

# **Water Oil, and the Arab Region's Sustainable Development?**

**Atif Kubursi**

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## ABSTRACT

Water basins in the Arab region may not be connected geographically, but they are connected strategically. Israel and Turkey have forged strategic alliances that are under-pinned by manipulating water availability to other riparians. Israel's long arm has reached Ethiopia trying to pressure Egypt into a more accommodating stance, and Turkey is trying to extract political and economic concessions from Syria and Iraq by adjusting the flow of the Euphrates. It is clear that the Arabs need not only work towards a more sustainable economic development strategy by moving off non-renewable resources and a more rational conservation of their resource base. They also need desperately a strategic posture, an alliance to coalesce their powers into a meaningful force that can protect and safeguard their water interests in an environment of global warming in which water is becoming increasingly more scarce.

## المياه والنفط، والتنمية المستدامة في المنطقة العربية

عاطف قبرصي

### ملخص

قد تكون الأحواض المائية في المنطقة العربية غير مترابطة جغرافياً، إلا أنها مترابطة على المستوى الاستراتيجي. فقد عقدت إسرائيل وتركيا تحالفات استراتيجية يمكن أن تكون أساساً للتأثير والتلاعب بالمقدرات المائية للأطراف الأخرى المستفيدة من هذه المياه. فقد وصلت الذراع الإسرائيلية الطويلة إلى أثيوبيا في محاولة للضغط على مصر في وقفة تجهيزية. كما تحاول تركيا انتزاع بعض التنازلات السياسية والاقتصادية من كل من سوريا والعراق بالتحكم بتدفق مياه الفرات إليهما.

وتخلص الورقة إلى نتيجة مؤداها أن حاجة الدول العربية لا تقتصر فقط على العمل باتجاه تنمية مستدامة أو مواصلة، وذلك بتقليل الاعتماد على الموارد غير المتجددة والترشيد العقلاني لقاعدة الموارد، بل إن الحاجة أصبحت ملحة لوقفة استراتيجية، لتحالف تلتحم فيه كل طاقاتهم بقوة ذات معنى، تقدر على حماية وتأمين مصالحهم المائية، في جو من التسخين العالمي، أصبحت فيه المياه تزداد ندرة.

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## Introduction

In a comparative assessment of the global economy and the capacities of states and societies to adjust to endemic changes, the American historian, Paul Kennedy (1988), observes that “more than any other developing region”, the Middle Eastern and North African countries are afflicted by debilitating wars and internal disorders. In Kennedy’s assessment, the Arab world remains the least prepared to meet the challenges of the next century.

Equally pessimistic and skeptical of Arab chances in the next century is a 1995 World Bank study entitled *Global Economic Prospects and Developing Countries*. It portrays a pessimistic and bleak outlook for economic growth and development in the Middle East and North Africa. During the 1980s, according to this study, the region’s economic growth averaged less than 1 percent with the world average being over 3 percent. A combination of population growth around 3 percent, falling real oil revenues, dismal export performance, the astronomical costs of two Gulf wars, several civil wars, and an unending wasteful expenditure on military procurement have coalesced to undermine any meaningful future economic prospects for the region.

While indeed the 1980s represent a lost decade for the Arabs and the early 1990s have not augured well for improvement, the aforementioned critics fail to recognize the debilitating effects of hostile external influences, rapid and unpredictable structural changes in the new economy and some positive Arab achievements in the areas of education, health and basic infrastructural development. The real issue, however, remains — why has development remained so elusive in the Arab World? What are the factors that might account for this abysmal growth?

Few regions of the world have their fortunes, livelihood and destiny as fundamentally tied to natural resources the way the Arabs do. It is this excessive dependence on natural capital and non-renewable resources that is perhaps at the heart of the Arab development malaise. Two basic natural resources — oil and water — account for and explain almost the entire economic structure, performance and problems of the region.

It is in the way the scarcity of water and the abundance of oil in the region interacts that defines the economic and environmental parameters within which Arab economic future is articulated. The mechanisms and modalities through which the two resources interact and shape events in the region are indeed complicated and complex. They involve the confluence of economic, geopolitical, environmental and technological factors. While it is difficult to disentangle and dismantle this complex phenomenon, it is clear that each of these factors has a separate and pronounced influence on the unfolding reality of the region.

The Arab world is one of the most water scarce and water stressed regions of the globe. While the region is home to 5 percent of the people of the world, it has less than 1 percent of its renewable fresh water. Alternatively, the region is the world’s largest depository of oil

accounting for over 66 percent of the total proven oil reserves, 25 percent of the world's annual oil production and over 56 percent of the world's oil exports. Ironically, while water and oil presumably never mix, they do so, and with a vengeance, in the Arab region.

Today's annual per capita availability of fresh water in the region is only one third of its 1960 level (World Bank, 1996), falling from 3300 cubic meters per person in 1960 to less than 1250 cubic meters in 1995. This is the lowest per capita water availability in the world. Moreover, some of the Arab Gulf countries and Palestine have per capita availability averages that are even below 10 percent of the regional average of 1250 cubic metres. Even Lebanon, a country that is considered to be relatively water endowed, shows an average of no more than 1200 cubic metres (Gleick, 1993).

The growth of population and industry are responsible for increasing the demand for water everywhere. This is, however, only one aspect of the problem. Actual physical scarcity, even in the Middle East region, is not the only key issue. Conditions of economic and strategic scarcity seem to be more pressing: there is enough water to meet society's need, but there are few incentives for wise and efficient use of this critical resource. As well, military power is exercised brutally to deny large segments of the region's population their rightful shares of water.

Water shortages can be dealt with in a number of ways, i.e. increasing supplies and the water system efficiencies and/or through conservation and demand management. The latter are more recent in nature and less used. They are increasingly becoming more urgent and more dependent on using economic instruments such as efficiency prices and conservation compatible with incentive regimes. But for these economic instruments to work, there should exist an understanding of how these instruments work and why. For their efficient employment, it is also critical to have a clear set of objectives and strategies that coordinate their use and well tested institutions with credibility to monitor, guide and implement incentives for their application. Equally important is the development of a macroeconomic context compatible with micro efficiency while also being consistent with standard notions of equity and justice. In a special section of this paper devoted to the Harvard's water model, an attempt is made to point out these issues in a detailed and specific way (Fisher *et al.* 1996). Nonetheless, there remains a number of questions and these need to be answered clearly and conclusively.

