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Application of Water Allocation System Model to the Palestinian - Israeli Water Conflict

تطبيقات نموذج نظام تحصيص المياه في الصراع الفلسطيني الإسرائيلي على المياه

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Abstract

Water in the Middle East is a scarce resource. This scarcity is adding another dimension to the conflict between Palestinians and Israelis. This dimension is the conflict over the ownership and the distribution of water. In the late nineties experts both in and out of the region started to estimate the value of water in dispute. These ideas were elaborated in a computer model called Water Allocation System (WAS 3.3).

The paper applied the WAS 3.3 model to explore the economic consequences of various water scenarios. The questions answered in this paper are related to the distribution of water in the region, the production of additional water to cover the growing demand, the provisions for dry years, the allocation of costs and benefits and price charge to the consumers of water. Variables in the various scenarios are population growth and land ownership and the ownership of water.

In this paper, only implications and results from the Palestinian side will be discussed. Also, all the simulations in this paper are taken for the planning year 2010. The outcome of this paper shows that additional quantities of water should be made available to the Palestinians, regardless of the assumed scenarios in the different simulations. Also, the outcome shows that all parties in the region will gain if cooperation exists between these parties once the question of water rights is determined.

ملخص

إن مصادر المياه في الشرق الأوسط تعتبر مصادر شحيحة وقد أدى هذا إلى إضافة بعد أخر للصراع الدائر بين الفلسطينيين والإسرائيليين . هذا البعد هو الصراع على الحقوق المائية من المصادر الطبيعية المتواجدة في المنطقة. وفي نهاية التسعينات بدأ مجموعة من الباحثين من المنطقة ومن خارجها في حساب القيمة الاقتصادية لهذه المياه المتنازع عليها وقد بدأوا بوضع أفكارهم في برنامج حاسوب سمي بنظام توزيع المياه (WAS 3.3).

إن الهدف من هذه الورقة هو تقديم شرح موجز عن هذا النظام والنظريات والافتراضات الموجودة فيه بالإضافة إلى تطبيق هذا النظام لدراسة الانعكاسات الاقتصادية التي قد تنتج عن السيناريوهات المختلفة. الأسئلة التي

ستجيب عليها الورقة تتعلق بتوزيع المياه بين الدول المختلفة وإمكانية الحاجة إلى مصادر إضافية خاصة في سنوات الجفاف هذا بالإضافة إلى توزيع التكلفة والفوائد وتحديد أسعار المياه للمستهلك. والعوامل التي سيتم تغييرها في السيناريوهات المختلفة هي السكان والنمو السكاني وملكية الأرض وملكية المياه.

يتطرق الباحث في هذا الورقة إلى الانعكاسات والنتائج على المجتمع الفلسطيني ويركز في السيناريوهات على السنة ٢٠١٠ كسنة يتم التخطيط المستقبلي لها. من النتائج الأساسية التي توصلت إليها هذه الورقة هو الضرورة الملحة في إعطاء الفلسطينيين كميات مياه إضافية من الحوض الجوفي الجبلي ومن نهر الأردن بناء على مبدأ الاستخدام الأمثل وهذا واضح في جميع السيناريوهات التي تم دراستها. وكذلك فقد اتضح من السيناريوهات المدروسة أن التعاون في إدارة مصادر المياه يعود بالفائدة الاقتصادية على جميع الأطراف ولكن بعد تحديد الحقوق المائية لكل طرف.

1. Introduction

Water has always been a sensitive issue in areas where water is scarce. In the Middle East, the ownership and the distribution of water is an important aspect in the conflict between the Israelis and the Palestinians. In the late nineties experts both in and out of the region started to estimate the value of water in dispute and to explore the idea to trading water between Israel, Jordan and the Palestinian Territories. These ideas were elaborated in a project headed by Frank fisher, Professor of economics at MIT, and involving academics from Harvard and non government experts from Israel, the Palestinian territories and Jordan under the auspices of Harvard's institute for social and economic Policy in the Middle East (ISEPME). Preliminary computation showed that all parties could benefit if water would be soled from areas where it is relatively abundant to areas where water is scare. Also the maximum value of the water in dispute was computed by accounting for the cost of replacing it, i.e. the cost of sea water desalination. The computation showed that the value of the water in dispute is limited and would never justify a war. The ideas and concepts were formalized in a computer model (WAS) for the economic valuation of water. To facilitate this model considerable efforts was spent on the establishment of the needed data base.

