THE ECONOMIC IMPACTS OF SALINITY INCREASE IN THE CENTRAL VALLEY

ECONOMIC SUMMARY AND CONCLUSIONS

September 9 2008

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This section contains a description the REMI model the direct economic impacts, and the REMI model results.

1.1 The Potential Benefits of a Central Valley Salinity Management Plan

1.1.1 Regional Economic Models, Inc. (REMI)

The following description of the REMI model was adapted from REMI Policy Insight 9.5, Model Documentation, 2007 Regional Economic Models, Inc[1]

REMI Policy Insight is probably the most widely applied regional economic policy analysis model. Uses of the model to predict the regional economic and demographic effects of policies cover a range of issues; some examples include electric utility restructuring in Wyoming, the construction of a new baseball park for Boston, air pollution regulations in California, and the provision of tax incentives for business expansion in Michigan. The model is used by government agencies on the national, state, and local level, as well as by private consulting firms, utilities, and universities.

The original version of the model was developed as the Massachusetts Economic Policy Analysis (MEPA, Treyz, Friedlander, and Stevens) model in 1977. It was then extended into a model that could be generalized for all states and counties in the U.S. under a grant from the National Cooperative Highway Research Program. In 1980, Regional Economic Models, Inc. (REMI) was founded to build, maintain, and advise on the use of the REMI model for individual regions. REMI was also established to further the theoretical Model Documentation – Version 9.5 3 framework, methodology, and estimation of the model through ongoing economic research and development.

A detailed description of REMI is presented in an Appendix **X**.

1.1.2 The Central Valley REMI Model

REMI regions are configured as a county or by a group of counties. The Central Valley REMI Model was configured as a four region model made up of the Sacramento, San Joaquin and Tulare Basins, and the Rest of California. The following maps delineate the Central Valley Regional Water Quality Control Board, the major hydrologic basins located in the Region, the counties related to that delineation, and final county-basin configuration.

The Central Valley encompasses the hydrologic area drained by the Sacramento River, the San Joaquin River, and the hydrological closed area known as the Tulare Sub-basin. Those drainage areas form the basis of three of the REMI regions (Table 5.1).

[1] http://www.remi.com/downloads/documentation/Policy_Insight_9-5_Model_Documentation.pdf. {REMI, 2008 #89}

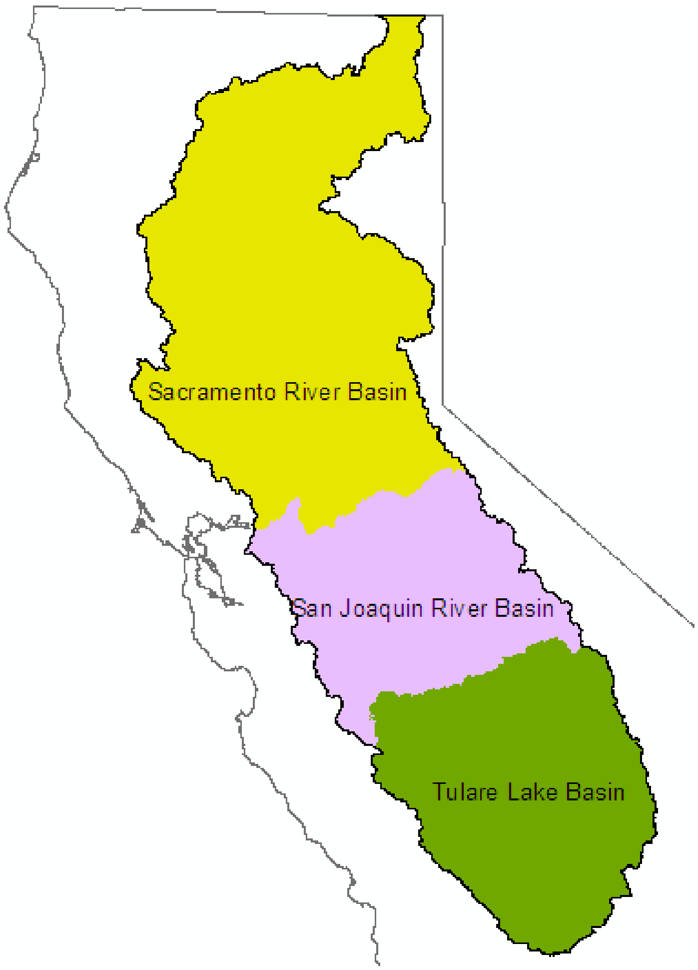


Figure 1.1 The Sacramento, San Joaquin and Tulare Basin of the Central Valley

Determining the counties that represent the REMI region is important since counties are not delineated by hydrologic criteria. The California county map was overlaid on the Central Valley Basin map to select the counties that would represent the basins (Figure 5.2). From the overlay, it is evident that certain counties could be included in two of the basin designations. For example, Siskiyou, Modoc, Lassen, Napa, Solano, Contra Costa and Kern counties have substantial areas inside and outside of the Central Valley delineation. Another problem is presented by Fresno County. Although located entirely within the Central Valley, it is divided between the San Joaquin and the Tulare Basins.

