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WATER MARKET BASED CONFLICT RESOLUTION

by

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INTRODUCTION

Conflicts over water are invariably influenced by the economic value of the resource. Water markets are not normally a substitute for other methods of conflict resolution, but by generating gains from trade, technology and reallocation, markets can make a zero sum bargaining situation into one where the dispute is over sharing the gains from trade. This latter situation in which there are no losers but only relative gainers is easier to resolve. Given the past tradition of rigid administrative allocation of water, the current conditions of rapidly changing water demands, technologies, and market structures have considerable potential for generating net gains in water value and thus facilitating the resolution and stability of water conflicts.

The "negotiator's dilemma" described by Lax and Sebenius (1986) is characterized by the contradiction between two goals facing the negotiator. The two goals that often generate conflicting negotiating positions between parties are: Maximizing the total benefits to be divided from the resource and maximizing their share of the resulting benefits. Markets bring three important attributes to the first goal of maximizing the total benefits from the resource and can help reduce the strategic linkage between the two goals. First, market actions generate net benefits from gains from trade and technological adoption. Second, correctly structured markets for water can substantially reduce strategic behavior and thus isolate the first goal of optimizing the total benefit from strategies to improve individual allocations of the benefits. Third, markets provide a flexibility to adjust to changing conditions and thus make agreements based on them more robust to change.

Water is a commodity that has not traditionally been allocated by markets due to its scale of development and a common view that water allocation is too complicated for markets. Water supply development has been polarized into very small private projects and very large public projects. Hand dug wells and sarkias are examples of very small scale development, while the Aswan Dam, California Central Valley Project, and the Four Rivers Dam are examples of very large scale publicly funded projects. Management and conflict resolution of water systems by a powerful central authority has been a characteristic of irrigated societies for millennia. Hillel (1994) argues that the creation of the organized nation state in Egypt and Mesopotamia were driven by the need to organize orderly irrigation development. Despite this tradition, there has been a very recent and strong trend to examine the effectiveness of markets for the allocation of water. This paper examines the potential and limitations of markets in the resolution of conflicts associated with water allocation and development.

The recent interest in water markets has been stimulated by several changes in world water resources. The first is the changing scarcity of water in both quantity and quality terms. The increasing scarcity is sharpened by the realization that global demand for water has grown by 2.4 % per year from 1970 -1995 and is projected to increase another 30% by 2020, (Rosegrant et al 1997). Several of those countries that have achieved food sufficiency from irrigation are looking for more efficient water use as increasing supplies are shifted to urban and industrial uses and the population expands. Yet other countries are counting on following the same path of food development by expanding irrigated agriculture, but under conditions of greater water scarcity and competition than in the past. These water development plans will cause conflict between economic sectors in a country and among countries with common or linked water sources.

Markets have shown a distinct advantage over centrally planned allocation where the economy concerned is characterized by: first, the need to adjust to changing demand and supply pressures, and second, to signal the optimum rate and type of technical change to decentralized decision makers. Correctly functioning markets have an adaptive structure that is very similar to that evolved by biological systems to cope with change and uncertainty. The adaptability and resiliency of market structures are well suited to water based economies that are rapidly becoming more similar to the energy, communication and information economies. These industries are characterized by large infrastructure investments, changing technologies, fluctuating scarcity values, and decentralized end-users. The dominant driving force changing the communication and information sectors is technology. However in the gas and electricity sectors, structural changes have been driven by changing scarcity values, while the supply development and conveyance technology has remained less altered.

Despite their advantages, some aspects may make them unsuitable for some types of water conflict. First, the very anonymity of the market that makes them so ruthless and efficient in removing laggards and promoting efficiency means that market solutions have little to contribute to solving equity questions of the initial allocation of resources. Only where the efficiency gains from market allocation exceed and can compensate for initial allocation inequities can markets resolve or defuse conflicts over initial allocations. Second, markets are viewed with suspicion by water administrators as they require relinquishing control over micro allocation and technology decisions. There is no way around this, since markets, by design, shift the allocative power to the water user. It is this market feature which simulates optimal water use. Finally, costs that are external to market prices such as salinity accumulation are also a source of market failure. For these reasons the decision to allocate water resources by a market structure will not always resolve conflicts. However, as the use of water becomes more like other market based agricultural and industrial inputs, the advantages of markets in stimulating technology adoption, signaling resource scarcity, and coaxing resource reallocation will assist in the resolution of water conflicts.

