CH2MHILL®

An Engineering Perspective on Climate Adaptation, Risk, and Resiliency

Presented by:

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Climate Change and America's Infrastructure

Tempe, AZ

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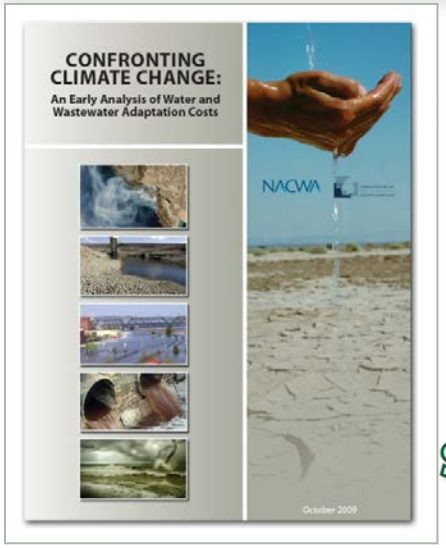
Introduction

- Adaptation – an engineering and cost perspective
- Evolving consideration of climate in engineering
- Uncertainty and risk planning – approaches and issues
- Frameworks for climate risk and resiliency planning
- Case study

Global adaptation cost estimates -variable and big

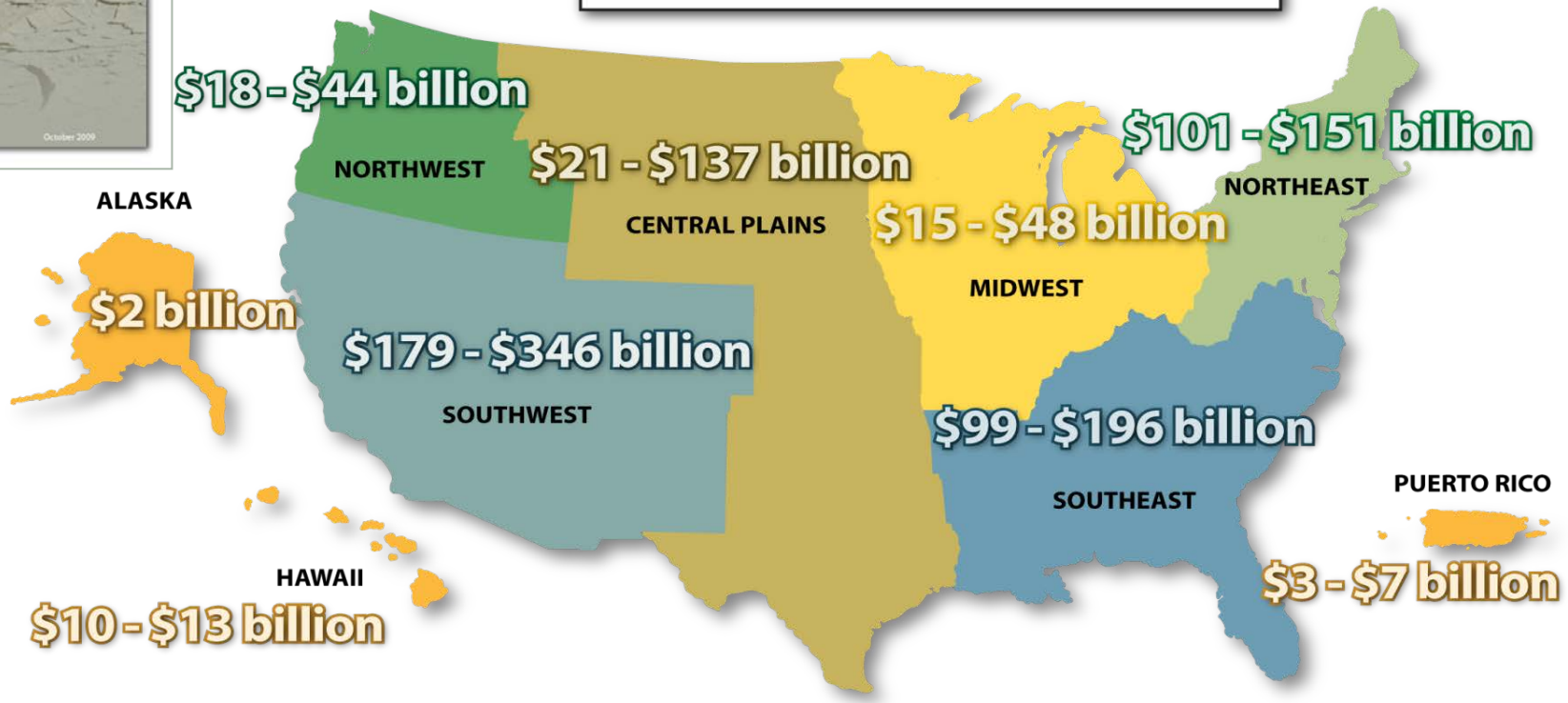
Source	$ US Billion per year , current to 2030-2050
World Bank (2006)	9-41
UNDP (2007)	86-109
UNFCC (2007)	49-171
Parry et al. (2009)	~2-3x UNFCC estimates 100-500

Closer to home… just for the water sector



SUMMARY
Drinking Water = $325 - $692 billion
Wastewater = $123 - $252 billion

GRAND TOTAL
Drinking Water
and Wastewater = $448 - $944 billion



Climate Influences Many Aspects of Infrastructure Planning, Design, and Operations

