effective.

Water markets tend to be more suitable for surface water when physical transfers are possible. However, one must not expect large-scale results from this option, at least in the short term. Preparation before implementing such an option is certainly needed. This involves the necessary infrastructure, such as the distribution network and quotas, and changing the reluctance of users towards acceptance of water markets and fighting against cultural reluctance (ethical influences). The first preparatory action may involve high costs and in some cases may not be justified compared with expected outcomes, while the result of the second is not predictable. The appropriate “environment” for active water markets that combines both water scarcity and heterogeneity amongst farmers is a prerequisite for successful results. In the case of Syria, the notion has not yet been addressed officially though informal practices are recognized leaving a place for possible application, in particular in critical basins that are ripe for this option. As an alternative to water markets, optimal centralized policy is proposed to manage surface water demand. However, this policy can only be effective if it is embedded into an integrated set of measures that create the synergy necessary to achieve the anticipated objectives (technical, institutional, legal, economic and social). It also requires reform on all fronts.

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