Water management, Middle East peace and a role for the World Bank *

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1. Introduction

Conflicts over water between countries are usually seen as a zero sum game, that is, a gain for one country is a loss for another country. Such a view of water allocation does not incorporate the fact that water is an economic good. Economic goods are by definition scarce. When water is seen as an economic good and if it is allocated efficiently, then all users benefit. In the case of most economic goods, competitive markets can be expected to provide the mechanism for efficient allocation. But for water allocation the markets are usually not competitive because there are very few sellers of water and social and private costs and benefits are not the same. While uncompetitive markets are the problem within a country, the difficulties are magnified when there are water interdependencies between countries. Even if one country allocates water efficiently (through competitive markets or by employing an optimization model) within its own territory, its allocation could be sub-optimal if water interdependencies are not incorporated.

While optimal water allocation could only but help, growing water scarcity is a problem in a number of regions in the world. The

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Middle East is a region where water scarcity has been a serious problem resulting in conflicts and the scarcity could result in future conflicts if water allocation is not resolved in an economic context. Most prominently, water has been an issue between Israel and the Palestinian National Authority (PNA); it was an element leading to the Iran-Iraq war and continues to be a problem there; it has been and is a source of conflict between Turkey and Syria; and it has adversely affected Syrian-Iraqi relations. If regional water allocation is not properly addressed, it could become the source of a much wider regional conflict involving Iran, Iraq, Israel, Jordan, the PNA, Lebanon, Syria and Turkey.

The World Bank is the entity that is in the best position to ameliorate water conditions in a number of regions around the world, especially in developing countries. While agriculture continues to be a dominant sector in most developing countries consuming a larger share of water resources than all other users combined, the World Bank still looks at agricultural and water projects in regions in an independent fashion. The World Bank finances agricultural projects; and it only finances water projects which do not affect water resources in other countries (unless the affected country concurs). Such an approach is bound to be sub-optimal, as it does not incorporate the interdependencies of agricultural and water projects across countries. A more appropriate approach would begin with an optimization water management model to manage water resources among countries whose water resources are interdependent. Based on this, the World Bank could better assess agricultural and water projects around the world. This would provide the basis not only for more efficient water allocation and agricultural development, but it would also contribute significantly to regional peace around the world.

The basis for such an approach has been provided by Franklin Fisher and his colleagues (2000). Such an approach would have obvious benefits for the Middle East region, the focus of this study. These countries have a few sources of water, these are largely state-owned, and social costs and benefits do not invariably coincide with private costs and benefits. Fisher *et al.* have developed an optimization model to allocate water resources in Israel, Jordan and the areas controlled by the PNA. Besides allocating water efficiently, the model provides a powerful tool for analyzing the costs and benefits of water-related infrastructure, such as pipelines, desalination, leakage reduction and estimating the economic gains from efficient water allocation in both a single country and from cooperation between a number of countries, especially the trading of water permits.[1]

In this paper, we first discuss water interdependencies in the Middle East (with country-by-country details in the Appendix); second, we focus on existing and potential regional disputes over water and the limited contribution of international law. Third, we review the Fisher optimization model and its applications. Finally, we outline an important role for the World Bank.

2. Water in the Middle East

2.1. *Regional overview*

The region comprising Northern Africa and the Middle East is the driest in the world.[2] Annually, it has 355 billion cubic meters (Bm^3) of renewable water resources, compared to 5,379 Bm^3 in North America, 4,184Bm^3 in Africa, and 9,985Bm^3 in Asia.

Currently, this region of 284 million people (5% of the world's population) has access to 1% of the world's fresh water; with each person using 1,250m^3 of water every year, while in North America it is 18,742m^3 per person, 7,485m^3 in Africa, and 3,283m^3 in Asia. Given the rising population and pollution in North Africa and the Middle East, it is expected that the amount of available fresh water for each person will be halved in the next thirty years. As it is, 16% of the people in the region (45 million people) currently lack a safe water supply, as fertilizers, pesticides, municipal and industrial waste, dumping, saline infiltration, landfill seepage and over-exploitation degrade regional water sources.[3] Clearly, the situation is not sustainable.

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[1] The authors point out that their model is being further refined to incorporate three more critical dimension-temporal interdependence (multi-year), seasonal variations, and a finer treatment of water quality. They should also incorporate environmental considerations.

[2] According to World Bank statistics. See World Bank (1999).

[3] World Bank (1999).

In Table 1 we provide the basic data for these countries.[4] The pattern of water use in the Middle East differs broadly from that in the rest of the world. While 87% of withdrawn water is used for irrigation in the Middle East, the world average is 69%. As a result, only 13% goes toward municipal and industrial use, while normally this figure is 31%. These proportions in the Middle East aggravate the regional water shortage, as does antiquated city plumbing that in some places causes a loss of 50% of municipal water. Currently, there are fragmented efforts by local, national and international organizations to address these problems, but these have not proven effective, and efforts are often wasted as actions are duplicated or contradict each other.

TABLE 1

WATER AVAILABILITY AND USAGE IN THE MIDDLE EAST[a]

	Annual renewable resources (Bm^3)	Annual withdrawals		Per capita availability in 1995 (Bm^3)	Water Usage (%)		
		Bm^3	% of annual renewable resources		Domestic	Industrial	Agricultural
Iran	118.8	46.5	39	1826	4	9	87
Iraq	104.0	43.9	42	4952	3	5	92
Israel	2.1	1.9	90	375	16	5	79
Jordan	0.8	1	125	213	20	5	75
Lebanon	4.8	0.8	17	1200	11	4	84
Syria	5.5	3.3	60	385	7	10	83
Turkey[b]	196	31.6	16	541	17	11	72
West Bank and Gaza	0.2	0.2	100	105	12	13	75

[a] World Bank (1999, Illustration 3).
[b] Figures for Turkey come from the UN Food and Agriculture Organization, Aquastat, Tables 13 and 14; http://www.fao.org/waicent/faoinfo/agricult/agl/aglw/aquastat/tables2.htm.

[4] We have excluded the countries of the GCC (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates) from our discussion as they have little interdependence to other countries in the region.

2.2. *Regional water disputes*

Essentially, there are four major disputes over water in the Middle East: control of the Karun (Iranian name) or Shatt-al-Arab (Arab name), the Euphrates River, the Jordan River and the coastal and mountain aquifers.

The Karun is not a conflict based on providing the people of Iran and Iraq with a source of water for consumption, either domestic or agricultural. While these waters certainly do allow for agricultural development, their most important function is to serve as a transit corridor through which goods from the interior can be taken to the Persian Gulf for export. The conflict surrounding the course of this river is, therefore, a dispute over the river as a border and over who controls its access, since it is the only point at which Iraq has an outlet to the Persian Gulf.[5] From 1980 to 1988, a war, resulting in hundreds of thousands of deaths and enormous economic loss, was fought between Iran and Iraq; this war was a result of Iraq's bitterness over the 1975 settlement of the issues surrounding this waterway.