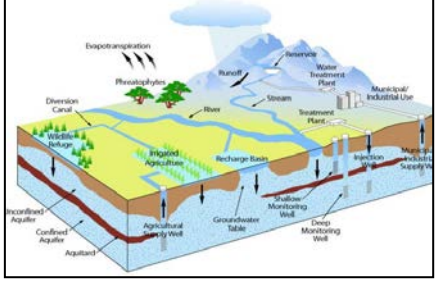
Sea level rise

Temperature

Precipitation

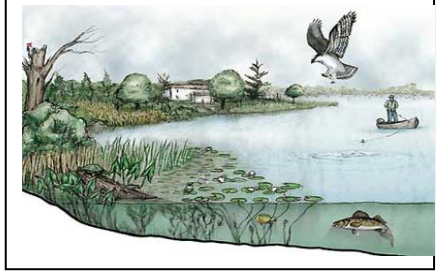
… and not all are impacted the same …

Water Resources



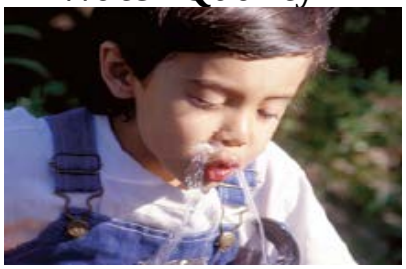
Agriculture

Ecosystems



Flood Management

Water Quality



Coastal Regions

Energy

Infrastructure

Engineering Assumptions Underscore Infrastructure Planning

Stationary or static system components (typical)

- Climate
- Natural landscapes
- Ecosystems
- Natural populations
- Resource availability

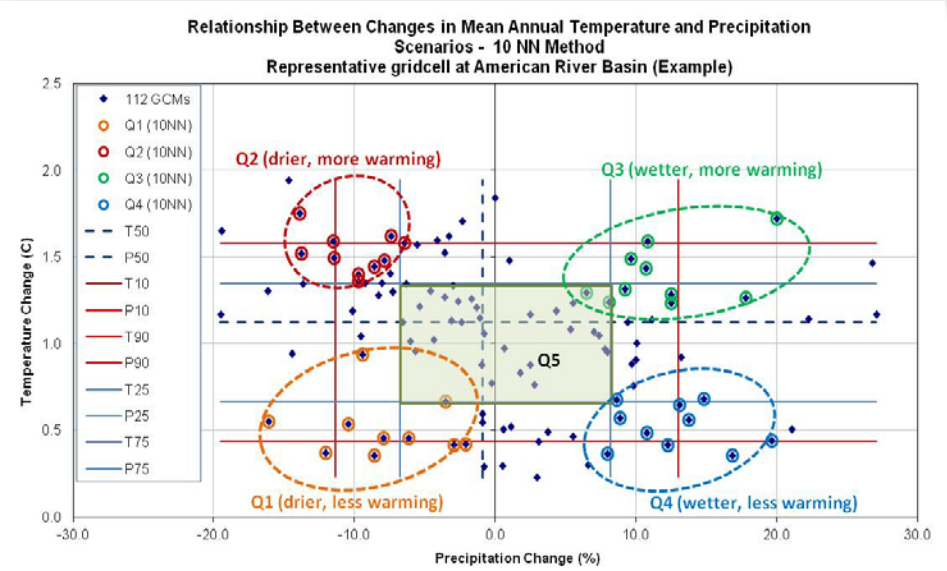
Dynamic system components (common)

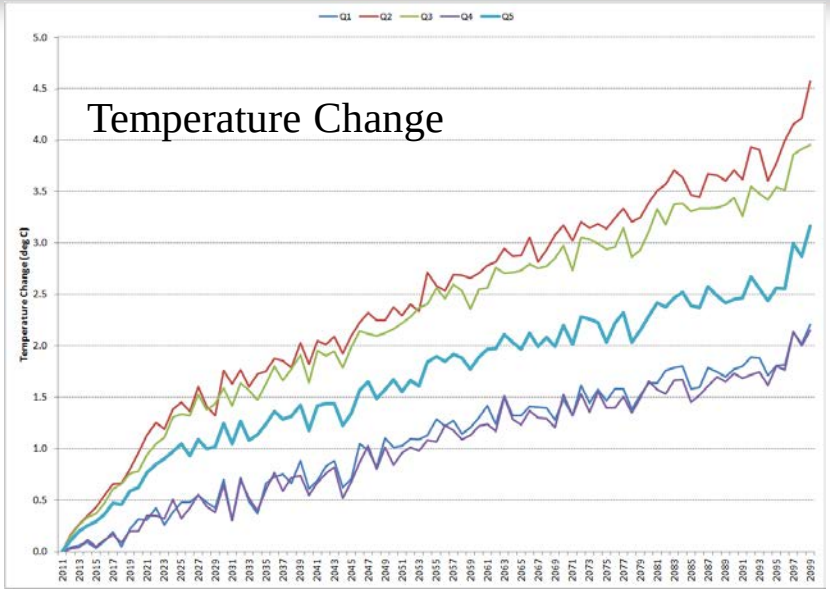
- Human population
- Human-influence land use
- Policies and regulation
- Technological advances

Must consider important drivers of uncertainty to be dynamic, non-stationary;

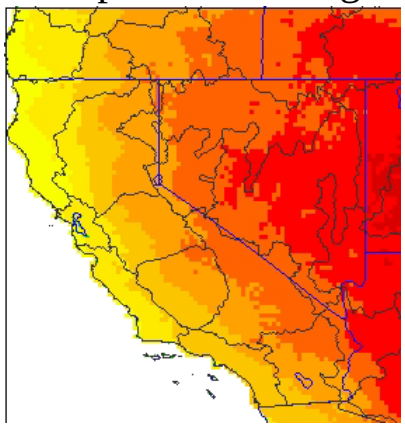
Context-sensitive, but climate is usually a major driver

