Agriculture-to-Instream and Urban Water Transfers in the Central Valley of California: An Economic Reality Check

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Abstract

More than two million acre-feet (MAF) of water transfers from agriculture to urban and instream are discussed and debated in California. We use a regional agricultural production and water transfer model to evaluate potential third party impacts of transferring one MAF of water from the Central Valley of California. A range of impacts is estimated under three different scenarios. Our base scenario shows that the adverse economic impacts in the area of origin include a $170 net personal income loss for each acre-foot of water transferred, and 8 job losses for each thousand acre-feet of water transferred.

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INTRODUCTION

Water transfers have recently increased in importance as a way to meet water demands in California. The movement of developed water from areas of surplus to areas of deficit has been viewed as a way to improve water use efficiency at a net economic gain for buyers and sellers. With the success of the State Drought Water Bank in 1991, 1992, and 1994, many are heralding water transfers as the quickest, least expensive, and most environmentally benign solution to California's water supply and reliability problem. In recent years, the transfer of over two and half million acre-feet of water has been discussed and debated by federal, state, or local agencies (Table 1). Although most of the proposals have not materialized, and a few were short-lived after failing public scrutiny, water transfer alternatives are increasingly seen in water plans by local water agencies in California. The menu of transfer alternatives may include one-time spot transfers, short - term agreements for drought years, or long-term agreements for average year transfers. As shown in Table 1, the discussion of water transfers generally focuses on the purchase of water from agricultural willing sellers to meet instream flow and urban demand. One of the key issues in this type of water transfer is the third party impact on the economic base of rural farming communities. Farmers and other local interests fear that water transfers will lead to idling of farmland, loss of jobs and local income, reduced government revenue, and increased costs for social programs. The objective of this paper is not to evaluate the feasibility or cost of such water transfer proposals in California; rather the objective is to use two economic models to evaluate third party impacts that could result if one million acre-feet (MAF) of irrigation water in California's Central Valley were transferred to instream and urban uses. More specifically, we ask:

Table 1: Potential Large-Scale Water Transfers Discussed in California, 1997[1]		
PROGRAM	**TRANSFER PROPOSED (acre-feet per year)**	**TRANSFER TO**
CALFED[2]	1,250,000	Instream
Central Valley Project Improvement Act (CVPIA)[3]	365,000	Instream
Bay-Delta Settlement Agreements[4]	200,000	Instream
Monterey Agreement[5]	130,000	Urban
The Metropolitan Water District of Southern California[6]	300,000	Urban
Contra Costa Water District[7]	150,000	Urban
Santa Clara Valley Water District[8]	100,000	Urban
San Diego County Water Authority[8]	200,000	Urban
Total	**2,695,000**	

NOTE:

1. This table only lists major water transfer discussions, and it does not list all of the transfer proposals currently discussed in California.
2. CALFED Bay-Delta Program: Memorandum on Land Retirement, January 1998.
3. CVPIA Interim Water Acquisition Program, the California Water Plan Update, Bulletin 160-98, Volume 1, Public Review Draft, January, 1998.
4. Settlement agreements currently are being negotiated between water rights holders and the SWRCB. The number shown in the table is a preliminary estimate.
5. Department of Water Resources, State Water Project Supplemental Water Purchase Program, Draft Environmental Impact Report, California, December 1996.
6. MWD, Southern California's Integrated Water Resources Plan, Executive Summary, Report Number 1107, 1996.
7. Contra Costa Water District, Responsibly Planning For the Future, 1995 Annual Report.
8. The California Water Plan Update, Bulletin 160-98, Volume 1, Public Review Draft, January, 1998.

- Who would be the most likely sellers?
- What would be the relative price ranges for water sales in different regions?
- What crops would be fallowed or switched as a result of transfers?
- What would be the adverse impacts on personal income and employment in water selling regions?

Three scenarios are analyzed to estimate a range of impacts, including a base scenario, a scenario for no CVP service and exchange contract water transfer, and a scenario for groundwater substitution for transferred water.

This paper is organized as follows. Following this introduction, past water transfers in California are briefly reviewed. This is followed by an introduction to agriculture in the study area, the California's Central Valley. The economic models used in this study are then discussed. Finally, results and interpretations are presented and conclusions are drawn.