The objective of this project is to present and apply the WAS 3.3 model to explore the economic consequences of various water scenarios. Questions to be answered are related to the distribution of water in the region, the production of additional water to cover the growing demand, the provisions for dry years, the allocation of costs and benefits and price charge to the consumers of water. Figure 1 shows the location of the study area.

Variables in the various scenarios of this paper are:

1. Population growth. Three scenarios are considered related to the resettlement of refugees: a growth with 0, 1.75 or 3.5 million additional inhabitants. It will be assumed that the population growth will concentrate in the fertile districts of the West Bank.
2. Ownership of water. Three principles for ownership will be considered: equity (each inhabitant will have an equal quantity); equality (the quantity available for drinking water will be equal for Israelis and Palestinians); the catchment approach (rights to the water are proportional to the recharge in the catchment area controlled).

The first variable, the population will have consequences for the demand of water, since the demand for domestic water supply is directly related to the number of inhabitants. The second variable will affect the availability of water to the various users in the region and the cash flows. Simulations will be made assuming it related to the two variables. In addition, simulations will be made assuming “full regional cooperation“, which means that the water related benefits for the region are optimized.

The assumption of regional cooperation implies (by definition) a win-win situation in which both parties, seller and buyer, will gain.

2. Description of the Water Allocation System Model (WAS 3.3)

The water Allocation System (Amir and Fisher, 1999) is based on the view that water is an economic good, although it is one with special qualities. This view implies that:

- Water has a cost (composed of at least the production- and distribution cost);
- Users produce benefits from using the water. If the availability of water is limited, only the most beneficial activities will be realized. As a consequence, the demand for water will be reduced if the price increases,
- The economic optimum water distribution is the one that produces maximum benefits for the users of water; and
- However, water in certain uses (i.e. agricultural or environmental protection uses) can have value that exceeds its private value to water users. These social values must be respected.

The studied area (the West Bank and Gaza Strip) was divided into a number of districts according to the Palestinian division. Within each district, water demand curves were defined for each household use, industrial use, and agricultural use. The annual renewable amount of water from each source was taken into account such as the pumping cost thereof. Allowance is made for recycling of wastewater, and the possibility of inter district conveyance is taken into account. This procedure was followed using actual data for the year 1995 and projections for future year 2010.

Environmental issues were handled in several ways. First, water extraction is restricted to annual renewable amounts; second, an effluent charge can be imposed on households and industry; finally, the use of recycled water in agriculture can be restricted.

The WAS model generates the water distribution for the region that produces the optimal benefits to the model user. It computes the value of an additional quantity of water and the shadow value at a particular location. The distribution of water over the areas is such that the total benefit from water related activities is maximal. The model can be used for planning and cost-benefit analysis either within a country or region-wide. It may also aid in setting water disputes.

The model has been applied to the Israeli, Jordanian and Palestinian water systems under the Institute for Social and Economic Policy in the

Middle East (ISEPME) project. Each of the three countries is subdivided into districts, which are treated as homogeneous units. Each district has access to specific water resources and the value of water depends on district- specific data on water related activities. These data were obtained from the different existing reports such as the Middle East regional study on Water Supply and Demand Development, the USAID, 1993 water Resources Action Program and the UN 1996 study on economic and social conditions in the West Bank (UN, 1996).

2.1 Water supply may be from one or more of the following four categories

- Surface water from rivers;
- Groundwater from the Mountain aquifer system;
- Recycled and treated waste water, or
- Desalination of salty water.

2.2 Water demand includes

- Public water supply to households;
- Industry, and
- Agriculture.

It is assumed that water consumption is influenced by the price of water in the form of a constant price elasticity demand curve. The formula for the demand curve is (Amir, 1999):

$Q= a\, P^{b.}$

where P is the price paid for the water
Q is the quantity of water consumed;
a is a scale parameter
b the demand price elasticity

The coefficients and b may be sectors and by district. Values of these coefficients were obtained from available data.

2.3 Water treatment costs (or the environmental necessity for such treatment) are incorporated into the model in the form of “effluent charges”. The model assumes a constant cost of $0.30/m^3 that is assessed on urban and industrial users. The model allows the user to adapt the value by district. Additional treatment to allow wastewater to be used in agriculture involves an additional charge ($0.10 in the present version).

