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Water issues in the Middle East challenges and opportunities

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Abstract

The Middle East is the area encompassing the Fertile Crescent,[2] the Arabian Peninsula,[3] and Egypt. Most of the countries of the region are semiarid or arid where water resources are limited, and the majority of these resources are shared among several riparian parties. The international rivers in the Region are the Tigris, the Euphrates, both shared among Turkey, Syria and Iraq; the Orontes, shared between Lebanon, Syria and Turkey; the Jordan (including the Yarmouk), shared among Lebanon, Syria, Israel, Jordan and Palestine; and the Nile with nine riparian parties on it of whom only Egypt is totally dependant on it. There are shared water bodies in the form of transboundary groundwater aquifers, some of which are renewable like the aquifers underlying the border areas between Turkey and Syria; Lebanon and Israel; Syria and Jordan; and northwest Iraq and Syria; and Israel and the West Bank of Palestine. Others are non-renewable aquifers containing fossil water such as the aquifer underlying Egypt, Libya and Chad; the aquifer underlying Jordan and Saudi Arabia; and that underlying the Arabian Peninsula. There are other fossil aquifers underlying the states of Kuwait, Saudi Arabia and Iraq; Jordan and Iraq; and Iraq and Syria. There may be some others on which data is not available.

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[2] Comprising Iraq, Syria, Lebanon, Jordan, Palestine and Israel.

[3] Comprising the Republic of Yemen and the Gulf Cooperation Council members which are: the State of Kuwait, the Kingdom of Bahrain, the State of Qatar, United Arab Emirates, the Sultanate of Oman and the Kingdom of Saudi Arabia.

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1. The population and water strain

The population size of the countries and their renewable water resources are shown in Table 1. The available water resources consist of renewable groundwater resources and surface water resources augmented by productive soil moisture. Estimates are made by the author of the water shares from international rivers to different riparian parties for the purpose of approximating the total water resources available to these parties. To these resources, soil moisture should be added (as calculated below) to account for its role in supporting agriculture (usually rain-fed farming). The rain-fed areas of each country are also shown to give an idea on the role of soil moisture in the production of food.

Water is allocated in these countries for consumptive uses in the different purposes of municipal, recreational and industrial purposes; in irrigation and fish farming for agricultural purposes; and for non-consumptive uses, mostly in power generation, and in transportation. The bulk of the consumptive water use is in irrigation. Except for the Fertile Crescent, and the southwest corner of the Arabian Peninsula, plant production in the Middle East is not possible without irrigation, a practice known by the people of the region for millennia. Irrigation in south Iraq was initiated some 6000 years ago, but was interrupted due to water-logging and soil degradation (Postel, 1999a). In the valley of the Nile, however, it has been sustained since it was first practiced some 5000 years ago (Postel, 1999b). All irrigated agriculture depended on surface water drawn primarily by gravity from the rivers of the region. Rain-fed agriculture started in the Fertile Crescent many thousand years before.

Rainfall that constitutes the source of water resources — surface, ground, and soil moisture, has been fluctuating in the region around a certain average since the beginning of the Christian Era. Until about the middle of last century, the Region had been able to sustain its population

Table 1
Total water resources availability and requirements, 1998

Country	Population (thousand)	Rain-fed area (dunum/capita m^3/capita)	Water resources			Per capita water req., (m^3/yr)
			Soil[a]	Renewable[b]	Total	
Egypt	65978	0.	0.0	925	925	1400
Iraq	21800	0.9243	231	2752	2983	1400
Israel	5984	0.4001	100	335	435	650
Jordan	4671	0.6744	168	172	340	1400
Kuwait	1811	0.0055	—	—	—	650
Lebanon	3191	0.9276	232	1504	1736	1400
Oman	2382	0.0042	—	420	420	650
Qatar	579	0.0691	17	172	189	650
Saudi Arabia	20181	1.0951	273	119	392	820
Syria	16250[c]	3.2067	800	1785	2585	1400
UAE	2353	0.0383	10	85	95	650
West Bank	1350	1.2858	321	67[d]	388	1400
Yemen	16887	0.6354	159	242	401	1950

[a] This is the irrigation water equivalent as calculated later.
[b] *Source*: The World Water 2000–2001, the Biennial Report on Freshwater Resources (pp. 199–201), by Peter H. Gleick, Island Press, Washington DC. Some figures pertaining to international rivers are adjusted by the Author.
[c] Estimated by Author.
[d] Water shares now used by Israel not included.

throughout the years. Water strain[4] started to show since the 1970s although a good part of it was masked there-to-fore by deficits sustained by the countries of the region in the foreign trade in food commodities. All the countries of the region, with the exception of Lebanon in sporadic years, have been sustaining deficits in the foreign trade in food commodities. Jordan, for example, managed a deficit of $115 per capita in food trade alone in 1998. The factors that brought about the water strain correspond to increases in population size, introduction of modern technology that enabled easier access to water and introduced piped distribution and use networks, expansion in irrigated agriculture with efficiencies improving much slower than the rates of expansion, and improvements in the living conditions of people.