This old controversy can be traced back to border disputes between the Persian and Ottoman Empires. A 1639 peace treaty between these empires used vague language to designate the Karun or Shatt-al-Arab as the official border between them. In particular, it did not take into account the fact that there were Arab tribes living on the Persian side of the river, and that the Ottoman Empire would want to claim these people and their territory as their own. War broke out in the beginning of the 1800s, which concluded in another treaty, the Second Erzerum Treaty of 1847. This peace also proved unstable due to unresolved issues surrounding the Shatt-al-Arab. It did not, for example, state whether the border was to be demarcated on either bank or down the center of the river.[6] A protocol signed in Constantinople in 1913 was to have created a commission to officially judge the exact border, but the outbreak of World War I precluded its determination. Another commission studied the border in 1938, and it was debated into the 1950s, but any progress that was made was reversed by a revolution in Iraq. Instability followed, and as Iran grew

[5] Martsching (1998).
[6] Hunseler (1984, p. 11).

militarily, it began to assert its claims. Iraq was induced into signing the Algiers Agreement of March 1975, which placed the border between the two countries in the center of the river. Iraq wanted to control the whole river, but Iran, as the stronger of the two, insisted on controlling half. The issue has not yet been amicably resolved.[7]

The issue of controlling the water of the Euphrates is another significant source of conflict in the region. The point of conflict comes from the fact that both Syria and Iraq depend to a large degree on Euphrates water in order to sustain their agriculture and to provide for other requirements. Meanwhile, at the headwaters, Turkey is developing the vast GAP project (SouthEastern Anatolia project), which is continually restricting the flow of this river. Of the three countries, Turkey is in the strongest position both because it controls the source of the Euphrates (98% of the water in the Euphrates is contributed by Turkish sources) and is the strongest politically. Beyond the Turkey-Syria border, there are only a few, insignificant tributaries that drain into the river.[8] These factors combine to create a situation in which discussion of the issue cannot effectively take place under the current circumstances.

In 1974, a dry year, both Turkey and Syria began filling reservoirs that they had built along the Euphrates, causing its flow to stop. The Arab League attempted to mediate the situation, but failed.[9] Syria pulled out of the league, and both countries massed their militaries on the border. In the last minute before war broke out, Saudi Arabia succeeded in mediating an unofficial agreement between the would-be belligerents. Syria agreed to use no more than 40% of the water of the Euphrates, allowing Iraq access to 60%.[10] Despite Saudi Arabia's efforts at averting the war, relations have never healed between these two countries.

Turkey, in a plan presented during a 1984 meeting on the topic, is of the opinion that there is enough water to satisfy all the riparians, and that the issue has reached its current level of controversy because of exaggerated statements of need by all parties. Turkey takes the po-

[7] See Martsching (1998).
[8] Kor (1997).
[9] Soffer (1999, p. 111).
[10] Kor (1997).

sition that through a program of inventory studies of land and water resources, and evaluation of those studies, a logical agreement can be made based on the true water requirements of each country.[11]

Iraq, of the three, is most dependent on the water of the Euphrates River. Developments in Turkey, and to a lesser extent in Syria, alarms the Iraqi government, which sees its share of the resource dwindling annually. Iraq takes the position that the situation can be best resolved through a mathematical distribution, based on need as well as historical rights. Each country would then notify a trilateral commission of any further development, which would then analyze the intended project in the context of the water resources of each country, evaluate its impact and determine whether the development should proceed. Finally, Iraq demands that Turkey allow significantly more water to flow downstream than it does currently.[12]

Syria also claims historical rights, in addition to supporting a plan much like that of Iraq. Syria would like to see a project set up among the Euphrates riparians that would begin with a statement by each country of the amount of water it would like from the source. The total water resources and needs of each country would then be studied. The water would then be distributed among the countries according to each one's demands. If the demands of all three, however, exceed the total capacity of the river, then each country's share would be deducted proportionally to the shares of the others.[13]

Third, the use of the Jordan River creates another set of complex relationships, claims and dependencies. Its four tributaries, and thus its origins, are international in nature. The Yarmouk River originates in Syria, the Banias in Israeli-occupied Syria, the Hasbani in Israeli-occupied Lebanon and the Dan in Israel. The Jordan river itself can be claimed, at least in part, by Israel, Syria, Jordan and the Palestinians. The intersection of so many interests and tensions amidst outright political hostility among the actors creates a potential flash point for open aggression.

In the 1967 war, Israel took control of the Upper Jordan (north of the Sea of Galilee) and established a security zone that included the headwaters of the Banias and Hasbani rivers. Syria maintained control

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[11] Kor (1997).

[12] *Ibid.*

[13] *Ibid.*

of the upstream portion of the Yarmouk River, but the Palestinians and Jordan, farthest downstream on this river basin, are the riparians most dependent on this source of fresh water. In the West Bank it is the only fresh surface water, and in Jordan the situation is even more dire. Although the Palestinians can depend, at least to some extent, on the renewable resources from the mountain aquifer, the Jordan and Yarmouk rivers are the most significant renewable water resources in Jordan.

There have been three attempts to resolve the various claims on the Jordan River. The United States led an effort from 1950 to 1953 among all the riparians, but the Arab parties to the talks dismissed the United States outright as a biased third party. During 1976-81 and 1987-90 the United States made further attempts to resolve this conflict, although the second only included Israel and Jordan; these failed as it became clear that water rights had become intrinsically tied to politics. Without a settlement of the Israel-Arab dispute, agreement on the Jordan River is beyond reach.

The conflict is, as with the Euphrates River, based on usage and the difficulty that downstream parties have in attaining adequate amounts of water. The difficulties are compounded, however, by ethnic and religious contention. Currently, the Jordan River and its tributaries are being used at their maximum potential, and as pollution continues, this level is likely to fall off.[14] Allocation of the water is therefore of importance, primarily to Israel and Jordan. The 1994 peace treaty between Israel and Jordan included some provisions on this subject, including recognition of each party's dependency on the Jordan River and steps to take to maintain water quality.

There are other disputes surrounding the control of this river. The Israeli occupation of the Golan Heights is another source of conflict within the Jordan River basin. This area contains some of the headwaters of the river, and is thus important to Israel. Syria, of course, still claims sovereignty over this area. Syria and Jordan's plans for developing a dam on the Yarmouk have also raised tensions. As mentioned above, Israel had long blocked this project; thus World Bank funds could not be forthcoming. Now that Syria and Jordan have found an alternate source of financing, construction is set to be-

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[14] Soffer (1999, p. 120).

gin, but meanwhile Israel is making demands to increase its allotment of water from the Yarmouk.[15]

The aquifers under Palestinian-controlled territories, and particularly the mountain aquifer, is the fourth major source of water-related disputes in the Middle East. The Palestinians claim the right to use this water by virtue of their sovereignty over the territories, and demand a total of 550-560Mm^3 from the aquifers in the West Bank and Gaza.[16] Israel claims that by pumping water that would naturally emerge anyway in Israel, they are simply taking what is theirs. Making the issue all the more delicate is the fact that the coastal aquifer is slowly being destroyed by salt water intrusion from overpumping and that the areas in the mountain aquifer, from which water can be most efficiently pumped, are near the Green Line separating the Israelis from the Palestinians.[17]

The central theme to the conflict over these resources is the inequality of access that each side, the Palestinians and the Israelis, have to the available water. According to a Palestinian consumer protection organization, Palestinians in the West Bank and Gaza get forty liters of water a day, compared to the 300 liters that Jewish citizens receive. They blame settlers who, they allege, pump water freely for crops in the desert, leaving the Palestinians without enough to fulfill their basic household needs.[18] In fact, the Palestinian communities are often restricted to what water arrives in trucks as their wells run dry or as water becomes too infused with salt to be potable. Last year, when the region suffered from a drought, some Palestinians had available water for one or two days a week.[19]

Efforts have been made to address the problems raised by the competing claims on these aquifers, but until now, no concerted effort to implement a real program for equitable water distribution has been successful. The Oslo Agreement provided for a Water Resources Working Group, in which Israel, Jordan and the Palestinians would participate. This body is intended to facilitate cooperative solutions for addressing increased demands on scarce water resources. Also, in accordance with the Oslo Agreement, the coastal aquifer is to be re-

[15] Green Cross International (2000).
[16] Soffer (1999, p. 191).
[17] *Ibid.* (p. 133).
[18] *Hamas News* (1999).
[19] King (1999).

turned to Palestinian control, even while Israel insists on continuing to manage the mountain aquifer. Article 5 of the agreement puts off the permanent resolution to the issue in the context of the final peace talks.[20] Clearly, this groundwater is tied up in considerable political negotiations.

