Chapter 9
The Water Sector in MENA Region: The Way Forward

Slim Zekri

Abstract This chapter summarizes the most important water policies implemented in the seven countries considered in the book. It also assesses the progress made by each of the countries on the reforms judged fundamental to avoid water crises and social unrests and ensure water security for a sustainable development. The chapter concludes with a comparison of reforms undertaken worldwide and suggests some urgent measures that would speed up balancing supply and demand. Essentially demand management and cost recovery are judged urgent to undertake and feasible by learning from the successful energy price reforms undertaken in Iran and Oman for instance.

Keywords Water policies · Reallocation of water resources · Treated wastewater reuse · Cost recovery

9.1 Introduction

Traditionally, citizens of Middle East and North Africa (MENA) countries were wise users of water as witnessed by the historical water infrastructure and the way water was managed at homes and in public places in these arid countries (Salleh and Taher 2012). In the southern part of Tunisia, for instance, rainwater harvesting for drinking purposes was and still a must in most houses. Separation of grey water from bath rooms for garden irrigation was a common practice. The use of slightly saline water from wells for other uses than drinking was the rule as well as the use of dry latrines. People were paying the full cost of water and several charity institutions were in place to provide water for low-income families. With urbanization, centralized governments spread their water services to the communities and most of the aforementioned practices vanished, although an important part of the cost of

S. Zekri (✉)
CAMS, Department of Natural Resource Economics, Sultan Qaboos University, Al-Khod, Sultanate of Oman
e-mail: slim@squ.edu.om

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water services was and is still paid by public authorities, that is, sending distorted signals about water scarcity.

Generally speaking, MENA countries have not been able to accompany the social and economic changes with the required institutional and technical innovations in the water sector to cope with the water scarcity during the last 100 years. They contended themselves with the adoption of solutions designed to Western water-rich countries. It took long to properly realize the severe water scarcity in MENA countries and to start the journey for water policy reforms. Seminal works on MENA water issues date back to the 1990s. Gleick et al. (1994) addressed MENA water scarcity and potential wars on water as well as the potential solutions to avoid conflicts such as agreement on transboundary water, allocation of surface and groundwater rights, transfer of water from the agricultural sector to the urban sector, improving water use efficiency, desalinated water, water banks, and water markets, as well as the consideration of climate change effects. Brooks et al. (1997) summarized the way demand management can be undertaken as an essential and effective policy tool for Africa and the Middle East. They stressed on the following tools: institutions and laws, market-based measures, non-market-based measures, and direct intervention. The authors stressed that the conditions in the north are different to the point that MENA and African countries should rely on their own research to develop appropriate options. The Northern countries have utilized their capital assets and energy to overcome deplorably bad water management. Brooks et al. (1997) argued that solutions to water scarcity and conflicts should be looked from outside the water sector and wars over water are a myth. The authors introduced the concept of virtual water and international trade of agricultural products as a solution for water-short countries. Mubarak (1998) explicitly recommended that the agricultural and its role must shrink to avoid overuse and depletion of the water resources. The first World Bank (2007) report on water perfectly defined the problem and solutions to the region's water scarcity and brought the discussion to the political arena. The World Bank (2017) report is an update of the situation as well as the options available to decision makers. All recent and previous publications agree on the diagnostic and severity of the water situation in MENA and the need for reforms. In this chapter, a quick summary of the reforms that have been undertaken in the seven countries is presented with some recommendations for future reforms. Public decision makers and stakeholders of the water sector are called to perceive the overall picture of the water sector and to consider investments in the security and governance of water as investments in peace and security. There is an urgent need to consider a better allocation of the scarce water resources through demand side management such as water rights, regulations and quotas, water pricing, water trading, and subsidy reform (Cousin et al. 2019).