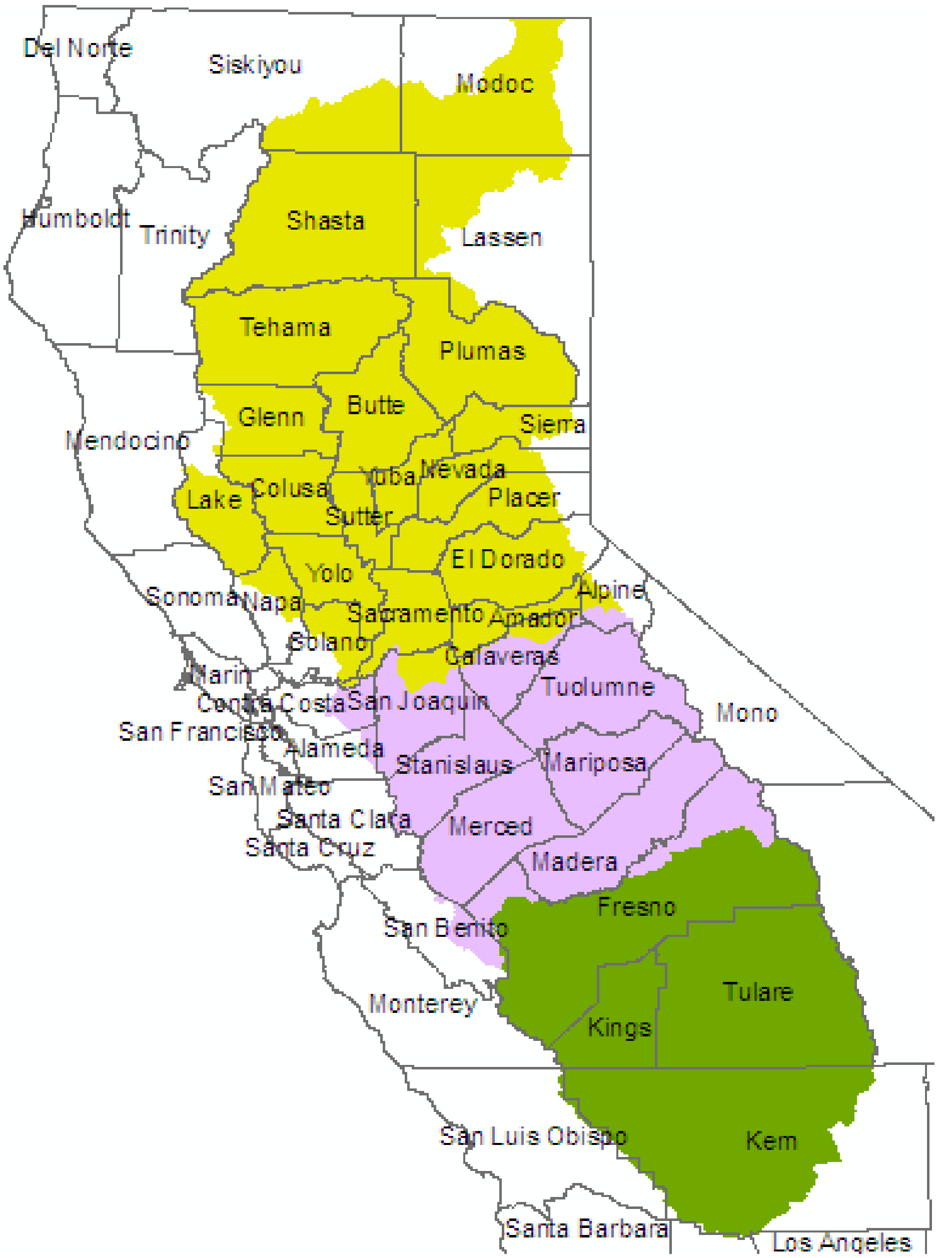


Figure 1.2. CA Counties and Central Valley Regional Water Quality Control Board Basins

Since aggregations of county data represent each basin model, the effect of including or excluding each county needs to be assessed. Counties were included in the REMI model if a substantial portion of the counties population and economic activity was affected by the actions of the Central Valley Water Board.

The following maps indicate the counties that were included in each REMI Basins, the hydrologic configuration of the three basins, and urban areas. The shaded areas of the Central Valley that are outside of the County designations indicate areas whose data are not included in the Basin model but should be included. Non-shaded area inside the county boundaries represents areas whose data are included in the Basin REMI model but should not be included.