Future Climate Uncertainty is Large

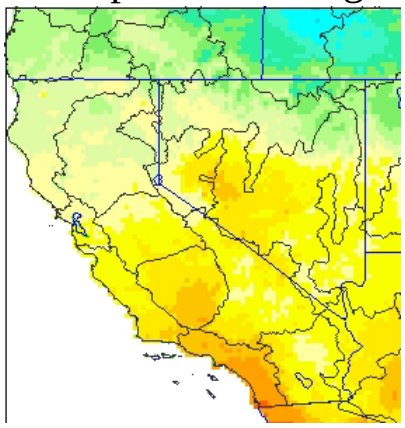


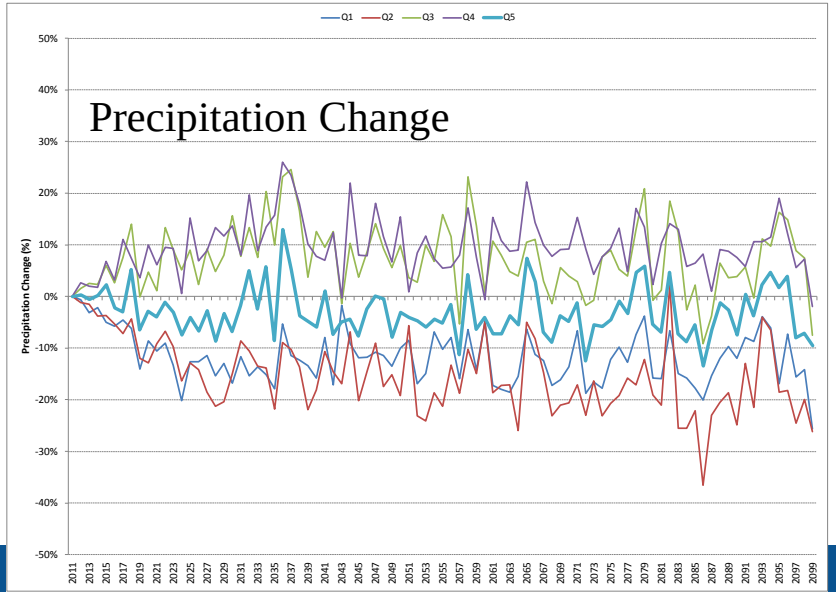


Temperature Change



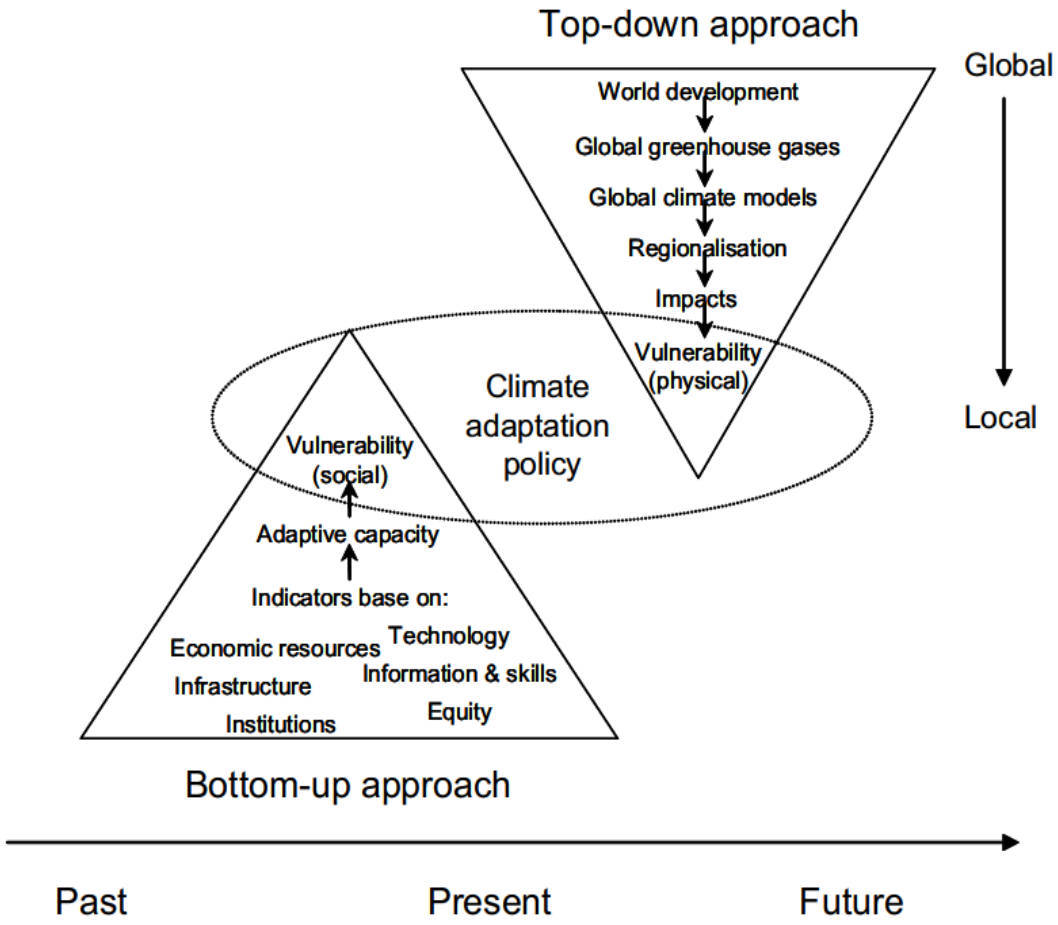
Precipitation Change





Risk Perspectives and Approaches

- Prediction Oriented
  - Uncertainty characterized, reduced, and managed
  - Leads to questions such as “when will science by actionable”?
- Resilience Oriented
  - System focused with greater acceptance of irreducible uncertainties
  - Emphasizes resiliency, robustness, and adaptive management
- Hybrid approaches are becoming more common