WATER TRANSFERS AND AGRICULTURE IN THE CENTRAL VALLEY

This section first describes some basic water facts for California. The 1991 State Drought Water Bank is discussed next. Finally, crop production and irrigation water use in the Central Valley of California are introduced next.

Basic Water Facts in California

Like other Western States, California has a rich water resource; however, the water is not well distributed. For example, while over 60 percent of the total annual runoff is in northern California, over 70 percent of the demand is in southern California (Table 2). Agriculture uses about 80 percent of the total applied water. Because of the differences in endowments and historical water allocations, the water costs between the south and north and between agricultural and urban are substantial, as shown in Table 2.

Table 2: Some Basic Water Facts in California		
	Northern California	Southern California
Average Runoff (maf)	50.0	28.7
Agricultural Applied Water Use (maf)	9.1	33.6
Urban Applied Water Use (maf)	2.0	6.7
Average Agricultural Water Cost ($/af)	10-30	20-250
Average Urban Water Cost ($/af)	80-300	200-1000

Source: California Department of Water Resources, Draft *California Water Plan Update*, Volume 1, Bulletin 160-98, January 1998.

To balance water demand and supply and to allocate water more efficiently, California has built one of the most sophisticated water conveyance systems in the world (Figure 1). For many years, water supplies have been developed as needed; usually, the supply has been adequate to meet demands. The recent droughts (1987 to 1992), however, demonstrated the inadequacy of supplies to meet demands in dry conditions. Developing new facilities has become more and more expensive and environmentally difficult. As a result, the transfer of water from areas with water surpluses to areas with deficits has come to be viewed as an economic way to manage California's water resource. Although water transfers between individual water users within a water district have always existed in California, inter-regional water transfers were very limited before the 1987 to 1992 droughts.

The State Drought Water Bank was established in 1991 to acquire and transfer water to meet critical needs during the continuing, severe drought that year. In 1991, the Department of Water Resources (DWR) bought 820,000 acre-feet of water from willing sellers. DWR paid $125 an acre-foot and sold the water for $175 an acre-foot. The difference between the purchase and sale price resulted largely from Delta conveyance losses. About half of the purchased water came from growers who were paid not to irrigate their land (Table 3). Approximately 170,000 acres were fallowed by both riparian and appropriative water users (Howitt, et al., 1992). One-third of the water came from groundwater substitution, and the remaining amount was from stored water, mostly from the Yuba County Water Agency.

Table 3 shows about one third of the water was delivered to urban users by the 1991 Water Bank. Another one third of purchased water was not taken by buyers, it remained in storage at the end of the year. The rest of the water was purchased to satisfy Delta outflow requirements for through-Delta transfers or bought by agricultural users.

Table 3

Sources And Allocations Of 1991 State Drought Water Bank (Thousand Acre-Feet)

Sources	
Fallowing	420
Ground Water	258
Storage	142
Total	820
Allocation	
Agriculture	83
Urban	307
Fish & Wildlife	0
Delta Outflow	165
In Storage	265
Total	820

SOURCE:
DWR, PEIR for State Drought Water Bank, 1993b.

Agriculture in the Central Valley of California

The Central Valley of California is an important agricultural region for both California and the U.S. The Valley produces almost all of almonds, artichokes, dates, figs, kiwifruit, olives, persimmons, pistachios, prunes, raisins, clovers and walnuts produced in the United States. Agriculture is an important employer, and it affects the regional economy through the expenses from farming activities. Nearly one in 10 jobs, and more than $35 billion in related economic activity in California, are provided by Central Valley agriculture (CDFA, 1998).

Table 4 shows irrigated acreage and production value, by crops for three regions. A map of the region is shown in Figure 2. The main crops in the Sacramento River Region include rice, field crops, and tree and vine crops. Tree and vine crops are the largest in the San Joaquin River Region; they are followed by cotton and field crop. The Tulare Lake Region has the largest cotton acreage among the three regions. Tree and vine crops are also important in that region. Alfalfa hay shows significant acreage in all three regions. Vegetable crops and tree and vine crops account for 42 percent of the total irrigated acreage valley-wide, but they produce over 73 percent of the total production value. In contrast, alfalfa hay and field crops account for 33 percent of the acreage, while producing 10 percent of the total value.