The Sacramento River Basin includes 19 counties (Figure 5.3). Solano County was included in the Sacramento Basin model but the communities of Vallejo, Benicia and Fairfield are outside of the Basin. The same conditions exist for the communities in the Lake Tahoe area. The Siskiyou County communities of Mount Shasta, Dunsmuir and McCloud located in the Central Valley region but not included in the REMI model.

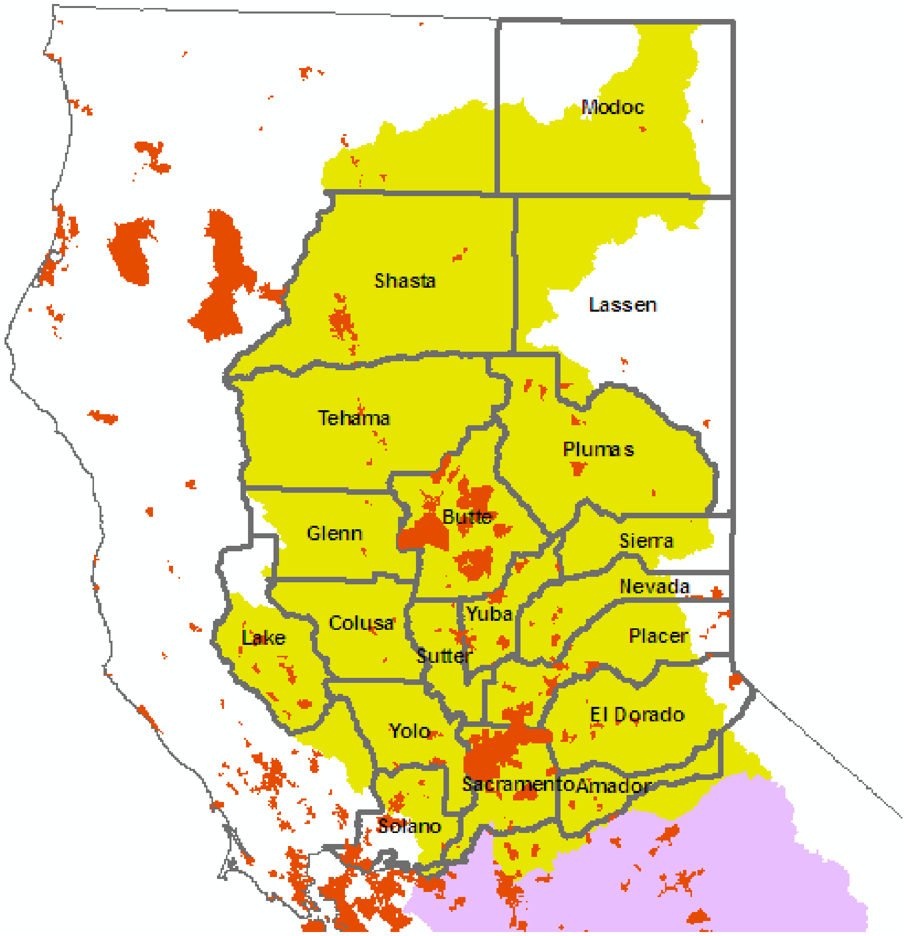


Figure 1.3.. Sacramento Basin REMI Model County Configuration.

A number of communities located just south of Sacramento (Lodi and a portion of Stockton) are in the Sacramento hydrologic region but also in San Joaquin County which is included with the San Joaquin Basin REMI region.

Figure 1.4 is a map of the San Joaquin Basin REMI model configuration and includes eight counties. A number of communities in Contra Costa County are not located in the Central Valley Region. These communities include Pittsburg, Concord, Lafayette, Walnut Creek, Orinda, Moraga, Danville, San Ramon, El Cerrito, Richmond, Crockett, Rodeo. The decision to include Contra Costa County in the REMI was model based on the amount of agricultural production located in the Delta and the economic contributions of Antioch, Oakley, Bethel Island, Brentwood, Byron, and Discovery Bay.

Some Fresno County communities located in the San Joaquin Basin are included in the Tulare REMI Basin.