The paper will first examine the characteristics that are required for effective water markets to operate. In the next section the types of water conflict that are amenable to market based resolution are defined, and those conflicts for which markets are unsuitable are noted. In the final section some applications of markets to actual or potential water conflict situations are discussed.

CHARACTERISTICS OF WATER MARKETS

Property Rights

A necessary condition for any market is that the sellers have a clearly definable formal or informal property right. Water resource rights can be simply divided into Water Rights and Usufructory rights, the former being a legal title to transfer the stock asset of water, while the latter restricts the water right to the annual flows. Most discussions of water markets refer to the sale of permanent water rights. The usual procedure is to decouple the water rights from the land title and allow the two commodities to be traded independently. This system is optimal if the costs of defining and enforcing the trades so that they do not induce third party effects are acceptable. In many cases where the water rights are not vested in the end-users or the ability to measure third party impacts is limited, water markets can operate on the basis of spot, option, or lease markets. If the water use rights are informal and occur as part of membership in a village, water users association, or local custom, market actions require that there is consensus on the property rights. Clearly this restricts the extent of disputes that can be reconciled by these informal markets.

Transaction Costs

Transaction costs of markets are the costs of defining, negotiating and enforcing the market transactions. It is the magnitude of these transaction costs and difficulty of defining and measuring water property rights that has traditionally driven water allocation to centrally controlled systems. To avoid harming third parties who rely on the return flows from water use, water trades must be restricted to the consumptive use of the water. Defining the consumptive use of water requires a tradeoff between precision and transaction cost. One of the oldest and best functioning markets for water rights that exists in the State of New Mexico has lowered transaction costs by vesting the decision on consumptive use in one person, the State Engineer. For a long period the State Engineer had a simple, and well know solution. The consumptive use was always assumed to be fifty percent of the water right. The theoretical gain in efficiency from adjusting the consumptive use to individual transfers is unlikely to compensate for the substantial increase in the transaction costs associated with determining the actual consumptive use. This is borne out by comparing the water transfers in New Mexico with those in the State of Montana. Montana has similar tradable water rights to New Mexico, but uses a court procedure to establish the consumptive use of the rights on a case by case basis. While there is a steady commerce in water in New Mexico, there are very few trades in Montana.

Like New Mexico, California has employed the principle of simplicity over precision in marketing the usufructory rights that predominate in the state. These usufructuary rights require a different set of compromises to reduce transaction costs of annual or period sales of water. The California State Department of Water Resources has operated several Drought Year Water Banks (in 1991, 1992, 1994 and 1995) that buy and sell water. The underlying basis for assessing the consumptive use in irrigated agriculture, which provides most of the supplies, is to assess the net water use on the basis of standard crop consumptive requirements.

Another important requirement is that the conveyance capacity for the water trades must be available at a reasonable cost. Determination of excess capacity in conveyance systems and methods of pricing it are additional transaction cost components that are not as easily simplified as consumptive use of applied water.

Strategic Behavior and Price Formation

Strategic action by one or all parties in conflict can block the resolution of the problem or lead to distinctly sub-optimal solutions. The two phases of conflict resolution, maximizing total benefits and maximizing individual allocations of the benefits, that were defined earlier in the "negotiator's dilemma" are a source of strategic behavior. Often, one of the parties will not fully reveal their technological potential in the first phase of maximizing total benefits from the water resource so that they can accumulate the unallocated benefits in the second benefit allocation stage.

Market systems for determining the total benefits reduces this strategic behavior in two ways. If the market has a sufficient participants, or in economic terms is thick enough, individual actions will be masked by the market equilibrium. While two parties may still negotiate over a particular sale, the existence of a market price will dominate the deal and provide an alternative against which to measure individual actions. An example of this is demonstrated in the different responses to water demands under market and allocative systems during the 1991 California drought. In the initial stages of this drought, as the Drought Water Bank was being formed, water contractors were asked by the Department of Water Resources to define their minimum level of water for "critical needs" during the coming drought. Given the current system of average cost pricing and allocation by a politically determined formula, the contractors had no incentive to underestimate their critical needs. The critical needs for April 1991 are shown in Table 1.

Table 1.

California Drought Year Demands (Million cubic meters)

	"Critical Needs" April 1991	Actual Purchases October 1991
Urban/Industrial	409.99	379.00
Agriculture	205.00	101.99
Total	614.99	480.99

As the Drought Water Bank became established and the drought progressed, it became clear that there was ample water at the fixed sale price of $175 / acre foot. In fact, substantial quantities of water were unsold and carried over by the bank to 1992. The point is that when faced with the choice of buying as much water as they wanted, the contractors reduced their "critical needs" by 22%. Under strategic negotiation a water user has "needs", whereas under a market system these needs are scaled down to *demands* that reflect the true willingness to pay by the water user.