Is water different from other commodities? Is its value infinite and "thicker than blood?" Can price for water be determined much like any other commodity? Can water be traded and shared? Are wars fought over water inevitable? Can reasonable arrangements among riparians be negotiated? What constitutes an equitable distribution of shared resources? These are some of the complex questions that arise about water and arouse passion. There is no area of the world where these passions are stronger or more pressing than in the Middle East where severe water scarcity is compounded by historical suspicions, asymmetries of power, and the exploitation of strategic advantages by the countries of the region.

Much has been written about water in the Arab region especially during the last few years. Most of the writings focus on hydro-politics and tend to create a hydrophobic environment towards the subject. Some analysts have even suggested that the region's next war will be fought over water. Others, stressing a more sombre tone, try to establish explicit and implicit links between water scarcity and regional security. Some go even beyond that and offer a wide array of solutions to deal with the water crisis. These solutions range from multi-billion dollar peace pipelines from Turkey, Lebanon, or Egypt; to Medusa Bags ferrying water from countries with water surplus to those in short supply; to tugging icebergs from northern areas; to mega-desalination projects. Regional parties meet, in both official and unofficial capacities, in an attempt to solve or moderate the water crisis in the region. Their plans include joint management proposals, fixed quotas, data exchanges, human resource development, technology transfer, strategies for enhancing water supplies, water conservation programs, equitable utilization schemes, water banking, cross border storage projects, water diversion plans and programs for the prevention of environmental degradation.

After more than a decade of meetings and negotiations, however, the gap in the positions among regional parties remains as wide as ever. In the next few pages to follow, a discussion follows about the waters of the Middle East. It focuses in particular, on the Israeli-Arab water disputes in the groundwater aquifers and the Jordan Water Basin and the conflicts of Syria and Iraq with Turkey in the Euphrates/Tigris Basin and those between Egypt, Sudan and Ethiopia over the Nile waters.

Admittedly, water is a particularly sensitive and critical issue for all parties to the conflicts. But the attempt to find an equitable solution for water crisis in the region would go far to enhance the possibilities of achieving regional stability and sustainability. Conversely, failure to reach this equitable solution will, most definitely, obstruct any efforts to attain these goals.

There is no alternative to an honest and forthright discussion of the region's water issues. A frank discussion of the current unsustainable reality involves a comprehensive analysis of a number of difficult subjects. These include, but are not restricted to: mismanagement, inequities, the outright denial of the Palestinians' inalienable right to their water resources, the flagrant Turkish dismissal of Syrian and Iraqi downstream riparian rights and the potential dangers of not reaching an equitable solution to share the waters of the Nile. It is only then that the regional parties can negotiate long term regional arrangements. Before then, agreements concluded under duress and/or ignorance of the range of possibilities and options cannot be expected to last.

**Table 1. Water availability and usage in the Arab world and neighbouring countries**

Country	Annual Renewable Resources (MCM)	Annual Withdrawals		Per Capita ARR 1995 CM	Water Usage %		
		(MCM)	As % of ARR		Domestic	Industry	Agriculture
Algeria	18400	3000	16	655	22	4	74
Egypt	58000	56300	97	1005	7	5	88
Bahrain	N/A	200	N/A	N/A	60	36	4
Iraq	104000	43900	42	4952	3	5	92
Jordan	800	1000	125	213	20	5	75
Kuwait	N/A	N/A	N/A	N/A	64	32	4
Lebanon	4800	800	17	1200	11	4	85
Libya	700	2800	400	130	15	10	75
Morocco	30000	11000	37	1083	6	3	91
Oman	2000	1300	65	1053	3	3	94
Qatar	200	150	750	N/A	36	26	38
Saudi Arabia	2200	3600	164	118	45	8	47
Syria	5500	3300	60	385	7	10	83
Tunisia	4400	3000	68	489	13	7	80
UAE	300	400	133	167	11	9	80
Yemen	3000	3900	130	176	5	2	93
Palestine	200	200	100	105	12	13	75
Iran	118300	46500	39	1826	4	9	87
Israel	2100	1900	90	375	16	5	79
MENA avg.	355	183	52	1250	6	7	87

MCM = million of cubic metres

Source: World Resources 1992-1993; Pacific Institute for Studies in Development, Environment and Security, Stockholm Environment Institute, and World Bank Estimates, 1990-1995.

### Water Crisis in the Middle East: The Issues

The water crisis in the Middle East has a lot to do with some general characteristics of water and their peculiarities in the region and still more with the underlying power structure of the state system within the region.

Among the many special complicating characteristics of water and the balance of power in the region that contribute to the crisis, the following are the major ones:

- (i) Water is a scarce resource the availability of which is far below the competing demands. This scarcity is more pronounced in some specific areas of the region and even within the same state. It is not uncommon to find areas and groups of people with abundant water and others with nil or little amounts. The scarcity issue is about relative scarcity and not absolute scarcity. The physical scarcity is complicated by economic

scarcity where actual prices for water are fractions of the true scarcity price (shadow). When prices are below scarcity prices, waste and over use are quickly observed. There are many examples in the Middle East, particularly in Israel, where subsidies have engendered a culture of waste.

- (ii) Water is fugitive, reusable, stochastically supplied resource and whose production can be subject to economies of scale. In this respect, water has many of the characteristics of a common property resource and a quasi public good. The secure supply of water in much of the region, where security is defined as the probability of its availability 9 out of 10 years, is less than 5 percent. It is rarely recycled, and variability in rainfall is multiples of what it is in other regions.
- (iii) Water is typically a non-traded commodity that is rarely sold in a competitive market. There are few overt water markets where suppliers and demanders exchange water. Recently markets in water rights have emerged in several parts of the world. The most notable examples are in Colorado, California and Argentina. But most of these markets are within national entities and often represent simulated market solutions. There are only few international examples of water trade, but it is not difficult to conceive viable schemes for this trade. There is now rich literature on this subject that can help in designing efficient markets.
- (iv) Water values generally differ from the price otherwise obtainable in a free and competitive market. It is often the case that water has social value that is above what private users are willing to pay for it. The allocation of water often reflects national and social policies and priorities towards agriculture, the environment and national security that go beyond promoting the interests of private entrepreneurs. Social and policy considerations apart, the diversion of actual prices from their scarcity values imposes social costs on the domestic economy as well as on other riparian countries.
- (v) Water is not only a desirable commodity, its availability is critical for life. There are little or no substitutes for it. Furthermore, it is a well entrenched principle that no matter how scarce water is, every person is entitled to a minimum quantity that is considered consistent with human dignity. This minimum amount is considered a natural right of people and part of their overall human rights as citizens and individuals.
- (vi) Very few countries have water supplies exclusive to themselves. It is often the case that surface water, i.e., rivers, passes through several countries and aquifers are shared. More than 85 percent of the water available to the respective countries of the region originates outside their borders, or is shared in a common aquifer with others. It comes as no surprise that there are no well defined sharing agreements among riparian countries and that history is rife with water conflicts. Water is part of the tragedy of the commons.