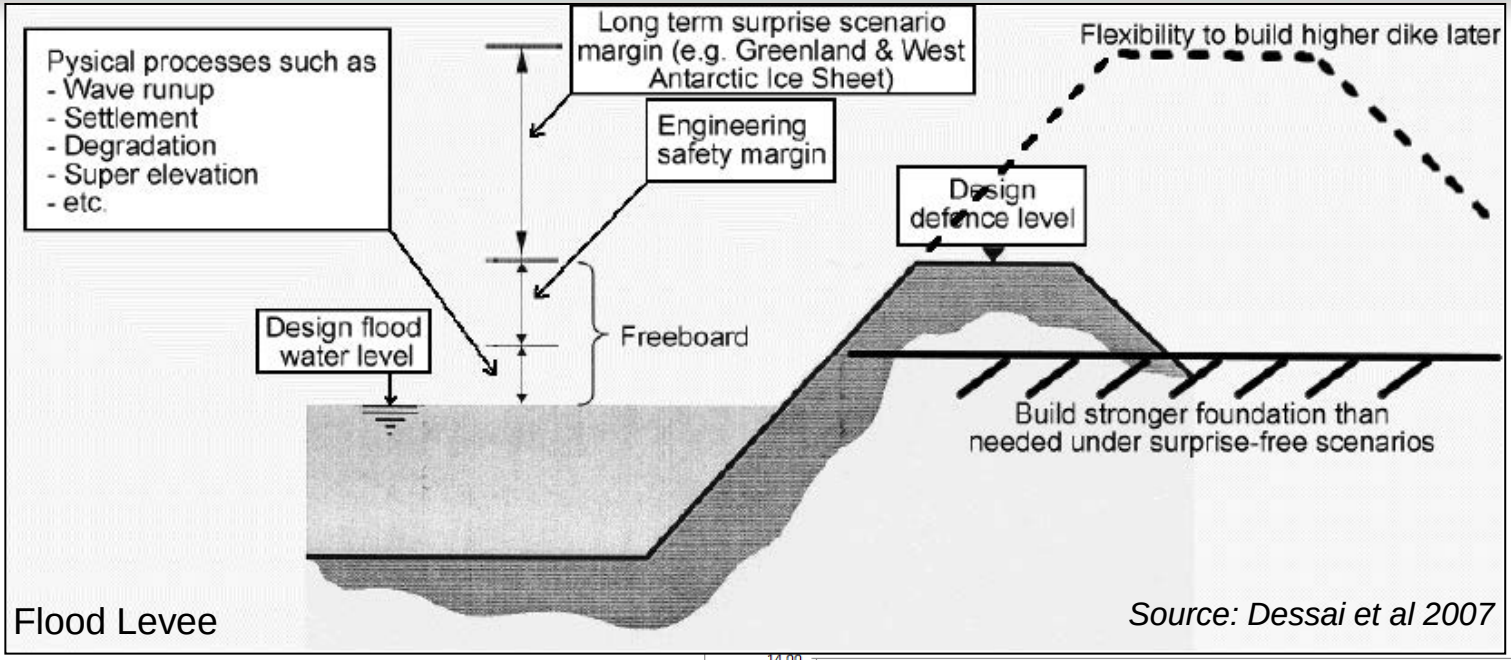


Source: Dessai and Hulme 2004

Learning to Love Volatility – “Black Swans”

- Resiliency means exploring the risks that can be measured or estimated and those which cannot be directly measured but likely have a high impact (black swans)
- *“We should try to create institutions that won't fall apart when we encounter black swans—or that might even gain from these unexpected events” (N. Taleb, WSJ Nov. 2012)*

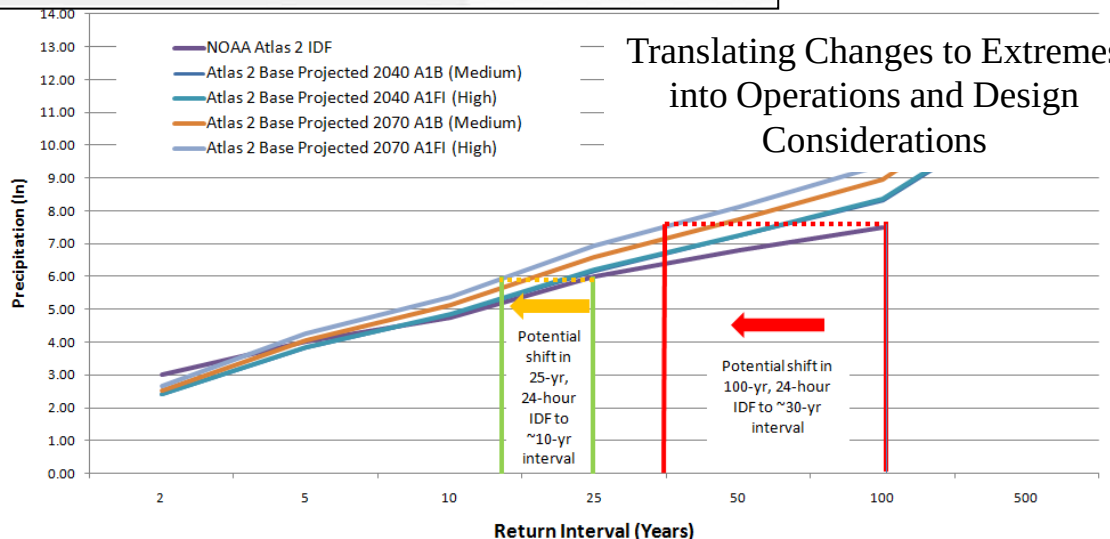
Flexible Design Approaches can Accommodate Uncertainty