Even though the quantity of water traded in the California water markets is only 6 -12% of the total consumption in dry years, the establishment of a price at which water can be bought or sold has an effect on the whole water sector. The price of water provides a benchmark against which users can evaluate alternative water uses and conservation measures, and modify their demands accordingly.

<u>Flexibility</u>

Water supplies are inherently variable and it is hard to design allocation rules that will operate efficiently and equitably under different levels of scarcity and demand. Water markets have the ability to automatically adjust to different water years and demands. While the California drought markets, with prices that are fixed for a given year, are not a good example of full adjustment, the three markets that have been consummated so far, do illustrate that the price, quantity and demands for water can adjust to different scarcity levels, even with fixed prices (see Table 2). Now that confidence in water markets is growing, I would hope that a price flexible system will be operating for the next drought.

Table 2

A Comparison of Three Annual California Drought Water Banks

Year	Sale Price	Quantities Bought (Million cubic meters)			
		Urban	Agriculture	Environment	Total
1991	$0.142/m^3$	379.00	101.99	0	480.99
1992	$0.058/m^3$	49.32	118.37	29.59	197.28
1994	$0.055/m^3$	30.83	178.79	0	209.62

In response to three different drought years, the fixed annual price for the Water Banks was set at rates that varied by 60%, and the amount of water purchased at these prices varied by 56%, showing that supply is price responsive. The Water Bank was able to supply water to each of the three main consumption sectors. In the case of the environmental purchases in 1992, the State government provided the funds for its agency in charge of Fish and Game to purchase water for critical wetlands and in-stream uses. This use of water markets to achieve environmental goals at minimum cost will be a significant part of future water trades in California.

CONFLICT AND MARKET SUITABILITY

To reiterate the point made in the introduction, water markets can be a very valuable method for increasing the total benefits, but cannot solve conflicts over the initial distribution of the rights to different amounts and priorities on water resources. In some cases, the ability to increase the total benefits will make the conflict over resource allocation easier to resolve. This section defines examples of water conflicts that can be assisted by the introduction of water markets.

Reallocation Among Sectors

In most arid countries water development has been concentrated in the agricultural sector. The allocation of water by custom and administrative decisions is usually based on the technology and priorities prevailing at the time that the water was developed. As water use technology and economies develop and the scarcity value of water changes, the allocation of water resources among sectors and regions should also change. Water markets provide a self-compensating and flexible system that encourages voluntary reallocation of water among sectors and distributes the gains from such changes.

Given the inherent uncertainty in water availability, the supply of water can be stabilized by building sufficient excess capacity to accommodate extreme situations such as a fifty year drought or flood. An alternative approach is to make both the supply system and the water demands responsive to changing scarcity conditions. Using this more flexible system of supply and demand modification, the same physical facilities can provide the same degree of supply reliability to those water users who require it, while providing cheaper water supplies to those users who are willing to trade supply reliability for water cost.

In many parts of the Western U.S., the federal government was active between 1950 and 1975 in building subsidized water supply systems. For agricultural water supplies the subsidy ranges from 5- 35% of the cost of water. Use of this subsidized water is constrained to agriculture in designated regions and farms. Under these restrictions it is not surprising that some of this low cost water is utilized in low productivity uses and applied with inefficient technology. Faced with growing demands from environmental and urban uses, the potentially cheapest water in financial and environmental terms is often obtained from transfers from low value agriculture. To persuade these farmers to voluntarily sell water to other uses, they must be offered a premium over their net value of the water in its current use. Since this use value includes the value of the water subsidy, any marketing proposal must pay the farmer to give up their subsidy as well as their water.

Proposals to pay farmers for the full value of the water are met with criticism on the grounds that the current users are being paid not only the value of the subsidy but also the residual value of the water. While this view is logical from a distributional and equity perspective, it is not going to change the perspective of individual agricultural water users. The users regard the subsidy as part of their property right and are not going to relinquish it without payment. In fact, it is very likely that the current landowner implicitly paid the subsidy value as part of the land valuation if they purchased the farm.

Water policy makers are faced with the dilemma of encouraging market reallocations that are efficient in that they minimize the cost of reallocating water, but have to accept the equity transfers that are needed to persuade the farmers to modify their production practices and technology. Essentially the dilemma is whether it is worth privatizing past public sector investments in order to get greater efficiency in current and future water use. Given the seemingly inexorable increase in the scarcity value of water, the question is not one of whether, but when, past users should be allowed to cash in their subsidies in exchange for the potential reallocation of the water.