- (vii) While total water supply may be limited, and, few if any, substitutes exist for it, there exist substantial possibilities for intersectoral and interregional substitutions. As well, there are a number of technologies and conservation packages that rationalize demand and raise the efficiency of its use. Part of the water scarcity crisis in the region is the fact that agriculture uses over 70-80 percent of the total available domestic supply. It is typically the case that other needs are suppressed, but this leaves wide room for intersectoral reallocations. Besides, water is transported from one part of the country to another, e.g. Israel transports water from the northern part of the country to the arid south). This regional reallocation to make the desert bloom is at the heart of the water problems of the region. It is suggestive of the possibility and capacity to effect interregional allocations, should such changes become necessary or desirable.
- (viii) While the quantity of water is in short supply in the region, concern for preserving its quality is perhaps more pressing. Syria is more worried about the quality of water rather than the quantity that will be left after the irrigation schemes that Turkey is contemplating for the South-East Anatolia Project. Pollution and saline intrusion of the aquifers are being recognized increasingly as critical factors in planning for the future.

The current allocations of shared water resources in the region are not the outcome of agreements, negotiations or equitable principles. Rather, they reflect the asymmetries of power in existence and the abilities of the strong to impose their will on the weak. Turkey and Israel, even if one is a downstream riparian and the other is an upstream one, have both managed to monopolize and utilize water shares far and beyond those that any rational and equitable allocation system consistent with basic international laws governing transboundary resources would entitle them to. There is a deep and profound dichotomy between the balance of power governing current water allocations in the region and the balance of interest of the riparian parties.

### **Israeli-Arab Water Conflict**

The headwaters of the River Jordan, located in northern Israel, the occupied Golan Heights and occupied southern Lebanon (including Israel's self-proclaimed security zone), feed Lake Tiberias. Syrian, Lebanese and Jordanian waters (most importantly the Yarmouk River) as well as springs in Palestine's West Bank and Israeli springs feed the Jordan River below Lake Tiberias. As a whole, these elements constitute the Jordan International Drainage Basin, a naturally-defined area that cannot be artificially sub-sectioned.

As a result of Israel's occupation of the Golan Heights and its control over southern Lebanon, Israel controls the headwaters of the Jordan River. In its pre-1967 borders, Israel accounted for only 3 percent of the Jordan basin area. It currently controls the greater part of the Jordan Basin waters. At present, Israel draws an annual 70-100 million cubic meters (mcm) from the Yarmouk, and pipes 1.5 mcm per day from Lake Tiberias into its National Water



Carrier (Rudge 1992). Consequently, the River Jordan, which in 1953, had an average flow of 1250 mcm per year at the Allenby Bridge (Main 1953), now records annual flows of just 152-203 mcm (Soffer 1994).

Israel has restricted Arab water usage and has continued to exploit Arab water resources. Presently, more than 85 percent of the Palestinian water from the West Bank aquifers is taken by Israel, accounting for 25.3 percent of Israel's water needs. Palestinians, Syrians and Jordanians are also denied their right to utilize water resources from the Jordan and Yarmouk Rivers, to which Syria, Jordan, Israel and Palestine are riparians. Israel has already diverted the waters of the Al Wazani River in south Lebanon and exercises full control over the Lebanese Hasbani River. There are grounds to suspect that Israel is also diverting part of the Litani River into the Haifa aquifer. West Bank farmers historically used the waters of the Jordan River to irrigate their fields, but this source has become quite polluted as Israel is diverting saline water flows from around Lake Tiberias into the lower Jordan. Moreover, Israeli diversions from Lake Tiberias into the National Water Carrier have considerably reduced the flow of the Jordan River, leaving Palestinians downstream with only effluent discharges.

In Gaza, the coastal aquifer serves as its main water resource. Other water sources in Gaza such as runoff from the Hebron hills, have been diverted for Israeli purposes. The Gaza strip which housed only 50,000 people before 1948, is now one of the most densely populated regions in the world. This is the result of the high levels of forced immigration following the 1948 and 1967 conflicts, and the high rate of natural population increase. Gaza's coastal aquifer now suffers from severe saltwater intrusion, Table 2.

**Table 2. Fresh Groundwater Balance of the Gaza Governate (1995)**

<b>Inflow Component</b>	<b>MCM/ Year</b>	<b>Outflow Component</b>	<b>MCM/ Year</b>
<b>Average recharge by rain</b>	<b>21</b>	<b>Domestic abstraction</b>	<b>32</b>
<b>Recharge from wadis</b>	<b>0</b>	<b>Irrigation abstraction</b>	<b>40</b>
<b>Groundwater from Israel</b>	<b>7</b>	<b>Industrial abstraction</b>	<b>1</b>
<b>Return flow (domestic)</b>	<b>13</b>	<b>Settlements abstraction</b>	<b>6</b>
<b>Return flow (irrigation)</b>	<b>18</b>	<b>Groundwater outflow</b>	<b>2</b>
<b>Brackish water inflow</b>	<b>20</b>	<b>Evaporation in Mawasy area</b>	<b>0</b>
		<b>Drop in groundwater table</b>	<b>-2</b>
<b>Total</b>	<b>79</b>	<b>Total</b>	<b>79</b>

Source: Ministry of Planning and International Cooperation, 1996

With regard to total water consumption, an Israeli uses 370 cubic meters per year (CM/year), compared to an average Palestinian use of 107-156 CM/year, while a Jewish settler uses 640-1480 CM/year.

Israeli restrictions have drastically limited the irrigation of Palestinian land so that today only 5.5 percent of the West Bank land cultivated by Palestinians is under irrigation, the same

proportion as in 1967. By contrast, about 70 percent of the area cultivated by Jewish settlers is irrigated.

The per capita water consumption among Palestinians in sectors other than agriculture, is approximately 25 CM/year in the West Bank, and 50 CM/year in the Gaza Strip, while it is 100 CM/year in Israel. This outlines the suppressed demand of Palestinians. The unsuppressed Palestinian demand is estimated at 125 CM/year per capita and therefore consumption would increase if restrictions were lifted (Isaac et al. 1994).