The per capita water availability including productive soil moisture compared to the requirements (as calculated below) and shown in Table 1, indicate that there are three countries with adequate water resources in the year of data (1998). Iraq, Syria and Lebanon had adequate water resources in that year and the rest of the countries were undergoing water strain because of the failure of the available water resources to meet the requirements. A look at the status of foreign trade in food commodities[5] indicates that all the countries of the Middle East sustained deficit that year, including the water surplus countries. The situation is actually more drastic because the water availability displayed in Table 1 above includes water mined from renewable

[4] Water strain, a term introduced by the author, is the ratio between water shortage and water availability, with shortage measured as the difference between requirements and availability.
[5] Food and Agriculture Organization, "Agricultural Trade Year Book—1998", FAO, Rome, Italy.

and from fossil aquifers. The agricultural water deficit increases when only sustainable levels of water uses are maintained, and the agricultural trade deficit would therefore increase above the levels reported for the year of data.

2. Definition of water requirement

Water requirement, as used herein, is defined as the amount of water per capita required to meet the municipal, recreational and industrial demands, M, and the irrigation water, Irr, necessary to produce sufficient food to maintain an average diet. The first part of the requirement, M, is determined by assigning a daily consumption rate that varies with the income. An average of 200, 225, 250 and 300 l are assigned for the consumption of countries of low, lower middle, upper middle, and high income categories as defined by the World Bank. For industrial purposes, an average daily rate of 20, 25, 25 and 30 l are assigned for the four income categories, respectively. Additionally, the efficiency of conveying the municipal water to the consumer varies with income and values of 65%, 70%, 75% and 85%, respectively, for the above four income categories are attainable. The annual allocation for municipal, recreational and industrial purposes at the source of water thus amounts to 123, 128, 133 and 141 m^3, respectively.

To produce food for a balanced diet, an average of 815 m^3/capita/yr is needed (El Musa, 1997) measured at the root of the plant (see Appendix A). Overall conveyance and distribution efficiencies of irrigation water vary in accordance with the affordability of the country to invest in advanced irrigation methods. Overall efficiencies of 55%, 70%, 72%, and 75% are attainable[6] by the four income groups in respective order. Productivity per unit flow of water varies with the use of advanced technology, and weights are assigned to the four income groups at 0.75, 1.0, 2.0, and 3.0, respectively. This means that a high income country can, by virtue of advanced agricultural production technology, produce from a unit flow of water three times as much as a lower middle income economy country, and 1.5 times the production from the same unit flow of an upper middle income country. Additionally, the food consumption varies from the above average diet, and is assumed to be 0.90, 1.00, 1.10, and 1.20 of the average for the four respective income groups. The efficiency of food consumption also varies, and it is higher for lower income categories, i.e., there is less waste of food in the consumption of the lower income people. Factors of "food management" efficiency are assigned, in relative terms, as 1.2, 1.1, 1.0, and 0.9 for the low, lower middle, upper middle and high income, respectively. Finally, the agricultural productivity per unit water flow varies with the advancement the country has achieved in economic and social development, and is assumed, in relative terms, to assume factors of 0.75, 1.0, 2.0 and 3.0 for the low, lower middle, higher middle and high income economies, respectively.

When the above figures and assigned efficiencies are applied, the irrigation water requirement per capita will amount to: 1534, 1383, 1265, 1375 m^3/capita/yr for the low, lower middle, upper middle and high income economies, respectively. The factor of productivity is considered, and these values are divided by that factor to yield 1833, 1265, 692 and 511 m^3/capita/yr for the four income categories, respectively. The total water requirement is the total of the irrigation requirement and the municipal, recreational and industrial requirement and is approximated as

[6] Judged by the experience of the author in irrigation projects in the MENA countries (1973–1996).

1950, 1400, 820, and 650 m^3/capita/yr for the low, lower middle, upper middle, and high income categories, respectively.

It is interesting to compare these four figures of requirement with the conclusions reached by other workers. Postel (1996) concluded that 400 m^3/capita/yr is required to produce food. This compares well with the 511 figures computed for the high-income category. Allan (1994) suggested that a figure of 1000 m^3/capita/yr is a likely, very conservative figure. It is lying between the 511 and 1265 figures for the upper middle and the lower middle income, respectively. A third figure of 1570 m^3/capita reportedly has been suggested by the Food and Agriculture Organization as reported by Falkenmark (1996), a figure almost the average of the low (1833) and lower middle (1265) income requirements as calculated above. Finally, a figure for the total requirement of 1700 m^3/capita/yr was reported by the World Bank (Serageldin, 1995a), it is almost the average (1675) of the requirements calculated above for the low income (1950) and the lower middle income economies (1400).

Soil moisture contributes substantially to the production of food. As such, it should be counted as part of the available water resources in as much as it is capable of supporting rain-fed agriculture. To make soil moisture comparable with irrigation water, an "irrigation water equivalent" needs to be calculated. This entails assumptions pertaining to the productivity of rain-fed agriculture as compared to the irrigated agriculture.

Experience in Jordan suggests that irrigated areas of the Jordan Valley produce about 4.5 tons/ha for certain varieties of wheat, compared to an average of about 1.5 tons/ha in rain-fed areas in the Jordanian Plateau with average precipitation of 375 mm/yr. This suggests that the productivity of irrigated agriculture is about three times that of rain-fed agriculture. Worldwide, Gleick (2000) states that the irrigated area was 18% of the crop area and produced, in 1998, 40% of the world food. If the balance is attributed to rain-fed agriculture, it means that 82% of the crop area which was rain-fed produced 60% of the crops. Hence, by simple calculation, the productivity of irrigated agriculture worldwide is 3.03 times the productivity of rain-fed areas, or, simply three times as productive as rain-fed areas.