9.2 Water Policies in MENA

Flagship policies of the seven countries considered in this book are summarized in this section. Algeria created a Ministry of Water Resources since year 2000 with a mandate to elaborate and implement policies and strategies in the context of water resources and environmental protection. Algeria started since 2008 coordinating with its neighbors Libya and Tunisia to sustainably manage the common groundwater resource. Algeria also has agreements with Tunisia on the management of surface water in the Medjerda basin. In the Sahara, the Foggaras (equivalent of Aflaj in Oman) represent a good example of sustainable groundwater management. Some of these Foggaras are still alive and functional in several oases. However, in general, groundwater abstraction is still not monitored, though in some parts of the country groundwater rights are in use. The urban sector is given absolute priority of water allocation among sectors. The allocation to the agricultural sector is determined yearly after subtracting the demand for the urban sector. The supply and management of water utilities are achieved through a mixture of public and private entities. Although seawater desalination has been able to address the water shortages, it resulted in a considerable increase in energy use by the water sector, which reached 4983 GWh in 2011 and is set to more than treble to reach 16,090 GWh by 2030. The predicted increase is caused mainly by seawater desalination, water transfer projects, supply of water through pipes, and wastewater treatment facilities.

In Egypt, the water sector responsibilities are divided between two ministries: the Ministry of Water Resources and Irrigation, in charge of water resources planning and management, irrigation, and agriculture drainage, and the Ministry of Housing, Utilities and Urban Communities, in charge of domestic water supply and sanitation. The irrigation water delivery costs are indirectly recovered through agriculture land taxes. The costs of investments on irrigation improvement and drainage are recovered from the farmers in the form of installments. A large number of water user associations (WUAs) exist in Egypt and a new law aims to devolve more roles to the WUAs such as recovering the costs of irrigation, investment projects, and operation and maintenance of central pumps. Domestic water has the highest priority over other sectors in Egypt's water policies. In case of shortages, the domestic water demand takes priority in satisfying demand over other sectors. In 2018, urban water prices have been increased. Four block prices are used for domestic uses, while another four different prices are used for the different economic sectors. Wastewater treatment costs vary from 75% to 98% of the fresh water price. Private sector is being involved in wastewater treatment projects that treat and supply treated wastewater for reuse in the cities. Egypt depends almost totally on the surface water from the Nile River, whose basin is shared by 11 countries. Yet there is no formal agreement among all these countries on the water shares. However, a declaration of principles was signed in 2015 by Ethiopia, Sudan, and Egypt, agreeing on the rules of the first filling and the operation of the Grand Ethiopian Renaissance Dam.

In Iran, the water sector is under the responsibility of the Ministry of Energy (MoE) and the Ministry of Agriculture (MoJA). Both surface and groundwater uses are subject to water permit, which is issued for a specific use and nontransferable. Water is considered a national wealth, but groundwater is regarded as private property and thus some trade between farmers is allowed. The traditional Qanat (equivalent to Foggara and Falaj) system is also based on ownership of groundwater rights. Urban water prices are set at very low level that does not allow cost recovery for political reasons. Nonetheless, the government has put in place a national task force to address the problem of adaptation to water scarcity with demand management given the highest priority. The task force also extends to provinces where decisions on allocations, arrangements, and agreements between different sectors are reached on the basis of operational temporal and spatial demand. Mechanisms for settling water disputes are established at two different levels and are based on arbitration. Drought preparedness strategies for emergency situations are in place with established "Agricultural Product Insurance Fund," and extended loan reimbursement deadlines provision and aid measures such as the provision of agricultural inputs, small and medium funds, food subsidy, and forages in cases of drought/flood emergencies. The country has also finished comprehensive assessment work of global warming impact on the hydrology and water resources. One major policy to adapt to climate change consists of building desalination plants in the coastal cities in partnership with the private sector. Iran has treaties and agreements with most of its neighbors on the several Transboundary Rivers and shared wetlands. However, agreements on shared aquifers are lacking.

In Jordan, three organizations share the water responsibility. The Ministry of Water and Irrigation (MWI) is responsible for the policy making and sector planning. The Water Authority of Jordan (WAJ) is responsible for the infrastructure development and service delivery of both fresh and wastewater, and the Jordan Valley Authority (JVA) is in charge of the irrigation water in the Jordan Valley. Jordan has put in place an advanced groundwater policy. Groundwater is monitored and metered. Smart-card controlled abstraction and quotas are being introduced progressively in the wells. Farmers pumping more than 75,000 m^3/year pay a fee. Priority allocation of groundwater is given to high value uses, while supporting the sustainability of existing agricultural plantations. Expropriation of use rights arising is possible against fair compensation. Allocation of groundwater for irrigation is recommended from aquifers where water quality does not qualify for use in municipal and industrial purposes, and contingency plans shall be made for the purpose of allocating the water from privately operated wells for use in the municipal networks. Water user associations (WUAs) establishment started in 2001 with a diversity of legal status. However, most WUAs are legally under the cooperatives law and recognized by JVA. Treated wastewater is heavily used in agriculture and desalination of brackish water for irrigation is starting with 1.5% of total irrigation water being desalinated brackish water. Urban water services are intermittent and households depend on top roof reservoirs. Both fresh water and wastewater utility services are based on increasing three block tariffs. Users also pay an added value tax that is increasing according to the block tariff and it reaches \$0.42 /m^3 for the upper block of above 100 m^3 per month. The total price of water services for the highest