The recent peace talks at Camp David included, according to some reports, a discussion of increasing Palestinian control of the West Bank groundwater, although nothing was worked out. The Palestinians remain upset about quotas imposed on the use of water they perceive as their own, frequent unavailability of water and the lack of resources to connect all houses and communities to water lines while settlers pump relatively ample amounts of water. For the Palestinians, the issue is one of survival as well as sovereignty.

2.3. *Water interdependence*

In Table 2, we have created a simple matrix to delineate water interdependence among the countries within the region. We have used high, medium, low and zero designations. The high designation is used if over 30% of a country's supply currently comes, or is projected to come within the next ten years from the affecting country; medium if it is between 8 and 30%; low if it is between 0.5 and 8%; and zero if dependence is non-existent. As can be seen from the Table, the disputes described above correspond to the greatest amount of interdependence.[21]

As the Table indicates, Israel is most significantly affected by the Palestinian Authority. Additionally, it needs to worry about two relatively small sources. The first is the water that enters its territory in the Hasbani River from Lebanon and the Yarmouk River from Syria. Since much of this water exists in or transits Palestinian-occupied areas, the situation would change dramatically if the Palestinians regain sovereignty. The balance of power, as far as water rights are concerned, would then fundamentally change, shifting from Israel

[20] On line at http://www.memri.org/docs/oslo1.html.

[21] In constructing the Table, we have assumed that the Golan is returned to Syria. In this assumption (or indeed in the entire Table), we do not intend to make any political statements.

to the Palestinians. The second source is the water from the Jordan River in Lebanon and on the Golan.

The Table also highlights the successive dependence that Turkey, Syria and Iraq have on each other. It also demonstrates that this system is relatively isolated. Although Syria receives a significant amount of water from Lebanon and Iraq from Iran, these countries are primarily dependent on the actions of the upstream state, Turkey.

TABLE 2

REGIONAL WATER INTERDEPENDENCE*

Affecting country	Iran	Iraq	Israel	Jordan	Lebanon	Syria	West Bank/ Gaza	Turkey
Affected country								
Iran	–	low	zero	zero	zero	zero	zero	zero
Iraq	high	–	zero	zero	zero	high	zero	high
Israel	zero	zero	–	low	medium	medium	high	zero
Jordan	zero	zero	high	–	low	medium	high	zero
Lebanon	zero	zero	zero	zero	–	zero	zero	zero
Syria	zero	zero	zero	zero	high	–	zero	high
West Bank/ Gaza	zero	zero	high	zero	medium	medium	–	zero
Turkey	zero	zero	zero	zero	zero	low	zero	–

* In this Table, in order to address Israel and the Palestinian territories separately, some water sources, such as the coastal and mountain aquifers and the Jordan River were counted twice. Where this was done, the impact on the West Bank and Gaza is measured as if these territories were sovereign. When measuring the impact on Israel, however, it is assumed that the Palestinian territories remain a part of Israeli. In all these assumptions we are not making any political statements.

One interesting note from the Table is that although Iraq is highly dependent on Iran for much of its water, the dispute between them is limited to the Karun or Shatt-al-Arab system. It indicates that should any rapprochement occur between these states, the series of rivers that flow into the Tigris from Iran could become a source of new conflict. This is especially true if Iran begins to develop these systems, either for agricultural, industrial or domestic use. As it stands, however, Iran has not taken advantage of this potential point of leverage.

3. International law and water disputes

There is very little basis in international law to settle disputes over water rights.[22] To provide some perspective, however, it is useful to summarize what tenets exist, while keeping in mind that international law in this sense is not enforceable when sovereign states are involved. The International Court of Justice might have jurisdiction over some of the disputes raised in the Middle East surrounding international waterways, but in general, a country is only held accountable to customary law to the degree that it itself feels bound by it. In any case, international law has not dealt with the issue at hand.

There are three principles of water sharing in occupied territories: the Fourth Geneva Convention (1949), the Hague Regulation (1907) and various UN General Assembly and Security Council resolutions. Essentially, an occupying state does not have sovereignty over occupied areas or its resources – it only has authority there. The occupant has two responsibilities. First, resources from the occupied territory can only be taken to satisfy the needs of the military physically there, and cannot be taken to provide for military in other regions, including the home territory. Second, the occupier must respect the interests and needs of the inhabitants, meaning that it cannot take all the resources and leave nothing behind for the people to survive with. Above all, an occupying force cannot use authority over a conquered area to further its own interests or the needs of its own population.[23]

The International Law Association adopted the 1966 Helsinki Rules on the Uses of International Rivers. Among other things, this document states that "each basin state is entitled, within its territory, to reasonable and equitable share in the beneficial uses of the waters of an international drainage basin".[24] The rules also state that all users must agree to a new claim on the water of an international river.[25]

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[22] As to be expected, countries do claim the right to ownership on the basis of historical use.

[23] Salmi (1997, p. 22).

[24] *Ibid.* (p. 30).

[25] *Ivi.*

4. Fisher's optimization model

The Fisher *et al.* model can be applied to districts within a country or to two or more countries which have interdependent water supplies, water demands, water costs and related water infrastructures.[26] Specifically, in the model, the geographical region under management is divided into a number of districts. Within each district, demand curves for water are defined for household use, industrial use and agricultural use. The annual renewable amount of water from each source is taken into account, as is the pumping cost. Allowance is made for recycling of wastewater, and the possibility of inter-district conveyance is taken into account. Environmental issues can be readily modeled. The model permits experimentation with different assumptions as to changes in infrastructure, for expansion or installation of conveyance systems, and creation of seawater desalination plants and the like. The user specifies the national and regional policies toward water that are desired; and the results provide the user with the means to examine how the user's policies can be efficiently implemented and what the consequences are.

Given the water constraints and the choices made by the user, the model allocates the available water so as to maximize net benefits. The result of the maximization is a system of 'shadow' prices. The shadow prices associated with a particular constraint show the extent by which the net benefits from water would increase if that constraint were relaxed. For example, where a pipeline is limited in capacity, the associated shadow value shows the amount by which benefits would increase if capacity were slightly increased. This is the amount that those benefiting would be willing to pay for more capacity. The central output of the model are the shadow values of water at given locations – the amount by which the benefits to water users (in the system as a whole) would increase were there an additional cubic meter per year available free *at that location*. It is also the price that the buyers at that location, who value additional water the most, would just be willing to pay to obtain an additional cubic meter per year.

[26] This section is adapted from Fisher *et al.* (2000).

Beyond uses for more efficient water management, the model could be used to assist in water negotiations and to foster cooperation in water. These uses are:

a) Because the model reveals the value of water in different locations (taking into account the user's own policies and values), it enables water disputes to be monetized, which should assist in their resolution. This is particularly so because the availability of seawater desalination puts a ceiling on the value of water to any country that has access to the sea.

b) Each party can use the model to evaluate the consequences to itself of different proposed water agreements.

c) The model can show the value of cooperation in water. Cooperation can involve the trading of 'water permits' – short-term permits to use another party's water at specified locations. Such trading would take place at the shadow values given by the model's output and would lead to *joint* gains wherever the parties value water differently. Further gains are possible from the construction of joint infrastructure.

To fully achieve these benefits for a region, it is essential to include *all* countries whose water conditions are interdependent and to construct a multi-year model.