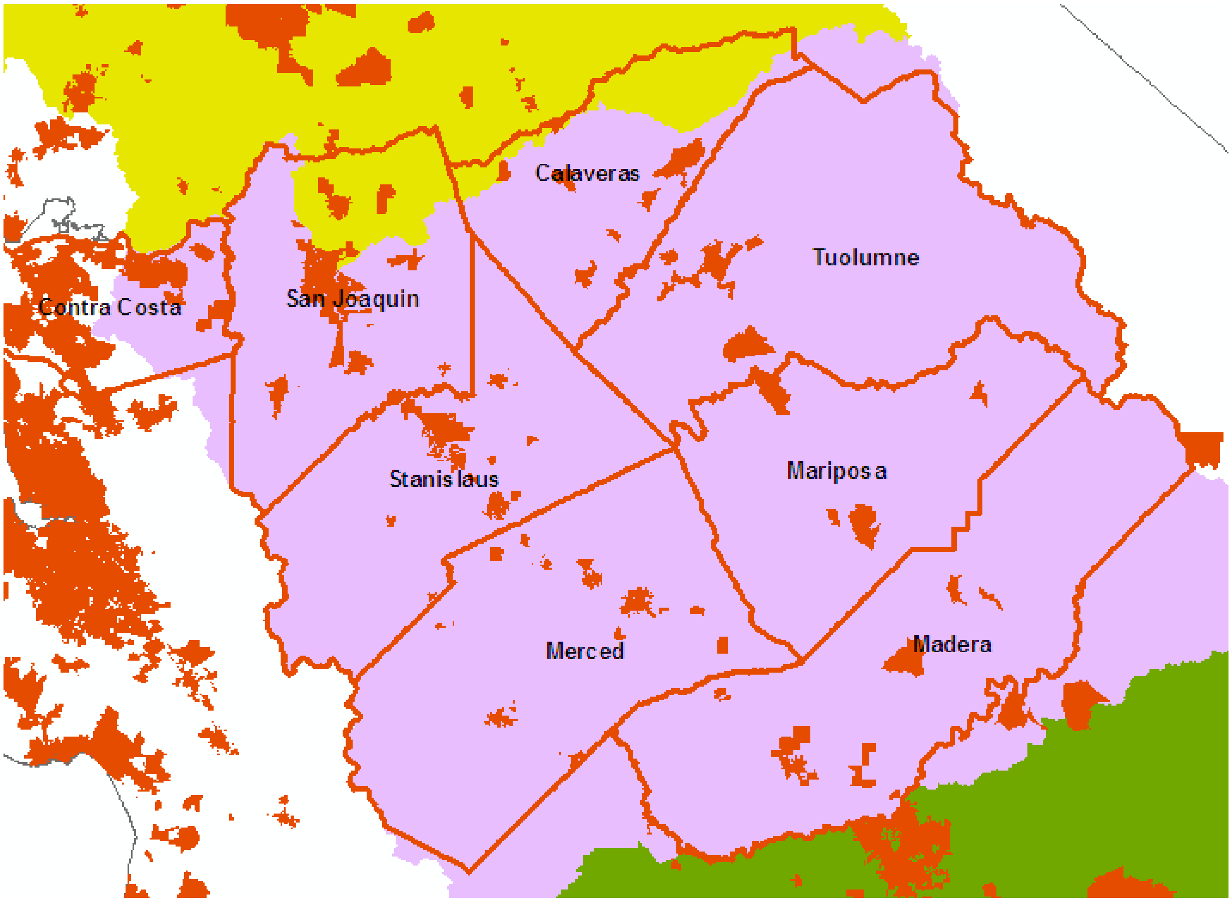


Figure 1.4. San Joaquin Basin REMI Model County Configuration

The Tulare Basin REMI model configuration consists of five counties (Figure 1.5). Kern County has a number of communities that are located out of the Tulare Basin including Edwards AFB, Rosamond, Mojave, Ridgecrest, Boron and California City. The economic activity and population are not sufficient to significantly affect the REMI results for the Tulare Basin.

The total effect of the differences between the county and hydrologic basin delineations is that the REMI results reported by the three Basins and the Rest of California are over or under reported. However the total impacts of salinity accumulations on economic activity are representative and not affected by the county-hydrological delineations.