Distributing the Effects of Environmental Cutbacks

Another category of water related conflict concerns the imposition of environmental constraints on water use or the reduction of types of use to achieve environmental objectives. In the past decade, the imposition of environmental constraints on water use, or the reallocation of developed water to environmental uses has dominated the changes in water use in Europe, the U.S. and the Antipodes. The burden of the cuts in water resources should be distributed equitably over all users of the water. An initial approach would be to distribute the cuts in proportion to the initial property rights. However, given the heterogeneity of regions and types of water use it is unlikely that an equitable distribution of cutbacks is also the most efficient least cost distribution.

The concept of tradable rights, or permits, can be used to reallocate the initial cuts in a cost minimizing manner. The initial step is allocate or impose the quantities of water to be cut across water users in a manner that is perceived to be equitable. The usual procedure is to pro rate the cut back in proportion to the current property rights, essentially an even distribution of the burden. Unless there are substantial income inequities, distribution of the costs in proportion to the benefits of water use can usually be negotiated. However, it is probable that the cost of cutting water use varies substantially among users, this situation would result in the uniform distribution solution being equitable but inefficient. At this second stage, water users are encouraged to trade their cut back requirement permits. The permit market will establish a price that minimizes the cost of fulfilling the cut back requirement. Initially farmers with high costs of cut backs due to high value perennial crops will offer to pay some other farmer to cut back more. The initial offer will be below their cost but above their estimate of their neighbor's cost. Since the marginal cost of the cut will increase as the quantity cut increases, a unique price will be established. The majority of the cuts will be concentrated in those areas with the lowest costs, but the farmers in those areas will make an increased return on the additional water cuts. In essence, the more costly operators are forced to share some of their revenues with the less prosperous areas.

The idea is demonstrated by a theoretical analysis done for a region in California which was forced by legislation to reallocate about 12% of its subsidized water back to environmental purposes. The legislative solution (the Central Valley Project Improvement Act CVPIA) was applied to growers in California's San Joaquin valley and required two levels of cut in irrigation deliveries of 986 million m^3 in dry years and 1,603 million m^3 in normal rainfall years. The economic effect of these cuts was evaluated under two alternatives that correspond to the first and second stage of the tradable permit approach. In stage one the cuts are allocated in proportion to the water entitlements to the growers from the Central Valley Project. In the second stage the growers are encouraged to trade their cuts amongst themselves so that their net returns to agriculture are maximized for the region. Results from the study (Zilberman, D et al 1994) are summarized in Table 3.

Table 3.

The Economic Cost of Water Cuts Under Alternative Systems

986 million m^3 cut	Decrease in Revenue ($ million)	Decrease in Profit ($ million)	Decrease in Employment (1000 jobs)
Proportional Allocation	85.96	45.50	2.15
Local Market Reallocation	18.88	9.82	0.47
1,603 million m^3 cut			
Proportional Allocation	145.83	76.95	3.65
Local Market Reallocation	52.43	26.69	1.31

Figure 3 shows that the market trading of the water cuts reduced the net cost per cubic meter of water from 4.6 cents / m^3 to 1.0 cents / m^3 for the smaller cut and 4.8 cents / m^3 to 1.7 cents / m^3 for the larger cut. In this modeling exercise the market reallocation of the water cuts reduced the cost by 78% for the smaller cut and 65% under the large cut. Similar reductions in the impact on total regional revenue and employment are shown in table 3. These results slightly exaggerate the gains from trading as the transaction costs of the trade are not known and were not included in the model. However, the substantial cost reductions from trading the cuts in water made this provision of the legislation an important bargaining point in resolving the conflict that this proposal generated.

Accommodating New Development Rights in Over Appropriated Basins

A third type of water conflict that can be assisted by market action occurs when the flow in a river basin has been so heavily appropriated by downstream users that later development by upstream holder of water rights causes conflict. Conflict along a water course can arise due to disputes over water quantity or water quality. Quantity conflicts arise when the flow in the basin is over-appropriated by optimistic administrators. Development of water resources up-stream often lag a long way behind down-stream appropriations, due to differences in the inherent fertility or more commonly the distance to markets afforded by the river. Quality conflicts arise when the use of water upstream imposes external cost on downstream users in the form of salt or pollutants in the return flows to the water course. Even assuming a uniform concentration of pollutants in the return flows from all water uses, the upstream uses will impose greater externality costs merely due to the fact that they will impact more downstream users. If the level of technology used in upstream water use is lower, or its propensity to generate contaminants is greater, the problem of external costs on down-stream users is exacerbated. The difference in costs imposed by water use between up-stream and down-stream locations provides the potential for market reallocations in the same way as differences in profitability and productivity. There are net gains to concentrating water use in areas where the external costs are lower, and corresponding gains from trade exist among these areas.