5. A role for the World Bank

As discussed earlier, there is very little in the body of international law that can be put to use in resolving regional water disputes. On the one hand, countries waste their precious water resources, largely on agriculture, with little regard for implications for the quantity and quality of water availability tomorrow and with almost zero regard for implications for their neighbors. On the other hand, when water scarcity looms its ugly head, they are ready to do battle over their sovereign rights, heritage and national security. All the while, as Fisher and his colleagues so eloquently point out, better domestic water management can divert, or at least significantly delay, such a crisis; regional water management may postpone a crisis indefinitely and if all else fails then at least for countries with access to the sea, desalination provides an upper bound cost estimate for additional water supplies.[27] Thus, through better water management political crises and military conflicts can be thwarted.

The availability and access to water should not be allowed to become a political issue. It should be seen and resolved as an economic issue. Once it is taken out of the realm of economics and made political, then it is harder to resolve. Political differences invariably invoke nationalism, with a greater likelihood for military conflicts. The United Nations cannot resolve what is at its core an economic issue. The United Nations was set up as a political forum and it functions as such. Water issues are mishandled by the UN because the UN tries to settle them as political issues.

In contrast to the UN, the World Bank was set up as a financial institution. Its ongoing mission is to promote economic development and growth in developing countries. It does this by financing structural adjustment programs and projects in developing countries. These projects include dams, irrigation, general water resource development, electricity generation and distribution and much more. The World Bank's agricultural projects in a country affect water demand, in turn affecting water supply in another country if their water resources are interdependent. Although the World Bank is already involved in water and water-related projects in developing countries, it does not take a holistic approach.

The World Bank should be actively involved in water-related projects in many regions. First, it should adopt a model to assist all developing countries in domestic water management to use available water optimally over time. Second, it should recognize that supposed non-water projects, such as agriculture, have water implications for a country and may impact water availability in other countries. Third, it should use a similar model for regions to ameliorate regional water issues for *i)* countries that are water interdependent and *ii)* regions where some countries have water surpluses while others have deficits. Fourth, the Bank should provide a continuous forum to discuss the results of their regional water management model. The Bank could propose voluntary cooperation, such as the sale and swap of water permits between countries. Fifth, where countries and regions are following Bank prescriptions and shortages still persist, the Bank should

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[27] For a discussion of the cost of desalinated water, see Askari (1980).

adopt a policy of providing some of the financial resources necessary for efficient large-scale desalination projects. In short, the World Bank should act as an honest and impartial broker to give advice to help manage water resources and resolve water-related disputes in an economic and financial, as opposed to political, context.

The World Bank has been involved in the area of water and sanitation for a considerable period of time. The World Bank acknowledges the importance of this issue for the world by noting that one billion people do not have access to safe water and two billion lack safe sanitation.[28] These problems, if unaddressed in the most efficient manner, will only deteriorate over time with growing population and increasing water scarcity. The various components of the World Bank Group – IBRD, IDA, IFC and MIGA – are committed, either directly or indirectly, to ameliorating water and sanitation problems of developing countries. In 2000, the ongoing water supply and sanitation investment projects of the World Bank numbered ninety-two and had a total capital commitment of over US$ 6 billion.[29] While the World Bank financed these projects on a stand-alone basis, it still admits that:

> "Water is a finite resource with many competing uses. Protecting and allocating this resource can only be done in a holistic framework encompassing the different water using sectors (water and sanitation, irrigation, hydropower, and ecosystems) at the river basin level".[30]

It is now time to take a holistic approach. But a holistic approach should go beyond the above description. It should also incorporate water interdependence across countries and the intertemporal dimension of water.

Finally, as with almost anything else, it is better for the World Bank to start such a program sooner as opposed to later. The size of the problem is smaller and the difficulties surrounding it more manageable if the Bank gets involved while there are viable options. This is especially so in the case of water where pumping today from underground aquifers, both replenishable and especially non-replenishable, has a major impact on tomorrow's water availability. The need

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[28] World Bank (2000, p. 4).
[29] *Ibid.* (pp. 5-10).
[30] *Ibid.* (p. 19).

to act soon is further reinforced by today's policies toward water pollution and its environmental impact. Before water problems become serious, they are more likely to be seen as economic as opposed to political in nature; thus the earlier potential water disputes are addressed, the more likely it is that they will be resolved in a more efficient and peaceful manner.

APPENDIX

Country water conditions

Iran

Iran is a semi-arid country,[1] but is currently able to satisfy its water requirements every year from its own internal resources. As indicated by World Bank data, Iran withdraws only 39% of its annual renewable resources. Nonetheless, water management is of major concern. In the last ten years, Iran has been aggressively improving its water management, principally in order to supply its agricultural sector. As of 1997, the country had 49 dams under construction and 70 under plan. An extensive network of irrigation and drainage canals has also been built.[2] In early 2000, a 333Km (207 mi.) pipeline began transferring water (for municipal and industrial use) from the Zayandeh River in the central part of the country to the dry province of Yazd, initially carrying $1m^3$/second, with this figure expected to increase to $3m^3$/second.[3]

Despite being generally arid, Iran has many significant sources of water. Of relevance to the issue of water in the Middle East as a whole are a series of rivers that cross the Iran-Iraq border to become tributaries of the Tigris River: the Greater and Lesser Zab Rivers, the Al-Adhaim (Nahr Al Uzaym) River, the Diyala River and the Al-Karkha River. Finally, the Karun River has been the focus of international attention. (The Arab countries refer to the lower part of the Karun, where it forms a boundary between Iran and Iraq, as the Shatt-al-Arab.) There are two major lakes, Orumieh in the northwest and Hamoun in the east. Aside from the rivers mentioned above,

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[1] Average rainfall varies significantly across Iran. The deserts rarely receive more than 50 mm, while the Caspian Plain in the north receives more than 1600 mm a year. Therefore the average rainfall for the whole country, 252 mm, is a misleading figure. Figures based on Food and Agriculture Organization of the United Nations estimates for 1997 (FAO 1997b).

[2] *Iran Today* (1997, p. 5).

[3] Reuters (2000).

the Helmand River is an international river flowing to Iran from Pakistan and Afghanistan, and the Arax River forms the border with Azerbaijan. The Nahr at Tib, Deuerage and Shahabi rivers flow into Iraq, but all contain very saline water, which is unfit for agriculture or human consumption. Finally, there are many seasonal streams that contribute to Iran's water resources.

There are some major trends in water management in Iran that have the potential to eventually impact the Middle East in a more significant way than Iran currently does. At present, Iran is mostly isolated from the river systems of the Middle East, except for the Tigris River tributaries mentioned above. These rivers provide Iraq with a significant amount of its water and account for about half the flow of the Tigris in Iraq. For the time being, they are not a source of dispute in the region but could become so in the future if unaddressed. As mentioned above, however, Iran is currently undergoing a modernization scheme to improve water management. A significant part of that plan is the use of dams, which will, as development continues, restrict the flow of Iran's rivers as reservoirs fill. Water management is also a critical element in Iran's effort to broaden its agricultural sector. This is part of an initiative that began in the 1970s. In the period between 1978 and 1983, Iran increased its amount of irrigated croplands by almost 4%. A new plan for 1995-2000 anticipates a significant increase in agricultural water use.[4] In essence, the implications of water development in Iran could be significant for Iraq in the future. Greater Iranian use of water will reduce Iraq's share, creating further instability in bilateral relations that are already tense.

Iraq

Up-to-date information on Iraq's water resources is difficult to obtain due to its international isolation for the last ten years. The climate is semi-arid, with rains falling from December to February through most of the country, and from November to April in the northern mountains. On average, Iraq receives 154mm of rain a year, but this figure is inflated by high averages in the mountains. Most of the country (60%) gets less than 100mm a year.[5] As indicated in the World Bank numbers, Iraq has enough water to support its own needs, but deterioration of water quality and the disintegration of water management facilities, including treatment plants and canals (in large part due to economic sanctions), have led to increasing difficulty in providing water for the population, industry and agriculture.