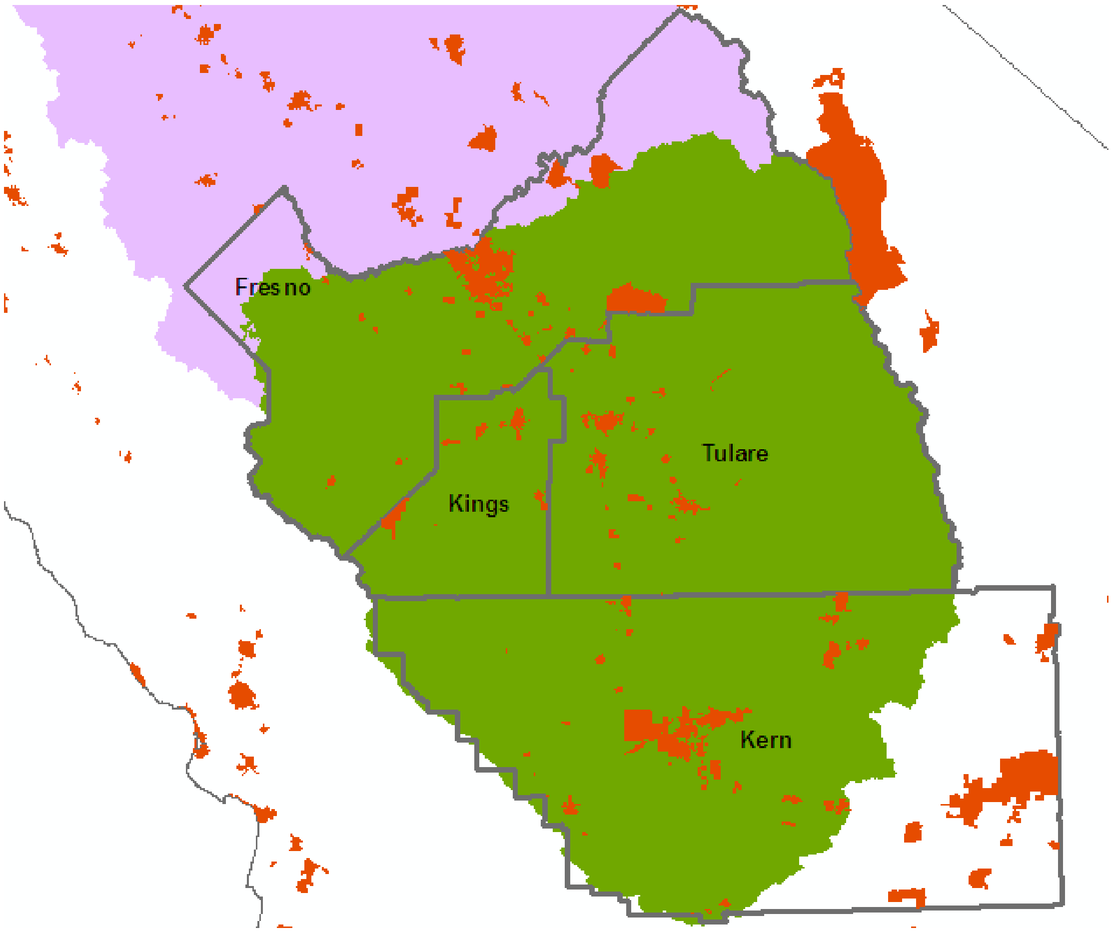


Figure 1.5. Tulare Basin REMI Model County Configuration

1.1.3 Direct Economic Impacts

Sectors directly affected by salinity accumulations include households, manufacturing, wine production, food processing, confined animal operations and irrigated agriculture. Table 1.1. contains a summary of those sector cost and production changes for the three Basins in the Central Valley, and the corresponding REMI variables and data input units.

Households purchase water softeners and replace salt damaged appliances and water pipes as salinity concentrations of water supplies increase. The additional consumer spending represents a positive economic impact but it is offset by a decline in other expenditures on other consumer items. REMI accounts for this change in consumer spending patterns and it is based on historical expenditure patterns. The net effect is a slight decline in total economic activity with some sectors increasing and others declining.

Utilities and manufacturing will experience additional production costs due to higher salinity levels of their water supply. The cost of an increase in salinity concentration of one part per million was estimated to be $21.41 per acre foot for industrial water users. Total industrial water use was estimated by the Department of Water Resources for the three Basins. Total water use was allocated to industrial sectors on the basis of output. Actual costs of salinity increases were calculated by multiplying sector water use by $21.41 and the projected average basin increase in salinity concentration by 2030.

Production decreases in wine production, food processing, and confined animals due to probable regulation on salinity disposal were estimated and entered into REMI as reductions in output.

Impacts to Irrigated agriculture were characterized as reductions in commodity production due to increases in soil salinity.

Table 1.1. Direct Changes in Sector and Regional Economic Activity, 2008-2030

Sector REMI Variable	Units	Region	Direct Change 2008	Direct Change 2030
Household Cost Changes due to Increased Salinity Concentrations in Water Supply				
Consumer Spending (amount) Household Operation	2006 Chained National $ (M)	Sacramento	$2.150	$2.868
		San Joaquin	$1.705	$2.239
		Tulare	$1.380	$1.714
		Total	$5.235	$6.821
Industrial Production Cost Changes due to Increased Salinity Concentrations in Water Supply				
Production Cost (amount): by Utility and Manufacturing sector	2006 Fixed National $ (M)	Sacramento	$1.049	$14.423
		San Joaquin	$1.524	$15.379
		Tulare	$0.768	$11.333
		Total	$3.346	$41.135
Wine Production Changes due to Salinity Disposal Requirements				
Firm Sales (amount) Beverage,tobacco prod mfg	2006 Fixed National $ (M)	Sacramento	$0.000	-$7.446
		San Joaquin	$0.000	-$7.859
		Tulare	$0.000	-$2.365
		Total	$0.000	-$17.670
Food Processing Changes due to Salinity Disposal Requirements				
Firm Sales (amount) Food mfg	2006 Fixed National $ (M)	Sacramento	$0.000	-$12.357
		San Joaquin	$0.000	-$29.632
		Tulare	$0.000	-$27.778
		Total	$0.000	-$133.340
CAFO Production Changes due to Salinity Disposal Requirements				
Firm Sales (amount) Agriculture	2006 Fixed National $ (M)	Sacramento	$0.000	-$6.970
		San Joaquin	$0.000	-$66.647
		Tulare	$0.000	-$85.383
		Total	$0.000	-$159.000
Irrigated Agricultural Production Changes due to Increases in Soil Salinity				
Firm Sales (amount) Agriculture	2006 Fixed National $ (M)	Sacramento	$0.000	$0.000
		San Joaquin	$0.000	$0.000
		Tulare	$0.000	-$184.714
		Total	$0.000	-$184.714