An example of a study of a large river basin in the Western U.S. that quantifies the economic externalities of salinity between different parts of the river is Lee and Howitt (1996). The Colorado River basin drains an area of sixty three million hectares within six states. Irrigation development over 1.25 million hectares has greatly increased the flow of naturally occurring salts into the river. Each year, groundwater flows from irrigated agriculture and natural springs transport nine million tons of salt from basin soils to the

Colorado River. This salinity level is further concentrated by diversions in the upper regions of the river, basin exports and evaporation. Currently more than half the irrigated acreage in the basin is classified as saline with total dissolve salts in excess of 1,300 mg/liter. In addition to irrigation development, the Colorado is a critical water supply to large urban and industrial water users in Arizona and Southern California. The high level of salinity causes significant treatment and repair costs to the municipal and industrial users and imposes yield losses to downstream agriculture. For simplicity, the regions on the Colorado can be aggregated into the Upper and Lower basins. The two basins are classic examples of upstream - downstream externalities with 63% of the irrigated land in the lower basin impaired by salinity, and 72% of the salinity in the lower basin originating from the upper basin. In addition to the spatial externality, there is also a wide difference in the value of water between basins. In the upper basin crops yield profits ranged from $11- $249 / acre, while in the lower basin Imperial valley the profits are $249 - $ 567 / acre. Urban uses in the lower basin are more sensitive to the costs of salinity. There are several alternatives for salinity reduction, among them federally sponsored projects whose cost of salinity reduction ranges from $5 to $300 per ton of salt removed. In addition to direct salt removal projects, the salinity in the river can also be reduced by changes in the practices and extent of irrigated agriculture in the Upper basin. By constructing a linked hydrologic - economic model reflecting the spatial allocation of water quantity and quality, the economic costs of salinity control under alternative scenarios is analyzed. Table 4. shows the economic impacts of the alternatives.

Table 4.

Annual Change in Net Revenues ($ million)

	Optimal	Status Quo	Constant Profit
Lower Basin M&I	92.48	41.12	44.09
Agricultural Profits	-14.66	0.673	0.695
Upper Basin Agriculture	-16.27	0.023	-0.004
Lower Basin Agriculture	1.610	0.650	0.699
Government Expenditures	-22.59	-37.548	-36.483
Net Change in Welfare	55.45	4.324	8.302

Table 4 shows that there is a large economic incentive to internalize the Upper Basin salinity costs impose on the Lower Basin. The study analyses the effects for five regions, but even with the aggregation, it is clear that the Lower Basin could offer agricultural users in the Upper Basin twice their current marginal product for water and salinity reductions and still show substantial savings in public and private expenditure and lost profits. The analysis is performed for three scenarios, an optimal basin wide analysis that selects the mix of changes in irrigation technology, cuts in irrigated crops in the Upper Basin and federally funded salinity reduction projects that are justified by the salinity reduction benefits in the Lower Basin. The two other scenarios that are compared with the Optimal results are termed the Status Quo and Constant Profit scenarios. The Status Quo scenario holds cropping and irrigation patterns in the Upper Basin constant and relies on substantial federal investment to reduce the current level of salinity which improves crop yields in the Lower Basin. The Constant Profit analysis does not restrict irrigation and acreage in the Upper Basin and allows reallocation of agriculture for salinity reduction, but does require that Upper Basin agricultural profits are held constant.

Under the status Quo and Constant Profit scenarios, the reduction in salinity in the Lower Basin still justifies substantial federal expenditures. However, because the cheaper alternative of modifying Upper Basin irrigated agriculture is precluded, the expenditures are $15 million per year higher, and the net increase in welfare is only 10 -16% of that achieved by the Optimal solution. The combination of lower federal expenses and higher Lower Basin benefits under the Optimal run shows that the ability to trade water between Lower Basin municipal and industrial uses and upper Basin irrigated agriculture would have substantial returns to both the regions involved and the federal government. Despite this substantial potential gain from trade, current inter-state politics have de-railed two tentative attempts at inter-state water trading on the Colorado river. One possible reason for the embargo on inter state trades is that the inter state Colorado Compact on water quantity was based on unusually high flows and over appropriated the river. Upper Basin states fear that the willingness to sell water will be interpreted as signaling lower use values, thereby implying a greater ability to compromise on the basic level of appropriation. If the over appropriated quantity could also be included as tradable quantity, further progress to a more efficient allocation of water quantities and quality on the Colorado may be achieved.