2.4 Conveyance of water is from one district to another or within a district. In the WAS model the cost of conveyance within a district is a counted for by a constant value (the default assumption is zero). The cost of conveyance from one district to another where the appropriate infrastructure exists or is to be built varies according to the distance and elevation.

The existing version of the model (WAS 3.3) is for one annual average conditions.This means that annual variations were not included. The capacity of surface and groundwater resources is defined as the average annual renewable quantity. Similarly, the demand for water is a single value representing the total quantity used in a representative year. Besides, the assumption of average annual conditions the model cannot account for variations of supply and demand over time, the model can be used to study the potential for improvement of the spatial distribution of water resources in a region.

The effect of drought or surplus conditions can be investigated by varying the annual renewable quantities assumed to be available to the system (Eckstein et. al., 1994).

The interface of WAS allows the modification of all key data, including demands, supplies and infrastructure. In addition, social policies may be implemented in the model. Model results may viewed either in schematic or tabular form. Each scenario may be saved or deleted or printed for future reference. The model provides a powerful tool for the analysis of the costs and benefits of various infrastructure projects and this can be done in more than one way.

First, in the case where two districts are not connected by pipeline, river, or canal have shadow values more than the estimated operating and maintenance cost of conveyance in the case of the presence of a pipeline. The construction of such pipeline warrants investigation. Similarly, where shadow values do not differ by so much, then such pipeline would not be used if it were built.

Second, shadow values can be used for other purposes. For example, if one runs the model without assuming the existence of seawater desalination facilities, then the shadow values in coastal districts provide a cost target at which seawater desalination would be economically viable. Similarly, shadow values in districts to which imported water would come from outside or which would receive desalinated water as a result of canal construction show the cost targets at which the water in question would have to be made available in order to provide additional benefits.

Finally, by running the model with and without a projected infrastructure project, one can find the increase in annual benefits that the project in question would bring. Taking the present discounted value of such increases gives the net benefits that should be compared with the capital cost of project construction.

3. Simulation Runs and Results

In this paper, alternative scenarios for the year 2010 will be considered. For the year 2010 many papameters are uncertain outside the water sector. Perhaps the most important of these for our purposes is the size of population that will inhabit the region. This is especially true for the Palestinian population, a politically sensitive matter. Hence, we examine the effect of quite large increase in Palestinian population. We begin, however by using the population projection provided by the Palestinian Center Bureau of Statistics (PCBS) (USAID,1997). Ten different simulation runs will be performed. A certain parameter or a group of parameters will be changed for the different simulation runs and the effect on the different output parameters will be assessed. These different runs with their main output results are presented below.

3.1 Future situation (2010), existing water allocation and price policies (F0a)

This run assumes the situation of the year 2000 as regards to lack of cooperation, infrastructure, and allocation of water. Results show that Palestinian situation is one of crisis. Per-capita urban consumption has fallen in this run from 36 cubic meters per-year to 23 cubic meters per yearfor the year 2010. According to the assumption of this run, there is no wastewater recycling to provide relief. Moreover, the use of an overall average figure masks the magnitude of the crisis in a country with no internal inter-district conveyance system. In some districts, the estimated per-capita consumption is as low as 5 cubic meters per year (in Rammallah and Hebron) or even less in Palestinian Jerusalem.

The crisis is signaled in a more general way as well. The shadow values of water in some Palestinian districts are alarmingly high, generally well over $1.00 per cubic meter. In some districts, they are so high as to be totally unreasonable as price to be paid (Ramallah: $23,10; Hebron: $30.62; and Jerusalem: $58.22).

Of course, such prices are unreasonable. As indicated, they signal a crisis situation, a situation that is simply not feasible, given the existing water resources. Obviously, increased supplies are necessary.

Such supplies can come from three sources. They can come from Israel through reallocation of water and cooperation; they can come through the construction of recycling facilities and the provision of conveyance infrastructure to promote a more efficient use of water, or they can come from outside sources altogether either through water import or desalination.

In this run, the shadow values of water on the Mediterranean Coast in Gaza are high enough to make it worth exploring the use of desalination or of imports. We shall see, however, that, save in drought situations, that phenomenon disappears when other measures are taken.

3.2 Future situation, price policies, reallocation and cooperation, but no additional infrastructure (F1a)

Now we alter the situation by permitting reallocation of additional water quantities to the Palestinians and cooperation exists between the parties, although we provide no new infrastructure over the existing one to facilitate it.