The water needed to support a crop in irrigated agriculture is more than the rain needed to support the same crop in rain-fed areas. This is due to the aridity of irrigated areas and the evaporation rates therein. In effect, it takes about 650 mm of irrigation water to support the irrigated wheat crop (Baker & Harza, 1955), as opposed to 375–400 mm of rainfall to support the rain-fed wheat crop. In rain-fed areas, if a winter crop is not planted, a summer crop can be supported with only soil moisture stored from the previous rainy season. It does not take any additional water to support, for example, a summer crop of vegetables in rain-fed areas, but it takes about 800 mm of irrigation water to produce that crop in irrigated areas. Since the area allocated to winter crops in rain-fed areas is substantially larger than the summer crops, it may be assumed that the water needed, under irrigated agriculture conditions, to produce the same crops that rain-fed agriculture supports is about twice as much.

The area of rain-fed agriculture in a given country, only one-third as productive as the irrigated areas is considered effectively utilizing 375 mm of rainfall (0.375 m). The volume of water, per capita, thus utilized is calculated by multiplying the rain-fed area per capita times that productive intensity. Any rainfall in excess of that effective depth goes to runoff and to ground water recharge, both forming the renewable water resources of the country, or contributing to international water bodies.

Thus, the equivalent amount of irrigation water needed to produce what rain-fed agriculture produces from 375 mm of effective precipitation becomes $375 \times 2 \times 1/3 = 250\,m^3$/dunum/yr. The renewable ground water and surface water should be augmented with the "irrigation water equivalent", equals to $0.25\times$ the rain-fed agricultural area in square meters, to yield the total available water resources. This has been done for the selected countries examined in this study, and the results are listed in Table 1 above.

3. Issues in the water challenge

Issues in the water challenge in the Middle East are not much different from the primary challenge water poses elsewhere. Characteristics of the region may color certain challenges differently. Economic, social, demographic, cultural, environmental, political, or developmental characteristics leave their print on the water challenges at large. In actuality, the determinants of policy in regards of coping with the water challenge heavily draw on the characteristics of the concerned society. Full cost recovery, a principle favored in pursuit of higher water use efficiencies, is contingent upon the average per capita income in a given country and the pattern of national income distribution. The income factor, in turn, is a function of the levels of economic and social development that the country has attained. Embedded in this are demographic factors that identify the vulnerable groups who need the support of society in the form of cross subsidies, and so on. In short, there is no template that applies to all societies undergoing different levels of water strain and facing varying degrees of water challenge. This fact brings to the fore a major challenge to the countries of the Middle East; it is to formulate a national water strategy under which various water policies can be formulated, adopted, applied and updated as necessary. The strategy should also address the institutional arrangements that are needed for implementation of the contents of the water strategy and the associated policies.

4. Challenge I: the imbalance in the population–water resources equation

Without down playing the weight of the other water challenges, the readily recognizable challenge in the Middle East is the ever-growing imbalance in the population–water resources equation, both locally within a country, and nationally country-wide. The region's population growth over the past half century has been due to the high rate of natural population increase, the voluntary migration from the disadvantaged areas within a given country to the more advantaged areas in search of opportunities for better living. Urban areas have been the destination for migrants from the under-privileged rural areas. The third cause of imbalance has been the involuntary migration within a given country, primarily as a result of civil strife, and within the countries of the region because of hostilities and wars. Examples of the civil strife migrations exist in Lebanon, Iraq and Yemen; and the living example of wars and hostilities are the Palestinian refugees scattered all over the Middle East and the world. There are other examples in Iran as a result of the Iraq–Iran hostilities (the Tabi'yyah), and in Kuwait (the Bedoun) who are denied citizenship of either Iraq or Kuwait, across whose common borders these people keep moving.

Protection of water resources against environmental degradation is another aspect of this challenge. Most important is the invisible component of this challenge, and that is the protection of groundwater against depletion and pollution. Practices in many parts of the region carry with them the threat of loss of many groundwater aquifers. In Jordan, for example, groundwater is being utilized at about 200% of their sustainable capacity. The conditions in the Ghouta of Damascus is not any brighter. Groundwater levels have been declining there at alarming rates of 7 m/yr. Untreated wastewater is being used to augment the diminishing freshwater resources. The same can be said about the Sana'a and Taiz basins in Yemen, and about groundwater exploitation in the Gaza Strip of Palestine. Utilizing groundwater beyond the recharge capacity is, in effect, a process of mining of that aquifer. In some other countries, like Saudi Arabia and Jordan, fossil water is being mined for use in irrigation at substantial rates in the former (1 billion m^3/a), and about 45 million m^3/a in the latter.

Augmentation of the usable water resources provides some relief to the water strain. Wastewater treatment and reuse has been introduced to the region since the late 1960s. Jordan practiced the reuse of treated wastewater immediately after the wastewater treatment plant was installed for Amman in 1968, and an average of about 15 million m^3 of treated wastewater was put to use by farmers along the Wadi gorge in which the treated effluent was being discharged. The practice has been expanded ever since and as much as 55 million m^3 of treated municipal wastewater are being reused today. Israel, likewise, has embarked on the treatment and reuse of municipal wastewater since the early 1970s. The Dan region around Tel Aviv metropolitan area is perhaps the largest in Israel and supplies one branch of the National Water Carrier with about 200 million m^3/a. Egypt followed suit in the early 1990s when the wastewater collection and treatment systems were installed for Cairo and Alexandria. Yemen practiced the treatment and reuse of municipal wastewater from the Taiz wastewater treatment plant since the late 1980s, and from Sanaa plant in the late 1980s.