Table 4: Irrigated Acreage and Production Value in California's Central Valley

Region	Rice	Cotton	Alfalfa Hay	Field Crops	Vegetable Crops	Tree & Vine Crops	Total
Irrigated Acre (1,000 acres)							
Sacramento River Region	473	0	267	662	271	369	2,041
San Joaquin River Region	16	490	341	450	442	774	2,513
Tulare Lake Region	0	590	195	279	208	713	1,986
Total	488	1,080	803	1,390	921	1,856	6,540
% of Total	7%	17%	12%	21%	14%	28%	100%
Production Value ($ Million)							
Sacramento River Region	400	0	92	288	672	406	1,859
San Joaquin River Region	13	532	138	266	2,048	1,335	4,332
Tulare Lake Region	0	651	115	171	1,247	1,734	3,917
Total	413	1,183	345	725	3,967	3,475	10,108
% of Total	4%	12%	3%	7%	39%	34%	100%

Note:
The numbers in the table represent an average from 1987 and 1992.

Source:
US Census of Agriculture, 1987 and 1992.

Central Valley agriculture receives irrigation water from CVP, the State Water Project (SWP), local water rights and water projects, and groundwater. Most of this water is delivered to farmers through irrigation districts and other water agencies. Table 5 shows irrigation water use in the three regions. On average, the CVP supplies about 25 percent of all irrigation water to approximately 200 water districts, individuals, and companies. About 15 percent of the CVP deliveries are under service and repayment contracts, and 10 percent are under Sacramento River Water Rights and San Joaquin River Exchange contracts. Through contracts with 29 water agencies, the SWP provides irrigation water within the Central Valley to Butte, Solano, Kings, and Kern counties. It also provides water rights deliveries to water rights holders along the Feather River (see Figure 1). On average, SWP delivers about 2 MAF a year, or 9 percent of the total irrigation water used in the Valley. Local surface water supplies (those not delivered by either project) average 5.5 maf or 24 percent of the total. Groundwater is a significant supply of irrigation water in the Central Valley, particularly during drought years. On average, groundwater provides 42 percent of all irrigation water.

Table 5: Irrigation Water Use in California's Central Valley

	Sacramento River Region	San Joaquin River Region	Tulare Lake Region	Total	Percent of Total
CVP Water Service and Repayment Contracts	661	1,641	992	3,294	15%
CVP Sacramento River Water Rights And San Joaquin River Exchange Contracts	1,561	764	5	2,330	10%
SWP Water	890	11	1,038	1,940	9%
Groundwater	2,455	3,309	3,619	9,383	42%
Local Surface Water Rights	1,798	2,302	1,388	5,488	24%
Total	7,365	8,027	7,043	22,435	100%

Note:
The number shows an average of 1990 and 1995.
Source:
The California Water Plan Update, Bulletin 160-93, October 1994, and Draft Bulletin 160-98, January 1998.

The Model

To evaluate third party impacts of an assumed transfer of one MAF of water from the Central Valley agriculture to instream and urban uses, two models are used: the Central Valley Production and Transfer Model (CVPTM) and IMPLAN. CVPTM is used to estimate the reductions in irrigated acreage and crop production value that would result from water transfers and to estimate potential increases in revenue from water sales. Regional impact multipliers obtained from IMPLAN are used to estimate regional income and employment losses that would be associated with water transfers.