block tariff is quite high, for an intermittent service, with \$6.12 per m^3. The lowest price is \$1.56 per m^3 for demand below 15 m^3/month. Assuming an average family of 5, this is the equivalent to 100 liters/cap/day at a low price that does not cover the cost of service. Cross subsidization is inherent in the block design. Jordan has bilateral water agreements with its neighbors to manage shared surface water resources in the Jordan basin.

In Oman, the responsibility for water legislation falls mainly in the hands of the Ministry of Regional Municipalities and Water Resources. However, since the most important part of urban water is from desalination plants, the Public Authority for Electricity and Water (recently renamed to Diam) and Oman Power and Water Procurement Company play a major role on policies related to this sector. The Ministry of Agriculture and Fisheries deals with policies related to the use of the water for irrigation. Finally, the water semipublic company Haya is the player when it comes to wastewater treatment and reuse. Most renewable water is in the form of groundwater. Water is declared a national wealth with the exception of the traditional Aflaj systems where water is still a private property that is exchanged in formal markets among farmers. Since year 2000, regulations have been issued to meter and monitor groundwater. Technical difficulties of metering have delayed the implementation of this crucial law and the trend today is to use smart metering technology for this purpose. Urban water prices are heavily subsidized despite the block tariff structure. Ninety percent of the supply depends on seawater desalination with a heavy reliance on fossil fuel for this purpose. Reuse of wastewater is almost confined to urban landscaping. Treated wastewater is owned by Haya Company and its high price prevents its use in the agricultural sector, given the open free access to groundwater. The impacts of climate change on the water sector are assessed with absence of action plans on adaptation and mitigation.

The Ministry of Environment, Water and Agriculture is responsible for policy and regulation in Saudi Arabia. The agricultural sector remains the principal consumer of water resources in the Kingdom. In the 1980s, the Kingdom started its very ambitious agricultural program to realize self-sufficiency to meet its food requirements. The goals were successfully achieved and the Kingdom witnessed self-sufficiency in many food commodities. Since 2008, the Kingdom decided to phase out the wheat production subsidy program, which was started in the 1980s, which allowed the Kingdom to become the sixth largest wheat exporter at the expense of its water resources. Meanwhile wheat was replaced by Alfalfa, which consumes three times more water than wheat. In 2015, the Saudi government decided to stop the cultivation of green feed within 3 years. Farmers would not be allowed to grow fodder after 2019 and are encouraged to produce less demanding water high value crops. The Ministry of Environment, Water and Agriculture is planning to impose metering on individual wells and to allocate water shares for users. Until 2015, consumers in Saudi Arabia paid only 1% of urban water service costs. In 2016, five block tariffs were introduced but prices are still on the low side and the water bill for consumption not exceeding 60 m^3/month does not exceed \$24/month for water and sanitation. This will allow covering 30–35% of the costs and plans are in place to achieve full cost recovery.

