Measuring the Economic Impacts of Environmental Reallocations of Water in California

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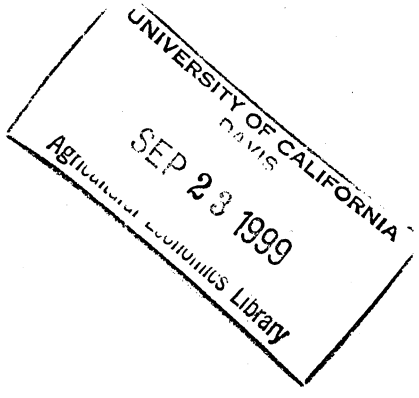


Growing environmental demands for water pose serious challenges for managing California's water resource systems. California's water managers are attempting to meet increasing urban and industrial demands while trying to devote more water and financial resources to rehabilitate and enhance environmental resources. Solutions to these problems will require substantial investments of capital and significant operational and managerial changes in the system. With traditional sources of surface supply development largely precluded due to their development cost and environmental effects, substantial changes in the property rights and payment for California water will be necessary to effect the required reallocation. The emergence of environmental interest groups as a major competitor for California's water has radically changed the traditional "iron triangle" of agencies, urban users and irrigated agriculture that had synergistic goals and was responsible for development of the existing water structure in the West. The new group of water interests has essentially contradictory goals and divided power. The urban agencies have the money, irrigated agriculture has the water rights, and the environmentalists have substantial electoral power. This division of power means that each group can block effective action on the water reallocation that is needed to address the current environmental demands. This ability to block change was applied by different groups for 13 years between the defeat of the Peripheral canal around the Delta in 1982 and the initiation of the Bay Delta accord in 1995. The impasse was broken by threats by the U.S. Department of Interior and Environmental Protection Agency to restrict Delta water exports on the basis of the declining fish populations and the Endangered Species Act.

The principal environmental effect on California water supplies is from two different legislative actions. The Central Valley Project Improvement Act (CVPIA) was enacted in 1992 and reformed several aspects of the Federally administered Central Valley Project. The two main changes were that substantial quantities of water were transferred from irrigation to environmental uses (Table 1). In addition, farmers were permitted to sell up to 15 percent of their water supply. In 1995, another legislative reallocation, termed the Bay Delta Accord, was jointly enacted by the state of California and the Department of the Interior (CalFed). This complex legislation, which is still evolving, reallocates further water supplies from both urban and agricultural users to environmental restoration projects.

The paper opens with a brief statement of the magnitude of current environmental reallocations of water in California. Supply and demand response data from State run spot markets in 1991, 1992, 1994 are used to show that California water markets are price responsive. Given this result, we argue that market reallocation methods will supercede the traditional command and control approach to water planning.

Table 1 shows the quantity of the surface water supplies reallocated from contractors in the two main State and Federal water supply projects. Due to the inherent variability of California's water supply, the quantities reallocated are defined based on the type of water supply year. The impact of the two environmental reallocations is an 8.6 percent reduction in aggregate surface supplies to contractors in normal rainfall years and a 21.8 percent reduction in dry year supplies. These reductions in supply are skewed in their impact by differences in the water rights that are manifest in the form of different levels in permissible reductions. For example, within the contractors for Federal water

there is a subgroup termed "Exchange" contractors who exchanged their long held riparian water rights for supply rights from the Federal project. Understandably, the exchange contractors were able to negotiate more favorable treatment in dry years than other contractors with no prior rights. This difference in water priorities results in a "roll down" effect of water cuts that increase the proportional reductions for those with the weaker water rights.

The need for a reallocation of surface water supplies has brought the long simmering debate on the merits of traditional command and control reallocation versus markets for water allocation to a decision point. Public water projects are traditionally analyzed using some variant of the Requirements Planning (R P) approach. Using this approach, the water requirements are projected, and the role of economic analysis is to calculate the lowest cost of achieving the requirements and an acceptable method of pricing and recovering these costs. In contrast, the market Supply-Demand (S D) approach to water planning explicitly recognizes the effect of high user prices on water demand and conversely the effect of the willingness-to-pay for water and reliability on the quantity demanded. The S D approach does not start with an attempt to predict planned quantities for agencies and private parties, but focuses on the costs of different levels of supply and the willingness to pay for different quantities, and reliability. In the Supply-Demand approach, the final quantity and type of water is an outcome of the analysis, and will vary as willingness to pay or costs of supply change. The demand for supplies of water for pure public purposes such as environmental flow requirements is generally considered price insensitive, and thus is measured in quantity terms.

