

Developing New Methods for Incorporating Climatic Uncertainties into Water Planning

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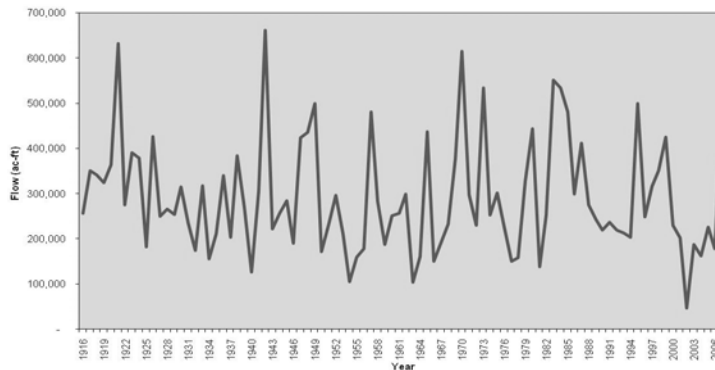
Outline

- Why we need new planning methods to address climatic uncertainty
- Seven steps of adaptation
- Water Utility Climate Alliance's Decision Support Committee activities
- Four promising planning methods

Traditional Water Supply Planning

- Based on observed weather and hydrology
- Uses paleo-reconstruction, stochastic and other advancements
- Assumes historic variability, history repeats, stationary climate

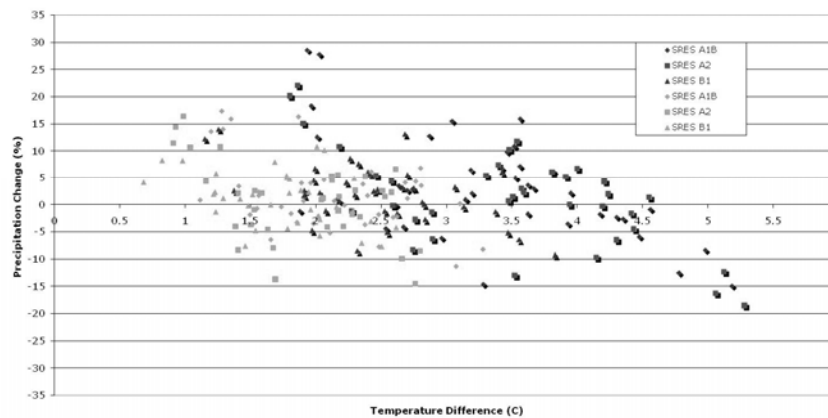
South Platte River At South Platte
Annual Natural Flow
1916-2007



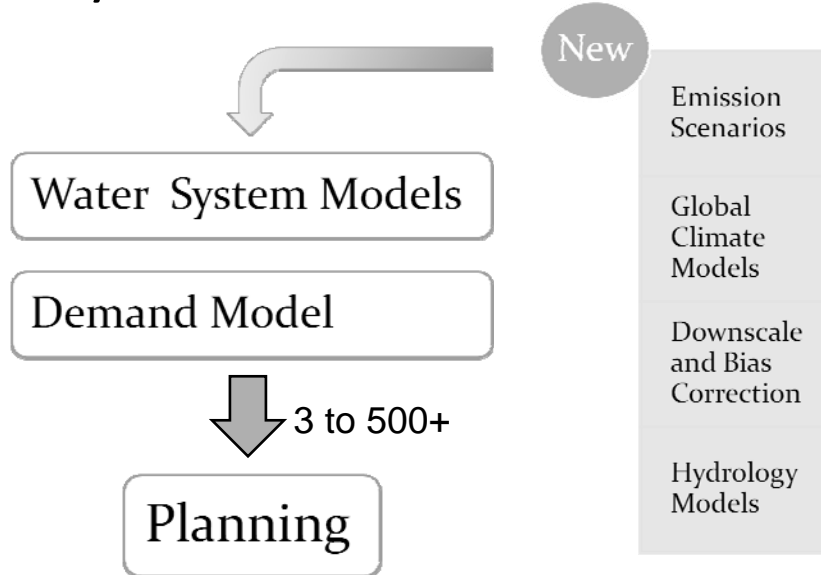
Climate Uncertainty

- Which model? Which scenario? What's the accuracy?

Change of Annual Values
2025-2054 minus 1950-1999 (blue)
2055-2084 minus 1950-1999 (red)



Analysis



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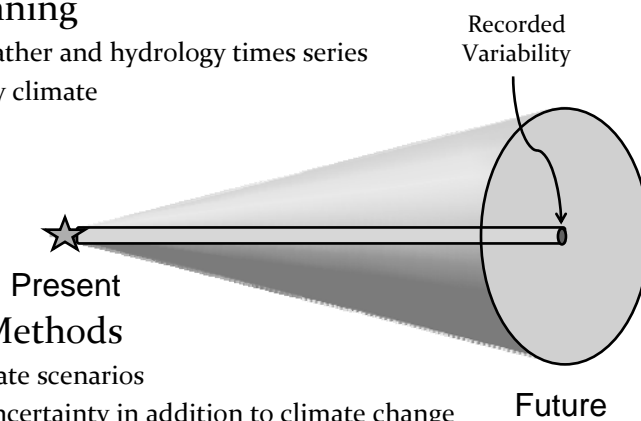
Cone of Uncertainty*