The Ministry of Agriculture Hydraulic Resources and Fisheries is the main responsible for water in Tunisia with the exception for the treatment of wastewater, which falls under the responsibility of the Ministry of the Environment. The water law was promulgated in 1975, which established the ownership of all water resources as public resources, transforming old property rights into use rights. Resource allocation is done at central level through Master Plans and absolute priority is given to urban water. Since the 1990s the government started a vast reform program aiming to devolve the responsibility of water management to water user associations. Thousands of associations were created, but their dependence on the state is heavy due to political, technical, and financial interferences. Shallow groundwater is not monitored and illegal drillings are numerous with the consequences of overabstraction and salinization. Deep aquifers, whose exploitation is reserved to the public authorities, require much heavier investments and special equipment for drilling, which are not available easily. Treated wastewater reuse is very limited, given the low quality and availability of better surface/ground quality water. Disposal of secondary treated wastewater into the sea has severely degraded the quality of the beaches surrounding the capital city Tunis. A rigorous policy of annual increase of irrigation water prices has been implemented since 1991 in order to achieve cost recovery. WUAs have been authorized to set water prices taking into account the budget balance. Financial and technical incentives to save water are in place since 1995. The country depends on imports for staple food, while exporting water-intensive crops such as dates. Domestic water is metered and billed along with wastewater with cost recovery being a major policy. Users do even pay an added value tax on the water bill. Water allocation for the environment is well established even though during drought periods the primacy is for the urban sector. Tunisia has agreements in place with its neighbors Algeria and Libya on the use of the transboundary groundwater resources while for surface water only consultation mechanisms, particularly in case of flooding, are observed. Climate change impacts are well assessed, but action plans on mitigation and adaptation are not yet clearly planned.

9.3 Reforms Within the Water Sector

Table 9.1 summarizes the main reforms within the water sector in the seven selected countries. These reforms are related to the reallocation of water from rural to urban users and from agriculture to industry, freezing of the irrigated area, permitting and monitoring of groundwater and implementation of laws, reuse of the treated wastewater for agricultural purposes, tertiary treatment of the wastewater for food safety and environmental protection, cost recovery for urban and treated wastewater, and access of the poor to drinking water.

The reallocation of water from rural to urban users and from agriculture to industry has not been undertaken explicitly in any of the seven countries. Supply augmentation has been the rule so far. No clear-cut policies or water rights for the surface

Table 9.1 Degree of adoption of reforms within the water sector

	Algeria	Egypt	Iran	Jordan	Oman	Saudi Arabia	Tunisia
1. Any reallocation of water from rural to urban users and from agriculture to industry?	No	No	No	No	No	No	No
2. Are we still seeing an increase of the irrigated area?	Yes	Yes	Yes	No	No	Yes	Yes
3. Any allocation of quotas and monitoring of groundwater?	No	No	Yes	Yes	No	No	No
4. Tertiary treatment of wastewater	Yes	No	No	No	Yes	Yes	No
5. % of reuse of treated wastewater (TWW) in agriculture and landscaping	3%	7.2%	40%	91%	68%	50%	29.6%
6. Cost recovery for TWW	No	No	No	Yes	No	No	No
7. Cost recovery for urban water	No	Yes	No	No	No	No	Yes
8. Access of the poor/marginalized population to drinking water	Yes	Low	Yes	Yes	Yes	Yes	Yes

water exist on how much water should be allocated to the urban sector in the present or the future. However, except for Oman and Saudi Arabia, the urban sector has the highest priority when decisions of allocations are needed such as during drought periods. This implies that the urban sector is satisfied at the expense of the farming sector without any compensation for the later. One of the most important recommendations for the MENA region has been to cut down the irrigated area or at least not increase it in face of the increased competition for water. Five of the seven countries have been seeing an increase in the irrigated area during the last decade, except Jordan and Oman. It looks like that MENA countries are not being able to find alternative rural development options to the expansion of irrigated agriculture. Still the easiest option is to support farmers' access to irrigation water as a mean of income improvement and stabilization of the populations in the rural areas. Even though reduction of the irrigated area seems to be an internal water sector reform, in fact rural development based on industrial activities is a necessary reform that should come from outside the water sector to offer well-paid jobs to reduce the dependency on irrigated farming. Unfortunately, rural development is totally neglected in most of the MENA countries or development options are restricted to agricultural development (Nin-Pratt et al. 2018). Anticipating water depletion in rural areas is of extreme importance in several locations, mainly when unsustainable groundwater is used. MENA countries have to have clear plans on how much water would be sustainable in many villages depending on irrigation and prepare plans for relocation of the population or changing the economic activities to less dependent activities on water.