Flood Levee

Source: Dessai et al 2007

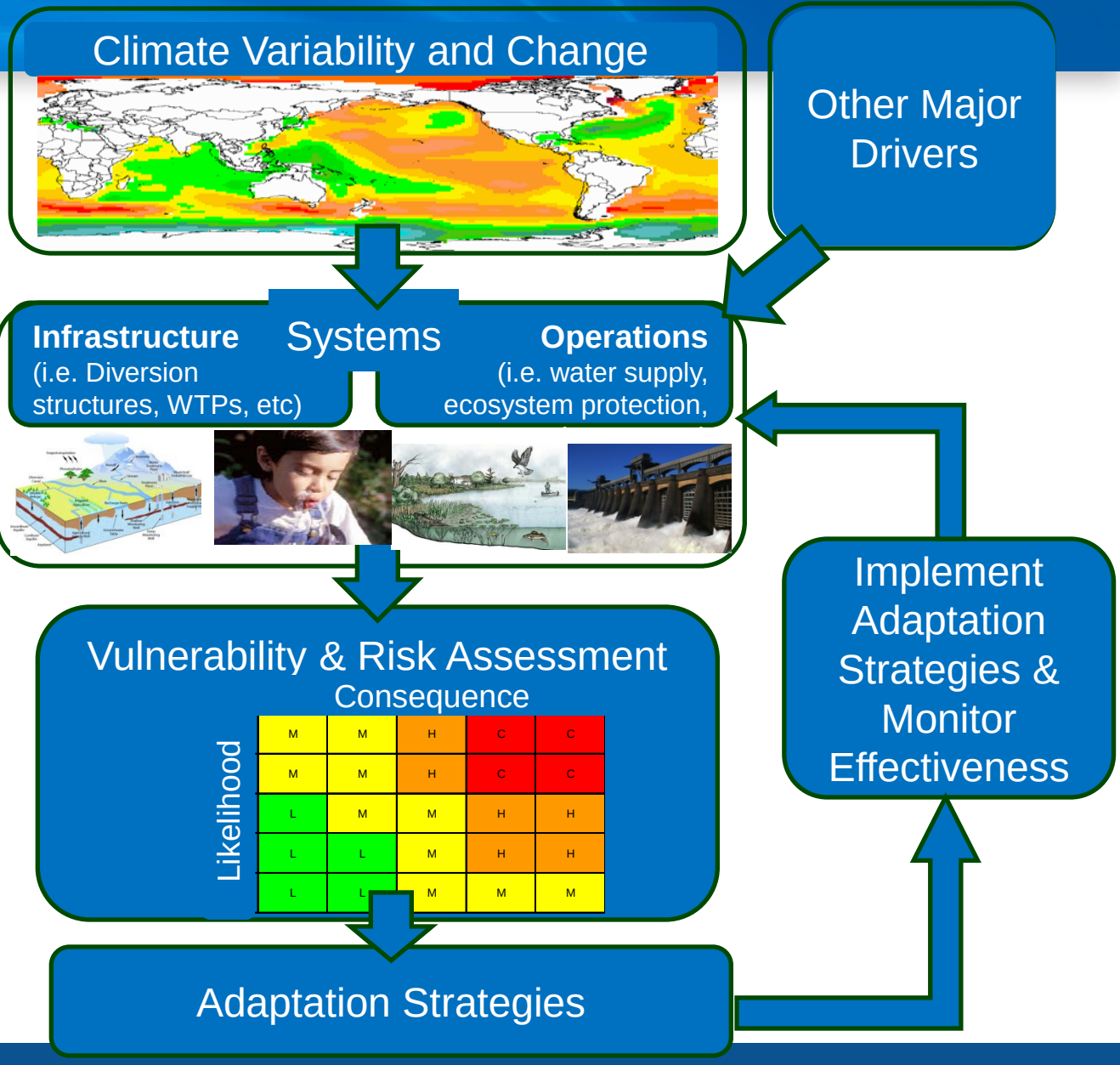
Green Stormwater Infrastructure



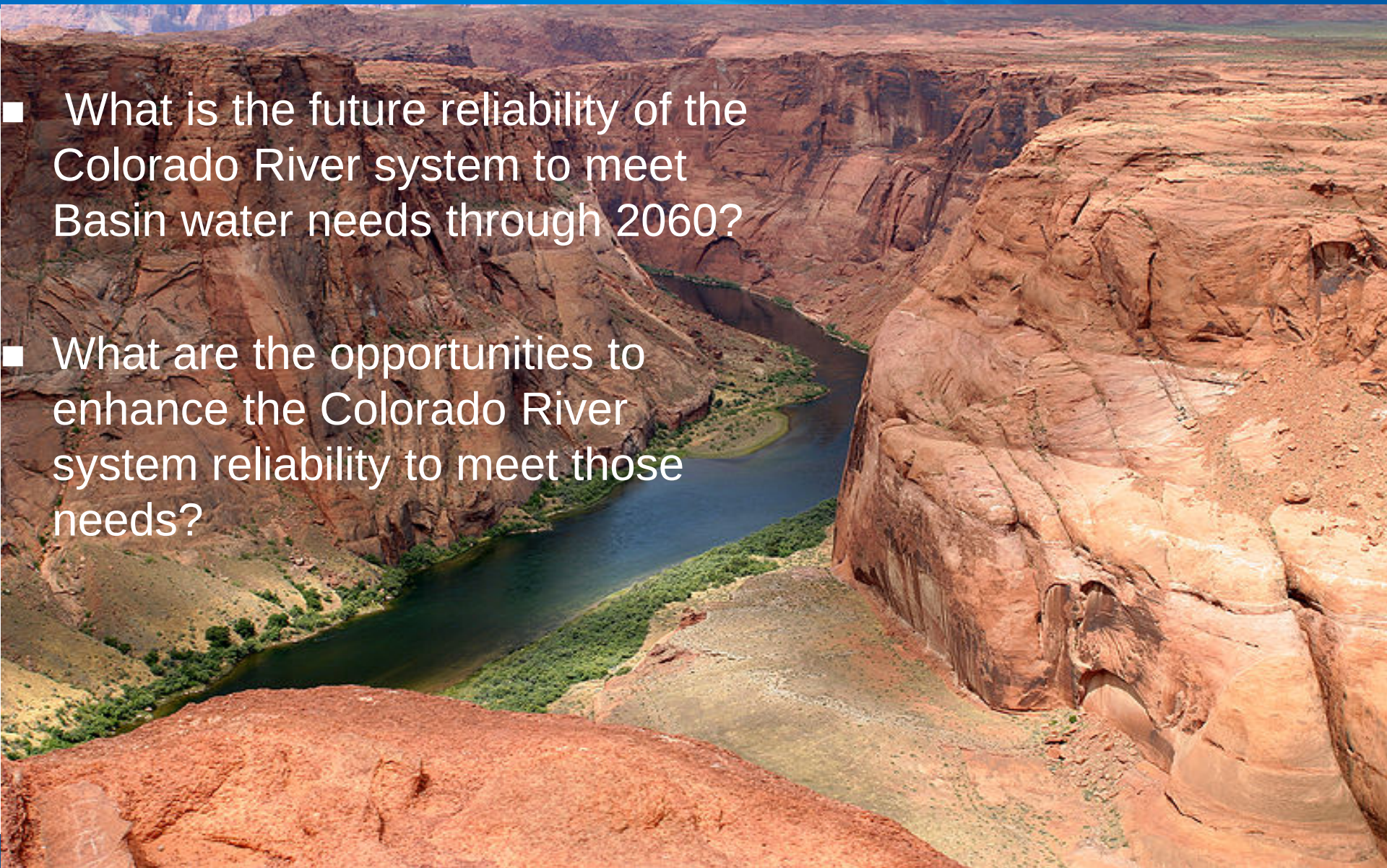
Translating Changes to Extremes into Operations and Design Considerations

Framework for Climate Risk and System Resiliency Planning

- Infrastructure only exists as part of systems – most are getting more complex
- Resilience needs to developed for systems
- Integrated systems support our communities and society