Augmentation of municipal water sources is done through the desalination of seawater. The countries of the GCC produce about 80% of the total desalination output in the world. Saudi Arabia desalinates water in the Eastern province and pumps it to Riyadh in Najd and the towns of Qaseem. Desalination is the source for municipal water in Jeddah, Mecca, Madeenah, the major cities of the Hijaz province and Abha and environs of the Aseer province. All other GCC countries have embarked on seawater desalination. More recently, Israel is building a modest desalination plant for the town of Eilat, and is seriously considering award of another major plant on the Mediterranean with a 50 million m^3 annual output. Palestine has built one in Deir el Balah of the Gaza Strip with finance from the European Union. Desalination is likely to be the major source of municipal supplies to sea resorts on the Red Sea and the Gulf of Aqaba.

The opportunity of success in meeting this major challenge of imbalance in the population-water resources equation lies in a four-fold effort:

(a) Demand controls, including controls on population sizes and their involuntary drifts. In this respect, the repatriation of Palestinian refugees, numbering[7] more than 1.463 million in Jordan, 0.365 million in Lebanon, 0.366 million in Syria, 0.773 million in Gaza, and about

[7] United Nations Relief and Work Agency for Palestine Refugees, UNRWA, Registration Statistical Bulletin for the Second Quarter, 1998, Amman, Jordan. Other Israeli sources put the total number at 4.987 million with 2 million in Jordan, 1.116 in the West Bank, and 0.7 million in Gaza (see Ha'aretz newspaper, 21 July 1995).

0.555 million in the West Bank is one such step to relieve the water strain in the West Bank, Gaza, and in Jordan. However, relief for these parties is pressure on the recipient country, Israel. The time for decision on these matters is approaching as the pieces of the Middle East Peace Process are picked up and negotiations resume. Repatriation of other people displaced because of civil strife should also be pursued.

(b) Integrated rural development should be the motto of the region to boost rural incomes and improve the quality of life in rural areas. Success in such endeavors will discourage migration from rural areas to urban areas, and may even reverse that phenomenon. Examples of success can be found in Jordan where the integrated development of the Jordan Valley resulted in many benefits, on top of which was the arrest of migration from the Jordan Valley to the urban areas, and reversing this phenomenon.[8] Because of integrated development there, the population increased from 63,000 people in 1973 to about 250,000 in 1988. Birth control measures have to be promoted and public education enhanced.

(c) Protecting the available water resources against environmental degradation, and augmenting them with other acceptable sources (wastewater treatment and reuse, water harvesting, sea water desalination, use of fossil water for domestic purposes).

(d) Improving the water use efficiency by cutting down losses of conveyance, evaporation and over-application on the one hand, and, on the other, improving the agricultural yield per unit flow of water and unit area of land. Modern irrigation methods, protected agriculture practices, soil fumigation techniques, and advanced on farm water management are good examples to achieve the former objective, and the adoption of improved seeds, advanced production techniques and enhanced research and extension services are good examples for the achievement of the latter objective.

5. Challenge II: water management

In as much as the slogan "water for the people" is valid anytime and anywhere, the inverse slogan, "people for the water" is equally legitimate and valid. In practically all the countries of the Region, water is treated as a public good, owned by the people for the benefit of the people. The public sector is in charge of water development and management in all the countries of the region. Water legislation reflects the public ownership of water, and stresses the State control, on behalf of the people, over the water resources. Government institutions have been entrusted with the task of water management including water resources development, operation and maintenance of water projects, staffing, imposing the water tariffs, and billing and collection of financial dues.

As the water strain persists and intensifies with time, water management demands the employment of technical and managerial skills of which the region is in short supply. Additionally, water infrastructure, as it ages with time, needs to be cared for through careful maintenance and/or replacements and renewals. Current management response to emergencies or

[8] See "The Jordan Valley 1973–1986—A Dynamic Transformation", an assessment of the development of the Jordan Valley undertaken by Louis Berger et al., at the request of the Jordan Valley Authority, Amman, Jordan and USAID/Amman, 1988. Copies available from either organization.

even to regularly anticipated maintenance problems leaves much to be desired. Government management of such sensitive services is not known to be the best, and can be improved by outsourcing the management services.

Modernization of drinking water standards need to be followed up for updating the standards and specifications. Adjustment of treatment systems may have to be implemented to cope with the requirements of updated standards. Compatibility of resource availability with the need to apply stringent specifications and standards need to be carefully examined and weighed against cost and practicality.

Unaccounted for water runs at unreasonably high proportions of the served water. Amman, for example registers up to 55% ratio of unaccounted for water. Karak in south Jordan registers 65%, and Mafraq in the north registers even higher percentage. Other capitals and cities in the region are not much better. Reduction of unaccounted for water is an urgent priority to be achieved. It is the least expensive option to improve revenues and conserve wasted water.

The qualifications of workers in the water sectors lag behind the requirements of meeting serious challenges. As one example, about 70% of the workers at the Water Authority of Jordan have high school diplomas or less. The remuneration of these workers, in the majority of cases, is below what is needed to provide for a family a reasonable quality of life. Over employment is a characteristic problem in the countries of the region, and its persistence adversely affects efficiency and cost of service. There are about 10–20 public employees per 1000 connections in the Region as compared to 2–3 employees in efficient utility agencies (Serageldin, 1995b). Work ethics have deteriorated and need to be overhauled, with stringent measures applied to violators.

Management tools, in terms of both hardware and software, are as old as the water supply projects. These tools are inadequate to meet the challenge of competent water management needed in all the countries of the region. They need to be modernized, and workshops set for their maintenance.