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[4] So far, there have been no reports as to whether or not this plan was successful. See FAO (1997a).

[5] FAO (1997b).

All of Iraq's surface water sources drain into the Karun (Iranian name) or Shatt-al-Arab (Arab name) River, which is formed by the confluence of the Tigris and Euphrates rivers, and forms part of the international border with Iran. Every year it discharges 77 billion m^3 (Bm^3) of water into the Persian Gulf.[6] Water quality suffers due to the fact that this river is downstream of two major, long rivers and their tributaries. High use of water upstream has led to an increase in the salinity of the Shatt-al-Arab's water and its concentration of run-off from agricultural products. Increasingly, raw sewage is being dumped into Iraqi rivers, all of which eventually run into the Shatt-al-Arab.[7] Control of this river is a source of dispute between Iran and Iraq. Before their war, the Algiers Agreement of March 1975 established the border in the middle of the Shatt-al-Arab, though Iraq later rejected this arrangement, leading in part to the beginning of the eight-year war between these countries.[8] The dispute over control of the river has not yet been resolved and will be discussed in more detail below.

The Shatt-al-Arab's main tributaries, the Tigris and Euphrates rivers, are the primary sources of fresh water in Iraq. Before Turkish and Syrian development of these rivers, they provided Iraq with 75Bm^3/year. In recent times, this level has dropped significantly.[9] The estimated use of these rivers for domestic and industrial purposes is 5-6Bm^3 and 52Bm^3 for irrigation. If one assumes that upstream development projects in Turkey and Syria will proceed at a slow pace, there will be enough water in this system to fulfill Iraq's needs until 2010. In the years after that, water levels are expected to drop in both rivers due to heavy usage, contributing to a build-up of salinity and pollution, as there will not be enough water to flush the system to the sea.[10] The sources of both these rivers are in Turkey, flowing generally southeast through Syria before entering Iraq. In the absence of an agreement on the use of the water of the Tigris-Euphrates system, Iraq is left with whatever Syria and Turkey allow to flow downstream, despite what it claims as a 5,000 year-old historical right to the system.[11]

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[6] Global Environment Monitoring System, "Annotated digital atlas of global water quality", Table 3: General characteristics of Asian rivers, on-line at http://www.cciw.ca/gems/atlas-gwq/table3a.htm, accessed 28 March 2000. The GEMS/WATER Programme is run jointly by several United Nations organizations: the World Meteorological Organization, United Nations Environment Programme, the World Health Organization and UNESCO, with the purpose of monitoring the world's fresh water supplies.

[7] *National Geographic Magazine* (1993, p. 56).

[8] Martsching (1998).

[9] Soffer (1999, p. 100).

[10] *Ibid.* (p. 105).

[11] *Ibid.* (p. 75).

The Euphrates River is 2,780Km long, flowing south then east from its origin in eastern Turkey, through Syria to Iraq, where it merges with the Tigris River. The Iraqi portion of the river's course is 662 miles, or about 35% of its total length.[12] About 88% of the water that eventually flows into the Shatt-al-Arab from the Euphrates comes from Turkey, causing the downstream states to be highly dependent on the policy of upstream states.[13] Historically, Iraq has been the primary user of Euphrates water, but in recent years, both Turkey and Syria have undertaken large development projects using this water, thereby decreasing Iraq's share. Seasonal floods, on which Iraqi farmers traditionally depended, have been reduced due to the upstream dams and, as a result, the soil is not regularly washed out. As farmers irrigate, salinity is building up in the soil, and vast tracks of Iraq's farmlands are being ruined.[14] The Euphrates has a naturally erratic flow. The record high was registered in 1968 when it discharged $55Bm^3$, and the low was in 1961 at $15Bm^3$.[15] The discharge of the Euphrates changes over its course through Iraq due to withdrawals, seepage and evaporation. At Hit $900m^3$ of water flow through every second. Further downstream at Hindiya the rate is reduced to $590m^3$/second, and finally at Nasiriya, in the southeast, the average discharge is $400m^3$/second.[16]

The Tigris River has a course of 1,959Km from eastern Turkey to the Shatt-al-Arab River in Iraq, 77% of which is within Iraqi borders.[17] About half of the water that merges with the Euphrates has come all the way from Turkey. The rest of the input is mostly from tributaries that have drained from the mountains of Iran.[18] The Tigris suffers from many of the same problems as the Euphrates, though there is less upstream development. Water quality suffers as levels of salinity and pollution rise due to heavy withdrawals, seepage and evaporation.[19] Paralleling the situation with the Euphrates, Iraq's access to water from the Tigris is limited by the absence of a formal, international agreement on each riparian state's rights. The Tigris digresses from the Euphrates model, however, in that it receives a large amount of input within Iraqi borders from a series of tributaries, making

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[12] *Ibid.* (p. 73).

[13] Agence Europe, on-line at http://www.medea.ce/en/index050.htm, accessed 30 March 2000.

[14] *National Geographic Magazine* (1993, p. 56).

[15] *The Economist* (1999, p. 43).

[16] Global Environment Monitoring System, "Water Monitoring – Station Inventory in Middle East", on-line at http://www.cciw.ca/gems/summary94/emrastnv.html, accessed 28 March 2000.

[17] Soffer (1999, p. 73).

[18] Agence Europe, on-line at http://www.medea.ce/en/index177.htm, accessed 30 March 2000.

[19] Soffer (1999, p. 77).

Iraq less dependent on Syria and Turkey for a reliable flow. The flow itself is variable, depending on the time of year and peaking in the spring. At its peak flow, discharge is $3000m^3$/second; at its minimum, $300m^3$/second.[20]

The tributaries of the Tigris River also contribute significantly to Iraq's water resources; these all originate in Iran. The Greater Zab River meets the Tigris downstream of Mosul, Iraq, where it contributes $13.5Bm^3$ of water. The Lesser Zab supplies the Tigris with $7.9Mm^3$ when they join at Fatha. Upstream of Baghdad, the Al-Adhaim (Nahr Al Uzaym) River has a discharge of $1.5Bm^3$ and the Diayala River contributes $5.4Bm^3$ at Baghdad.[21] Further downstream the Nahr at Tib, Dewerege and Shahibi rivers add their saline waters to the Tigris, and finally, the Al-Karkha River drains $6.3Bm^3$ into the system.[22] The last river to make an impact on Iraq's water supply is the Karun River. This river, 500 miles in length, lies entirely within Iran, but becomes a tributary of the Shatt-al-Arab, contributing $20\text{-}25Bm^3$/year into that river.[23]

Aside from surface water sources, Iraq has a small amount of groundwater available for consumption. This is found in two locations. One is under the foothills in the northeast part of the country, and could maintain $10\text{-}40m^3$/second of discharge. As one moves southeast along this aquifer, however, the salinity gradually increases, so that at the southeastern extremity it is not potable. The other significant source for groundwater is a series of small aquifers situated on the right bank of the Euphrates. These have a total potential of providing $13m^3$/second, and although they can be somewhat saline (salt levels can reach 0.5mg/l), the concentration does not exceed limits for normal consumption. Lastly, there are other, scattered groundwater sources, but each one is found to be too saline (1mg/l) for use without expensive treatment.[24]

Israel

A look at basic data indicates that Israel could potentially face a severe water crisis. According to a 1992 study by the Native Center for Policy Research, Israel receives $600\text{-}800Mm^3$/year of renewable water resources, while domestic use in the country is $600\text{-}700Mm^3$/year.[25] Slightly different numbers are

[20] Czaya (1981, p. 38).
[21] Soffer (1999, p. 76).
[22] FAO (1997c).
[23] Soffer (1999, p. 74).
[24] FAO (1997c).
[25] Martin Sherman, of the Native Center for Policy, quoted by Arutz Sheva Radio, "Water: the secret strategic resource", 25 January 1996.