1.1.4 Reduction in Output-The Production of Goods and Services

Output is the amount of production, including all intermediate goods purchased as well as value added (compensation and profit). Output can also be thought of as sales or supply. The components of output are self supply and exports to other regions, the rest of the nation, and the rest of the world). Value added is a measure of the contribution of each private industry and of government to a region's gross regional product. It is defined as an industry's gross output, which consists of sales or receipts and other operating income, commodity taxes, and inventory change, minus its intermediate inputs, which consists of energy, raw materials, semi-finished goods, and services that are purchased from domestic industries or from foreign sources. Value added by industry can also be measured as the sum of compensation of employees, taxes on production and imports less subsidies, and gross operating surplus.

Table 1.1 shows a total regional direct annual costs of $44.064 million in Sacramento, $121.756 million in San Joaquin, and $313.287 million in Tulare. These cost changes result in greater reductions in output in the valley regions when the direct cost effects are translated through the REMI model. The average cost to output multiplier from REMI is 2.41, which results in the decreases in regional output shown in the first column of Table 1.2. In addition, REMI calculates the reduction in statewide economic out put due to reductions in central valley output.

The statewide effect adds another $0.992 billion to the central valley output reduction of $1.155 billion. Accordingly, output in California is projected to decline by $2.148 billion (2000$) by the year 2030 as a result of salinity accumulations (Table 1.2). Most of this impact will occur in the Central Valley with an estimated reduction in output of $1.155 billion but the impact to the rest of California is almost as much with $.992 billion. The output reduction in the Tulare Basin is projected to be $.766 billion in 2030. The impacts to the San Joaquin and Sacramento Basins are comparatively less at $.766 billion and $.12 billion.

Table 1.2. Decrease in Output, 2030 (Billion 2000$)

Area	Basin	Region	State
Sacramento	$0.120	-----	-----
San Joaquin	$0.269	-----	-----
Tulare	$0.766	-----	-----
Total Central Valley	-----	$1.155	-----
Rest of California	-----	$0.992	-----
California	-----	-----	$2.148

The “Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies” presents criteria for evaluating public water resources projects. The benefits of a water resource project or plan are defined as contributions to the Federal Objective which is defined as follows.

> “Contributions to national economic development (NED) are increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are the direct net benefits that accrue to the planning area and the rest of the Nation. Contributions to NED include increase in the net value of those goods and services that are marketed, and also of those that may not be marketed.

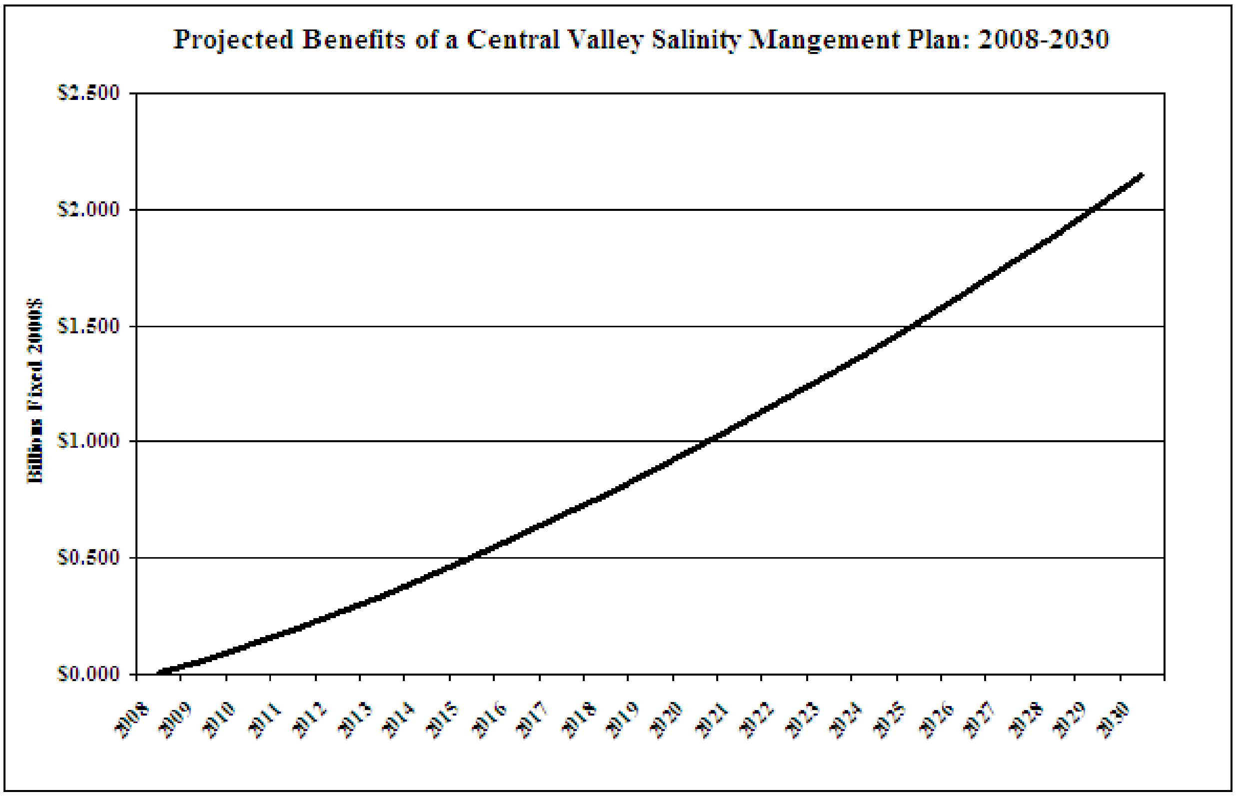
Since the objective of a salinity management plan would be to improve water quality by reducing salinity accumulations, the benefits of the plan would be embodied in the resulting increase in the value of the production of goods and services. An estimate of that value of is provided by the projected decrease in California output if salinity accumulations in the Central Valley are not managed.