Groundwater reforms have been introduced in Jordan and Iran. The best example in MENA is Jordan with clearly established water rights and metering. Iran has water permits in place indicating how much water can be pumped from a given well

in some areas, but no water rights. In the remaining MENA countries considered here, not only groundwater is still an open access resource, but wrong incentives such as subsidies to electricity and modern irrigation systems are causing further abstraction of the resource. Electrification of rural areas and availability of efficient submersible pumps have encouraged well owners to keep deepening their wells and abstracting more than the renewable rate of the resource. Decision makers are not interested in creating new laws and regulations to the management of the aquifers because this would entail more commitment and more work to be done administratively. Top decision makers are not willing to fund programs of property rights allocation and wells metering and monitoring due to the opposition of farmers. Furthermore, the existing technology of mechanical meters is useless and the smart online groundwater meters are still not affordable by nonoil countries (Zekri et al. 2017). Although some small communities have experiences of collective management, which is effective, there still remain the exceptions and cannot be generalized to aquifers tapped by hundreds of farmers. To be successful, groundwater policy reforms require that the online smart groundwater meters cost goes down, internet in the rural areas is generalized, and incentives to top decision makers to pass new laws and establish clear groundwater property rights are provided. The most challenging issue here is how to encourage public decision makers to undertake the reform. One option would be to fund such incentives by development aid institutions and link the payment to the achievement. Furthermore, some external support is recommended to establish pilot projects on groundwater smart metering and monitoring in MENA countries avoiding the overallocation of the resource and establishing high penalties for those who exceed their allocated quotas as main lessons from the Jordan experience.

Tertiary treatment of wastewater remains marginal in most countries except the oil-rich countries where most of the water treated goes to tertiary and even quaternary level. The environmental costs related to disposal of secondary treated wastewater are quite visible in the coastal areas where beaches have been polluted and are no longer swimmable. The question is whether MENA countries can afford investments on tertiary treatment. Most likely a direct payment for tertiary treatment is not affordable by the low- to middle-income families. The technology for tertiary treatment, in centralized plants, is still expensive for a wider adoption. Algeria has moved to tertiary treatment recently and has been able to bring back the capital city beaches to a clean level and usable for swimming and recreation. The consequent energy saving and time saving are substantial due to the opening of the capital city for swimming instead of travelling to nearby beaches for recreation. This positive externality would per se justify the partial funding of tertiary treatment by tax payers. An indirect payment, through beach front property taxes, can contribute to the funding of wastewater treatment plants and address partly the problem.

The reuse of TWW in agriculture and landscaping is progressing in MENA countries with Jordan on top of the list with 91% reuse rate. The high rate of reuse in Jordan is the result of important public investments to make the water available to farmers and the implementation of quotas for groundwater. Free access to groundwater does not encourage the reuse of treated wastewater. More public investments

in MENA are needed to develop the necessary infrastructure to convey the treated wastewater up to the farms. Currently most treatment plants are connected to the sea to dispose of the water. One would ask who will pay for such costly pipelines for water transfer from the urban to the rural areas. It is obvious that farmers will not be able to fund water conveyance infrastructure given the low prices they are receiving for their agricultural products. They have not paid for water conveyance from dams in the past too. Private investors will not fund such projects because of the low profitability and long pay-back period. If food security is an objective, public investments can be tapped, since food security is a public good. However, public funds are scarce in most MENA countries and such an option is unlikely to happen. International funding institutions and donors should consider such funding under the climate change fund since treated wastewater can be used as an adaptation measure to drought.

Cost recovery for treated wastewater is not achieved in any of the seven MENA countries considered in this book. The same applies to domestic water cost recovery with the exception of Egypt and Tunisia. Tunisia has undertaken long ago a strategy to recover the full cost of urban water and was successful in achieving this goal. The prices remained low for the low-income families and a seven-block pricing method is used. In fact, the first three blocks' prices cover less than half the current cost of water and are meant to protect the low-income families. However, all customers pay a fixed cost plus a variable cost according to the block. Furthermore, all consumers pay an added value tax of 18% on the total water bill. Although the Tunisian case has been relatively successful in achieving cost recovery, the pricing method has not been updated or changed for several decades. Part of the cross subsidy (31%) is ending up in the pockets of wealthy families, given that the block prices do not take into account the number of family members. Tunisia is also facing expensive marginal cost of raw water paid in hard currency due to the recent adoption of desalination technology in several cities in the coastal areas.