found in Soffer's book, in which Israel's potential for yearly water supply is stated as 1.6Bm^3 – though the difference can probably be explained by adding in the use of water that is not renewed during the year. The same source quotes current use to be 1.8-1.9Bm^3 annually.[26] In other words, Israel is already operating on a deficit, and water quality is already declining. A major cause of the water crisis is that when settlers arrived from Europe, they brought with them an agricultural culture.[27] Unfortunately, Israel's arid climate requires an enormous amount of water for irrigation. In Israel, 75% of water is used in agriculture, a sector that generates a mere 6% of GDP; the diversion of water to agriculture and to the growing population exacerbates the scarcity.[28]

Of Israel's major water sources, one of the most significant is the Sea of Galilee (also known as Lake Tiberias and Lake Kinneret). This has been a dependable source of fresh water, with no reports of water quality problems in the last thirty years, though increasing demand will likely cause a deterioration in its quality; it is 12.5 miles long, 5.6 miles wide and 64 square miles in surface area. It is fed by the Jordan River and its tributaries, which contribute between 80 and 600Mm^3 depending on the year; 50Mm^3 from lake bed springs; springs and floods that drain directly into the lake provide another 135Mm^3. But 270-300Mm^3 is lost every year to evaporation.[29] The Sea of Galilee's contribution to the annual Israeli water supply is significant, and its importance grows annually. It provides approximately 35% of the country's drinking water and roughly 25% of Israel's needs overall.[30] The exact contribution of the Sea of Galilee is, however, open to debate. The government says that of its total volume of 4Bm^3, 470Mm^3 are taken from the sea every year, including 1.4Mm^3 siphoned daily into the National Water Carrier (discussed below).[31] On the other hand, Soffer describes the sea as containing between 590-615Mm^3; and 87Mm^3 is used in the immediate region, 20Mm^3 goes into the National Water Carrier and 26-60Mm^3 is lost every year through spillage.[32]

The coastal aquifer was, until recently, another primary source of water in Israel. Located almost entirely in Gaza, its resources have been overpumped for years, lowering the water table, and allowing seawater to intrude into the aquifer and ruining its quality. It is naturally fed by rain (Gaza re-

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[26] Soffer (1999, p. 141).

[27] *National Geographic Magazine* (1993, p. 60).

[28] Isaac (1999).

[29] Soffer (1999, p. 123).

[30] Centre for Water Research (2000) and Ministry of the Environment of Israel (2000).

[31] Ministry of the Environment of Israel (2000).

[32] Soffer (1999, p. 141).

ceives 350mm in the north, 150mm in the south) and underground flow from the Negev, but consistent overuse, as well as pesticide-containing run-off and seepage from cesspools have seriously deteriorated the water's quality. It is becoming increasingly saline, much of it unfit for human consumption and agriculture.[33] Since occupying the area in 1967, Israel has claimed control over the aquifer. It, combined with the mountain aquifer (see below), provides 562Mm^3 of water, or about a third of Israel's water potential. Since the salinization of the coastal aquifer, pumping from that source has been slowed from 400Mm^3 to 245Mm^3 in an attempt to stem the infiltration of seawater.[34] In all, the supply in Gaza, coming entirely from the coastal aquifer, amounts to 35-50Mm^3, while the demand is for 190-200Mm^3 (150Mm^3 for agriculture and 40-50Mm^3 for domestic use).[35]

What is referred to as the mountain aquifer is actually a set of aquifers situated beneath the Palestinian-controlled West Bank. Most of the water in this aquifer was pumped before 1948 in what is today Israel. Although it is in Palestinian-controlled territory, Israel has managed the aquifer since 1967, and since many of the associated springs are in Israel, Israel claims the water as its own. The final status of the aquifer is scheduled to be decided with the final peace settlement between the Palestinians and Israel, although the Declaration of Principles from 1993 set up a discussion forum for the issue under the rubric of the Israeli-Palestinian Continuing Committee for Economic Cooperation.

The West Bank receives an average annual rainfall of between 500 and 709mm (20-27 inches) on the western slopes and between 100 and 500mm (4-27 inches) on the eastern slopes; slightly more than 30% of this seeps through the overlying rock layers to replenish the aquifers.[36] According to the Israeli government, the mountain aquifers are the most important source of household water in Israel at this point. These aquifers are also an important resource for the Palestinians, as they make up 40% of their water resources. The western aquifer in this system, sometimes referred to as the Yarkon-Taninim, can supply 340-360Mm^3 a year, while maintaining good water quality. Naturally, the water from this source flows to the surface by way of springs that emerge on the Israeli side of the lines, but extensive pumping has lowered the water table and these springs have been dry. The northern aquifer, called the Nablus-Gilboa or Jenin-Nablus, can provide 140Mm^3 every year. It has two levels, which furnish nearly equal amounts of water. As with the western aquifer, this one has been heavily pumped

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[33] Salmi (1997, pp. 16-17).
[34] Soffer (1999, p. 131).
[35] *Ibid.* (p. 147).
[36] Salmi (1997, p. 16).

over the years and the natural springs have been eliminated. From the eastern aquifer, 100Mm^3 of water are being extracted annually, but this one is substantial enough that it still generates some surface springs. The Wadi Kelt has a flow of 18Mm^3, Ujah 10Mm^3 and Fashhai 40Mm^3, and all of these streams tend toward significant salinity. Judging from the fact that these springs continue in spite of the pumping, it is accepted that more water could be extracted from this source.[37] All of these aquifers supply water that is generally of good quality. Since the water lies beneath porous rock, however, it is prone to pollution, such as from agricultural products or insufficient water treatment, as pollutants are caught up in rainwater runoff. In all, the mountain aquifer can supply the West Bank with 610-670Mm^3, which matches the minimum requirements of the Palestinian communities in the region. Currently, 310-360Mm^3 of water is being moved to Israel to supply Tel Aviv, putting a strain on water resources for the local inhabitants. Meanwhile, Palestinians claim all the water, based on ideas of sovereignty, while Israel claims that since the water naturally rises in springs on Israeli territory, Israel itself has historical rights.[38]

The Jordan River (with sources in Lebanon and in the Golan) is another significant source of water for Israel. It is formed in northern Israel when four tributaries, the Yarmouk, Banias, Hasbani and Dan rivers, meet above the Sea of Galilee. They receive their waters from the rains and snows off Mount Hermon, totaling 44Mm^3. The river flows south through the Sea of Galilee, exiting with a flow of 69Mm^3, then on to the Dead Sea for a total course of 206 miles. Historically, where the Jordan River flows out of the sea of Galilee, it carried 675Mm^3 of water, but heavy irrigation and the National Water Carrier diminished the discharge.[39] The composition of the Jordan River was initially outside of Israeli borders in Syria, but during the 1967 war, Israel took control of this territory.[40] The Jordan River is the only permanent source of surface water in the West Bank as it forms its border with Jordan. It is, therefore, of great interest to Syria, the Palestinians and Jordan. Israel, however, maintains significant control over the river's waters. By claiming the significant waters of the Sea of Galilee for irrigation, Israel restricts the flow of the Jordan River, reducing the amount available for the Palestinians and Jordan. By pumping more of the water into the National Water Carrier, Israel takes significant water volume out of the system where the other interested parties cannot take advantage of it. It is unclear exactly how much the Jordan River contributes to the Israeli water supply. Consid-

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[37] Soffer (1999, pp. 131-32).
[38] *Ibid.* (pp. 147 and 191).
[39] *Ibid.* (pp. 127-28).
[40] Lowi (1997).