We can immediately see that the gains are very large. The gain in total surplus is $425 million per year. As we should expect, most of this gain goes to Palestine which gains $420 million per year, with the remaining $5 million going to Israel.

The dramatic changes take place in Palestine. In particular, per-capita consumption by household nearly doubled for the year 2010, rising from 23 cubic meters per capita. Except in Palestine Jerusalem, where there is limited pumping capacity, the crisis districts improve greatly, with per-capita consumption in Ramallah and Hebron improving from 5 cubic meters per year to 52 and 47 cubic meters per year, respectively. Again with the exception of Palestinian Jerusalem, shadow values come down to well under $1.00 per cubic meter everywhere on the West Bank (There are no changes affecting Gaza in this run).

The increase in water allocated to the Palestinians came from the Jordan River near Jenin of about 60 MCM per year and secondarily by aquifer pumping (some 50 MCM per year). In the absences of a conveyance system, the benefits of this extra water are distributed to different districts by rearranging the pattern of aquifer pumping.

3.3 Future situation, no reallocation, no cooperation, removal of fixed-price policies (F0b)

As we did for the run (F0a), that is every thing will stay the same as for the present situation but we have removed the fixed price policies.

As compared to the base run with fixed price policies (F0a), the Palestinian situation is improved by $22 million per year, the largest gain coming in a gain of $423 million in buyer surplus and the largest loss ($636 million per year) being in government water " taxes". There is also a large reduction in unaccounted- for environmental costs ($215 million per year) and a small increase in profits ($22 million per year). The shadow values of water increase, but only by a cent or two per cubic meter.

3.4 Future situation, no fixed-price policies, reallocation and cooperation, but no additional infrastructure (F1b)

This run is as the previous one (F0b) except that additional reallocation of water to the Palestinian and cooperation between parties are now allowed.

When reallocation and cooperation is allowed, there is again large increase in surplus, as there was in the presence of fixed-price policies. This time the gain is $419 million per year with most of it going to Palestine. Based on this run, Palestinians take 68 MCM from the Jordan and also receive a substantial amount of aquifer water (although the transfers are now not only one way).

Palestinian per-capita urban consumption rises to 43 cubic meters per year, slightly more than in the fixed-price policy case. Other adjustments are similar to that case. This shows that the effect of fixed price policies is very small compared to the effect of allowing reallocation and cooperation among the different parties.

3.5 Future situation, removal of fixed price policy, reallocation and cooperation, recycling infrastructure added (F1 c2)

When recycling facilities are added in the Palestinian districts, total surplus increases by an additional $161 million over the previous run (F1b) where additional infrastructure was not included.

As we should expect in this run, the most dramatic improvement comes in Palestine, where per-capita urban consumption increases by 16 cubic meters per year to 59 cubic meters per year. Palestinian shadow values come down but remain infeasibly high in Palestinian Jerusalem and over $1.00 in all Gaza districts, showing that further improvement is needed. The pumping of Jordan River water in Jenin drops by 14 MCM per year, and there are other rearrangements.

This run shows that the additional development in infrastructure is a must especially in the wastewater facilities. The benefits from including these infrastructure is very high and make these infrastructure development very feasible.

3.6 Future situation, reallocation and cooperation, recycling, adding conveyance links (F1c)

When conveyance links between the different Palestinian districts are added to the system, there is another dramatic improvement, with total surplus rising by an additional $155 million per year over the run (F1b) where no conveyance links are added.

There are major international movements of water in this run. Jenin now extracts 82 MCM of Jordan River water and passes 35 MCM from the Israeli National Carrier, Hebron receives 56 MCM and Gaza 42 MCM from the same facility. In turn, the Gazan districts export 21MCM of recycled wastewater to the Negev.

In Palestine, per-capita urban consumption rises to 74 cubic meters per year, and shadow values fall. The shadow values in Gaza fall to about $0.50 per cubic meter, making desalination no longer an attractive proposition in a normal year. Palestinian consumption of both types of water (fresh and treated) rises accordingly.

By the time we reach this run, recycled water plays a very large role, with Israeli agriculture consuming 545 MCM per year (out of 1897 MCM per year total) and Palestinian agriculture 211 MCM per year (out of 614 MCM per year total). These results may be too high, as we have not controlled for possible restrictions on the type of crops likely to be grown in certain districts.