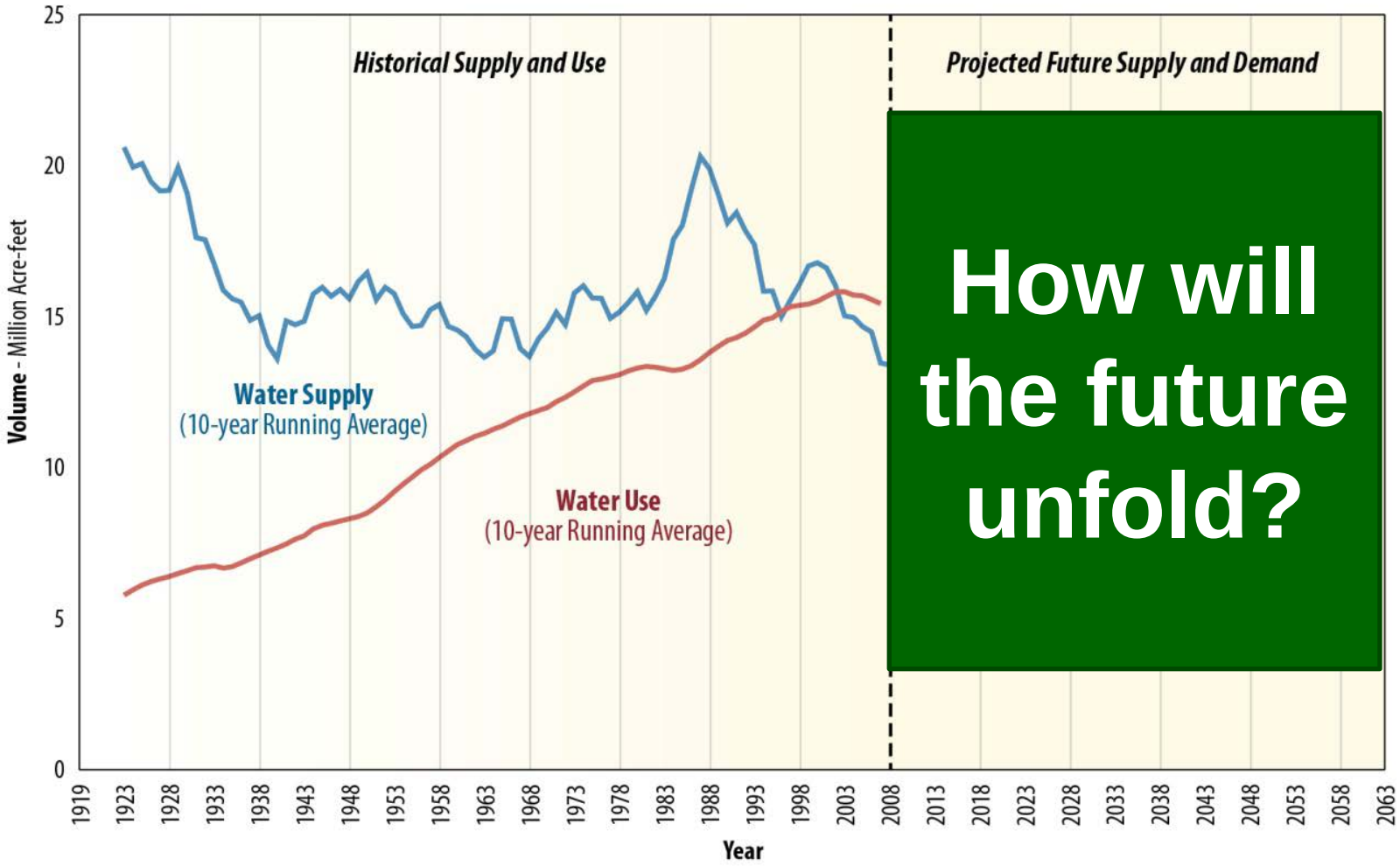


Colorado River Basin Water Supply and Demand Study



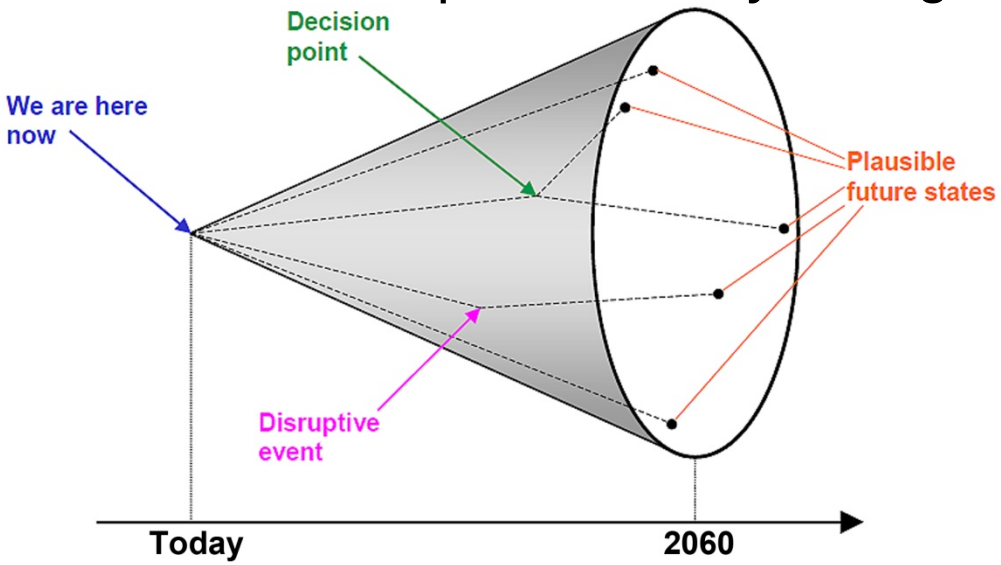
- What is the future reliability of the Colorado River system to meet Basin water needs through 2060?
- What are the opportunities to enhance the Colorado River system reliability to meet those needs?

Colorado River Basin Study: The Challenge



Scenario Planning: Addressing an Uncertain Future

- The path of major influences on the Colorado River system is uncertain and can not be represented by a single view