In general, public water authorities in MENA should keep up with the reforms in the potable water sector and updating and upgrading the technology used in the distribution sector and provision of better water quality to citizens. Potable water price reform and pricing method should be a priority in the reform. Water consumption in several MENA countries is unreasonably high reaching +400 m^3/cap/day. Low administered water price is the main cause of such a behavior. Recent experience of the fuel price reform shows that people adjust properly to higher prices and no social uprising is mentioned, fundamentally when the low-income consumers are protected through direct subsidies. Oman introduced a fuel reform in 2016 by lifting the subsidy and establishing fuel price based on international market prices (Boughanmi and Khan 2019). The low-income families receive a direct subsidy, covering the price difference for 200 liters of fuel per month, every time the price goes beyond Omani Rials 0.180/liter. Low-income families apply for the subsidy online and receive an electronic card to access the subsidy in the gas stations. Substantial positive impacts have been observed and sale of petrol and diesel in Oman dropped by 6.2% and 7.2%, respectively, during 2016 and 2017 compared to a constant rise in fuel demand over the past years. People tended to reduce unneces-

sary trips and prices of fuel-inefficient cars dropped by more than 20% in both the new and used markets (*Muscat Daily*, January 23, 2017). Krane (2018) argued that MENA countries have launched reforms of energy subsidies driven by a number of converging trends such as fiscal stress from low world oil prices, international environmental pressure, and an untenable growth in domestic consumption of exportable commodities. Paradoxically, Krane mentions the escalating regional instability as a positive factor conducive to reforms as well. The successful experiences in energy prices reforms can be taken as good practices to encourage subsidy reforms in the potable and wastewater sectors. Ex ante studies on best pricing methods and subsidy targeting are highly needed in all MENA countries to inform decision makers on the potential gains and the range of maneuver to squeeze demand and delay costly supply projects. Price reforms should be accompanied by advice provision to users on the available technologies that allow water saving at homes such as lower shower heads, dual flush toilets as well as technologies for grey water treatment for garden irrigation. Separation of grey water from black water should become a building code for the new buildings with gardens. Rainwater harvesting should be encouraged too, whenever possible, to reduce run-off in the cities. Water demand management should become the major component of policy changes in MENA to curb water demand. This should be accompanied by improvements in water services, essentially better water quality wherever needed to increase the acceptance of stakeholders and users. An increase of water prices accompanied with a better quality of drinking water would result in net saving for most users who depend on bottled water.

Urban water is quite more expensive than agricultural water. Thus, from an economic point of view, saving urban water is as important as saving agricultural water. The increase in water desalination capacity in the MENA region has been dramatic during the last 5 years. Relying on water purification to satisfy future urban water needs is not sustainable given the energy and environmental impacts of desalination, unless the shift to renewable energies is taken seriously. Thus, further saving urban water demand can postpone heavy investments in desalination capacity.

Several cities around the world have introduced smart water meters. One advantage of the smart meters is the reduction of nonrevenue water (see South Africa's experience) besides the detection of postmeter leakage, which can result in 5–10% of a city's water demand reduction if fixed (Britton et al. 2013). Sønderlund et al. (2016) reviewed and analyzed 21 papers on the effect of smart metering and feedback given to consumers on reduction of water consumption. Overall, they found that feedback to consumers on their water consumption does change consumption practices. Water saving depends on the type of feedback information, frequency, and granularity. The feedback was more effective when it was combined with time variable water price and depends on baseline consumption. High consumers tended to reduce consumption more than low water users. Thus, a combination of smart water meters and a revision of water pricing and pricing methods should go together to address the future potable water demand in MENA.

Generally speaking, the seven countries have facilitated access of the poor/marginalized population to drinking water. A solidarity tax on urban water users is

established in Morocco to support funding of projects aimed to improve access to potable water for rural households (Ait Kadi and Ziyad 2018). This is a good example that could be followed by other MENA countries, which would accelerate the water access of rural households. If such a tax is properly explained to urban water users, it will be easily accepted given the solidarity meaning of it. Rural water projects need not be in the form of pipes, given that houses are scattered. In many places, rainwater harvesting reservoirs are a good option. They can be equipped with small motor-pumps at house level and avoid the community management problems. Individual reservoirs of a capacity of 60 m^3 allow a water security of 50 liters/cap/day of very high quality.