The standard R P approach requires that planning "needs" for different types of water are projected as an input to the analysis. In the case of California, the State Department of Water Resources generates a planning document every five years. The most recent version (Bulletin 160-98) forecasts water supply shortages in 2020 to be 2.9 million acre-feet in a normal year and 7 million acre-feet in a drought year. Figure 1 shows that meeting this forecast shortfall from traditional supply sources would involve supply costs that are at least three times the current marginal value product of water .

A significant problem with the R P approach is that quantities are chosen without explicitly balancing the supply cost with willingness to pay. In the past, direct subsidies or average cost pricing covered shortfall between the willingness-to-pay and supply costs. A recent California proposition (Proposition 218) requires that increases in public payments for water must be based on additional benefits received. The result of this change is that all water uses, except pure public goods, can be expected to pay the actual incremental cost of additions to supplies. Given this approach to water planning, the critical parameters are the elasticities of water demand and supply rather than projections of "needs" and shortages.

The R P approach has served well where water projects are dominated by clear public demands and substantial economies of scale in project construction. However there are several factors that lead the two methods to arrive at different conclusions on the quantity of water supply that will be demanded. Reallocation of the existing supplies due to environmental legislation has the following characteristics that have precipitated a change in water supply and demand analysis. First, additions to the water supply will serve a combination of public and private uses. The different uses will require different

pricing policies. Second, stimulated by the high cost of traditional supply sources , additional supplies increasingly rely on alternative sources, such as conservation, reuse and water trading whose cost functions are often scalable. Thirdly, if the willingness-to-pay and incremental costs of water supply are required to balance, as seems to be the case under California's proposition 218, average cost pricing and cross subsidization are precluded. Finally, the response to the two large environmental changes in water use will be multi-staged projects where additional information on the supply costs and willingness-to-pay will emerge as the project evolves.

In short, the S D approach is more consistent with the current joint agency Cal-Fed approach of "Adaptive Management". The probable outcome in terms of costs and water quantities can be calculated by starting with the current initial conditions and applying the rules and response functions to incremental changes.

Figure 1 shows a state supply function for an additional 3.2 million acre-feet of water. The graph shows the incremental quantities and costs of different types of supply. The most notable feature is that the largest quantity, 2.4 million acre-feet, and lowest cost of water are derived from the non-structural supply sources of conjunctive groundwater use and water market sales from fallowed irrigated land. The supply costs in Figure 1 only reflect the minimum reservation price for water sales, and as such, underestimate the market-clearing price for water.

Figure 1 shows that the California supply response to environmental reallocations relies heavily (1.3 million acre-feet) on the response from voluntary water sales generated by short term fallowing of irrigated crops. Some modifications to California

water rights are needed to make such short term spot markets a permanent part of the solution.

The use of markets for reallocating environmental water has the potential for significant efficiency gains over command and control procedures. By providing incentives for the supply of environmental water to be extracted from uses with the lowest value marginal product, markets enable the environmental requirements to be met at substantially lower social costs than command and control procedures.

The California Department of Water Resources has operated three spot water markets during the drought years 1991, 1992, and 1994. The following results show them to be effective reallocation mechanisms on both the demand and supply side. The effect of a market in tempering dry year demands is demonstrated in the different responses to water demands under market and command and control systems during the 1991 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 supplies for "critical needs" during the coming drought. The contractors stated that the level was 499 thousand acre feet. Given the current system of average cost pricing and allocation by a politically determined formula, the contractors had an incentive to overestimate their critical needs.

As the Drought Water Bank became established and the drought progressed, it became clear that there was ample water at the fixed purchase price of $175 / acre-foot. In fact, actual purchases were 389 thousand acre feet (Table 2) and 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 at the fixed price, the contractors

reduced their "critical needs" by 22 percent. Even though the quantity of water traded in the California water markets is only six to twelve percent 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 supply response to water markets is shown by the following data for 1991, 1992 and 1994. Once started in 1991, inter-basin markets resulted in substantial trade volume in quantity or financial terms. Inter-basin trades in 1991 accounted for 818 thousand acre feet of water with a value of over $111 million (Howitt, Moore & Smith). The California water market reoccurred in the form of a drought water bank in 1992 and again in 1994 with a widening variety of types of trade and a volume that changed with water availability. The sale prices in 1992 and 1994 were lower than can be anticipated in future dry years due to the carry over of water from 1991 and restrictions on the land fallowing permitted. In 1995 a potential drought water bank based on sales and purchased options was formed and operated before increased supplies reduced option demand (Jercich).

The three California markets that have been consummated so far illustrate that the price, quantity and demands for water can adjust to different scarcity levels, even with fixed prices (see Table 2). 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 demand is price responsive.