The CVPTM

CVPTM was developed to evaluate water transfer opportunities affected by the Central Valley Project Improvement Act of 1992. The objective function of CVPTM can be simplified as

$$OBJECT = \sum_R \sum_C \left[YLD_{R,C} \bullet P_C - IRCST_{R,C} - OTCST_{R,C} \right] \bullet XN_{R,C} - \sum_R \sum_W WP_{R,W} \bullet WAT_{R,W}$$
$$+ \sum_R \sum_C CS(XN_{R,C})$$
$$- \sum_R \sum_Q \sum_W TRCOST_{R,Q,W} \bullet WTRAN_{R,Q,W} \; |AT_{R,Q}$$
$$+ \sum_D \sum_Q \sum_W TRFRAC_{D,Q} \bullet WTRAN_{D,Q,W} \; |AT_{R,Q} \bullet \left[WPRI_D - TRCOST_{D,Q,W} \right]$$
$$+ \sum_D MICS(TRFRAC_{D,Q} \bullet WTRAN_{D,Q,W})$$

where

R, Q	= Central Valley agricultural production regions
C	= Crops
W	= Water sources, including CVP contract water, CVP water rights water, State Water Project water, local surface water, and groundwater
YLD, P	= Crop yields and output prices
IRCST	= Annualized irrigation system cost
OTCST	= Other production costs
XN	= Irrigated acres
D	= Municipal and Industrial (M&I) regions
WP	= Water cost per acre-foot
WAT	= Applied irrigation water
CS	= Consumer surplus for agricultural product users
TRCOST	= Conveyance cost and other transfer cost per acre-foot of transferred water
WTRAN	= The amount of water transferred out of the selling region
AT	= Water transfer feasibility matrix
TRFRAC	= Ratio of sold water to received water
WPRI	= Price of transferred water received by M&I users
MICS	= Consumer surplus for instream and urban water users

CVPTM includes 22 agricultural crop production regions (R,Q) and 12 crop categories (C). For this analysis, CVPTM results are aggregated into 3 regions and 6 crop categories as shown in Figure 2 and Table 4, respectively. Transferred water (W) is differentiated into five types in CVPTM: CVP contract water, CVP water rights water, SWP water, local surface water, and groundwater. One of the most important features of CVPTM is its allowance for five types of water in water transfers (WTRAN), transfer costs (TRCOST), transfer feasibility (AT) and other constraints represent. CVPTM is linked with several other economic and hydrologic models to obtain information such as urban water transfer demand functions and irrigation water deliveries and groundwater pumping.

The objective function consists of two parts. The first part (the first two lines) represents the irrigated crop production sector. CVPTM maximizes the sum of the producer's surplus, measured as the net revenue from irrigated crop production, and the consumer surplus (CS).[1] The second part of the objective function shows water transfer sector. This sector includes three parts shown as lines 4 to 6 in Equation (1). They represent (a) the transaction cost of water transfers between agricultural regions; (b) the net revenue received by agricultural sellers selling water to instream and urban users; and (c) the net benefit of water transfers to instream and urban buyers, measured as consumer surplus (MICS).[2] CVPTM solves for the water price, crop mix, amount of irrigated land, and level of water transfers that will maximize the sum of the net revenue and consumer surplus for both agricultural production and water transfers.[3]

To test the reasonableness of CVPTM estimates, California's 1991 water bank was simulated using the model. The results of the simulation were quite reasonable, and somewhat conservative. The net water sold into the simulated water bank was 314,000 acre-feet at just over $126 per acre-foot, compared with the actual 380,000 acre-feet at $125 per acre-foot.

The IMPLAN Multiplier

Third party impacts arising from water transfers include (1) physical effects of transfers, such as impacts on groundwater recharge and reuse of return flow, and (2) economic impacts on both the buying and the selling regions directly engaged in the transfer. This paper focuses exclusively on third party impacts on agricultural selling regions where farm

[1] CS depends on the demand functions used. For simplicity, we use a general term here.
[2] We use a general term here for simplicity.
[3] A detailed description of CVPTM is available from authors.

business losses occur when farmers transfer water and fallow land. These businesses depend on these farmlands being in production, either directly, as a source of employment, or indirectly, through landowner expenditures (e.g., payments to fertilizer company, local stores, equipment dealers, professional service providers, etc.). The removal of these lands from production can result in fewer jobs and less money available in the local economy.

IMPLAN is an input-output database and software program that calculates input-output multipliers. For this analysis, these multipliers were adjusted to reflect specific agricultural production conditions in the Central Valley. In addition, we assumed that (1) in an owner-operator condition, 90 percent of sale proceeds from transfers is re-spent in the region, and (2) in a tenancy situation, 80 percent of the sale proceeds goes to the landowner and 20 percent goes to the tenant. Based on 1992 farmland owned and rented in the Central Valley (Census of Agriculture, 1992), we estimated that 72 percent of the revenue from water sales would be re-spent in the region under the above assumptions.

