





**Project Objectives: Please type your responses, and answer the questions in a style appropriate for laymen.**

**ProjectObjectives\_10**

The goals of my research are to develop a method for quantifying the uncertainties and risks in a number of approaches to instream flow management and water supply management, and to develop a formal decision-analysis framework to inform and decision-making in a multi-objective, uncertain context.

The objectives of my dissertation work are to produce the following products:

- A water resources model that incorporates water operations and hydrology, including snowmelt dynamics, and is able to thus address limitations in existing tools for assessing climate impacts in California. The model will also be more transparent and accessible to managers and stakeholder groups.
- A method for uncertainty analysis in this model, based on Latin Hypercube analysis of 1) resampled downscaled GCM output 2) land use and land cover and 3) population projections. The model output will be probabilistic estimates of instream flows and water deliveries under a variety of scenarios, for use in a risk analysis.
- A generalizable method for empirical application of economic risk analysis techniques to evaluation of management decisions under uncertainty.
- Case studies demonstrating empirically the importance of risk aversion in decision-making under climate change and the potential applicability and implications of this method for negotiated and flexible in-stream flow agreements.

**Summary of progress in meeting each of these goals and objectives**

**ProgressSummary\_11**

-I have developed and calibrated a hydrology and water operations model of the case study basins. Part of this work (hydrology modeling) has been published, and the remainder of this modeling effort is in final draft form for my dissertation, pending approval of my committee, and will be prepared for publication.

-I have developed the method for investigating impacts of climate change, urbanization, and population growth. I have implemented the method for the case study basin, and preliminary results are intriguing. The results are pending, and will be incorporated into Chapter 2 of my dissertation and prepared for publication this summer.

-I have drafted a method for application of risk and risk aversion to decision-making for water managers, and am working to finalize my interview methods.

-To support all of this, I have developed computational and software infrastructure to manage the large suite of model runs, and developed most of the statistical scripting necessary for data handling and analysis.

**PROJECT MODIFICATIONS:** Please explain any substantial modifications in research plans, including new directions pursued. Describe major problems encountered, especially problems with experimental protocols and how they were resolved. Describe any ancillary research topics developed.

**Modifications\_12**

I have made some shifts in emphasis in the project as I have learned more about the research, to make the project results more interesting and tractable.

A substantial new direction in the project is the focus on urban and agricultural water supply risk in this first round of case studies. There are several reasons for this shift in emphasis during methods development, primarily data availability and tractability of the analysis.

Instead of pursuing resampling of climate inputs as originally proposed, I decided to use an existing ensemble of downscaled data. The reason for this is developments in the recent literature suggesting that 'ensemble completeness' is the primary factor for representing climate variability.

I also added water use efficiency, another CALFED goal, as a scenario variable, as it will have a substantial effect on model results over the century timescale.

The current case study topics directly support CALFED goals, and all of these methods can be adapted for environmental flows in future work.

While not a part of the funded project, I also conducted work on environmental governance in the Delta, collaboratively with Giorgos Kallis and Richard Norgaard. This work included co-editing a Special Issue of the journal Environmental Science and Policy, and co-authoring two articles for this issue.

**BENEFITS AND APPLICATIONS:** Suggest the relevance of these new findings to management. Describe any accomplishment, that is significant effects your project has had on resource management or user group behavior. CALFED is looking for "management cue" (see <http://science.calwater.ca.gov/pdf/soemgmtcues.pdf>).

**BenefitsApplic\_13**

It is a bit premature to describe the relevance of the findings, but if preliminary results prove robust, I will have some highly relevant and highly package-able management cues to report.

**PUBLICATIONS:** List any publications, presentations, or posters that have resulted from this funded research. Give as many details as possible, including status of paper (e.g., in review; in press), journal name, conference location and date of presentation. Please note (as outlined in the conditions of the award) that each fellow is required to submit an abstract for an oral or poster presentation at each State of the Estuary conference and CALFED Science Conference during the duration of the fellowship.

**Publications 14**

I have recently published and presented work both in the direct areas described above, as well as in related but separate work on environmental governance in the Delta.

Recent publications:

Charles A. Young, Marisa Escobar, Martha Fernandes, Brian Joyce, Michael Kiparsky, Jeffrey Mount, Vishal Mehta, David Purkey, Josh Viers, and David Yates. 2009. "Modeling the Hydrology of California's Sierra Nevada for Sub-Watershed Scale Adaptation to Climate Change." *Journal of the American Water Resources Association* 45(6): 1409-1423.

Giorgos Kallis, Michael Kiparsky, and Richard Norgaard. 2009. "Collaborative governance and adaptive management: Lessons from California's CALFED water program." *Environmental Science and Policy* 12(6): 641-643. Special Issue, G. Kallis, M. Kiparsky and R. Norgaard, Eds.

Richard Norgaard, Giorgos Kallis, and Michael Kiparsky. 2009. "Collectively engaging complex socio-ecological systems: re-envisioning science, governance, and the California Delta." *Environmental Science and Policy* 12(6): 644-652. Special Issue, G. Kallis, M. Kiparsky and R. Norgaard, Eds.

Michael Kiparsky. 2009. "The sedimentation-upwelling model for the science-policy interface." *Water Policy* 11: 107-124.

Recent presentations:

Giorgos Kallis, Michael Kiparsky (presenter), and Richard Norgaard. "Collaborative Governance and Adaptive Management: California's CALFED Water Program." State of the Estuary Conference. Oakland, CA. September 29-October 1, 2009. Oakland, CA.

Michael Kiparsky, Giorgos Kallis, and Richard Norgaard. "Adaptive management and collaborative governance: Lessons from the CALFED Bay-Delta Program." Invited panelist at University of Idaho College of Law Natural Resource and Environment Symposium 2009 - Transboundary River Governance in the Face of Uncertainty: The Columbia River Treaty. Coeur d'Alene, Idaho. April 2-4, 2009.

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**COOPERATING ORGANIZATIONS:** List those agencies and/or persons who provided financial, technical or other assistance to your project since inception. Describe the nature of their collaboration.

**CoopOrganiz\_15**

David Groves (RAND): Assisted with software and computational development, and WUE scenario development.  
David Purkey, Chuck Young, Brian Joyce (SEI-US): Assisted with hydrology and operations model calibration.

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**AWARDS:** List any special awards or honors that you, or mentor or members of the research team, have received during the duration of this project.

**Awards\_16**

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**KEYWORDS:** List keywords that will be useful in indexing your project.

**Keywords\_17**

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**PATENTS:** List any patents associated with your project.

**Patents\_18**

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