



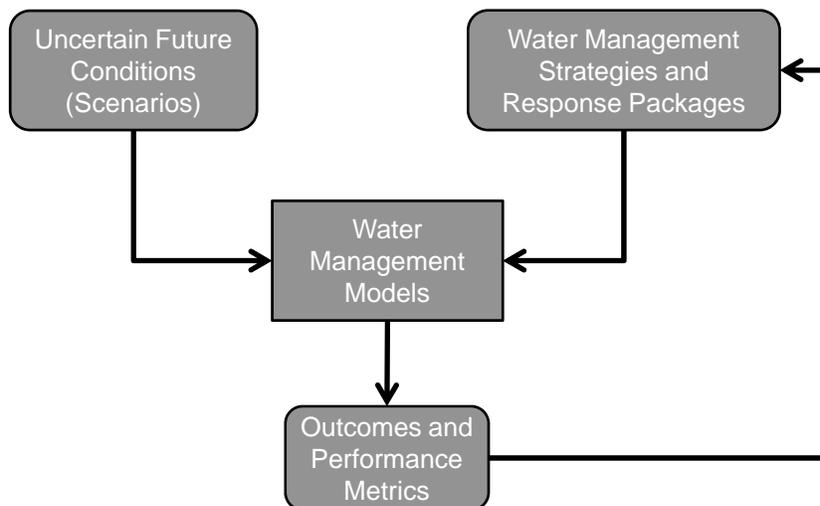
INFRASTRUCTURE, SAFETY,
AND ENVIRONMENT

A Decision Framework for the 2013 California Water Plan

**David Groves and Evan Bloom (RAND)
and Brian Joyce (SEI)**

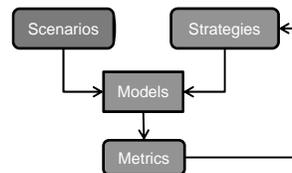
**SWAN Meeting
May 13, 2011**

California Water Plan Update 2013 to Apply a New Framework to Evaluate Management Strategies



Scenarios Are Used to Ensure Robustness of Future Water Management

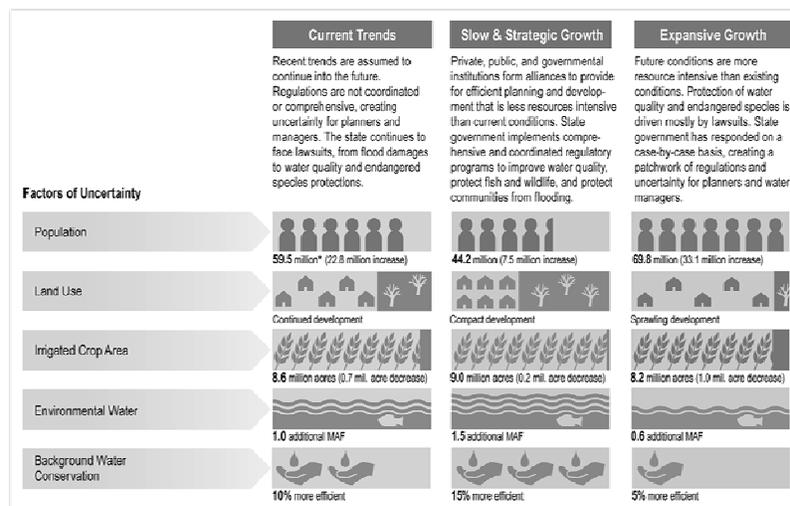
- Scenarios are not predictions of the future
- Scenarios describe alternative plausible yet very different future conditions
 - Scenarios explore key uncertainties that the water community has little control
- Robust management strategies perform sufficiently well under many plausible scenarios



RAI 10

3 Mar-2011

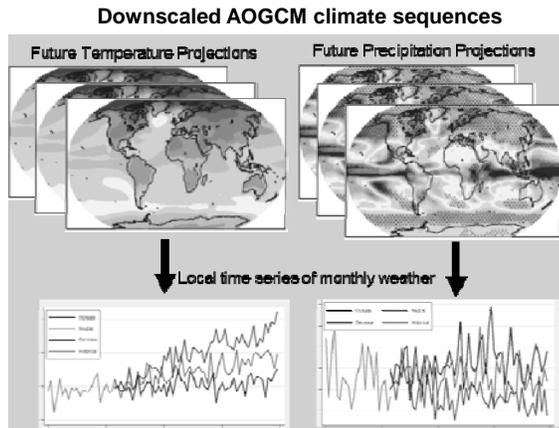
CWP Update 2009 Developed Three Demographic and Land Use Scenarios ...