Results and Interpretations

Base Scenario

A fixed water transfer demand function is created at the Delta to buy up to one MAF of water from willing sellers across all agricultural regions (See Figure 2 for the Delta location). The Delta is at the confluence of California's two largest rivers, the Sacramento and the San Joaquin. It is at the center of all water facilities providing drinking water for two thirds of Californian's population.

The land-fallowing component of the 1991 State Drought Water Bank allowed only the evapotranspiration (ET) portion of water provided by land fallowing to be transferred. The Governor's 1992 water policy stated that water transfers should involve only real, not "paper" water. This study adopts the assumption that only ET, or irrecoverable loss, is transferable. In addition, the base scenario assumes that groundwater substitution for transferred water is not allowed. Thus, transferred water has to be generated by land fallowing and crop switching. Finally, a set of hydrologic criteria based on the existing condition in 1995 was used as a starting point; these criteria included water deliveries based on a 1995 level of demand for crop production, the Biological Opinion for Winter Run Chinook Salmon, and the 1994 Bay-Delta Accord requirements. Table 6 summarizes the base scenario results for the three regions.

Table 6: Regional Impacts of the Transfer of One MAF of Water From the Central Valley of California, Base Scenario

	Sacramento River Region	San Joaquin River Region	Tulare Lake Region	Total
Direct Losses				
Land Fallowed as a Result of Transfers (1,000 acres)	-154	-112	-86	-352
Crop Revenue Loss ($ Million)	-81	-81	-74	-236
Total Personal Income ($ Million)	-183	-129	-98	-410
Employment Loss (Man-years)	-13,959	-7,645	-6,269	-27,874
Gains From Water Sales				
Amount of Water Sold (1,000 AF at the Delta)	431	328	241	1,000
Receipts From Transfers ($ Million)	48	41	33	123
Total Personal Gain ($ Million)	110	74	56	240
Employment Gain (Man-years)	8,255	6,291	5,159	19,705
Net Gain/Loss				
Personal Income ($ Million)	-73	-55	-43	-170
Employment (Man-years)	-5,704	-1,354	-1,111	-8,169

About 50 percent of the MAF transfers are from the Sacramento River Region, 30 percent are from the San Joaquin Region, and the rest are from the Tulare Region. The cost of the transferred water is estimated at $115/af, $121/af, and $160/af, respectively, for the three regions, or at an overall average of $123/af. The differences reflect water resource endowment and crop mixes among the regions. The costs include conveyance costs to the Delta and the costs associated with conveyance losses and Delta outflow requirements.

Table 7 shows land fallowing by crops and regions, as a result of the MAF water transfers. Over 60 percent of fallowing is expected to occur in alfalfa hay and field crops and 37 percent in rice and cotton. High value crops will account for less than 5 percent of all land fallowing.

Table 7 Land Fallowing As a Result of MAF Water Transfers, Base Scenario

	Rice	Cotton	Alfalfa Hay	Field Crops	Vegetable Crops	Tree & Vine Crops	Total
Irrigated Acre (1,000 acres)							
Sacramento River Region	-44	0	-58	-48	-3	-1	-154
San Joaquin River Region	-2	-35	-50	-20	-3	-1	-112
Tulare Lake Region	0	-40	-30	-14	0	-2	-86
Total	-47	-75	-138	-81	-7	-4	-352
% of Total	13%	21%	39%	23%	2%	1%	100%

Total gains in personal income and employment from water sales are $240 million and 19,705 man-years, respectively. On the other hand, 352,000 acres of crops would be fallowed to supply the MAF. This would result in $236 million of direct loss of crop revenue, or $410 million loss in personal income and 27,874 job losses in the area of origin.

The net economic impacts of the MAF transfers to the areas of origin are the loss of $170 million in personal income and 8,169 jobs. That is a $170 personal income loss for each acre-foot of water transferred and 8 job losses for each thousand acre-feet water transferred.