One overall conclusion from these runs is that for the year 2010, with the base population projections, a combination of reallocation of water to Palestinians, cooperation, recycling and conveyance infrastructure essentially meets the water needs of the two parties with both of them gaining. We shall now test whether those conclusion hold if the Palestinian population is much larger or if there are drought conditions.

3.7 Future situation as in F1c, but with Palestinian population increased by 1.75 million people (F1c-rsa)

Especially since a different population makes buyer and total surplus comparisons impossible, the additional of 1.75 million additional Palestinians naturally reduces per-capita urban consumption. This is especially true in Palestine, where that consumption falls from 74 to 63 cubic meters per year, still well above actual current levels.

The additional population does not produce an obvious crisis. Shadow values rise, particularly in the Gaza area where they become $0.54-$0.68 per cubic meter, fairly close to the lowest estimates of desalination costs. Of course, much of the avoidance of crises is brought about by increased transfers of water from Israel.

3.8 Future situation as in F1c, but with Palestinian population increased by 3.5 million people (F1c-rsb)

When the increase in Palestine population is 3.5 million rather than 1.75 million people, Palestinian per-capita urban consumption decreases to 59 cubic meters per year, still well above current levels.

Desalination in Gaza now appears to be more desirable option than before, since shadow prices now range from $0.61to $0.77 per cubic meter in the Gaza districts. This run shows the real need to permit northward transfer of water in Gaza Districts.

3.9 Drought and desalination: Future situation as in F1c but drought conditions (F1c-d30 and F1c-d40)

For our next set of runs, we returned the Palestinian population as projected by the Palestinian Center Bureau of Statistics (PCBS) and considered the effects of drought conditions. We performed two runs in which the yields of all naturally occurring water sources were reduced by 30% and 40%, respectively. It should be understood that we can only investigates such an effect for a single year.

In the 30% case (Flc-d30), total surplus is reduced relative to F1c (the corresponding case of no drought) by $87 million per year. Palestinian per-capita urban consumption falls to 67 cubic meters per year from 74 in the same run (F1c) without drought conditions.

Shadow values rise, making desalination a likely option in Gaza ($0.70-$0.84 per cubic meters). Of course, the Judgment that desalination plants should be built depends on whether one believes it is worth doing so to protect against such drought conditions or taking other measures such as inter-year storage.

In the 40% case (Flc-d40), total surplus has fallen by an additional $87 million per year. Palestinian urban per-capita consumption is down to 61 from 74 cubic meter per year (in F1c).

Shadow values in Gaza are now well over $1.00 per cubic meter. Were such conditions to continue, desalination plants would surely be warranted in Gaza. With an extensive conveyance system such as the Israel National Carrier, placing a desalination plant in one district takes pressure off the delivery system for other districts thus possibly obviating the necessity for additional plants.

3.10 Future situation, infrastructure, but no cooperation (F0inf)

As already stated, we have concluded that, even in 2010, with the base population projections, a combination of reallocation of water, cooperation and recycling and conveyance infrastructure essentially meet the water needs of the two parties with both of them gaining. An obvious question is whether cooperation is required or whether infrastructure alone would do the job. As we shall see now, infrastructure alone will not suffice. Particularly for the Palestinian, reallocation of additional water and cooperation are very necessary ingredient. Moreover, our conclusion about desalination is changed if cooperation does not occur.

When we run the model without additional reallocation of water and without cooperation but with the same infrastructure as in run F1c, total surplus (relative to that run) declines by $242 million per year in this run. These are the gains from reallocation and cooperation in the presence of substantial Palestinian infrastructure.

The effects of lack of cooperation and no additional reallocation are, of course, felt the most in Palestine (although both parties lose). Whereas, with cooperation and allowing reallocation, Palestinian urban consumption per capita is 74 cubic meters, without reallocation and cooperation, that consumption is only 41 cubic meters, a decline of about 45%.

The shadow values in all Palestinian districts in this run are above $1, with the Gaza districts having values close to $1 per cubic meter and all West Bank districts having values well above $2 per cubic meter (except Jericho, where the value is just below that figure). This means that it would not be efficient to supply Gaza from the West Bank. Indeed, the situation in Gaza appears less troublesome than that in the West Bank.

New sources of water are needed, and desalination would definitely be warranted in Gaza. Indeed, so bad is the situation on the West Bank that, in the absence of other alternatives, it would be worth pumping water uphill from desalination facilities in Gaza to add to West Bank supply.