Consumers' awareness, and the awareness of political and social leaders and decision makers of the scale of the imbalance in the population–water resources equation, is not as thorough as the situation dictates. The annual share of a Jordanian of renewable water resources, for example, runs at $150\,m^3$ in the year 2000. Soil moisture and its reliability allow the equivalent of about $150\,m^3$ of irrigation water. The total renewable resources per Jordanian was therefore $300\,m^3$ as compared to the $1400\,m^3$ needed to meet the requirements of municipal, recreational, industrial and agricultural uses. Users of groundwater were mining it at the rate of about $40\,m^3$/capita, making the total availability about $340\,m^3$/capita. An average of $50\,m^3$/capita have been used in municipal and industrial purposes, leaving $290\,m^3$ for food production. Compared to the requirements (see above), Jordan has been serving its population 39% of the needed allocation for municipal, recreational and industrial use, and had only 23% of the water (including soil moisture) that was needed to produce food. The water strain was managed by the rationing of municipal water (once a week or once every 2 weeks), and by a deficit in the foreign trade in food commodities that ran at about \$115/capita on average that year.

Public participation in water management has traditionally been very low. Even in years of drought, water public officials rarely consulted with the people. Public participation in Government decisions has rarely been on the agenda of the countries of the region since the early 1940s. The involvement of the public in the management of water, and indeed in many other

matters, needs to be institutionalized, promoted, and made part of the water management culture in the region.

The opportunities of success in meeting the water management challenge lie in the following measures, to be taken seriously and consistently:

- Improvement of efficiency of management, which requires human resources upgrades; overhaul of work ethics; reducing over-employment; improving remuneration for workers; updating management systems and tools; and, reducing unaccounted for water to the minimum acceptable levels (less than 10%).

Some countries have opted to contract out the tasks of municipal water and wastewater management for certain zones (Palestine in Gaza and Jordan for Amman.) The experience is recent and the appraisal is not yet made. Observation of performance, however, indicates that the government agency in charge (the Employer) has not come to grips with the fact that management has been out sourced, and that their authority in perpetuating the old management styles has been diminished or eliminated. Interference with the work of the contracting party, the actual manager, has been frequent. This, however, should not deter other countries from looking into the privatization of water management, not the resource or the infrastructure, under government supervision, especially where water strain is high.

The inadequate water management by Government should not be a call for privatization. As a matter of fact, social habits and traditional momentum of public ownership of water would not tolerate total privatization. However, the Government management systems have to be re-structured and improved. Water management can be outsourced in the form of Management Contracts. The form and content of such contracts can take different forms depending on the conditions of each country.

6. Challenge III: social and economic development

Achievement of social and economic development is a standing goal for all the governments of the region. The way of going about it differs. Some achieve it through central planning and others embark on partnership with the private sector. The social and economic development challenge is essential to meet so that the quality of life improves, and the disposable incomes for families are increased. With a high rate of population increase in the region, the countries have to achieve higher rates of economic growth to maintain the same standard of living and to improve it.

Social and economic development touches on the water sector in many ways. It sets the mode for financing the resource development, operation and maintenance. Only the oil-enriched countries in the region afford to finance the water development projects out of their own treasury. The other countries call upon contribution of financing agencies and friendly governments to help finance the projects in their water sector. An equally important consideration of social and economic development is the ability of the consumers to meet the real cost of water service. So far, none of the countries of the region has managed to impose water tariffs suitable for the recovery of the entire costs. Even the oil-enriched countries subsidize the water. Consumers pay but a fraction of the cost of operation and maintenance in Saudi Arabia for just one example. They, collectively pay the entire cost of operation and maintenance in Jordan and a small fraction of the

capital cost as well. In Egypt, the recovery ratio is less than the operation cost, and so is the case in the rest of the countries of the region.

Water subsidies should not be a policy. Charging the real cost of water helps improve the efficiency of use. However, the levels of economic development that the countries have achieved so far pose a real problem for full cost recovery. A fair share of the disposable income allocated to pay for municipal water was suggested to be around 2% or less (Serageldin, 1995c). If Jordan's case is taken as a measure, the total cost of water service ran at about 6% of the GDP in 1994. Reasons were tapping of remote sources, high pumping heads, over employment, and low management efficiency. There was about 4% cost subsidies carried by the treasury in the water tariff. The situation improved in 1997 when the tariff was set to recover the operation and maintenance cost, but subsidies are still there as only a small fraction of the capital cost was charged to the consumers. Not unless the per capita share of national income shoots up to $4500 can Jordanians afford to meet the requirements of full cost recovery of the existing systems. The additional water will cost even more.

Very modest real growth rates have been achieved in the region throughout the 1990s. Poverty has increased in many countries, especially Palestine, Jordan and Iraq. Yemen is not too far behind these countries in poverty levels, nor, for that matter, is Egypt. The end result is that families could hardly cope with the cost of modest living, and are not enabled to pay the real cost of water. In parallel, progress in democratization has been made, and better records of human rights have been attained by many of the region's countries. Toward achieving the objective of accelerated social and economic development, a New Deal between people and the State may be worth proposing: in such a New Deal, the State guarantees domestic peace, uphold human rights, transparency made part of public performance, serious accountability is adopted and pursued, corruption is minimized and eradicated, and democracy practiced in the most appropriate manner. People, on their part, should become active partners in managing the affairs of development and be the helpful beneficiaries they are supposed to be, protect democracy, pay their taxes, and uphold the laws and regulations of their society.