Scenario 2 – No CVP Service and Exchange Contract Water Transfers

This scenario restricts CVP service and exchange contract water from being transferred. All other assumptions are the same as in the base scenario. Water transfers out of the CVP service area are explicitly authorized by the CVPIA of 1992. Section 3405(a) of the Act states that individuals or districts receiving CVP water delivered under water service and repayment contracts and water rights settlement and exchange contracts, may transfer all or a portion of that water to any other California water user or water agency for any purpose recognized as beneficial under state law. Transfers must be approved by the U.S. department of the Interior. The purpose of this scenario is to evaluate the impacts on the water transfer market with and without the CVP service and exchange contract water.

The result for this scenario is shown in Table 8. It indicates that one MAF of transferred water would come more evenly from the three regions and more water would be sold by the Tulare Lake Region, compared with the base case. This is consistent with the fact that without two to three MAF of CVP service and exchange contract water participating in transfer market (see Table 5), most of the transferred water would be SWP water and local surface water. Over 50 percent of SWP water are currently delivered to Tulare Lake Region.

Table 8: Regional Impacts of the Transfer of One MAF of Water From the Central Valley of California Scenario 2 (No CVP Service and Exchange Contract Water)

	Sacramento River Region	San Joaquin River Region	Tulare Lake Region	Total
Direct Losses				
Land Fallowed as a Result of Transfers (1,000 acres)	-133	-127	-118	-378
Crop Revenue Loss ($ Million)	-90	-60	-84	-234
Total Personal Income ($ Million)	-162	-133	-133	-428
Employment Loss (Man-years)	-12,454	-8,766	-9,063	-30,283
Gains From Water Sales				
Amount of Water Sold (1,000 AF at the Delta)	312	348	339	1,000
Receipts From Transfers ($ Million)	39	47	48	134
Total Personal Gain ($ Million)	89	85	81	255
Employment Gain (Man-years)	6,658	7,213	7,458	21,329
Net Gain/Loss				
Personal Income ($ Million)	-74	-48	-52	-174
Employment (Man-years)	-5,796	-1,553	-1,605	-8,955

Average transferred water cost under this scenario is estimated at $134/af, $8/af (or 6 percent) higher than the base scenario. Higher selling price results in higher personal income and employment gains in the areas of origin.

The amount of land fallow under this scenario is 378,000 acres, which is 15,000 acres higher than the base scenario. The increased amount is mainly due to additional conveyance losses to transfer water to the Delta from farther distance because of unavailability of transferring CVP water from the places more close to the Delta, such as areas in the Sacramento River Region.

Compared with the base scenario, the net losses in personal income and employment in this scenario are higher. The loss of personal income is estimated to be $174 million, or $4 million higher than the base case. This is due to the higher loss of crop revenues resulted from the higher fallowing acreage. The total job losses in this scenario are estimated to be 8,955, which is about 1,000 more that the base scenario.

Scenario 3 - Groundwater Substitution

This scenario allows additional groundwater pumping in the area of origin to substitute transferred water. Sections 1220 and 1745.10 of California Water Code prohibit groundwater transfer or substitution unless consistent with an approved groundwater management plan by local water authorities. The purpose of this scenario is to evaluate the impacts of allowing groundwater substitution on the transfer market.

Table 9 shows that the average cost of the transferred water under this scenario is $95/af, which is $31/af, or 25 percent, lower than the base case. Hence, allowing the groundwater substitution would generate much cheaper water to the buyers.

Table 9: Regional Impacts of the Transfer of One MAF Water from the Central Valley of California
Scenario 3 (Allowing Groundwater Substitution)

	Sacramento River Region	San Joaquin River Region	Tulare Lake Region	Total
Direct Losses				
Land Fallowed as a Result of Transfers (1,000 acres)	-24	-60	-38	-122
Crop Revenue Loss ($ Million)	-13	-43	-33	-89
Total Personal Income ($ Million)	-36	-123	-109	-268
Employment Loss (Man-years)	-2,751	-8,640	-8,768	-20,159
Gains From Water Sales				
Amount of Water Sold (1,000 etaf)	123	421	456	1,000
Receipts From Transfers ($ Million)	11	47	38	95
Total Personal Gain ($ Million)	24	84	78	186
Employment Gain (Man-years)	1,806	7,109	7,215	16,130
Net Gain/Loss				
Personal Income ($ Million)	-12	-39	-31	-82
Employment (Man-years)	-945	-1,531	-1,553	-4,029