Currently negotiations are continuing under the auspices of the CalFed process. Talks were initiated in 1995 and spent three years wrestling with the problem of acceptable measures of environmental requirements and mechanisms. The focus was on

biology and engineering which led to a proposal that was acceptable to the fractious parties involved, but side stepped the critical question of who would pay the fourteen billion dollar cost of the proposed developments and improvements. The unrealistic cost of the first proposal led to a greater emphasis on costs and economic criteria in CalFed negotiations in the past year. A committee of economic stakeholders representing all viewpoints has met monthly with staff and consultants to clarify the stakeholder positions and assumptions. The stakeholders are classified into seven groups representing three regional groups of agricultural interests, two urban water user regions, the environmental organizations and a group that has no affiliation, but favors market and efficient pricing mechanisms. Using economic analysis, a common representation of the views of each group over the set of policy actions can be generated by showing the effects of alternative positions on the demand and supply functions for additional water supplies in different uses and regions. Interestingly, there is more consensus on the levels and elasticities of demand than on the acceptable sources of supply. However, by explicitly deriving regional supply functions similar to Figure 1 for each region, and set of supply assumptions the effect of negotiating positions on the cost and quantity of water available can be rapidly shown and compared to alternative positions.

The analysis of environmentally driven water reallocation is central to California's current and future water policy, and water markets have been shown to be an effective drought reallocation mechanism. Economic analysis has two uses in the reallocation process. First, as a critical part of implementing the environmental reallocation solution through market mechanisms, and second as a mechanism to compare and reconcile conflicting policy viewpoints.

Table 1.

The Impacts on California's Water Supplies of Environmental Reallocations

100 Acre feet	State Water Project	Central Valley Project	Total
Water Year. Average 1922-1994			
Total Project Diversions	3067	2822	5889
Change due to the Bay-Delta Accord	-98	-231	-329
Change due to the CVPIA	-6	-171	-177
Total Change	-104	-402	-506
Water Year Dry 1987 –1992			
Total Project Diversions	2545	2457	5003
Change due to the Bay-Delta Accord	-367	-513	-870
Change due to the CVPIA	61	-283	-222
Total Change	-306	-796	-1092

Source: CalFed Phase II Report 1998

Table 2

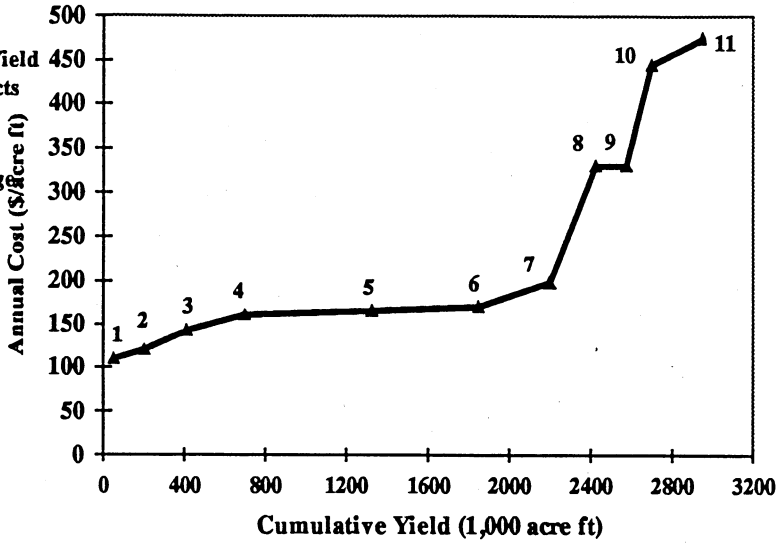
A Comparison of Three Annual California Drought Water Banks

		Quantities Purchased (1000 Acre feet)			
Year	Farm Sale Price*	Urban	Agriculture	Environment	Total
1991	$125/ac-ft	307.28	82.69	0	389.97
1992	$75/ac-ft	39.98	95.97	23.99	159.94
1994	$62/ac-ft	24.99	144.96	0	169.95

- The purchase price was 30% greater than the sale price due to the costs of conveyance carriage water.
- Source Jercich (1997)

Figure 1. Options for Increasing Water Supply

1. Conjunctive Use - Developable Yield
2. Supplies from Local Water Projects
3. Land Fallowing - Level 1
4. Land Fallowing - Level 2
5. Conjunctive Use - Active Recharge
6. Land Fallowing - Level 3
7. Land Fallowing - Level 4
8. Urban Wastewater Reuse
9. Surface Storage
10. Urban Conservation
11. Agricultural Conservation



Source: Least-Cost CVP Yield Increase Plan, 10/1995
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