ering that it is a primary source of water to the most arid region in the country, by way of the National Water Carrier, it is clearly important. It is also used for irrigation in the area around the Sea of Galilee, and also to some degree in areas further south as it meanders toward the Dead Sea; at this point, it is no longer potable due to extremely high salinity. Israel also makes use of the Jordan's tributaries before their confluence. In particular, $32Mm^3$ are taken from the Hasbani River.[41] Further, Israel claims $25\text{-}40Mm^3$ of water from the Yarmouk River.[42]

The National Water Carrier is a unique system in the Middle East. It was built between 1956-64, with American technical assistance, in order to supply water to the driest part of the country. Agriculture is being pursued in the Negev Desert with the water it provides. This vast project of pumping stations, canals and pipelines transports $420Mm^3$ of water every year from the Jordan River at the Sea of Galilee. Although it enables Israel to more effectively pursue settlement throughout the country, it is very expensive. Because the water is transported from the lake in the lowlands to the higher land in the central-southern area, the cost of the project increases.[43]

The Palestinian-controlled Territories

In the preceding section, we have already described the major water sources for the Palestinians because they are highly integrated into the Israeli water management plan. Given the uncertain nature of a future peace accord, it is useful to briefly touch upon water issues in these territories separately in order to highlight some possible ramifications of such an accord. The most important factor to note is that most of Israel's water sources, the coastal and mountain aquifers and the Jordan River are located in areas controlled by the Palestinians.[44] If a peace accord were to deliver control of these resources to the Palestinians and if water quality can be preserved, then these water resources would satisfy the consumption needs of the West Bank and Gaza. The problem with this scenario is that it leaves Israel with a significant deficit. The most likely outcome of any eventual peace talks is a compromise. Even setting aside political concerns, any augmentation of water supply to the Palestinians would inescapably cut into what Israel currently counts on to meet its own needs. Therefore, as Fisher *et al*. have pointed out, major ef-

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41 Salmi (1997, p. 20).
42 Soffer (1999, pp. 20 and 129).
43 *Ibid*. (p. 161).
44 Libiszewski (1995, p. 2).

fort is necessary to enlarge the water potential in the region through enhanced management and cooperation.

Jordan

Jordan's climate is very dry, and it is the only country in the region that is demonstrably consuming more water than what can be naturally supplied. While the northern highlands receive about 650mm of rain every year, the vast majority (90%) of the country's territory gets less than 200mm. Desert regions in the east and the south have less than 50mm of rainfall every year.[45] In total, rain in Jordan amounts to 1.123Bm^3 a year, of which 245Bm^3 becomes groundwater and 878Mm^3 becomes surface flow.[46] Currently, Jordanian supply cannot depend on rainfall, as it provides insufficient quantities of water. In addition to surface water, the country relies heavily on underground aquifers, which have undetermined volumes of water for exploitation. Currently, the demand for water in Jordan is at 994Mm^3, while the supply is 730Mm^3. Already, the country has a deficit of more than 260Mm^3. The situation is not expected to improve in the foreseeable future. Forecasts indicate that in another twenty years the demand will be 2.7Bm^3, from a total water potential of 0.8 m^3.[47]

Due to the lack of abundant surface supplies, Jordan relies on groundwater sources. It is estimated that 275Mm^3 of safe drinking water can be drawn from renewable aquifers every year. Some sources, however, are being overpumped in an effort to alleviate the shortage and as result water quality is suffering from increasing salinity. Withdrawal of nonrenewable fossil water provides a significant portion of the Jordanian supply. Jordan's Water Authority calculates that about 143Mm^3 of fossil water is extracted every year, and that 125Mm^3 can probably be safely taken from the Disi aquifer in the southern part of the country for the next fifty years.[48] Iran has even offered to make pipes for a project that would bring water from this underground reservoir to supply Amman for the next thirty years.[49] At least one source, the Arava Aquifer, extends over the international boundary with Israel. How such water, estimated at 40-70Mm^3, could or should be shared has not been decided.[50] When these sources dry up or become too saline, how-

[45] FAO (1997d).

[46] Murakami (1995, p. 169).

[47] Soffer (1999, p. 140).

[48] FAO (1997d).

[49] Agence France Press, in English, "Iran offers to build plants for Jordan water project", 25 April 2000.

[50] Soffer (1999, p. 130).

ever, they cannot be replenished, so reliance on them can only be short-term in nature. Already, some municipal and irrigation wells in Jordan have had to be abandoned because of this problem.[51]

Surface water is scarce. The Yarmouk River, on the border between Jordan and Syria, is one notable source. It is already heavily pumped by the upstream riparians, Israel and Syria, so little remains for Jordan in the southern part of its course. Jordan has wanted to exploit the Yarmouk more by taking part in a joint project with Syria to build a dam on its course. In the agreement, Jordan would get the water thus accumulated, and Syria would get the electricity generated. The project remained in limbo for a long time. World Bank policies prevent the World Bank from lending the necessary funds for the development because of a clause that mandates that projects on international rivers must be agreed to by all riparians. Since Israel was afraid that such a dam would cut into its own supplies, it refused to agree and funding seemed unattainable.[52] The standoff ended this year when the Arab Fund for Economic and Social Development agreed to provide the money. Construction on the Al-Wahdeh Dam was to have begun in July 2000.[53]

Aside from seasonal streams and wadis, all of which carry a minimal amount of water, the last significant source of water in Jordan is the Jordan River. One source even names this as Jordan's most significant source of water,[54] though this seems debatable. At any rate, due to heavy use upstream, again by Israel and Syria, only 30% of the original water is left where the river forms the boundary between the West Bank and Jordan. What is left is of low quality, since the Jordan River becomes increasingly saline as it flows south.[55]

In one of the more unusual ideas to alleviate the chronic shortage in this area, Turkey has offered to build a 'peace pipeline' to pump water to the most arid regions of the Middle East, including Jordan. This offer has been met with an uncertain silence.[56] In a similar vein, Jordan is eager to cooperate with Israel and the Palestinians in a scheme in which they would purchase water from Turkey. Instead of a pipeline, however, this plan calls for shipping the water over the Mediterranean to Israeli ports. It could then be trucked inland to where it is needed. While the Palestinians have not reacted to the idea, the idea is being seriously discussed as a real possibility in Israel.[57]

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51 FAO (1997d).

52 *National Geographic Magazine* (1993, p. 59).

53 Agence France Press, *cit.*

54 Lowi (1997).

55 Salmi (1997, p. 20).

56 *National Geographic Magazine* (1993, p. 50).

57 Agence France Press, *cit.* We are grateful to Franklin Fisher for pointing out Israel's interest in this scheme to us.