Figure 1.6 graphs the reduction in California output and as a result of salinity caused cost increases or reductions in production.

Figure 1.6. Projected Change in California Total Output: 2008-2030

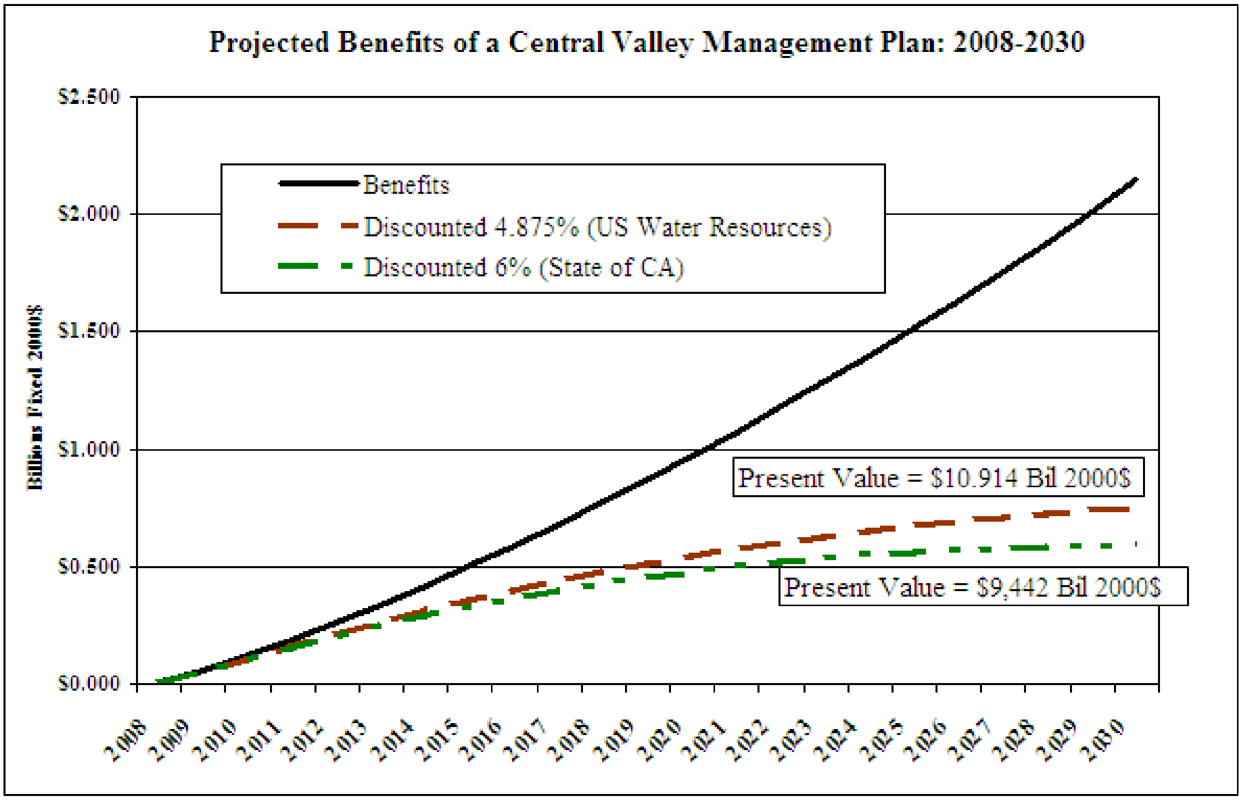
By redefining the projected salinity caused reductions in output to potential benefits of a salinity management plan, the same function can be graphed as a positive variable (Figure 1.7).