Evidently, then, cooperation really does matter. Evidently also, the question of whether the Palestinians should build desalination plants depends not only on he amount of water they receive in the final status negotiations but also on whether the parties cooperate in water or go their own ways.

3.11 Future situation, no cooperation, infrastructure, ownership of water proportional to population (F0e)

Now, in all the results so far, it has been the Palestinian who gains the most from reallocation and cooperation. This is because we have started with an ownership allocation (essentially that of Oslo II) in which Israel owns 80% of the Mountain Aquifer and all of the Jordan River. This means that results on additional quantities in the different runs allocated to Palestinians can and should reflect the that Palestinians should get in the final status according to the optimal water distribution. In our final runs, we explore the consequences of assuming that ownership is divided on the principal of “equity” in which there is equal ownership of water per capita based on the 2010 population projections. This means that Palestinian will get 40% of all available water resources in the area.

With equity distribution, in the case of no-cooperation and infrastructure just like (F0inf) which differ from the present one only in the division of ownership rights, the Palestinian total surplus is now $144 million per year higher and Israeli total surplus $13 million per year lower than with the previous division of ownership. Palestinian urban consumption rises from 41 to 68 cubic meters per capita.

The total gains from cooperation are also large, even though the gains in buyer surplus are offset in part by the fact that some of those gains are intra-country transfers. The total gains in surplus is $211 million per year. Plainly, both countries benefit from cooperation, and that fact is even plainer than in the case of a more uneven distribution of ownership.

Indeed, the fact that the Palestinian would benefit from cooperation even in this case is also revealed by the shadow values. While there is not a crisis, shadow values in Gaza are about $0.90 per cubic meter, indicating the desirability of desalination. Shadow values in the West Bank are lower, ranging from $0.06 in Jenin (which takes water from the Jordan River) to $0.73 in Hebron. It is interesting to note that, in the absence of desalination in Gaza, it is efficient to convey 7.6 Mcm per year from Hebron to Gaza. It is far more efficient, of course to supply Gaza from the Israeli National Carrier, and, as noted, this greatly aids Gaza household consumption which rises from around 44 cubic meters per capita to about 64 cubic meters per capita.

Hence cooperation remains very important. Of course, the present scenario is special in that, even with the same amount of water owned by each party, it would be possible to improve matters by rearranging the distribution of ownership over the different sources, with the Palestinians gaining in some places and the Israeli in other. But this too is a form of cooperation.

4. Conclusions

Water as an economic commodity has at least two implications for the design of a lasting water arrangement that is to form part of a peaceful agreement among neighbors. The first of these has to do with negotiations over the ownership of water quantities. The second, and more important implication has to do with the form and the basis that a water agreement should take.

The main conclusions obtained with the current version of the WAS model for the Palestinians can be summarized as follows:

Additional quantities of water should be allocated to the Palestinians from the renewable water resources in the area (the Mountain Aquifer System and the Jordan River System). Based on the above simulations, these quantities ranges from 250-300 Mcm/year.

Cooperation is a “win-win” policy that can be worth $50 - $150 million dollars *per year* by 2010. While the exact gains from cooperation naturally depend on the assumed allocation of ownership rights, both parties would always gain from cooperation. Note, in particular, that the gains to the selling party are over and above the amounts necessary to compensate its consumers for higher-priced or less water.

Desalination on the Mediterranean coast will not be needed in normal years. With cooperation in water and the construction of infrastructure (recycling plants and conveyance systems, largely for the Palestinians), there will only be a need for additional sources of water in 2010 in years of considerable drought.

The need for desalination will crucially depend on the status of cooperation in water. Without such cooperation and with the 1995 ownership allocations, the Palestinians will find desalination at Gaza an attractive option by 2010.

The construction of recycling plants in the West Bank and particularly in Gaza, will be highly beneficial regardless of water ownership or co-operation.

The usefulness of this approach does not end at the international border and such modeling effort and the analysis accompanying it can also be used in the resolution of water disputes. That use has at least two aspects: First, property rights in water are seen to be reducible to monetary values. Second, if this is done, negotiations over water can cease being limited to water it self and be conducted in a larger context in which water is measured against other things. Moreover, the availability of seawater desalination means that the monetary value of disputed water property rights will generally not be very large. If this is realized, negotiations over water should be facilitated.

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