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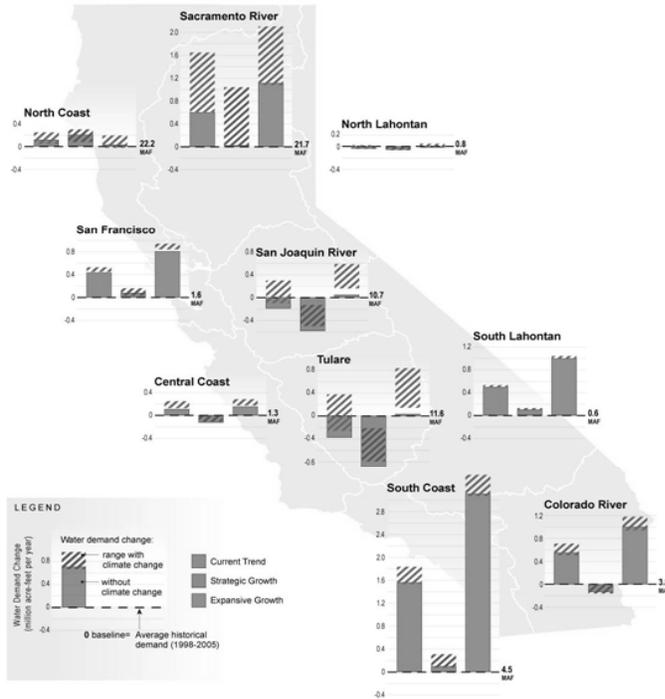
... Used 12 Climate Scenarios ...



- 6 AOCGMs
 - CNRM-CM3
 - GFDL-CM21
 - Micro32med
 - MPI-ECHAM5
 - NCAR-CCSM3
 - NCAR-PCM1

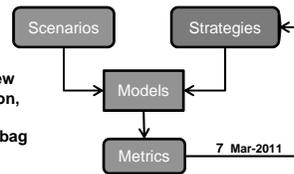
- Two emissions scenarios
 - A2
 - B1

... to Estimate Regional Water Demand Changes by 2050



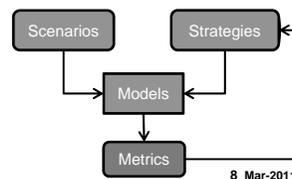
Update 2009 Described Numerous Resource Management Strategies

- **Reduce Water Demand**
 - Agricultural Water Use Efficiency
 - Urban Water Use Efficiency
- **Improve Operational Efficiency & Transfers**
 - Conveyance – Delta
 - Conveyance – Regional / Local
 - System Reoperation
 - Water Transfers
- **Increase Water Supply**
 - Conjunctive Management & Groundwater Storage
 - Desalination – Brackish & Seawater
 - Precipitation Enhancement
 - Recycled Municipal Water
 - Surface Storage – CALFED
 - Surface Storage – Regional / Local
- **Improve Flood Management**
 - Flood Risk Management
- **Improve Water Quality**
 - Drinking Water Treatment & Distribution
 - Groundwater / Aquifer Remediation
 - Matching Quality to Use
 - Pollution Prevention
 - Salt & Salinity Management
 - Urban Runoff Management
- **Practice Resource Stewardship**
 - Agricultural Lands Stewardship
 - Economic Incentives
 - Ecosystem Restoration
 - Forest Management
 - Land Use Planning & Management
 - Recharge Areas Protection
 - Water-Dependent Recreation
 - Watershed Management
- **Others:** Crop idling, dew vaporization, fog collection, irrigated land retirement, rainfed agriculture, waterbag transport



Update 2009 Also Defined Key Benefits

- **Provide water supply benefit**
- **Operational flexibility and efficiency**
- **Energy benefits**
- **Improve drought preparedness**
- **Reduce flood impacts**
- **Recreational opportunities**
- **Improve water quality**
- **Environmental benefits**
- **Reduce groundwater overdraft**



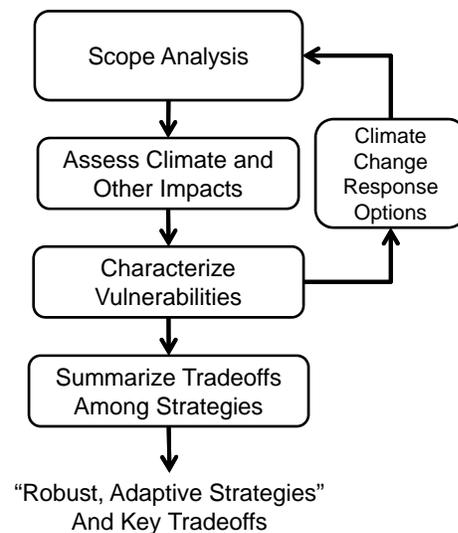
Water Plan Update 2013 Seeks to Identify Strategies Robust to the Uncertain Future

- **Not developing single, optimal strategy because there is....**
 - deep uncertainty about the future
 - a diversity of objectives
 - an evolving understanding of the system
- **Instead, analysis seeks to answer key questions:**
 1. **What are the threats?**
 2. **How would different responses mitigate these threats?**
 3. **What are the key tradeoffs among the more robust responses?**