Figure 1.7. Projected Benefits of a Central Valley Salinity Management Plan 2008-2030



Future annual benefits must be discounted to the present values. The Water Resources Planning Act of 1965 and the Water Resources Development Act of 1974 require an annual determination of a discount rate for Federal water resources planning. The discount rate for Federal water resources planning for fiscal year 2008 is 4.875 percent. The State of California uses a discount rate of 6 percent. Figure 1.8 contains graphs of the benefits using both discount rates. Total discounted benefits using the State of California discount rate is $9,442 billion (2000$) and $10,914 using the US Water Resources discount rate.

Figure 1.8. Discounted Benefits of a Central Valley Salinity Management Plan 2008-2030



The two benefit estimates are lower limits to the real benefits of a Central Valley salinity management plan for two reasons. First, not all of the salinity related damages are included in this study and second, the non-market benefits of a salinity reduction plan are not included.

2 CONCLUSIONS AND SUGGESTIONS FOR ADDITIONAL RESEARCH.

As this research project has evolved it has become increasingly clear that the hydrogeological knowledge of salinity, its levels, distribution, and accumulation in the Central Valley are not currently sufficiently precise to support the important regional policy conclusions that are required to control the costs of salinity. This study clearly shows that, on average, salinity in the Central Valley is a growing problem with very substantial economic and social impacts. The principal uncertainties associated with the results are caused by a lack of information on the physical parameters of salinity accumulation rather than the economic parameters. Our conclusions for future research can be summarized by stating that additional research expenditures should be spent on improving the hydrological knowledge of salinity accumulation, before additional improvements to the economic methodology are implemented.

Specific shortfalls in information that we encountered as far as follows.

2.1.1 Hydrogeological Information Shortfalls.

The projection of the area and level of salinity in the Central Valley over the next 30 years had to be estimated based on one set of projections, and the existing salinity profiles from the California Department of Water Resources. The projections of salinity growth are particularly difficult, since the balance between the two contributing factors of salt mobilization within the valley, and net imports of salinity in imported water are hard to disentangle, and thus associate with a particular policy change.

The variability of salinity in the basic water supply is not documented on a consistent basis throughout the valley. Clearly there is a wide range of salinity and its resulting economic impacts over different regions.

A third factor that influences shallow aquifer salinity, and the long-term effect on groundwater is the degree of percolation of salinity through the Corcoran clay layer to the deep aquifer. We were only able to find one estimate of this important parameter. Also, the effect of percolating salinity on the ambient salinity in the deep aquifer depends on its movement through the aquifer and effective pumping depth that groundwater users will face in the future. More work is needed to define these parameters.

A fourth variable of great uncertainty is the linkage between subsurface salinity, one to three meters below the surface, and the effective salinity in the crop root zone. Current agronomic measures of yield impacts are based on root zone levels, however there are many actions taken by farmers, such as increased leaching requirements, that reduce salinity impact on the root zone. The degree to which these actions are restricted by subsurface salinity needs to be estimated directly from farmer's responses.

2.1.2 Economic Information Shortfalls

Projecting economic impacts many years into the future inevitably results in uncertainty over the effect of future markets of California crops on the crop type grown and its salinity response. In addition, changes in water policy that increased the scarcity of water supplies in the Central Valley would, in consequence, change irrigation methods, drainage levels, and thus change and salinity accumulation.

Potential climate change over the next 30 years may also modify the crops grown in the valley, water supplies, and the net evapotranspiration requirements of crops. It is likely that these effects will tend to reduce the salinity burden in the valley.

Urban growth in the Central Valley and land availability for it will also change projections of salinity costs. The urbanization trend will reduce subsurface salinity caused by drainage, and increase the cost of ground water salinity increases.

The growth and regulation of CAFO operations in the Central Valley will influence both the change in salinity and other groundwater contaminants. The study shows that the existing CAFO development faces limitations on the economic ability to dispose of animal waste.

In summary, this study has shown that under the best current parameter estimates, projecting salinity growth at its current rate until 2030 would result in an annual loss of economic income by 2030 of $2.148 billion a year, and 25,000 jobs. Clearly this is a serious problem for the future growth and well-being of the Central Valley. In the short term, additional research needs to concentrate on resolving the principal uncertainties over the hydrogeological accumulation, spatial variation, and projection of salinity growth.