The prospect of substantial increases in water demand in the coming years renders it absolutely imperative to find a solution to Palestine’s water shortage. Demand projections for Palestine are shown in Table 3. The calculations are premised upon the population growth projections given above, and upon the lifting of current Israeli restrictions on water supplies.

**Table 3. Projected sectoral demand for Palestine**

Year	Domestic	Agricultural	Industrial	Total
1990	78	140	7	225
2000	263	217	18	495
2010	484	305	37	826
2020	787	415	61	1263

Source: Isaac & Selby, 1996

Water shortages in the region are expected to become more acute and critical as a result of over population, economic development and global warming. We cannot, therefore, count on natural trends to moderate the increase in demand. Rational policies are required to supplement any price adjustment to restrict and rationalize consumption.

### **The Turkish-Syrian-Iraqi Water Crisis**

On July 25, 1992 Turkey inaugurated the Ataturk Dam near Bozova in Southeast Anatolia. The dam is part of a large integrated multi-billion dollar irrigation and power generation complex that comprises 22 dams on both the Tigris and Euphrates rivers. By the year 2015, the new dams would help generate about 20 percent more electricity (more than 27 billion kilowatt-hours) and could irrigate 20,000 square kilometers of land (twice the size of Lebanon) which could theoretically double Turkey’s farm output. While the Euphrates and Tigris account for 28 percent of Turkey’s water supply, the two rivers represent over 40 percent of Syria’s and 80 percent of Iraq’s available water.

Turkey’s plan to fill the dams will drown 155 villages in Turkey, change the entire environment in the watershed and reduce the shares of Syria and Iraq in a fundamental way. When Turkey decided to divert the Euphrates and to fill the Ataturk dam in 1990, it shut totally its flow to Syria and Iraq despite an informal agreement with Syria to maintain the flow at 500

cubic metres per second. Both Syria and Iraq quickly realized the kind of difficulties the Turks can cause them. Despite major political difficulties between Damascus and Baghdad, the two leaderships quickly joined together threatening war over protecting their shares. Turkey discovered that it overestimated the rift between the two; it then re-opened the flow to its normal course. Water conflicts among these parties have never subsided. They are partly related to water, but they have a lot to do with strategic posturing.

Turkey is looking for a direction to project its power and interests. It has lost its advanced western post on the border of the Soviet Union and has been practically shut out of Europe. Turkey has abundant water but not much oil which Iraq, Iran and Syria have in different proportions. Water gives Turkey the instrument and pretext to project itself southward, while coveting oil gives it the impetus to project its power eastward. But Turkey has to contend with internal instability coming from the Kurds in Anatolia and the many ethnic groups that make up the Turkish mosaic.

The project is touted as transforming the area into a vibrant economy that can countervail the threat of the Kurds' Workers Party (PKK). There are, however, some strong reasons to believe that the project is intended to change the demography of the region by dwarfing the Kurds and flooding the region with other ethnic groups. Syria's preoccupation with the perpetual Israeli threat to its southern flank, its military presence in Lebanon and Iraq's defeat in the Second Gulf War, have combined to give Turkey wide room to project, unopposed, its military and water powers. The question is for how long and to what extent it can exploit Arab difficulties without paying internally for it. The Syrians are not taking chances and have explicitly and implicitly helped finance and protect the Kurds in their fight over Anatolia. The situation remains very precarious as long as Iraq is incapacitated. Iran is currently making up for the absence of Iraq, but is it in a position to affect the asymmetrical balance of power in the region? This is a crucial question at the moment following the death of Papandreou who was a staunch ally of Syria in its opposition to Turkey and the re-election of Yeltsin in Russia who is not prepared to risk his relationship with the west for Syria's sake.

The precariousness of the political situation is only matched by the variability of the flow of the Euphrates. The velocity of the Euphrates may fall as low as 100 cubic metre per second as it enters Syria at Karkamis in the summer and as high as 7000 cubic metres per second in April when the snow melts. The existence of the dams should theoretically allow Turkey to provide Syria with an even flow of 500 cubic metres per second throughout the year. It actually did this during the three drought years of 1989, 1990 and 1991. But recent events show Turkey exerting pressures on Syria through the variability of the water flow as part of a political strategy to extract concessions from it with regards to the presumed support Syria extends to the PKK. Turkey has gone as far as promulgating a military agreement with Israel that would extend Turkey's air space to Israeli planes. It is here where the problem lies. To what extent is Turkey willing and able to punish Syria and Iraq with impunity? Will Syria and Iraq remain indifferent to the repeated Turkish pronouncements and interruption of supplies? Are these interruptions truly tactical and therefore temporary, or are they the natural consequence of Turkey's decision to use a larger share of the water of the two rivers for its economic and political purposes far in

excess of its historical and equitable share? To what extent is Turkey able to maintain and escalate its cooperation with Israel against its Arab neighbors? What will be the internal and domestic repercussions within Turkey with its overt alliance with Israel against its Arab and Islamic neighbors?

Equally important and critical is the fact that even when the water flow is kept evenly at 500 cubic metre per second, is it of the same quality that it was in the past? There is considerable evidence that Iraq has already experienced a rise in the salinity of the water it gets from Turkey directly or through Syria, so much so that at Basra, much of the irrigated land are lost due to excessive salinity. The quality of water passing to Syria and Iraq is perhaps more important than the quantity. Both Syria and Iraq are adamant about protecting not only their quantitative shares, but also the quality of those shares.

It is now abundantly clear that the Euphrates and Tigris waters are tied to the waters of the Jordan. So are the waters of the Nile. The links are not physical, but strategic. Equitable shares among the riparian parties are falling prey to the imperatives of power and strategic alliances.

### **The Nile Waters**

In the late 1970s the late president Sadat of Egypt made a statement that he would be willing to provide Israel with water from the Nile. This prompted hostile reactions from Egyptians, Ethiopians, and from Israelis. With the population explosion that Egypt has been witnessing, local planners asserted that the Nile's waters would hardly be sufficient for the country's future needs. Israeli officials stated that the taps to such a vital resource should not be under the control of their former enemy and untried friend. Ethiopia reacted by declaring its intention to build a number of dams on the Blue Nile (the Nile's largest tributary which springs from there) to which Sadat threatened military intervention. In 1997, relations between the two countries were tested once more when it was rumored that Ethiopia, with Israel's help, was building dams on the Blue Nile. Sudan's chronic droughts have spurred concern over the Egyptian plans and have prompted the Sudanese to exert pressure on Egypt to renegotiate their water sharing plans.

