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Delta Dilemmas: Reconciling Water-Supply Reliability and Environmental Goals

Richard Howitt

The Sacramento–San Joaquin Delta is at risk from natural forces, and with it a substantial proportion of the San Joaquin and Southern California water supply. Economic and institutional results from a new inter-disciplinary study show that a radical change in policy may be required.

The agricultural and urban economies in Southern California are subject to an increasingly risky water supply through the Sacramento-San Joaquin River Delta. A large proportion of the San Joaquin and Southern California supply is routed through the Sacramento-San Joaquin Delta, located east of the San Francisco Bay Area. Most of this naturally marshy landscape has now been drained and converted into islands, many of them lying below sea level and protected by a system of 1,100 miles of artificial levees. The Delta serves as an important wildlife and habitat area; it has a significant recreational and agricultural economy, and serves as an essential conduit for water supply to the San Joaquin Valley agricultural economy and over 20 million urban dwellers in Southern California. The fragility of the Delta, as a system for water supply and fresh-water habitat, was recently brought into focus by two events: the collapse of levees around an island called Jones Tract in 2004, and the Katrina disaster in New Orleans.

This article reports on the economic and institutional aspects of a recent interdisciplinary study that examine a number of Delta alternatives. Last month, the Public Policy Institute of California (PPIC) issued a report titled, "Envisioning Futures for the Sacramento-San Joaquin Delta." The authors were Jay Lund, Ellen Hanak, William Fleenor, Richard Howitt, Jeffrey Mount, and Peter Moyle. With the exception of Hanak, a PPIC fellow, the authors are from University of California, Davis.

A Crisis in the Delta

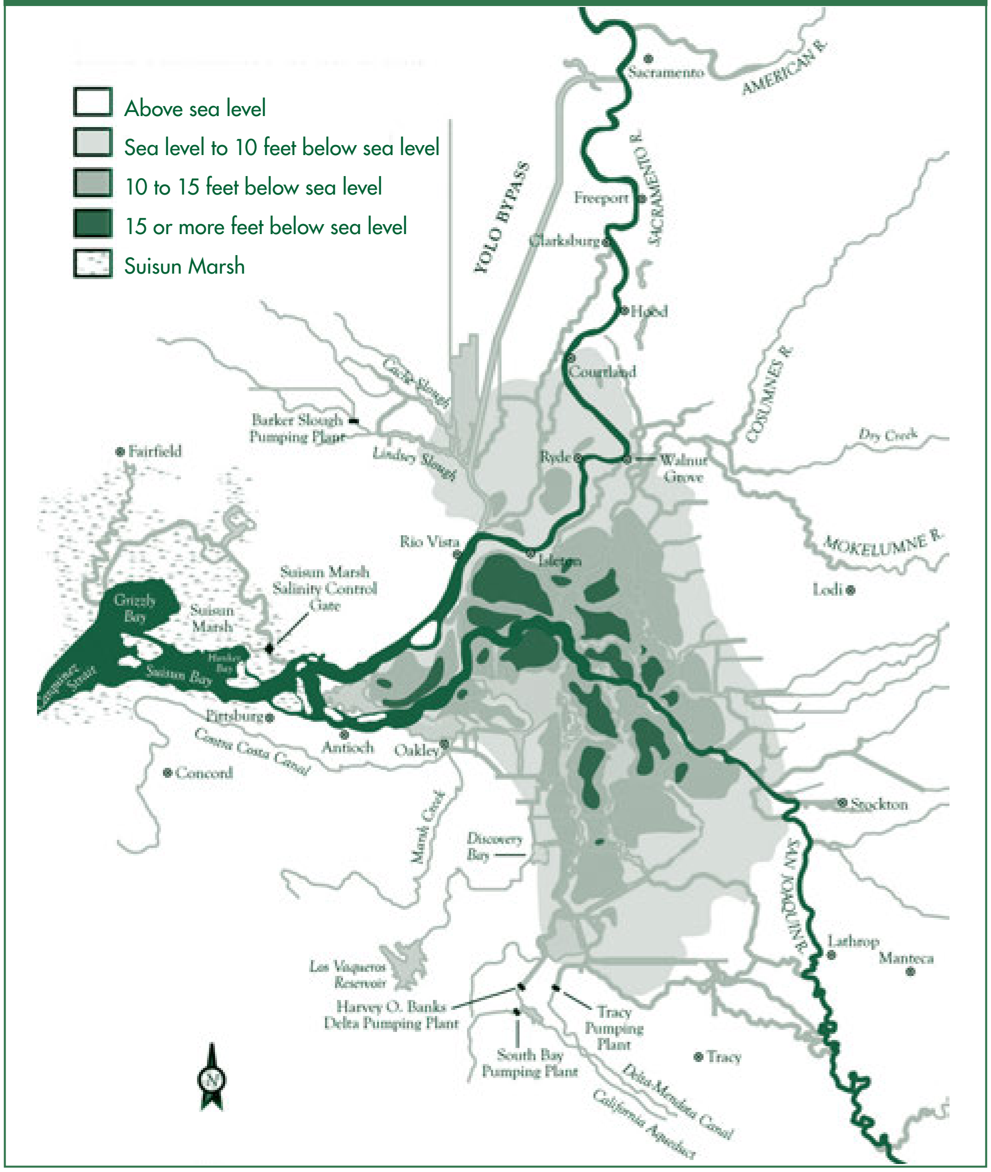
The Delta is in crisis at three levels: (1) the levee system is in poor condition and fragile; (2) several native fish species are in decline; and, (3) its governing institution, CALFED, is under financial and political stress.