Development is required for stability of the water sector, and water is needed for a steady pace of economic and social development. In this regard, another reversible slogan seems to be valid "Development for Water, and Water for Development".

The economic development and the income distribution pattern dictate the choice of options available for incremental water supplies. Seawater desalination, for example, is an option available to the coastal areas. The running cost of desalination is about $\$0.50/m^3$ at the coast line. To this cost one should add the cost of transport, distribution, and maintenance. If, on the average, $0.50 is added for these costs (more for inland consumption centers), the cost per cubic meter will be $1.00. If 10% of the water is unaccounted for, then the cost to be recovered will be $\$1.10/m^3$ of desalinated water. If the per capita reasonable domestic consumption under conditions of scarcity is set to about $70\,m^3/yr$, the cost to be met by the individual will be $77. If this cost is not to exceed 2% of the disposable income, then the disposable income of the individual should average $3850/yr. Levels of such incomes exist in Israel and the oil-enriched countries of the Region, but not in other countries as yet. In other words, Jordan, Palestine, Egypt, Syria, and Lebanon cannot afford to think, as yet, of the sea water desalination as an option for additional supplies. This observation is not a call for perpetual subsidies, but is rather a

call to sustain economic and social development at rates higher than normal in certain countries of the Region to permit society to meet eh increasing cost of living of which water cost is one.

In several countries of the Middle East, farming using pumped groundwater from tube wells has been introduced over the past few decades. The traditional irrigation water has for ages been from surface sources, rivers and streams. In Jordan and Palestine, such practices are not more than a half-century old. In Israel, farming is a tradition injected into the culture by the Zionist Movement as it was started late in the nineteenth century.[9] Unlike traditional irrigation areas that run centuries of continued use, the groundwater irrigation has barely taken root in the cultures of societies in the region. Serious consideration should be given to the diversion of water from these recent developments to more pressing demands for municipal and industrial water. This option is convenient because farming using ground water is in proximity of cities and towns that can consume that water. A social and economic survey of the farms and their dependent communities should be made before such decisions are made.

7. Challenge IV: management of international water

International rivers exist in the Region and so do transboundary groundwater aquifers. Arrangements for their management are not yet adequate, and are, at best partial. A summary of the status of international rivers is given below:

- *On the Tigris*: No riparian agreements exist, and the riparians are Turkey, Syria, and Iraq. Iran comes in as a fourth riparian on some of the tributaries.
- *On the Euphrates*: A bilateral riparian agreement is in existence since April 1990 between Syria and Iraq by which the two countries share the flow that crosses the Syrian borders from Turkey at the ratio of 42% for Syria and 58% for Iraq. Turkey has worked out a temporary arrangement with Syria under which a flow of $500\,m^3/s$ will be allowed to flow across the Turkish–Syrian borders. This flow amounts to about half the average annual flow of the River. However, Turkey is not yet a party to a formal riparian agreement with its co-riparians.
- *On the Shatt el Arab*: The riparian parties on the water course are Iran and Iraq. A major tributary to the Shatt, Nahr el Qaroun, rises and flows inside Iran before it discharges into the Shatt. An agreement reached between Iraq and Iran in 1974 in Algiers was revoked by Iraq in 1981. The status is thus rolled back to the times of dispute between the two countries over the international borders and navigation in the Shatt.
- *On the Orontes*: A bilateral riparian agreement exists between Lebanon, the upper riparian on the River, and Syria, the current Middle riparian. Turkey, the downstream riparian is not included in any official transactions concerning the River. This is because the part of Turkey in which the River flows before it discharges into the Mediterranean is the Alexandretta province, a Syrian province annexed to Turkey in 1939 by France. Syria contests the annexation, and the status of the riparian awaits the final settlement of that territorial dispute.

[9] The first tube well was drilled by the early Russian Jews settlers in Rishon Le Zion in 1882, cost donated by Baron De Rothchild. For details see "Diplomacy on the Jordan", by Munther J. Haddadin, Kluwer Academic Publishers, Norwell, MA, USA, 2002.

- *On the Yarmouk*: A bilateral agreements existed between Jordan and Syria since June 1953, and was replaced by another in September 1987. Another bilateral agreement exists between Jordan and Israel, signed in October 1994. Palestine, a partner in the water sharing, is not a party to any such agreements.
- *On the Jordan*: By the intermediary works of Ambassador Eric Johnston,[10] the riparian parties on the Jordan from the origins to the exit from Lake Tiberias are Lebanon, Syria, Israel and Palestine. No usable water was thought to flow in the Lower Jordan below Lake Tiberias since the riparian parties would exact their shares before those shares got to the Lower Jordan. No agreements exist on the Jordan north of Lake Tiberias, but they are expected to be the subject of negotiations within the Middle East Peace Process when it is revived.

  An agreement exists between Jordan and Israel to rehabilitate the Lower Jordan, whose natural waters would primarily be agricultural return flows from Jordanian and Israeli lands, and to share the flow, over and above current uses, on equal basis. A third riparian exists on the Lower Jordan, Palestine, who has not yet entered as a party to any riparian agreements.
- *On the Nile*: A bilateral agreement exists between Egypt and Sudan since 1959, and hopes are high that a multilateral agreement would emerge from the coordination meetings between the water ministers of Ethiopia, Sudan and Egypt, with participation at times by ministers from the other riparian countries on the White Nile.

None of the above agreements is all inclusive. They lack the inclusion of other riparian States; many of the agreements lack water quality component and tend to focus on quantity measures. The agreements need to be made all inclusive of the riparian parties and comprehensive in scope to ensure proper management of the international basins.