### **Other Arab Water Crises**

Of no less importance are the problems associated with Libya's decision to create an artificial river that would tap into non-renewable water resources that it shares with many neighboring countries including Egypt, Chad and the Sudan. This aquifer will also be connected to the Arabian Shield aquifer in Saudi Arabia and other Gulf countries. The river will not last long. It will discharge in a few years waters that took over 10,000 years to accumulate. It will also require a massive investment of scarce resources that otherwise, could be used elsewhere.

Libya's annual water usage is already 4 times larger than the sustainable annual rate (see

Table 1). The artificial river would create a far more serious diversion between sustainable use and actual recovery.

Few countries in the Arabian Gulf are recovering sustainable water yields. Bahrain is already short of water and water salinity is exceptionally high. The same problem is faced in Kuwait, Qatar, and the UAE. Saudi Arabia is currently pumping water far in excess of the annual rechargeable rate. Data from the World Bank suggest that this excess is over 67 percent of the sustainable rate. There are reasons to believe that this excessive exploitation rate is highly underestimated. Saudi Arabia has embarked on growing wheat using non-renewable water resources. While it is understandable that food security considerations may have prompted the Saudis to pursue this course, it is also true that the same objective can be realized through storage policies that are less costly and environmentally damaging.

With the exception of Tunisia that is shown in Table 1 to be drawing a high 68 percent of its water supply, Algeria and Morocco appear to have large water supplies in excess of their current demands using much less at 16 percent and 37 percent respectively. This variation in water availability among neighboring countries suggests that regional sharing arrangements are not only viable but necessary.

### **The Harvard Water Allocation System (WAS): Solution or Problem?**

Since 1994, the Middle East Institute for Social and Economic Policy at the Kennedy School of Harvard University has been developing a mathematical system called Water Allocation System (WAS). This system purports to resolve the water disputes between the Palestinians and the Israelis. The proponents base their solution on a scheme that separates water ownership from management issues using the Coase Theorem (Coase 1960) designed to unitize oil fields by grouping together individual owners competing for a fixed and common resource underground. Competition among individual owners often left them with much lower profits for each than those that could have been obtained had they jointly managed the resource. The Harvard WAS deals with Palestinian water as a disputed resource over which the Israelis and Palestinians compete. Therefore, the rationale is that the disputed water can be treated in the same way Coase treated disputed oil. The solution is to be sought in joint management of the common resource. The model, discussed in details below, typically generates low shadow prices (scarcity prices) for water. This is interpreted by the designers to mean that the financial magnitudes of the conflict are small and can be resolved at very low costs.

The author worked with the Harvard designing team as a consultant to the Palestinian team at the early stages of development of WAS. Ultimately however, the decision to quit was made when it became apparent that the model is mis-specified and inflexible that no adjustments could be made to take into account any of the author's criticisms. It was felt very strongly then that, in its present form, WAS optimizes the status quo of Israeli dominance and exploitation and the optimization results serve to legitimize this status quo. Surely, the competing parties must know ahead of any scheme or plan for joint management what their respective shares will be from cooperation. Even Coase Theorem itself requires a clear initial distribution of property

rights of the respective parties before unitization. Indeed, it is important to ask what difference does it make to a party that the joint profits are larger if its share is not going to exceed what it can realize by individual and independent action?

There are many other small points that require attention. The price elasticities that define the inverse demand functions are derived from general considerations and are not derived from any empirical estimation of these demand functions. Since the results are very sensitive to these elasticity estimates, it is crucial to validate the model with an appropriate set of these elasticities. The author thinks that a solution to this problem requires a full agricultural model that determines the water needs of this sector. This is now under construction for the Palestinians under a new research project with which the author is currently working on with the Applied Research Institute of Jerusalem.

Equally important to efficiency considerations that emerge from the use of shadow prices (scarcity prices) are equity considerations ensuring that the parties to the joint management are treated fairly. A new constraint is needed suggesting that the current imbalances of water use among the parties will be eliminated in the future.

A detailed structure of WAS is hereby presented which makes explicit the assumptions upon which the model is predicated. There are two objectives. The first is to expose the weaknesses of the model and to raise red flags now that many Arab parties are taken by the ease with which the model works. Second, once the weaknesses are rectified, the model can be reformulated in such a manner that it can have many potential applications in the region at large. These uses are particularly crucial in terms of forecasting future water needs, allocating efficiently the scarce resource over competing ends and locations, evaluating the costs and benefits of developing new water infrastructure, the impact of the use of recycled water and the imposition of environmental charges on water treatment.

### **Components of the WAS Model**

The model has three major components. These include the specification of the objective function, the specification of the constraints set and the design of scenarios and simulations. More important perhaps is the way the results are interpreted. This will be treated in a separate section of this paper.

Maximization is typically undertaken subject to constraints. Corresponding to each constraint, there is a price that reflects the amount by which the objective function changes if the constraint level is relaxed by a small amount. This is referred to as the shadow price, dual value, Lagrangian multiplier or opportunity cost.

Some of the typical constraints encountered in water models include availability or continuity constraints. For example, the amount of water consumed in a given region cannot exceed the amount produced there plus imports into the region from all other regions minus exports to all other regions. There are also upper bound constraints on the amount of water that

can be lifted from any given source without affecting its renewable availability. There are also upper bounds on the capacity of the conveyance system. Associated with each of these constraints is a shadow price.

The central shadow price in this water model is that of water itself. This shadow price is not fixed and changes by location. But the shadow price of water at a particular location is the amount by which net benefits increase if water is made more available by one unit (a cubic metre). It measures the amount of money that users of water at the location would be willing to pay suppliers than going without the additional unit of water.

Maximizing net benefits ensures that the shadow price is different from the cost of providing this additional unit of water. Consider a location at which the cost of pumping water is zero. If demand for water at this location (for their own use or for exports) is sufficiently large, the shadow price of water would be positive. Equivalently, net benefits to consumers would rise if additional water were available. Consumers will be willing to pay a positive price to suppliers even though it cost them (suppliers) nothing to produce the extra water. This suggests that although the direct cost of the extra unit of water is zero, its opportunity cost is not. There may exist a demand for this water elsewhere. If the region cannot supply this outside demand, they lose the money the importers would have paid for it.