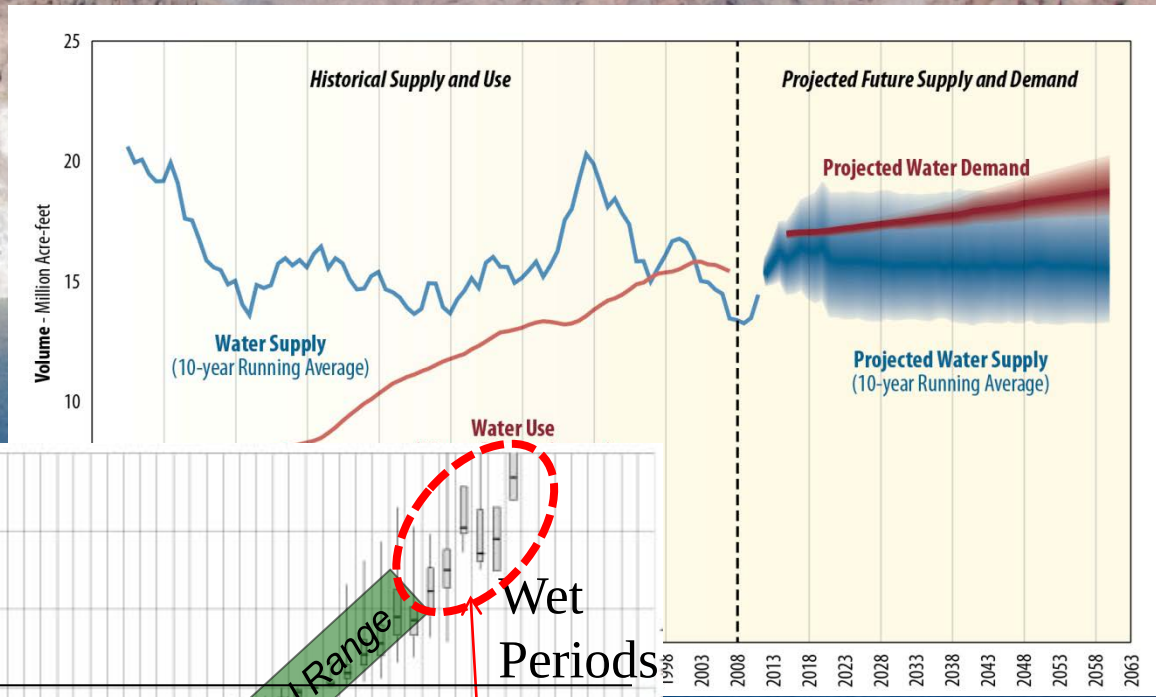
Water Supply Scenarios

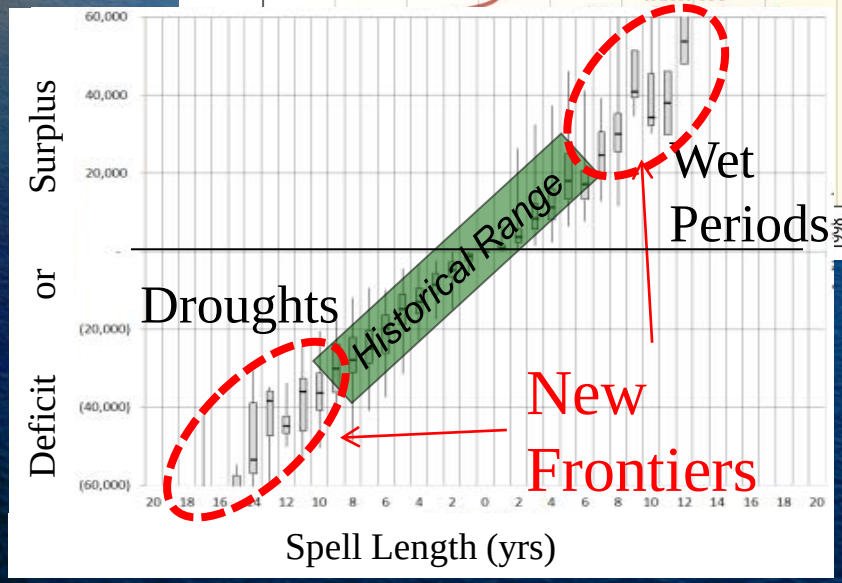
- Observed Resampled
- Paleo Resampled
- Paleo Conditioned
- Downscaled GCM Projected

Water Demand Scenarios

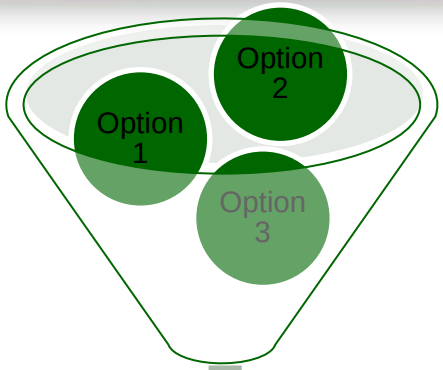
- Current Trends
- Slow Growth
- Rapid Growth
- Enhanced Environment

Mean shifts in climate and extremes require envisioning and adapting to new frontiers



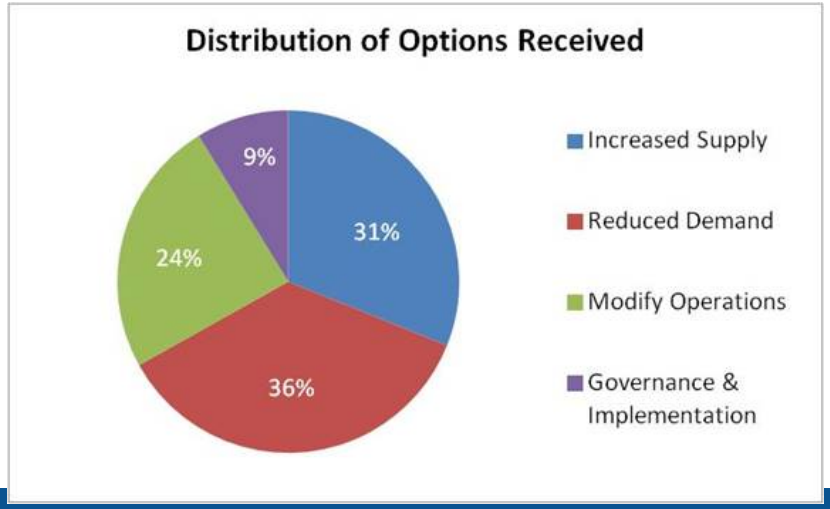


A Diverse Portfolio of Options Needed to Address Multiple Risks

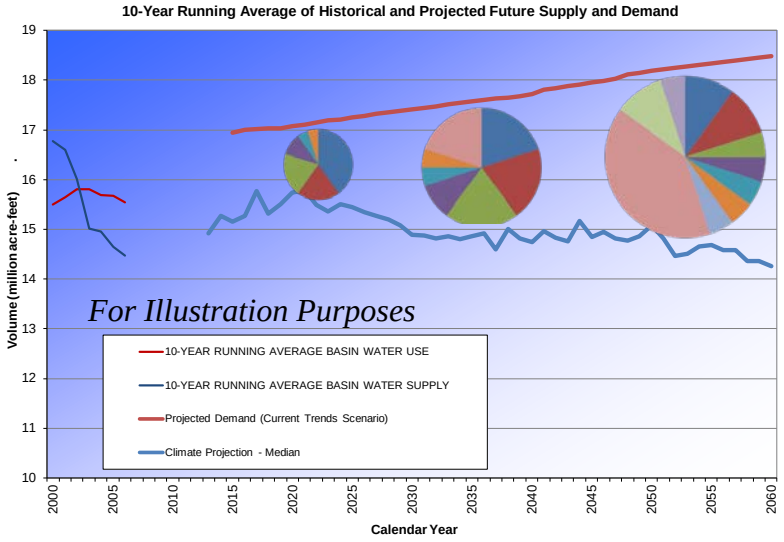


Increase Supply | Decrease Demand

Modify Operations | Governance & Implementation



- Understand the system
  - Over 60 MAF of storage mitigates for short-duration extremes
- Vulnerabilities are influenced by climate variability and other factors
  - Target actions that address key vulnerabilities
- Risks-based planning often leads to portfolios of solutions and adaptive implementation



Some Closing Thoughts …

- Incorporate climate information now; use existing frameworks where possible
- Greater certainty may not be on the horizon, thus emphasis needs to be on creating resiliency
- Systems approach and risk-based planning is required to achieve long-term resiliency
- Resources: no community has all the answers, people, $$, and time to address these risks independently – urgent need to develop and fast-track partnerships amongst science/academia, public sector, private, and NGO sectors

Questions?

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