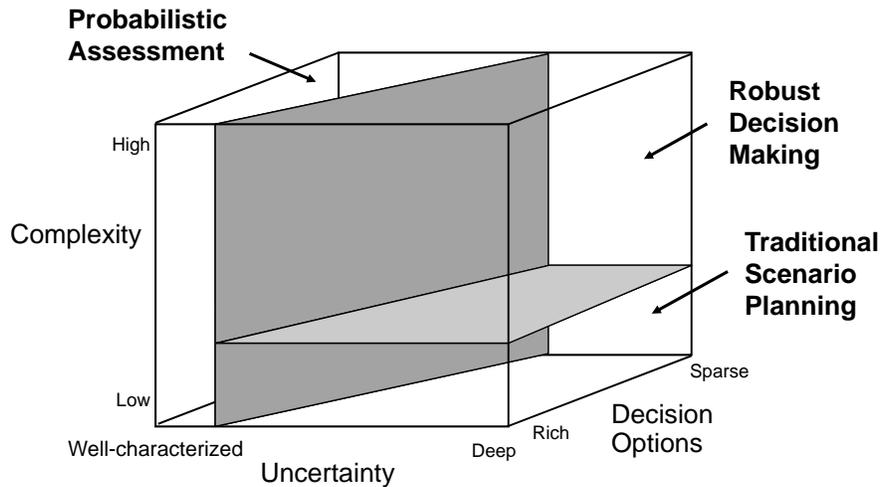
Robust Decision Making (RDM) Provides Means for Identifying Robust Water Management Strategies

Key attributes:

- Characterize uncertainty with multiple views of the future, generally
 - Multiple states of the world, or
 - Multiple probability distributions
- Use robustness not optimality criteria to compare strategies
- Conduct iterative vulnerability-and-response-option analysis to identify more robust, adaptive strategies



RDM Most Appropriate When Uncertainty Is Deep and Decision Makers Have a Rich Set of Options



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Key Outcomes of an RDM Analysis....

- Structures analysis of decision options against many scenarios
- Characterizes future uncertainty by focusing on vulnerabilities of strategies to scenarios
- Reveals key tradeoffs among response packages for deliberation
- Can be focused at different scales (e.g. state-wide or at individual region level)

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RDM Being Applied to Long-Term Water Planning Across California and the West

- Metropolitan Water District's IRP
- Water Resources Foundation Study on Climate Adaptation
- El Dorado Irrigation District's UWMP (w/ CEC funding)
- Denver Water's IRP
- Featured in January 2009 Water Utility Climate Alliance (WUCA) Report



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11

RDM Is Well Documented in the Literature

- Robust Decision Making Concepts and Methods
 - Lempert, R. J., Popper, S. W., and Banks, S. C. (2003). *Shaping the Next One Hundred Years: New methods for quantitative, long-term policy analysis*, RAND, Santa Monica, CA.
 - Lempert, R. J., Groves, D. G., Popper, S. W., and Banks, S. C. (2006). "A General, Analytic Method for Generating Robust Strategies and Narrative Scenarios." *Management Science*, 52(4), 514-528.
 - Lempert, R., and Collins, M. (2007). "Managing the Risk of Uncertain Threshold Responses: Comparison of Robust, Optimum, and Precautionary Approaches." *Risk Analysis*, 27(4).
 - Groves, D. G., and Lempert, R. J. (2007). "A New Analytic Method for Finding Policy-Relevant Scenarios." *Global Environmental Change* 17, 73-85.
 - Bryant, B. P., and Lempert, R. J. (2010). "Thinking inside the box: A participatory, computer-assisted approach to scenario discovery." *Technological Forecasting and Social Change*, 77(1), 34-49.

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14 Mar-2011

RDM Is Well Documented in the Literature

- Applications of RDM to Water Management

- Groves, D. G., Matyac, S., and Hawkins, T. (2005). "Quantified Scenarios of 2030 California Water Demand." California Water Plan Update 2005, California Department of Water Resources, Sacramento, CA.
- Groves, D. G., Knopman, D., Lempert, R., Berry, S., and Wainfan, L. (2008a). *Presenting Uncertainty About Climate Change to Water Resource Managers - Summary of Workshops with the Inland Empire Utilities Agency*. RAND, Santa Monica, CA.
- Groves, D. G., Lempert, R., Knopman, D., and Berry, S. (2008b). *Preparing for an Uncertain Future Climate in the Inland Empire – Identifying Robust Water Management Strategies*. RAND Corporation, Santa Monica, CA.
- Groves, D. G., Davis, M., Wilkinson, R., and Lempert, R. (2008c). "Planning for Climate Change in the Inland Empire: Southern California." *Water Resources IMPACT*, July.
- Groves, D. G., Yates, D., and Tebaldi, C. (2008d). Developing and Applying Uncertain Global Climate Change Projections for Regional Water Management Planning. *Water Resources Research*, 44(W12413).
- Lempert, R. J., and Groves, D. G. (2010). "Identifying and Evaluating Robust Adaptive Policy Responses to Climate Change for Water Management Agencies in the American West." *Technological Forecasting and Social Change*, 77.

Today We'll Apply RDM to Water Plan Through a Proof-of-Concept Analysis and Shared Vision Planning Exercise

Shared Vision Planning: Presentation (Cardwell)
 RDM POC: Presentation & Break-out Group #3 (Groves)