- **Traditional Planning**

- Uses observed weather and hydrology times series
- Assumes stationary climate

- **New Planning Methods**

- 500+ possible climate scenarios
- Many sources of uncertainty in addition to climate change
- Planning for greater uncertainty
- Robust over optimal



*Malcolm Pirnie

6

Seven Steps of Adaptation to Climatic Uncertainties

1. Deny Uncertainty
2. Debate Uncertainty
3. Investigate Uncertainty
4. Attempt to Reduce Uncertainty
5. Accept Uncertainty
6. Plan for Uncertainty
7. Adapt to Uncertainty



WUCA Decision Support Objectives

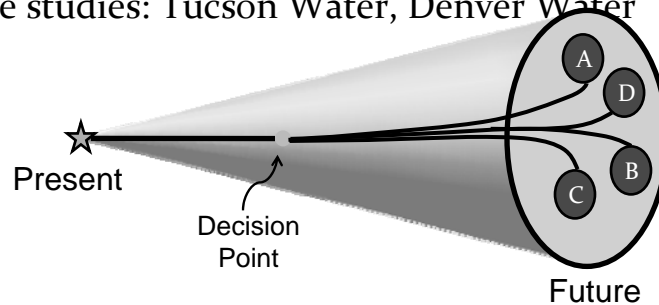
1. Aid in the transition from stationary to uncertainty based planning methods.
2. Bridge the gap between projections and the need to make decisions.
3. Identify, understand, and evaluate decision support methods to incorporate climate uncertainties into planning.
4. Raise awareness of decision support needs and promote research to improve methods.

Four Promising Planning Methods

- Scenarios Planning
- Robust Decision Making
- Decision Analysis
- Real Options

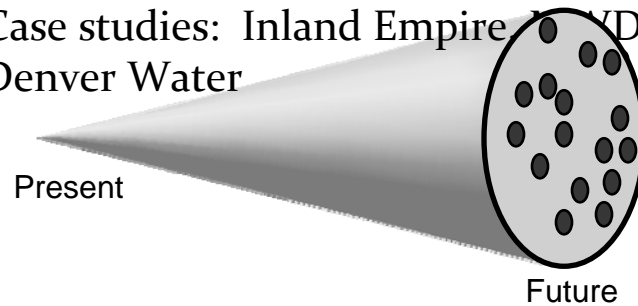
Scenario Planning

- Small number of equally likely scenarios [A, B, C, D]
- Common strategies (no regrets)
- Decision points
- Case studies: Tucson Water, Denver Water



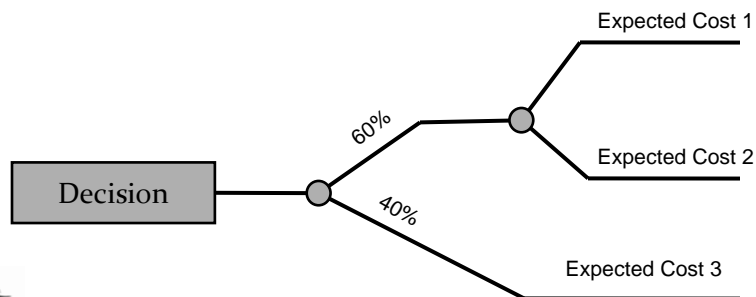
Robust Decision Making

- Computer analysis of many equally likely scenarios developed by RAND Corp.
- Iteration, hedging and decision points
- Case studies: Inland Empire, WND, Denver Water



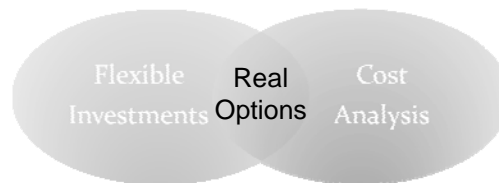
Decision Analysis

- Decision trees, probabilities and costs
- Minimize expected costs



Real Options

- Combines decision analysis and financial theory
- Decision tree and financial hedging concepts



Conclusions

- Climatic uncertainty won't diminish soon.
- Water utilities will need to make long-term decision that incorporate uncertainties about climate change.
- Traditional planning methods are inadequate for this use.
- Several promising methods are being explored.
- There is much more work to do on new methods
 1. Identify, understand, analyze and modify.
 2. Perform case studies
 3. Promote new methods

Contacts

- Marc Waage – Denver Water
- Lurna Kaatz – Denver Water
- Ed Means – Malcolm Pirnie
- David Behar – San Francisco Public Utilities Commission
- WUCA Webpage

Water Utility Climate Alliance

- The Water Utility Climate Alliance (WUCA) is dedicated to providing leadership and collaboration on climate change issues affecting drinking water utilities by improving research, developing adaptation strategies and creating mitigation approaches to reduce greenhouse gas emissions.
- Denver Water , Portland Water Bureau, Metropolitan Water District of Southern California , New York City Department of Environmental Protection, San Diego County Water Authority , San Francisco Public Utilities Commission, Seattle Public Utilities , and Southern Nevada Water Authority