An equally important issue of challenge is the absence of riparian agreements on the management of transboundary groundwater aquifers. There are hardly any two adjacent countries in the region without a transboundary aquifer underlying their territories. These aquifers could be renewable as is the case between Syria, Turkey and Iraq; Lebanon and Israel; Jordan and Syria; or are non-renewable, saturated with fossil water as is the case between Jordan and Saudi Arabia; and between the latter and each of the GCC countries and Yemen; or between Egypt, Sudan, Libya and Chad.

The absence of agreements on the international water basins in the region is not comforting. It adds to the tension that has developed in the region since the middle of the 20th century. However, the author does not subscribe to the theory of "water wars", and does not intend to do so in the future. The outcry of water wars originated in the United States in 1984 claiming that "the next war in the Middle East will be over water, not oil".[11] Other prominent World Bank officials joined in on the scare, but, fortunately, time has proven them wrong because the war that followed that scare was the Kuwait invasion in1990–1991 and its aftermath. Water was no where close to be a cause of that war. In fact, just before the Iraqi invasion of Kuwait, there was a serious consideration by Kuwait to draw municipal water from the Tigris with Iraqi consent.

[10] Ambassador Johnston was the special envoy of the President of the United States to work out a consensus over a Unified Plan for the Development of the Jordan Valley, 1953–1955. He reached an agreement with the Technical Committee established by the Arab League and with Israel. The Arab League Council opted to postpone decision on that agreement pending more studies.

[11] Publication by the Center for Strategic and International Studies by Joyce Starr et al., 1984.

There was cooperation over water, but the hostilities broke out because of territories that are rich in oil, not water.

The challenge of management of international basins can be met through National and International efforts. International agencies can help reduce the level of competition over water by introducing projects that can "stretch" the water resources to meet the demands of the riparian parties. Examples are: supporting the introduction of advanced irrigation systems, working out an acceptable standard for soil classification, inter-basin transfers where possible, and saving on water lost to evaporation without unduly adversely impacting the environment. Additionally, a specialized institution should be set up for the purpose of regional data gathering and standardization, and for the sake of preparing the ground work for settlement of water disputes through peaceful means.

8. Challenge V: formulating national water policies

The water challenges that the Middle East countries face, and are outlined above, are formidable. They cannot be left to be resolved on their own. The challenges were practically generated by people, and therefore people have to deal with those challenges. A national water strategy should be formulated in which the main outlines are stipulated. Under that strategy, a set of policies should be laid down and should be subject to adjustment and updating as the conditions may require. Preferably, the strategy should form the basis of legislation and the philosophy behind water legislation, and should spell out the institutional arrangements needed to meet the above challenges. It should be clear enough to deal with all the challenges to the best ability of the concerned country. Policies can address the various aspects of the water sector and its components.

In Jordan, for example, a national water strategy was formulated and adopted by the Council of Ministers, the highest administrative authority. Several policy papers were subsequently formulated and adopted by the same Council of Ministers. These papers were on "Irrigation Water Policy", "Wastewater Management Policy", "Groundwater Management Policy", and "Municipal Water Policy". Legislation in Jordan was not lacking, neither was the institutional set-up. However, the ability to cope with the domestic political and social pressures directed against the reform of groundwater practices was not up to the required level, and groundwater mismanagement is continuing with little control.

The other matters needed to be addressed in the national policies pertain to the extent of cost recovery, the levels of cross subsidies, the contributions by the Treasury, and the privatization of management, not the resource or its infrastructure. The privatization of the resources and the infrastructure assets, to the authors judgement, will be far off, if at all achievable.

9. Can a crisis be averted?

The author believes that the challenges can be met if the national political will of the concerned countries so decides. Granted, there are cases in the region where meeting the demand for water can, on the surface, only be achieved by diverting irrigation water to municipal use. Diversion of the ground water, used for irrigation in areas close to cities and towns, can be considered. Social

and economic survey and environmental impact assessment should be made before such a decision is made by any of the countries. However, diversion of traditional irrigation water to urban areas is not as attractive as some casually, may think. Agricultural societies in these historic irrigation regions are part of the demographic make-up of the Middle East since the dawn of civilization. The Middle Eastern agriculture runs deep in history and culture of the Region and of mankind. It is not a simple matter to do away with the historical occupation, agriculture, and have the people engage in alternative occupations in services and industry. Diversion of irrigation water to municipal uses will most likely propel social upheavals, and will redistribute the wealth in favor of the rich urban areas at the expense of the rural poor. More over, such diversion will cause people to follow the water and migrate to urban areas, posing a set of social and economic problems that are costly to prevent or mitigate.

Again, sustaining historical agriculture is not a call for perpetual subsidies of irrigation water. Early farmers depended on gravity for distribution of water in earth canals. The cost of water service was low and most of it was done by the farmers themselves. In recent times, water saving measures are needed to minimize water waste and improve water use efficiency. Irrigation water charges should be imposed and adjusted periodically to recover, at least, the cost of operation and maintenance.

Additional water for municipal and industrial purposes can be made available from non-renewable aquifers for countries with severe water shortages and hardships in acquiring more water. Tapping of fossil water for municipal purposes is conditional upon using it as a strategic reserve, i.e., until an alternative renewable use is made available.

