Integrated Economic-Engineering Analysis of California's Future Water Supply

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Problem Statement

California's water problems have grown in complexity and controversy to require new forms of analysis and new ways to identify promising solutions. Advances in data, software, and computing make it possible to undertake statewide economic and engineering analysis of California's water problems. Such analyses should 1) increase the range and integration of options evaluated, 2) improve the speed of analysis, 3) explicitly integrate economic and engineering aspects of evaluation, and 4) "optimize" to suggest promising solutions for more detailed consideration.

Approach

The approach taken to this problem has been to:
a) Develop a physically-based schematic of California's water storage and conveyance infrastructure, including major groundwater basins.
b) Develop explicit economic values for agricultural and urban water use throughout California's entire intertied water system for 2020 land use and population.
c) Identify minimum instream and wetland flow constraints to represent environmental water demands, since there is little consensus on their economic representation.
d) Reconcile DWR and USBR estimates of unimpaired 1922-1993 surface and ground water flows into the system, and identify problems therein.
e) Develop databases, metadata, and documentation of these data for use in statewide analysis and making this analysis more transparent.
f) Apply an economic-engineering optimization model to combine this information and suggest 1) promising capacity expansion and operational solutions, 2) the economic value of additional water to users, 3) the costs of environmental water use, and 4) the economic value of changes in capacities and management policies.

Specific goals for the analysis are to identify promising long-term capacity, operations, water transfer, and policy options from engineering and economic perspectives.

Accomplishments to Date

All the above steps and objectives have been accomplished and are now available on the project web site (or soon will be) as reports, appendices, schematics, databases, and software.

Ongoing Project-related Activities

A) Further funding has been obtained from the California Energy Commission, the US Bureau of Reclamation and the CALFED Bay-Delta Program.
B) Presentations, workshops, and training activities. (CALFED and USBR)
C) Climate change studies of California for the year 2100. (CEC)
D) Addition of hydropower and flood control economic value functions. (CEC)
E) Continued HEC-PRM software development. (CALFED)
F) Refine data and model to provide a usable, useful, public domain, and documented statewide water supply planning optimization model. (CALFED, CEC, and USBR)
G) Demonstrations of the value of economic-engineering optimization, databases, documentation, and analysis for application to California's water problems.

2001 Report Conclusions

1. Optimization based on fundamental economic and engineering principles is feasible and available for water management in California. Recent advances in computing software have made it possible to solve optimization problems as large as California and to store, present, and document data for such large-scale models. Advances in local and regional modeling, data gathering, and data reconciliation also have provided sufficient data to calibrate and run useful large-scale economic-engineering optimization models of California's water system. These advances complement advances in simulation modeling for California's water supply system.

2. Optimization results provide considerable information and insight for policy and operations planning. Examples of these results are presented in the chapters and appendices of this report, with some more related policy conclusions itemized below. These kinds of results illustrate the ability of economic and engineering-based optimization modeling to assemble and digest large quantities of information to make useful and insightful conclusions for regional and statewide water management. The results of these models have direct usefulness for policy, planning, finance, and operations planning problems regarding projected water scarcity at State, regional, and local levels.

3. Some qualitative policy conclusions emerge from model results. These include:
   a) *Regional or statewide water markets have considerable potential to reduce water scarcity costs.*
   b) *Economically efficient improvements in local and regional water management reduce demands for imports.*
   c) *Environmental flows have economic opportunity costs for agricultural, urban, and other activities.*
   d) *Economic values exist for expanding facilities.*
   e) *Some scarcity is optimal.*
   f) *Economically optimal water reallocations are very limited, but reduce scarcity and scarcity costs considerably.*
   g) *Greater conjunctive operation of local, regional, and statewide water resources decreases competition with environmental uses for limited streamflows*.

4. As with all modeling, there are limitations to the results. Nevertheless, the results from this type of optimization model are best seen as offering promising suggestions for improvements in water management, worthy perhaps of further testing and refinement with simulation-based analysis. The optimization model also is adept at identifying particularly costly constraints. The CALVIN model does not diminish the importance of other planning and analysis efforts, but rather provides an aid to placing local and other statewide planning efforts in context and giving them greater focus.

5. Development of the optimization model has highlighted some areas where additional data refinement and development are needed. While the current CALVIN model is useful, its limitations would be less and its results more accurate and reliable with additional refinement and reconciliation of input data and other improvements in the model. Problems are particularly common in the Tulare Basin and San Joaquin Valley. A broadly useful side benefit of large-scale optimization is that, if properly used, it provides a framework for analysis that insists that all water availability and demand data be consistent and transparent. This makes large-scale optimization useful for identifying important data gaps and inconsistencies. The model becomes a framework to see if the data pieces make sense together.