Lebanon

Though it is just north of parched Israel and Jordan, Lebanon is situated in a unique position on the Mediterranean coast and enjoys a more favorable climate. Due to prevailing weather patterns, Lebanon receives adequate rainfall during the year to satisfy its water requirements, although during the drier summer months water use becomes somewhat restricted.[58] Its estimated annual water potential is 38Bm^3, which is more than the current usage of 36Bm^3. All is not well, however; the growing population and deterioration of water quality are expected to render the currently available water resources inadequate within thirty years.[59]

The El Assi River, also called the Orontes River, originates in northern Lebanon and flows twenty miles north to Syria, traversing it and becoming the Syria-Turkey border before crossing into Turkey and emptying into the sea. The quality of this water is good while it is in Lebanon, although it gets continually polluted during its course. The flow of this river as it crosses into Syria is approximately 510Mm^3 every year, and an informal agreement between the southern riparians allows Lebanon to claim 80Mm^3 of this volume for its own use.[60] There is no conflict among Lebanon, Syria and Turkey over the use of the El Assi River, although Lebanon would clearly like to claim more of its water before it leaves its territory. No matter how dry the summers get, however, the Lebanese government is always aware that Syria is the dominant actor in bilateral relations, so the informal agreement is at least currently honored.[61]

The Litani River basin is in the eastern and southern part of Lebanon and is contained entirely within its borders. It is fed by karstic springs in the Beqa Valley and from the precipitation that runs off from the mountains. It flows southwest, then makes a sharp turn toward the west, after which it flows into the Mediterranean. The Litani is a cyclical river. Heavy winter precipitation causes 60% of the flow to occur between January and April. It is also cyclical in that its annual average flow varies according to a 4.5-year period. It ranges from 184Mm^3/year to 1Bm^3/year, but averages 580Mm^3. Lebanon uses it primarily for electricity production and irrigation.[62] Since this river is entirely contained within the borders of Lebanon, it might not seem a cause for international controversy. Until recently, however, this

[58] FAO (1997e).
[59] Soffer (1999, p. 134).
[60] FAO (1997e).
[61] Soffer (1999, pp. 208, 210-11).
[62] *Ibid.* (p. 213).

river maintained some aspects of being an international watercourse while Israel occupied the southern part of Lebanon (1982-2000).

The Hasbani River, before becoming a tributary of the Jordan River, originates in Lebanon where it provides a yearly supply of 160Mm^3 of water before entering Israel.[63] Aside from the El Assi, the Litani and the Hasbani, most of the water comes from smaller river basins that line the coast. These minor rivers drain directly into the Mediterranean Sea after completing a very short course. Because Lebanon is at a comparatively high elevation, it receives no water from international sources.

Syria

Syria has substantial amounts of water, however, large sections of its territory are arid. Based on historical sources and some more current observations, the United Nations Food and Agriculture Organization (FAO) estimates that Syria receives about 46Bm^3 of water every year through rainfall (about 252mm), which, following the regional pattern, falls mostly in the winter. Syria receives another 28Bm^3 from international water sources, while 31Bm^3 flows out beyond its borders, leaving it with a total potential of 43Bm^3.[64]

The most important of all the many rivers that flow through Syria is the Euphrates River. This river flows from Turkey through Syria, passing nine major cities, to Iraq. From this source, Syria receives 90% of its surface water supply.[65] In a desire to attain self-sufficiency, Syria has initiated large development projects aimed at controlling more water from the flow in a series of reservoirs and putting more land into agricultural production. The newest dam in Syria, the Euphrates Dam, is intended to irrigate 500,000 acres in the eastern part of the country.[66] There is no agreement among Turkey, Syria and Iraq to govern usage of either this river or the Tigris. It is inevitable, therefore, that Syrian development has an effect on Iraq's water supply downstream. Similarly, Syria is subject to the effects of Turkish development upstream. The annual discharge of the Euphrates in Syria is now about 26Bm^3. As Turkey continues to build dams, however, this is expected to drop 40% in the coming years, easily bringing about a deficit of 1-3Bm^3.[67]

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[63] FAO (1997e).
[64] FAO (1997f).
[65] Salmi (1997, p. 21).
[66] *National Geographic Magazine* (1993, p. 51).
[67] Soffer (1999, pp. 76 and 100).

The Tigris River, while a major source for both Turkey upstream and Iraq downstream, provides only a small amount of water for Syria's usage. It forms the international border with Turkey for somewhat less than twenty-seven miles before it flows into Iraq. Water along this course is pumped, although almost solely for irrigation purposes.[68]

The El Assi River flows into Syria from Lebanon. As small tributaries combine with the original flow that arrives over the border, Syria is able to exploit 1.5Bm^3. The El Assi flows through a long agricultural region where it is polluted badly by agricultural chemicals, and past several cities where it receives some sewage waste. Turkey, the upstream state, complains about the bad water quality of the river but does not depend on this source.[69]

In the arid southern part of the country, Syria is dependent on the waters of the Yarmouk River, whose headwaters it controls. The most recent numbers available indicate that in 1996, 200Mm^3 of water was used for agriculture in the south. Syria is, however, considering the construction of a pipeline to transfer 250Mm^3 to 1Bm^3 of water from the Euphrates to this region. While this would severely constrict the Iraqi water supply, it would eliminate pumping from the Yarmouk River, in which case more water would be available for Jordan, thus raising a helpful element to make Israeli-Syrian peace talks successful.[70]

The Jordan River is also an issue in Syria. It flows through the Golan Heights, which Israel currently controls but over which Syria maintains its claim of sovereignty. Due to the political and strategic situation, it is impossible for Syria to make use of the Jordan River's water, but one opinion circulated among Middle East observers is that it would be very difficult and expensive for Syria to pump water from the Jordan to the higher elevations where its farming areas are located. In future peace talks, Syria may be willing to allow Israeli control of this water as a concession during negotiations, which would help ease Israeli unease about its own water supply.[71]

Aside from numerous small river and tributaries of the above sources, the other significant water source in Syria is ground water. This resource has not been fully explored, but it is speculated that there is up to 1.6Bm^3 available for pumping every year, although it is also possible that this water actually flows underground to replenish Jordanian aquifers to the south. In either case, underground resources in Syria seem to be of good quality and are currently used only in very small-scale projects.[72]

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[68] *Ibid.* (p. 96).
[69] *Ibid.* (p. 208).
[70] *Ibid.* (pp. 135-36).
[71] King (1999).
[72] Soffer (1999, p. 130).

Turkey

Unlike other countries of the Middle East, Turkey generally possesses a very large water supply. In total, the country has a potential of about 110Bm^3, about half of which comes from the Tigris and Euphrates rivers.[73] Throughout the 1980s, Turkey used 25Bm^3 per year, so it is clear that, at least in a global sense, it does not experience water shortages as does the rest of the region. Therefore, our discussion of Turkey is limited primarily to the Tigris and the Euphrates, since these rivers are relevant to the downstream, and considerably more arid, Syria and Iraq.

Turkey's control of other countries' potential supply is of paramount importance in the region. In 1965, Turkey began what is often considered one of the most ambitious development projects in the world when it inaugurated the South-Eastern Anatolia Project (GAP) along both the Tigris and Euphrates rivers. When completed, 22 dams will impede the flow of both these rivers, contributing to the irrigation of fields in eastern Turkey that could otherwise only support one crop per year.[74] The GAP has thus far cost more than US$ 21 billion, most of which Turkey finances itself, because it has undertaken the project without agreement from Syria and Iraq and thus cannot rely on any World Bank financing.[75] Turkey controls the headwaters of these rivers, and has been able to do what it wants. In addition, Iraq and Syria have no mutual diplomatic recognition, and can therefore not present a united front to Turkey's forwardness in asserting control over the flow.[76]

Once finished, it is expected that GAP could cut the output of the Euphrates River by 60%.[77] In fact, temporarily at least, Turkey has already shut the water off completely. When the Ataturk Dam was completed and developers began filling the reservoir, the Euphrates River stopped flowing for one month in early 1990. Before shutting off the water, Turkey had allowed the average flow to be increased, but the shut-off nonetheless caused electricity and water shortages in Syria and destroyed the winter crops in Iraq. Turkey has since used its control over this essential river to force concessions from Syria, such as threatening to turn the water off again if Syria did not concede to Turkey's demands that Syria stop supporting Kurd uprisings and training Armenian terrorists.[78] The Tigris River, though also part of GAP, is being developed less dramatically, and while there are some issues about lower volumes through Iraq, there is considerably less controversy.

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[73] *Ibid.* (p. 88).
[74] *The Economist* (1999, p. 43).
[75] Soffer (1999, p. 91).
[76] Lowi (1997).
[77] *National Geographic Magazine* (1993, p. 50).
[78] Soffer (1999, pp. 92 and 112).

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