9.4 Reforms Outside the Water Sector

9.4.1 Water–Food Nexus

In MENA countries, the food self-sufficiency goal has been replaced by food security goal. However, aggregated data still show that farmers are the major user of water. Despite MENA countries' reliance on heavy food imports, Jägerskog and Kim (2016) estimated that agricultural products are responsible for 92% of internal water footprint. Furthermore, most of the water used for food production in MENA is blue water (water from reservoirs and aquifers) as opposed to green water (rainwater). This is due to the total dependence on irrigation in many MENA countries and partial irrigation of some crops in other countries. Consequently, any water transfer from the agricultural sector to other sectors of the economy will have consequences on the rural communities, unless properly compensated through water markets and via allocation of treated wastewater to agricultural purposes. This is currently not the case since in most MENA countries the priority of fresh water allocation is given to the urban sector. This management practice has been the rule since during droughts the irrigation water valves are shut down without any compensation while cities' water is not affected. The option of transferring wastewater to rural areas to mitigate scarcity, however, might not be economically feasible in most countries, since the major volumes are generated in low coastal areas far from where needed for irrigation. The cost of infrastructure and pumping up hill is quite high. This is being aggravated with the further concentration of the population in the coastal areas.

Saudi Arabia and the United Arab Emirates, two of the most water-scarce countries, have been investing in farmland acquisition as a strategy to mitigate water scarcity, reduce risk from international food prices volatility, and reduce dependence on virtual water hegemons (Jägerskog and Kim 2016). Some of the acquisitions were in Egypt, an already water-stressed country, and where crop production depends totally on irrigation. Furthermore, most of the deals, which cover 4.3 million hectares, are in the Nile River Basin in countries such as Ethiopia, Sudan, and

Egypt with poor rural communities and low level of agricultural technology. This will exacerbate the competition for blue water in these countries. This has been stated by Antonelli et al. (2017), who stressed that current MENA imports depend markedly on water resources available in other countries that are not always water-secure countries. It would have been wiser to acquire land in agriculture rain-fed countries since trading green virtual water is more efficient than trading blue virtual water. While green water can be used only to support vegetation growth in agricultural and ecological systems, blue water can be used to meet other more productive uses including urban uses. Trading blue water that is embedded in low-value water-intensive irrigated crops is an inefficient use of globally scarce water resources and MENA countries can improve their water balance by importing such crops (Gilmont 2015). Last but not least, reduction of food waste in most MENA countries will reduce the food trade balance deficit and generate some financial savings to invest in the irrigation sector.

9.4.2 Water and the Media in MENA

The role of the media in informing the public and water users is fundamental for supporting policy changes. A website search proves the absence of studies in MENA countries on the role of mass media and social media to inform the users on the challenges and options available for a water secure future. Public/private televisions hardly ever talk about water problems and options. Social media is also absent and managers of water utilities seldom send messages except when interruption of service is planned. Media in MENA should be used intensively to communicate to/with the public of the required urgent reforms and the cost of status quo. Water has to become visible in the news, documentaries, and debates. More communication and accurate information should be circulated in social media if decision makers would like to find the necessary support from well-informed users. Quite often people assume that water users are not willing to accept higher bills but observed behavior shows that users do pay much higher costs to adjust individually than if collective solutions are envisaged.

9.5 Climate Change

The International Panel on Climate Change expects that water shortages will hit the MENA region the hardest. Not only rainfall will be lower but also higher evapotranspiration rates are expected leading to higher crop water requirements and lower yields. As an example, Tunisia's both irrigated and rain-fed cereals' yields would decline under different climate change scenarios between 5% and 11% till 2050 (Breisinger et al. 2013). Although the seven countries considered in this book have undertaken studies on the impact of climate change, mitigation and adaptation measures are still not well prepared. Tunisia, for instance, counts on further diffusion of

water-saving technologies to save water. That is the only measure suggested in their strategy to cope with the change. This measure has shown its ineffectiveness in the past, as water saved is used by the same farmer to further intensification or extension of the irrigated area. No saving will happen in the absence of water quotas and administration of low irrigation water prices. MENA countries will have to find workable solutions to climate change such as water banking through aquifer storage and recovery during rainy years to face prolonged droughts, and introducing better engineered water-harvesting techniques in wider areas not confined to the traditional locations (Adham et al. 2016). Extending the irrigated area will not be possible due to water demand growth and expected lower supply as a consequence of climate change.