When demand for water at a particular source exceeds capacity, it still costs something to provide a specific user with an additional unit of water. That water can only be provided by depriving some other user of the benefits of the water, the foregone benefits are an opportunity cost.

Similarly, the shadow price associated with the limited capacity of a pipeline is the amount of net benefits that would increase per unit of pipeline capacity if that capacity were increased by a small amount. This is no larger than the amount of money those benefiting from the increased capacity would be willing to pay for more capacity.

Scarcity rent is the difference between the shadow price at a particular location and the direct marginal cost of providing water there. If the direct marginal cost is zero, the shadow price is equal to the scarcity rent. In a way, scarcity rent is analogous to per unit profit of a private producer. A positive scarcity rent is a signal that more water would be beneficial if it were available from that source.

## **The Mathematical Model Structure**

**Water Demand:** Three sectoral demands are defined: agriculture demand, industrial demand and urban demand. Agriculture demand receives special attention because farming is the dominant water user in the region and because important national policies typically relate to it.

The rate at which water is demanded by each sector depends upon the price of water

(US\$/m<sup>3</sup>) in that sector. The relationship between the rate of water use and the price of water is expressed by the sector's demand for water. These curves are all from the constant elasticity family.

$$Q_d = \left( \frac{P_{w_d}}{\beta_d} \right)^{\frac{1}{\alpha_d}}, \quad \beta_d > 0, \quad \alpha_d < 0$$

where

$Q_d$  = rate at which water is demanded in sector d and

$P_{w_d}$  = price of water in sector d

$\beta_d$  = the demand for water intercept in sector d

$\alpha_d$  = inverse of the price elasticity of water for sector d

There is no compelling empirical or theoretical warrant for using constant elasticity demand curves, but they have theoretically plausible qualitative characteristics and are easy to estimate and convenient to apply. But this convenience comes at a price. This price is high when the elasticity estimate is not accurate or real.

The objective function to be maximized is the sum of the net benefits from fresh water and recycled water.

$$\begin{aligned} \text{Max } Z = & \sum_i \sum_d \left( \frac{\beta_{id} \times (QD_{id} + QFRY_{id})^{\alpha_{id} + 1}}{\alpha_{id} + 1} \right) - \sum_i \sum_s (QS_{is} \times CS_{is}) - \sum_i \sum_j (QTR_{ij} \times CTR_{ij}) \\ & - \sum_i \sum_d (QRY_{id} \times CR_{id}) - \sum_i \sum_d (QTRY_{ij} \times CTRY_{ij}) - \sum_i \sum_d ((QD_{id} + QRFY_{id}) \times CE_{id}) \end{aligned}$$

Subject to:

$$\sum_s QS_{is} + \sum_j QTR_{ji} - \sum_j QTR_{ij} = \sum_d QD_{id} \quad \forall i$$

$$\sum_s QRY_{id} + \sum_j QTRY_{ji} - \sum_j QTRY_{ij} = \sum_d QFRY_{id} \quad \forall i$$

$$QRY_{id} = PR_{id} \times (QD_{id} + QFRY_{id}) \quad \forall i$$

$$(QD_{id} + QRY_{id}) \geq \left( \frac{P_{MAX}}{\beta_{id}} \right)^{\left( \frac{1}{\alpha_{id}} \right)} \quad \forall i, d$$

Bounds:

$$QS_{is} \leq QSMAX_{is} \quad \forall i, s$$

$$QD_{id} = QDL_{id} \quad \forall i, d$$



$$PR_{id} \leq PRMAX_{is} \quad \forall i, d$$

All Variables  $\geq 0$ ;

The inverse demand function can be expressed as a constant elasticity function:

$$P_{id} = B_{id} \times (QD_{id} + QFRY_{id})^{\alpha_{id}}$$

Where:

- s = Supply sources or steps {S1,S2,S3,S4,S5}
- d = Demand types {URB,IND,AGR}
- i = Region or district
- Z = Net benefits of water supply in  $10^6$ \$ (objective function variable)
- QS<sub>is</sub> = Water supplied from source s (of steps S1,S2,S3,S4,S5) to district i in Million Cubic Metres (MCM)
- QD<sub>id</sub> = Water demanded for sector d URB,IND,AGR) at district i in MCM
- QTR<sub>ij</sub> = Water transported from district i to district j in MCM
- QTRY<sub>ij</sub> = Recycled water transported from district i to district j in MCM
- QRY<sub>id</sub> = Water recycled from use d in district i in MCM
- QFRY<sub>id</sub> = Recycled water supplied to use d in district i in MCM
- QSMAX<sub>is</sub> = Upper bound of water supplied from source s to district i in MCM
- PR<sub>id</sub> = Percent of water that can be recycled from use d in district i in MCM
- PRMAX<sub>id</sub> = Upper bound on the percent of water that can be recycled from use d in district i in MCM
- CS<sub>is</sub> = Unit cost of water supplied from source s to district i in \$US/m<sup>3</sup>
- CE<sub>id</sub> = Unit environmental cost of water discharged by use d at district i in \$US/m<sup>3</sup>
- CTRY<sub>ij</sub> = Unit cost of transporting recycled water from district i to district j in \$US/m<sup>3</sup>
- CTR<sub>ij</sub> = Unit cost of fresh water transported from district i to district j in \$US/m<sup>3</sup>
- P<sub>id</sub> = Price of water at district i in \$US/m<sup>3</sup>

### **Interpreting the Model Results: Efficient Allocation Rules**

The efficient allocation of water requires that a number of conditions be met; these are generated by the model results. Below is a summary of some of the key findings.

Shadow price equals direct marginal cost of production and delivery plus scarcity rent. Water will be produced only from sources where the shadow price is at least as large as the direct marginal cost of production. This is the same as suggesting that water will only be produced

from sources where scarcity rents are non-negative.