The increasing risk of an interrupted water supply is shown in a 2005 study by Mount and Twiss, who calculated that a combination of land subsidence, earthquakes, and global climate change effects result in a 64 percent probability of a major collapse of the Delta in the next 50 years. Areas with significant land subsidence are shown in Figure 1. The cost of supply interruption from a rapid collapse and a two to three year recovery period was estimated to be on the order of $40 billion or greater.This level of infrastructure risk seems unacceptable for the California economy.

Environmental constraints are central to Delta policy. In fall 2004, routine fish surveys registered sharp declines in several pelagic (or open-water) species, including the Delta Smelt, a species listed as threatened under the Endangered Species Act. Subsequent surveys have confirmed the trend, raising concerns that the smelt, sometimes seen as an indicator of ecosystem health in the Delta, risks extinction if a solution is not

Also in this issue

Figure 1. Land Subsidence in the Delta



found quickly. The listing of the Delta Smelt as an endangered species introduced legal and political constraints as well as environmental concerns.

The governing institution for the Delta is also under pressure. In the mid-1990s a combined federal and state agency, CALFED, was formed to solve the impasse in Delta policy. CALFED was based on consensus politics and public funding. The stated theme was, "We will all get better together." Over its first seven years, CALFED spent approximately $1.5 billion on research and Delta improvements. The program yielded many scientific insights, but little in terms of observable improvements in the ecological health of the threatened species or water-supply reliability. As public funding dwindled, political divisions among the interest groups grew. The CALFED criteria that the beneficiary pays for private benefits ran into the familiar problem that plagues many attempts to extract private payments for what are perceived to be collective projects. As one observer wryly remarked, "The beneficiary clause should be rewritten as: 'The beneficiary pays, but not much, and not now.'" As a result of cost-allocation disputes, major Delta improvement projects were stalled by fiscal posturing. One of the problems with the CALFED requirement for consensus within interest groups was that the set of possible solutions examined was restricted. Only those solutions that maintained the 70-year policy of a year-round, fresh-water Delta were acceptable for further analysis. Since the current study was independent of state or federal funding we were able to examine a much wider set of alternative policies, some of which resulted in fluctuating salinity levels in the Delta. Three criteria were used to assess alternative policies: water supply, the environment, and the economic cost and impact of the policies. In addition, the study adopted an approach that focused on the trade-offs available rather than a consensus among all interest groups.

Study Findings

Findings from the study can be categorized as physical, institutional, and economic. This article focuses on the institutional and economic aspects.