The justification for the use of fossil water as a strategic reserve in municipal and industrial purposes is simple. Fossil water, like fossil fuel, is depleted through use with the passage of time. Mankind will have to embark on a new form of energy generation, environmentally friendly and affordable, to replace fossil fuel before it runs out. Otherwise, man's civilization that is now driven by energy will be threatened in its sustainability. As a new, affordable, environmentally friendly energy becomes readily available, the desalination of seawater becomes a workable option for the production of municipal and industrial water, and for pumping it to centers of consumption. Incomes will, hopefully, be enhanced by the use of the strategic water reserves to levels that will make people afford the cost of new water.

A race will thus be on: which resource would be depleted first, fossil water or fossil fuel. New forms of energy will have to come on line before too long. For if fossil fuel runs out first, civilization is doomed, and man's need for water becomes secondary.

The water challenge in the Middle East is many-fold as the above diagnosis indicates. The response to the challenge can be summarized as follows. Success in meeting it will have the countries concerned avert a sure crisis:

(a) Preserve the available water stock against degradation; augment the usable resources through the treatment and reuse of municipal wastewater, and agricultural return flows. Such undertakings require environmental and health controls for the protection of water resources and for the reuse of treated wastewater, and they, in turn, enhance the environment (collection and treatment of wastewater). These undertakings prove the validity of a reversible slogan: ''Environment for the Water, and Water for the Environment''.
(b) Pay due attention to continuous education of all workers in the water sector and optimize their number to reduce operations cost; employ updated facilities for water management, both

in terms of hardware and software; promote awareness in the ranks of the public, decision makers and political and social leaders; and, encourage and enhance participation of stakeholders in an appropriate form and format. Privatization of water management is a credible option with advantages of improving efficiencies. Another reversible slogan is valid, and it is: ''Water for the People, and People for the Water''.

(c) Augment the available water stock through new innovations, i.e., employing affordable techniques for the treatment and reuse of wastewater; for water harvesting; and for advanced management of soil moisture.

(d) Accelerate the pace of social and economic development; improve the national income and its distribution pattern in order that water consumers can afford the cost of their water consumption without government subsidies. Toward that objective, a New Deal between people and the State may be worth proposing: in such a New Deal, domestic peace is maintained and given highest priority, human rights are upheld, transparency made part of public performance, serious accountability is adopted and pursued, corruption is minimized and eradicated, and democracy practiced in the most appropriate manner. Development is required for stability of the water sector, and water is needed for a steady pace of economic and social development. In this regard, another reversible slogan seems to be valid ''Development for Water and Water for Development''.

(e) Restructuring of the Water Sectors in the countries of the Middle East including irrigated agriculture. Over employment should be phased out, as more jobs become available in other sectors as a result of accelerated economic and social development.

(f) Formulating national water strategy and national water policies, along with the legislation where needed and the institutional arrangements to cope with the multi-faceted challenge.

(g) Use of fossil water for municipal and industrial purposes until such time as seawater desalination becomes a feasible option for the concerned country; either by drastic improvement of the per capita share of national income, or by the introduction of new environmental friendly form of energy. After all, energy is generated from waterfalls, and sweet water is generated from salty seas with energy inputs. This proves the validity of yet another reversible slogan: ''Water for Energy, and Energy for Water''.

On the part of international parties, they can assist in their capacities as:

(a) *Partners*: by focusing more on assistance to restructure the water sectors and by extending technical support and capital assistance where needed. Consideration of debt relief and debt rescheduling will be helpful.

(b) *Intermediaries*: by promoting the riparian dialogue and the achievement of riparian agreements on international rivers and groundwater aquifers. In such endeavor, efforts are to be directed towards normalizing standards of soil classification, crop water requirements, irrigation efficiencies, and soil reclamation. The establishment of a regional institution to deal with international rivers and transboundary aquifers is another endeavor they can pioneer. The institution will undertake water conflict resolution challenges.

(c) *Lending Agencies*: promote and maintain a high level dialogue on the sector reforms and their requirements and follow-up.

(d) Support and reinforce energy research and assign it a higher priority.

Table 2
Composition of a Food Diet

Item	Lower middle income (MI)		
	Food consumption (kg/capita)	Water requirement (m^3/100 kg)	Water demand (m^3/capita)
Wheat	120	115–144	138–173
Rice	15	108–170	16–26
Sugar	35	125–200	44–70
Potatoes	25	14–22	4–6
Dry Pulses	7	167–330	12–23
Seeds (e.g., sesame)	2	200–500	4–10
Fresh vegetables	150	20–22	30–33
Melons	40	13–20	5–8
Bananas	26	25–40	7–26
Citrus	43	20–50	9–22
Grapes	25	25–50	6–13
Other fruits	47	40–50	19–24
Olives	7	50–67	4–5
Vegetable oil	15	500–800	75–120
Miscellaneous[a]		15–20	
Red meat[b]	10	875–1750	88–175
Poultry meat	22	188–375	41–83
Fish[c]	2	75–150	2–3
Milk[d]	120	69–138	83–166
Eggs[e]	5	300-600	15–30
Total	716		614–1017
Average			815

[a] Includes such items as tea and coffee.
[b] Composed of beef, sheep and goats. The water requirements, however, are for beef.
[c] Assuming fish from fish ponds.
[d] This is the fluid milk equivalent of both fluid milk and dairy products consumption.
[e] Egg consumption usually is given in number of eggs rather than in weight; 15 eggs are assumed to weigh 1 kg.
Average Agricultural Water $Irr_0 = 815$ measured at the root of the plants (including post harvest losses)
Source: Elmusa, see footnote 6 in the text.

Appendix A

See Table 2.

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