- (i) If water is transported between two locations  $a$  and  $b$ , then scarcity rent of that water must be the same at both locations. This follows from the fact that water can only be transported from  $a$  to  $b$  if the shadow price at  $b$  cannot exceed the shadow price at  $a$  by more than the transportation cost. Water will actually be transported from  $a$  to  $b$ , only if the shadow price at  $b$  is exactly equal to the shadow price at  $a$  plus transport cost.
- (ii) At each location the shadow price is equal to what consumers would be willing to pay for an additional unit of water and suppliers just willing to accept for selling that additional unit.
- (iii) If there is more than one use for the additional unit of water then the scarcity rent associated with all the uses, should be the same. If there are two competing uses for an additional unit of water, e.g. agriculture versus domestic use,  $r$  and  $d$ , the scarcity rents derived from  $a$  and  $d$ , should be equal. If the scarcity rent derived from using it in  $r$  is greater than from using it in  $d$ , then the additional units will go to the  $d$  use until the rent falls to the level derived from  $r$ .
- (iv) If a body of water at a particular location can be transported to many different locations, buyers of water at any other location will not be prepared to pay more than the shadow price at the supplying location plus transport cost.
- (v) Producers will always supply water first from the cheapest source (the lowest shadow price plus transport cost).
- (vi) Water prices can exceed direct marginal cost by the difference between the demand price and the direct marginal cost at that location.
- (vii) The price of water is not likely to exceed water's highest replacement cost. If desalination is the highest cost supply source, then when prices of fresh water rise beyond the cost of desalination, the model chooses to operate the desalination plants. There is no necessity that the shadow price at a particular location should be equal to the desalination cost per cubic metre there; only that it should be higher. How much higher depends on the spread between the demand curve and the desalination marginal cost curve at the chosen level of water.
- (viii) The value of water at any particular location should be valued by its scarcity rent at that location. This is the price consumers should be willing to pay for an additional unit after subtracting the cost of lift and delivery.
- (ix) The fact that people are willing to pay large amounts for small quantities of

water deemed necessary for life is accommodated by the model structure. The demand curve is downward sloping and people are ready to pay much higher prices for the first additional units of water. The optimizing model handles this case by assigning very high prices to the first few million cubic metres of water considered critical for the highest valued demand by households.

- (x) If there are choices between freshwater and recycled water, the cheaper of the two will be used if that use is permitted. Recycled water in the model is restricted to agriculture. It is produced by industries and households. The cost of recycling is constant and is typically below production costs of freshwater. Its conveyance costs are the same as those of freshwater but different pipes are used for recycled water. In the model results, agriculture will choose to use recycled water wherever it is available and is cheaper, thereby releasing water to higher valued uses (those with higher shadow prices) such as urban uses. An increase in demand for recycled water raises the shadow prices of freshwater upstream but reduces it for urban users to encourage the production of more recycled water.

### **The Arab Disease**

Many underlying structural weaknesses in the Arab economy hamper its ability to adjust to global change, meet the challenges of peace and protect itself from adverse changes in the international economic environment and the prevailing balance of power in the region. Over the 1970s and 1980s, the illusive Arab economy's "success" has masked many structural problems. They are now becoming more important for future economic performance. Only a brief account of the most salient problems are presented below.

The Arab economy is generally characterized by a heavy, if not exclusive, direct and/or indirect dependence on the rent from natural resources, i.e. oil. This dependence has propagated an *Arab Disease* that manifests itself in: (a) overpriced domestic currencies in the region to the detriment of developing effective manufacturing exports; (b) inflated costs of production that have ultimately undermined local industry and agriculture; (c) flooded domestic markets with cheap and large volumes of imports that have compromised the balance of payments of even the richest states; (d) engendering non-sustainable high consumption patterns that are divorced from high production; (e) encouraging investments in large projects that were often unnecessary, duplicative and unproductive and which often left the economy with large maintenance costs; (f) bloating government bureaucracies with overlapping rings of rent seekers; (g) divorcing income from production; and (h) exposing the domestic economies to the wide fluctuations of the world market for oil over which the Arabs have but little control.

The heavy direct dependence of the Arab oil economies and the indirect dependence of the Arab non-oil oil economies on the rent of oil, suggest that the Arab economy is based dangerously on non-renewable resources and that a good part of Arab production is no more than a severe depletion of Arab natural capital (Gelb 1988). In this sense, Arab income and production are basically non-sustainable (Sachs and Warner 1995). The Arab economy is

consuming far in excess of its renewable income and its genuine saving rates are negative. This is in stark contrast to the prevailing belief that the Arab economy has large savings and huge financial surpluses.

The last decade has witnessed a remarkable upsurge in the concern for the sustainability of economic development. Much of the impetus for this concern is rooted in the report of the Bruntland Commission in 1987 (World Commission on Environment and Development 1987). The report argues that current development practices, by exploiting and/or degrading the environment, may diminish the welfare of future generations. While it has long been recognized that economic activity has environmental consequences, what is crucial in the Bruntland Report is the emphasis on the complex and rich overlap between the economic and environmental spheres with linkages in both directions.

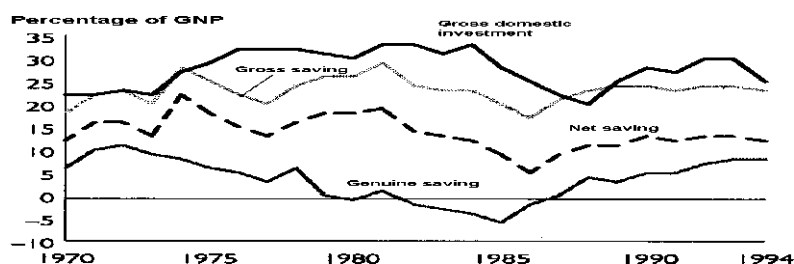
The United Nations Conference on Environment and Development (Rio Conference) in 1992 helped cement this recognition of the overlap and prompted many countries to commit to achieving sustainable development, among them, many Arab countries.

Not surprisingly, the concept of sustainable development is not clearly defined. Yet it is commonly understood that it is about creating and preserving wealth. In this context, wealth is broadly defined to include natural resources, human produced assets, healthy ecosystems, functioning social institutions and human resources. More recently, the United Nations' national accountants and others have developed a new concept generally known as the *Green GDP* (Hamilton and Lutz 1996). The new measure adjusts output, saving and investment measures to reflect environmental depletion and degradation.

Following the work of Pearce and Atkinson (1993), the World Bank now generates estimates of genuine savings that adjust the standard measures of net savings by subtracting costs of environmental depletion and degradation. The starting point is gross saving. This is calculated as a residual: GNP minus public and private consumption. In this way, gross savings represents the total amount of produced output that is set aside for the future in the form of either domestic investment or foreign lending. Gross saving rates say very little about the sustainability of economic activity. If capital depreciation is larger than gross savings, aggregate wealth as measured by produced assets, will decline. Net savings is a better measure of sustainability because depreciation of produced assets is subtracted from gross savings. It does not take into account the depreciation of other assets.