EXAMPLES OF CONFLICT RESOLUTION BY WATER MARKETS

Water allocation and cost in California has been dramatically altered over the past five years by three institutional modifications that are resulting in substantial changes in water use, value and allocation methods. In chronological order they are: (i) The Central Valley Project Improvement Act (CVPIA), 1992, legislation changing federally subsidized water development, (ii) The Monterey Agreement (1994) between contractors in the California State Water Project (SWP), and (iii) The Bay Delta Accord (1994) between state, federal and private groups to implement the CALFED program. This program is an ongoing process of negotiation and analysis between all the agencies concerned with water and environmental issues connected with the critical area in the Sacramento River Delta and the San Francisco Bay. The common theme running through these three changes is first, that they all incorporate types of market mechanisms to effect the reallocations, and second, the market solutions did not arise spontaneously from the gains from trade, but were stimulated as a response to external threats of regulation. The analysis of these institutional changes in California is used later in the section to draw parallels to other water conflict situations in the world.

The Central Valley Project Improvement Act (CVPIA)

The Central Valley Project is a set of linked water projects that run for half of the length of California, seven major dams are part of the project as are 650 kilometers of canals. The project delivers an average of 4,936 million m^3 for irrigated agriculture and 494 million m^3 for municipal and industrial users. This massive project was not without associated environmental problems which were manifest as reduced anadramous fish populations, loss of wetland area and reduction in water quality from irrigation drainage return flows. The CVPIA aimed to reduce these environmental impacts through three main types of adjustment of the project. The original project was conceived in the 1930's and took the form of large subsidized water supply facilities that delivered water at significantly subsidized prices and subject to constraints on its use and reallocation. The CVPIA legislation that modified the project has three major foci. (i) A change in the water pricing method. The pricing of water was changed to reflect an increasing rate for the last 20% of the water contract. The rate escalated to the full cost of water supply, but only over the last 10% of the contract. Despite the small proportions involved, the new cost structure has the essential feature of increasing marginal costs. (ii) The introduction of water sales. The new act allowed farmers to trade up to 20% of their water entitlement, without district approval, to buyers in different uses and regions. There are several constraints on water trading under the act designed to reduce environmental and pecuniary externalities and give other local contractors first refusal for the sale. The ability to trade water is shown by Loomis (1994) to be likely to have more effect on changing farm water technology than the increasing block rate prices. (iii) The environmental reallocation of project water is the third and dominant provision of the act. The total water involved in reallocation is 1,450 million m^3 of which 987 million m^3 is dedicated to attempting to restore anadramous fish populations. The act states that the water can be acquired by administrative action or private purchase. The other environmental water requirements are subject to purchase or voluntary reallocation. A levy on project water sales and transfers is assigned to an environmental restoration fund that is designed to provide some of the funds to purchase environmental water. While the CVPIA was not the result of a process of negotiation, but rather brute political calculus, the methods reflect the aim to implement self adjusting market processes to achieve the environmental goals. In one sense the bill represents a trade off of water reallocations against flexibility and transfers.

The Monterey Agreement

Unlike the legislative approach in the CVPIA, the Monterey Agreement is an agreement between the California Department of Water Resources (DWR) and the contractors for the State Water Project (SWP) administered by DWR. The State Water Project is similar to the federal Central Valley Project in that it stores and delivers about half the volume of the CVP water over longer distances. The balance of water is the SWP is tilted toward urban supplies which comprise sixty three percent of the supplies. The current supply capacity of the SWP is 2,960 million m^3 and is less than the 4,900 million m^3 originally envisaged. This supply shortage is especially important during California's droughts that occur with an unpredictable frequency of approximately seven years. The Monterey Agreement:

> " began as a search for an answer to a single - but critical- problem in managing the SWP: how to allocate the water supply equitably during times of shortage"

(California Department of Water Resources 1996)