9.6 Experiences Outside MENA

Experiences outside the MENA region showed that there are several ways to undertake policy changes. Albiac (2017) provides an excellent review of experiences from Australia, the European Union, the United States, and Israel, which is summarized below.

Australia has chosen to introduce water markets and favor the transfers from rural to urban areas with the commitment of huge public funds in the form of subsidies to farmers to improve irrigation efficiency and to buy back water for environmental purposes.

Europe concentrated on water quality rather than water quantity since scarcity is not imminent, except in the South. Surface water pollution was brought down, via command and control instruments, by heavy investments upgrading the wastewater treatment plants, industrial innovation leading to phosphates free detergents and the nitrates pollution reduction via best farming practices, and identification of vulnerable pollution zones. Cost recovery of urban water directive was instituted in 2012. Most transfers of water from rural to urban areas are through either central decisions giving priority to urban water users or informal water markets among farmers. Finally, large subsidies are allocated to farmers to improve irrigation efficiency and reduce the nutrient and salt pollution as well as the reuse of treated wastewater.

In California, the United States, water markets were initiated since the 1970s. These markets play an important role in water transfers from rural to urban areas and represent 4% of the total volume of water used in a year. Water markets growth is hindered by the regulations dealing with third party effects and environmental concerns. Substantial public spending for nonpoint pollution abatement is used but not yet achieving the desired goals.

In Israel, central monitoring using a combination of command and control with economic instruments was the approach used. The government decides on the permits for both surface and groundwater allocations with a full network of metering and generalization of treated wastewater for irrigation. Water is priced for all uses and fresh water is reallocated to industrial and urban uses while bringing treated wastewater to farms. Initially urban users cross-subsidized irrigation water prices

until 2016 when farmers started paying full financial cost of fresh water. Expansion of supply is based on desalination plants.

9.7 Conclusions

MENA countries have undertaken several efforts to improve water sector policies. The seven chapters show that the reforms vary considerably from a country to another. The major reform of proper water pricing and cost recovery is the most important policy in the water sector. Unfortunately, most countries considered in this book have not achieved this goal yet. Even the oil-rich countries, where the family's income is high enough, and are the ones who have the most severe scarcity, are still delaying water price reform. In most MENA countries, a bottle of water in a supermarket is more expensive than 1 m^3 of piped urban water. Price reform is the most important policy since it will bring down demand, delay building costly desalination plants, and reduce the pressure on wastewater treatment plants. Reuse of treated wastewater in irrigation remains a challenge in MENA countries and will require substantial public investments in conveying that water to farms. Most MENA countries depend on imports of food and will see this dependency increasing in the future due to population growth and climate change. Agricultural productivity will have to grow significantly without using more water. Workable and more realistic adaptation solution to climate change needs to be invented. Water for the environment is still the last priority, given the absolute scarcity mainly during drought periods. World experiences of water policy reforms indicate clearly the necessity of public intervention and substantial spending to overcome the costs of water scarcity. A major part of the public funds currently directed to urban water service subsidies should be reallocated to undertake the necessary reforms in the water sector in the future. The current level of international aid to the water sector in MENA needs to be revised upward. It should also be better targeted and linked to achieve some desirable changes such as passing new laws and allocating water rights to different types of users, although command and control measures followed by some countries allowed reforming the water sector. However, establishing water rights and quotas is a better instrument in water-scarce countries and several MENA countries have had such mechanisms in the past or still have some working but not updated.

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Dr. Slim Zekri is Professor and Head of the Department of Natural Resource Economics at Sultan Qaboos University (SQU) in Oman. He earned his PhD in Agricultural Economics and Quantitative Methods from the University of Cordoba, Spain. He is Associate Editor of the journal *Water Economics and Policy*. He has worked as a Consultant for a range of national and international agencies on natural resource economics, policy and governance, agriculture, and water economics in the Middle East and North Africa. He is Member of the Scientific Advisory Group of the FAO's Globally Interesting Agricultural Heritage Systems. His main research interests are water economics and environmental economics. In 2017, he was awarded the Research and Innovation Award in Water Science from the Sultan Qaboos Center for Culture and Science.