Almost 90 percent of the MAF are expected to come from San Joaquin River and Tulare Lake Regions. This is due to more groundwater availability in these two regions (See Table 5). The land fallowing resulted from the transfers is estimated at 122,000 acres, which are about 30 percent of the total in the base scenario. Allowing the groundwater substitution enables the sellers pumping additional groundwater to replace most of the sold surface water. As a result, less crop fallowing is needed. The net losses in personal income and jobs in this scenario are $82 million and 4,029, respectively. Both are less than half of the base scenario.

Conclusions

The third party impacts from water transfers to water selling regions are an important consideration in evaluating water transfer programs. Recent evidence from the State's drought water bank and deliberations over State water transfer policy have shown that these impacts are real, but their magnitude, distribution, and significance are still widely debated.

This paper applies an agricultural production and transfer model (CVPTM) and IMPLAN multipliers to evaluate regional impacts of transferring an assumed one MAF from agricultural regions in the Central Valley of California. Our base scenario results show that there would be willing sellers in the Central Valley agricultural regions to meet the MAF demand in pure economic terms, i.e., maximizing the producer and consumer surpluses. The average cost of transferred water is estimated to be substantially lower than other new water alternatives. Our base scenario shows that half of the MAF water is expected to come from the northern Sacramento River Region. This is consistent with what observed during the State Drought Water Banks. Under the no CVP service and exchange water transfer scenario, however, the MAF would come more evenly from all regions with a 6 percent higher price tag. The groundwater substitution scenario shows much lower crop land fallowing, lower water cost to sellers, and less adverse regional economic impacts

Without doubts water transfers from agriculture to instream and urban users would benefit individual sellers, buyers, and the State as whole as evidenced by the Drought Water Bank (Howitt, et al.). However, water transfers would likely cause some economic hardship to local rural communities, though magnitude may differ under different scenarios as analyzed in this study. Our base scenario shows that the adverse economic impacts in selling regions include a $170 net personal income loss for every acre-foot water transferred and 8 jobs losses for every thousand acre-feet water transferred. The total impacts are about 2 to 3 percent of the regional total.[4] This may not be considered significant. But the impacts can be more concentrated in a few areas of origin. Our analysis assumes that 72 percent of water sale incomes are expected to re-spend in the selling regions. But in reality, water sellers may retire from farming and spend most or all of their water transfer income vacationing in Hawaii or overseas. The water transfers can also affect local government interests. Reduction in local sales reduces sales tax revenues. Property taxes may be affected by change in asset values and other revenues may be

[4] According to 1997 California Statistical Abstract, the total local personal income and agricultural employment were $10.5 billion and 300,000, respectively. Thus the losses of income and employment under the base case would account for 2 and 3 percents of the total, respectively.

affected. Employment losses in directly and indirectly affected businesses may increase unemployment claims and costs of other social services. These impacts are not included in our estimates. They would certainly increase the magnitude of adverse economic impact in the area of origin.

REFERENCES

California Department of Water Resources, *California Water Plan Update*, Volume 1, Bulletin 160-93, October 1994.

California Department of Water Resources, Draft *California Water Plan Update*, Volume 1, Bulletin 160-98, January 1998.

California Department of Water Resources, *Program Environmental Impact Report, State Drought Water Bank*, DWR, California, 1993.

California Department of Food and Agriculture, California Agricultural Resource Directory 1997, Sacramento, 1998.

Howitt, Richard; N. Moore and R. K. Smith. 1992. "A Retrospective on California's 1991 Emergency Drought Water Bank." A Report Prepared for the California Department of Water Resources.

United States Bureau of Reclamation, Irrigation Water Rates for Central Valley Project, California, 1992.

United States Bureau of Reclamation, Municipal and Industrial Water Rates For Central Valley Project, California, 1992.

U.S. Bureau of the Census, Census of Agriculture, 1987 and 1992.