Measures of genuine savings are better indicators of sustainability because they value the changes in natural resources and environmental quality in addition to produced assets. The simplest way to explain this concept and the uses it can be put to is through a figure that depicts the accounts appropriately for Tunisia. The top curve in Figure 1 is gross domestic investment — the total investment in structures, equipment and inventory accumulation. When net foreign borrowing including net official transfers is subtracted from gross domestic investment, it results in an estimate of gross domestic savings. When depreciation of produced assets is subtracted, net savings is

arrived at. Finally, the bottom line, literally and figuratively, is genuine savings. This is derived by subtracting the value of resource depletion and pollution damages from the net savings.



Source: World Bank Calculations. *Expanding the Measure of Wealth. Environmentally Sustainable Development Studies and Monographs. Series No. 17. 1997*

**Figure 1: Genuine Savings In Tunisia**

Resource depletion is assumed to equal the total value of rents on non-renewable resource extraction. These rents are estimated as the difference between value of production at world prices and the total cost of production, including depreciation of fixed assets and normal returns on capital. Technically speaking, this measure is of accounting profits rather than scarcity rents. In this way, it results in an upward bias on the value of depletion and therefore a downward bias on genuine savings. This bias is serious for the Arab part of the world because of its heavy dependence on oil rents. No explicit adjustments are made for resource discoveries because these are treated as investment in the Standard System of National Accounts. The subtraction of environmental damage costs is restricted to the value of damage from pollution emissions calculated unjustifiably only for carbon dioxide, using a figure of US\$20 per metric ton of Carbon emitted (Frankhauser 1995).

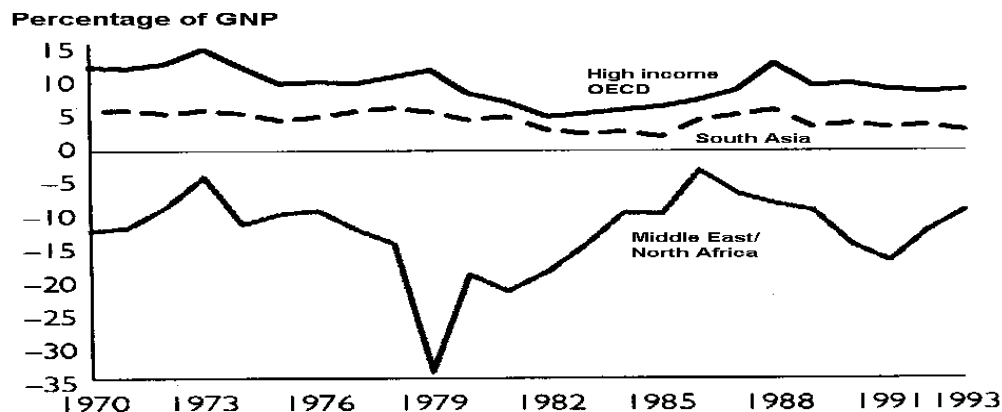
The estimates of genuine savings for the Arab region (MENA), show consistently negative figures (Table 4 and Figure 2). This is at variance with most other regions of the world. Negative genuine saving rates of 25 to 40 percent in Bahrain, Oman, Saudi Arabia and Yemen have not been offset by the modestly positive saving rates in the early 1990s such as those in Egypt, Morocco, Tunisia, Syria and Lebanon. Despite very heavy investments in infrastructure and industry in the region following the explosive rise in oil prices, the net effect of rapid depletion of oil stocks on genuine savings was still negative. Regional total consumption as a share of GNP rose from around 50 percent in the 1970s to more than 70 percent by the end of the 1980s, while at the same time, imports of food and manufactured goods flowed into the region as most of its oil-producing countries turned their current account surpluses into deficits. Despite recent gains in the overall saving rates in the region, negative genuine saving

rates hover around 10 to 15 percent.

**Table 4. Genuine saving ( percent of GNP)**

Region and Income Category	Average, 1970-79	Average, 1980-89	1990	1991	1992	1993
<i>Region</i>						
Sub-Saharan Africa	7.3	-3.2	-3.8	-1.2	-0.6	-1.1
Latin America and Caribbean	10.4	1.9	5.5	4.1	4.7	6.1
East Asia and Pacific	15.1	12.6	18.6	18.7	18.7	21.3
Middle East and North Africa	-8.9	-7.7	-8.8	-10.8	-6.6	-1.8
South Asia	7.2	6.5	7.6	6.3	7.1	6.4
High-income OECD	15.7	12.4	15.7	14.5	14.0	13.9
<i>Income Category</i>						
Low	9.8	3.3	5.7	7.5	9.0	10.5
Middle	7.2	2.9	10.0	9.7	7.8	8.1
High	15.2	12.3	15.9	14.6	14.1	14.1

*Note: Data include an adjustment for current spending on education*  
*Source: World Bank calculations*



*Source: World Bank Calculations. Expanding the Measure of Wealth. Environmentally Sustainable Development Studies and Monographs. Series No. 17. 1997*

**Figure 2: Genuine Saving Rates by Region**

Indeed, it can be easily be argued that these estimates are biased upward and therefore exaggerate the extent of non-sustainability of development in the region. They do so not only because they exaggerate the rent on oil, but also because they include no estimate of the positive and large investments made in human capital in the region.

Notwithstanding all of these considerations, economic development in the Arab region is not sustainable. Either consumption levels must be pared with sustainable income (Hicksian income) and or investment in all forms of wealth must be increased. The returns on the latter should have a present net value equal to the value of depleted oil reserves and environmental degradation.

### **Conclusion**

Water is an asset. It is rarely treated as such. Typically, it is valued at marginal cost of its reproduction. This is fine as long as water is considered as a renewable source. The fact of the matter is that most countries of the region face severe binding constraints on water and often use more water than is sustainably recharged. Scarcity premiums should be added to the cost of production to reflect this decreased availability of the asset. This increased valuation should create sufficient incentives not to waste it and the need to conserve and rationalize supplies and demands.

Water basins in the Arab region may not be connected geographically, but they are connected strategically. Israel and Turkey have forged strategic alliances that are underpinned by manipulating water availability to other riparians. Israel's long arm has reached Ethiopia trying to pressure Egypt into a more accommodating stance.

It is clear that the Arabs need not only work towards a more sustainable economic development strategy by moving of non-renewable resources and a more rational conservation of their resource base. They also need desperately a strategic posture, an alliance to coalesce their powers into a meaningful force that can protect and safeguard their water interests in an environment of global warming in which water is becoming increasingly more scarce.

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