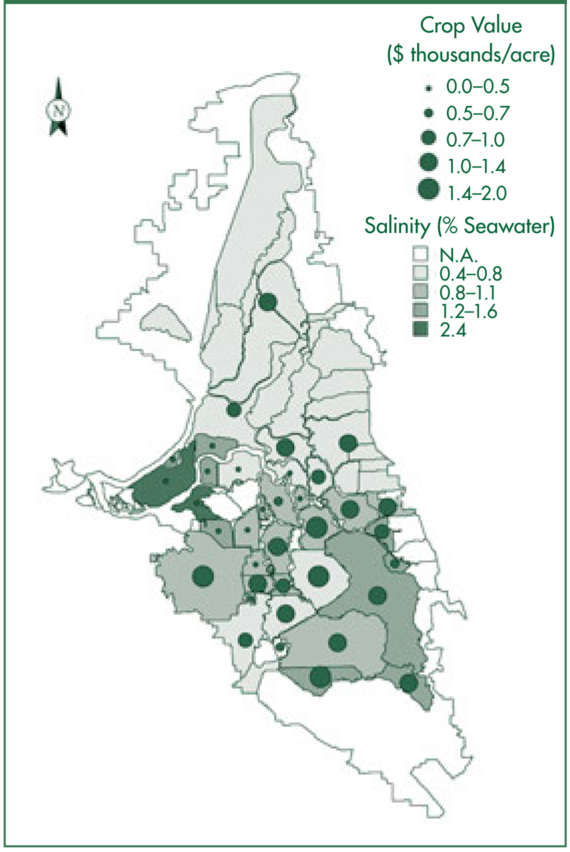
A key physical finding by the participating environmental scientists, is that a Delta with fluctuating salinity levels would be more hospitable for native species than the long-standing current policy of maintaining constant fresh water. A serious environmental problem in the Delta is the disruption of the food chain by invasive fauna and flora. Unlike many studies, both the environmental and economic criteria coincide on their preference for alternative Delta solutions. In this study, the usual tension between environmental and economic assessments has yet to arise.

The institutional paralysis that has recently gripped the CALFED process is a predictable outcome of blocking coalitions once the common property resource of public funding is removed. The study group recognized that for most solutions, not everyone would get better together and trade-offs will have to be made. However, for some public goods, we propose mitigation mechanisms. For example, easements to compensate for potential flood damage can be negotiated in advance of the event, rather than in the frenzied atmosphere of a flood event. The state faces an interesting policy problem regarding Delta mitigations. If enough parties cannot agree on a more sustainable solution, nothing is likely to be done. The Delta will then likely fail catastrophically, incurring major emergency expenses, plus restoration and remediation expenses under very unfavorable conditions. By investing in mitigations, some economically minor compensation costs (relative to California's $1.5 trillion/year economy) might be used to catalyze agreement on better long-term solutions for the Delta.

Given the reduction of public funding and the impotence of the "beneficiary pays" declaration, any feasible Delta solution will have to have a different method to raise funds from the many private beneficiaries. The infrastructure requirements of most of the alternatives under consideration have the usual decreasing marginal cost structure of public projects. The standard approach for constructing water resource projects is to optimally size projects based on engineering criteria, and then try to negotiate cost recovery from private agents. Understandably, this approach has a poor history based on perverse incentives. The study defines two principles for an alternative financing approach. First, project sizing and financing decisions must be made simultaneously. Second, given decreasing marginal costs and widely different elasticities of demand for water supplies, some form of differential pricing is required. For example, airlines use differential pricing to fill their aircraft. What is not yet clear, is how subsequent trading of capacity rights can be combined with differential prices.

The economic results of alternative Delta policies were all expressed in terms of costs, to make them directly comparable to project costs. Any change in water deliveries or farm production is expressed as a scarcity cost and is equivalent to the reduction in benefits from water used as an input to agriculture or directly consumed by urban users. Most of the economic impact analysis was performed using two economic-engineering models: the first, termed Calvin, models the whole California water economy; the second, disaggregated to the Delta agricultural economy, is called the Delta Agricultural Production model (DAP). The DAP model was constructed for the Delta study and was notable for costs that it did not show. A field level of compilation of Delta cropping showed the initially surprising results that the agricultural islands at risk in the central and western parts of the Delta had cropping patterns that were dominated by low-value crops (Figure 2). The DAP model showed that an increase in the ambient salinity, or the loss of an island to levee failure, did not result in large impacts to the regional or state agricultural economy. The crop survey showed that the high-value crops grown in the Delta tend to be clustered in those parts with deeper soils and more predictable water supplies.