In 1960, when the original contracts were negotiated, an administrative formula was derived that attempted to balance the ability to reduce water use between urban and agricultural contractors. The administrative rule initially allocated the cuts to agricultural customers who were reduced by not more than 50% in any one year or a total of 100% in a series of seven consecutive years. Any additional cuts in supply that are required would be apportioned in proportion to the contracted amounts. Essentially, agriculture took the brunt of the cuts, particularly in the 1987- 1992 drought and felt that they were carrying a disproportionate share of the burden. The urban contractors did not agree with this conclusion. The agricultural contractors situation was reinforced when some contractors experienced significant financial difficulty during the drought. In an attempt to forestall judicial or legislative solutions, a mediator was hired and negotiations between the parties commenced. Agreement was reached on fourteen principles that amended the current contracts after three months of negotiation. The fourteen points can be summarized in three general categories. (i) The reliability of the existing supplies was increased by new allocation rules that created an annual pool for water sales and allowed contractors to turn back water allocations without penalty. (ii) The financial integrity of small contractors was improved by establishing a self financing trust fund that could be drawn on by agricultural contractors in drought years. (iii) Several methods were taken to increase the flexibility of water management and delegate more management to local agencies. Specifically, the control of a groundwater storage system was transferred to local agencies, short term and permanent water sales between contractors were approved, the transport of water purchased from other entities was approved as was the ability to store water in other facilities.

By using financial and market mechanisms to increase the flexibility of the SWP, the Monterey Agreement essentially increased the capacity of the existing system to meet the changing demands in times of drought. The ability to reach agreement was based on the successful implementation of the first of Lax and Sebenius' negotiation goals, which is to increase the returns from the water resource. The California DWR was truly interested in serving its contractors, and was prepared to delegate additional management authority to the contractors to achieve the flexibility gains, and thus also the potential to reach a negotiated agreement. Often, the refusal by central agency managers to transfer the power over water allocation to the local level is the largest obstacle to implementing more efficient allocation systems. Without the incentives to act on the information known only to local water users, a market system cannot result in improved allocations.

The Monterey Agreement is an example of a successfully negotiated solution to a problem where rigid administrative rules restricted the capacity of a water system to meet new demands. Substitution of partial market mechanisms and local control for centrally administered allocations increased the effective capacity and financial integrity of the water delivery system.

The Bay- Delta Accord

A second agreement over California water allocation was signed in late 1994. The agreement, termed the Bay-Delta Accord, was between many parties representing state, local, federal, urban, environmental and agricultural interests. The group known as CALFED agreed to operate under a short term agreement for three years, while working out the details of a long term agreement. The driving force behind the agreement was the threat of rigid federal administrative action to protect several species listed as endangered under the US Endangered Species Act, and the possibility that additional species may be listed in the near future. Under this threat, the CALFED parties reached the three year agreement whose main points are: (i) New water quality standards for the Bay-Delta estuary that are integrated with the endangered species requirements. To meet these standards, the reduction in the water deliveries by the two main CVP and SWP projects will be substantial and is estimated at 1,357 million m^3 in dry years and 494 million m^3 in wet years. (ii) The adoption of an adaptive management approach in which the operations of the water projects can adjust to changing biological conditions. (iii) The signatories also committed themselves to establish a \$180 million restoration fund that can be used to finance wild life mitigation efforts. (iv) In exchange for these significant concessions, the water supply participants negotiated an undertaking that the government agencies would not seek any additional listings under the Endangered Species Act. (v) If any additional water was required for biological purposes, it would be obtained by purchase from willing sellers rather than administrative reallocation.

The process of developing a longer term plan is currently progressing and the initial three year agreement has fostered a cooperative management approach in the Delta for the first time. A cautionary note is that the two years since the agreement went into operation have been marked by higher than average precipitation and plentiful water supplies. The real test of the stability of the agreement will occur when the next drought reduces supplies and increases the price at which water can be purchased.

In the initial stages of the Bay-Delta negotiations, the majority of the political power favored the environmental position. Despite this starting point, a notable feature of the Bay-Delta agreement is that the goals of adaptability and flexibility are prominent and required to maximize the joint benefits from environmental protection and water supply. In the management actions, the use of market purchases, rather than administrative allocation, allows more flexibility.

These three recent changes in water institutions in California support the central conjecture of this paper, namely, that water markets are not a substitute for negotiation in water conflicts, but are often an essential part and an outcome of searching for a solution to water conflicts. Markets are able to encourage regional coalition building as they offer a potential for mutual gain, and by revealing prices discourage strategic demands. The role of water markets is particularly apt when water conflicts are characterized by new demands conflicting with fixed supplies that are centrally allocated by criteria that have not adapted to the change in demands. Two regions where international water conflicts are characterized by these conditions are the Nile Basin in Africa and the Jordan basin in the Middle East.

Potential Blue Nile River Basin Conflicts

Three countries have riparian claims to the water resources of the Blue Nile, Ethiopia, Egypt, and Sudan. The 1959 Nile Waters agreement calculated the historic yield at 74 billion cubic meters (BCM), and divided it between Egypt and Sudan in the proportions of 55.5 BCM to Egypt and 18.5 BCM to Sudan. Ethiopia was not a party to the negotiations and did not receive an allocation. Whittington et al (1995) point out that currently the water development plans of the three countries are on a collision course. The authors show that there are several opportunities for improving the net yield from the Blue Nile by changing the storage and management of the water to areas that have lower evaporation losses than the Aswan dam. In this respect, the renegotiation of the Nile waters is not a completely zero sum game and appears to offer the potential of an additional 4 BCM of water. The pressure for renegotiation will become stronger as Ethiopia, with a population already the size of Egypt, starts to participate in the international economy and avail itself of the development loans from the international community. Several researchers have suggested the concept of an international market for Nile water that could operate to maximize the collective benefits from the Nile. As stated earlier, clear property rights to the water are needed for a functioning market. However the agreement over the property rights of Blue Nile flows is unlikely to proceed without some of the compensation mechanisms that inter regional markets can provide. The process of negotiating property rights and establishing a regional water market will probably have to proceed simultaneously as in the California agreements.

A regional market for water in the Nile basin would give Ethiopia an incentive to settle the property rights allocation in the near future. Currently, Ethiopia cannot use Nile water, but with a regional market generating revenues, allocation of the property rights to the water will have an immediate payoff. From the perspective of Egypt, the settlement of the water allocation will reduce the uncertainty over water supply and will result in the gradual phase down of water use as opposed to unexpected cuts under drought conditions. The need to charge for water in the user countries will also help to stimulate more efficient water use and technology, which will enable Egypt to partially adjust to water changes. Despite the differences in magnitude, nationalities and economic systems, it does not seem too far fetched to compare the principles underlying the reallocation of the Nile waters with those in California.

Negotiating the Use of the Jordan River

The use of the Jordan River has been a source of political and military conflict for several generations and forms one of the most intractable aspects of a stable peace in the Middle East. The conditions required for resolution of the current conflict have been analyzed by Wolf and Lonergan (1995) and others. While the conflict over the Nile basin is difficult, that over the Jordan is even more complicated. The hydrologic interdependency between the countries in the region does not have a linear form as in the Nile basin. In addition, the potential for increasing the efficiency of water use is only obtainable at a much higher price. Changes in the efficiency of water use has potential in some countries and pricing water to reflect its marginal opportunity cost will improve allocation in the short run. However, the long run population and development trends in the three countries that rely on the Jordan river for water, (Israel, Jordan and Palestine) will build a very strong demand for additional supplies in the future. Advances in the efficiency of water use will buy a short time for longer term solutions that will require imports from Turkey or the Nile, or the development of regional desalination plants for urban water supplies and the consequent reduction in agricultural use of water. The correct pricing of water in the Jordan river basin is a precursor to the financial feasibility of the more expensive methods of supply augmentation. Some authors have proposed a formal market solution for Jordan water supplies. This may be possible at a later time, but given the current political conflict between the countries involved, marginal cost pricing at the opportunity cost of water combined with distributional rebates at average cost is the best economic incentive that can be proposed.

Conclusions.

The paper has demonstrated the important role and limitations of water markets as part of the resolution of water conflicts. Water markets are shown to result in three benefits to resolving conflicts. (i) There are direct gains from trade between the parties involved in a water market that remove or reduce the zero sum game aspect of the resolution. (ii) The anonymous structure of markets reduces strategic actions by individual agents. Even when the decision making is concentrated in some agents, alternative market structures can produce prices that are close to competitive structures. (iii) Markets have an additional value in information contained in prices which signal the value of water to the non participants in the markets and modify their actions.

There are three types of water conflict situation where the market benefits can be significant. (i) Inter-sector transfers within an economy that can be stimulated by changes in water technologies or demands. (ii) The optimal allocation of environmental reallocations of water across different regions and uses. (iii) Tradable adjustments to accommodate disputes between countries on a common river basin.

Water markets have a strong and increasing role to play in the resolution of water disputes, but they are part of the resolution process not a substitute for it. In fact, water markets rarely arise spontaneously, but are shown to usually emerge as part of the negotiated solution to a political or hydrologic problem.

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