Figure 2. The Value of Delta Crop Production



A simple analysis of the Jones Tract levee break in 2004 shows how a more flexible levee and island-rescue policy could redirect public funds. The Jones Tract levee collapsed for unknown reasons in June 2004. Decisions had to be made instantly, and the repair and restoration process was started immediately. Estimates of the total cost to the state vary, but range between $45 and $60 million. I estimate that the agricultural value of the 11,000 acres of land in Jones Tract is $28 million and, even allowing for some infrastructure costs of abandoning the island, it would seem to have been a rational use of public money to harden the levees on their inside and leave it flooded. Since it is impossible to make such calculations in real time, one of the short-term study recommendations is that Delta islands be examined for their value and restoration cost, and a "do not resuscitate" list is made of those that should be abandoned in the event of a levee break. Some of the cost of lost value may be amortized by a conditional easement on the island. Figure 2 shows some results from the DAP model that illustrate the wide range of salinity and productivity across the different Delta islands. The agricultural revenues are depicted by the size of the dark circles and vary from a few hundred dollars per acre to almost two thousand dollars per acre. The spatial distribution of salinity and crop revenues is significant. By comparing Figures 1 and 2, it can be seen that the low-revenue areas coincide with those islands most at risk due to land subsidence. Other runs of the DAP model calculated the loss in revenues from increased water salinity that can

Table 1. Economic and Financial Costs of Delta Alternatives

Alternatives	Investment Costs	Annual Costs from Water or Land Reductions: Statewide Water Users	Annual Costs from Water or Land Reductions: Delta Agriculture
Freshwater Delta			
1. Levees as Usual	~ $2 billion, plus increasing costs of failure and replacement	Increasing costs as levees fail	Increasing costs from island flooding
2. Fortress Delta	> $4 billion	No additional water scarcity costs	Some land out of production from island flooding
3. Seaward Saltwater Barrier	$2–$3 billion	No additional water scarcity costs	Increasing costs from island flooding
Fluctuating Delta			
4. Peripheral Canal Plus	$2 –$3 billion	Some water scarcity costs	$70 million/year
5. South Delta Restoration Aquaduct	$2–$3 billion	Some water scarcity costs	$41 million/year
6. Armored-Island Aqueduct	$1–$2 billion+	Some water scarcity costs	$30 million/year
Reduced–Exports Delta			
7. Opportunistic Delta	$0.7–$2.2 billion in Delta and near-Delta facilities	$120 million/year	$50 million/year
8. Eco-Delta	Several billion dollars for eco-restoration + water user investments	$500 million/year	$100 million/year
9. Abandoned Delta	~ $500 million	~ $1 billion/year	$200 million/year

NOTES: Capital costs do not include possible investment needs for nonwater infrastructure (e.g., roads, rail). All alternatives except #9 (and possibly #2) would require additional investments for urban levees to provide flood protection exceeding 200-year average recurrence. All alternatives except #8 and #9 would require additional investments for ecosystem restoration. Adding finer fish screening or bank filtration to intakes to reduce fish and larvae entrainment would increase costs and potentially reduce pumping capacities for alternatives #1–8. Water-scarcity costs occur when water deliveries are less than desired. Scarcity is often managed by price, rationing urban-water use, fallowing some farmland, or curtailing recreational activities.

result from levee failure of different Delta management approaches.

The study examined nine alternative Delta policies that ranged from a complete rebuild of Delta levees, to an abandonment of the Delta to the forces of nature. Table 1 provides a condensed summary of the costs of the alternatives. It includes all the options even though the economic and financial data available were incomplete. For options 5-6, the scarcity cost cannot be assessed in advance if the proposed system of simultaneous sizing and payment is used. Further details on the sources of data and assumptions can be found in Appendix E of Lund et al. Additionally, the inflation indices used to unify the investment costs are probably understated for recent changes in land and construction costs. At this level of analysis, it appears that those options that allow for a fluctuating salinity level in the Delta provide a more reliable water supply at similar or lower costs, and also provide an improved environment for native species. Based on the three criteria of water supply, environmental impacts, and economic effects, the study concludes that the first three alternatives that require a maintained fresh-water Delta are too risky for water supply, are equally costly, and do not have environmental benefits. On this basis, the study team recommends that alternatives 1-3 be removed from consideration. Likewise, the ninth alternative of abandoning the Delta had poor environmental effects and was excessively costly for the state's economy. The remaining five alternatives all have some degree of salinity fluctuation in the Delta, and different levels in infrastructure and water-supply deliveries. Clearly there is much technical analysis to be done before a preferred alternative is selected, but the message is unavoidable that existing Delta policy should change. The examination of Delta alternatives should be viewed in terms of smaller preemptive investments that would steer the Delta toward a "soft landing" into a more stable ecological and economic state, versus the growing risk of a catastrophic failure and "crash landing" of the state's water economy.

Richard Howitt is a professor and chair of the Department of Agricultural and Resource Economics at UC Davis. He can be reached by e-mail at howitt@primal.ucdavis.edu.

For more information, the author recommends the following reading:

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