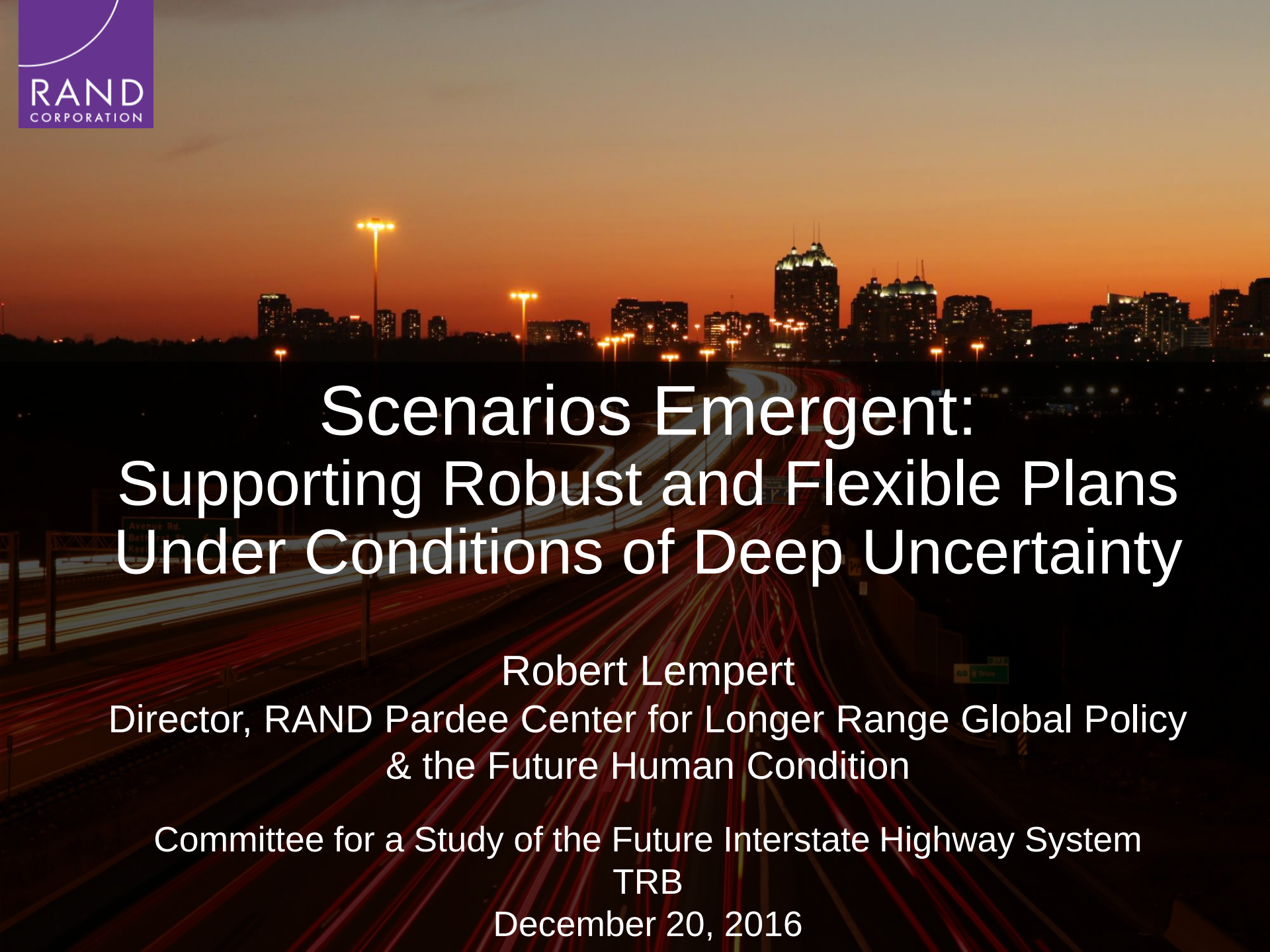


Scenarios Emergent: Supporting Robust and Flexible Plans Under Conditions of Deep Uncertainty

Robert Lempert
Director, RAND Pardee Center for Longer Range Global Policy & the Future Human Condition

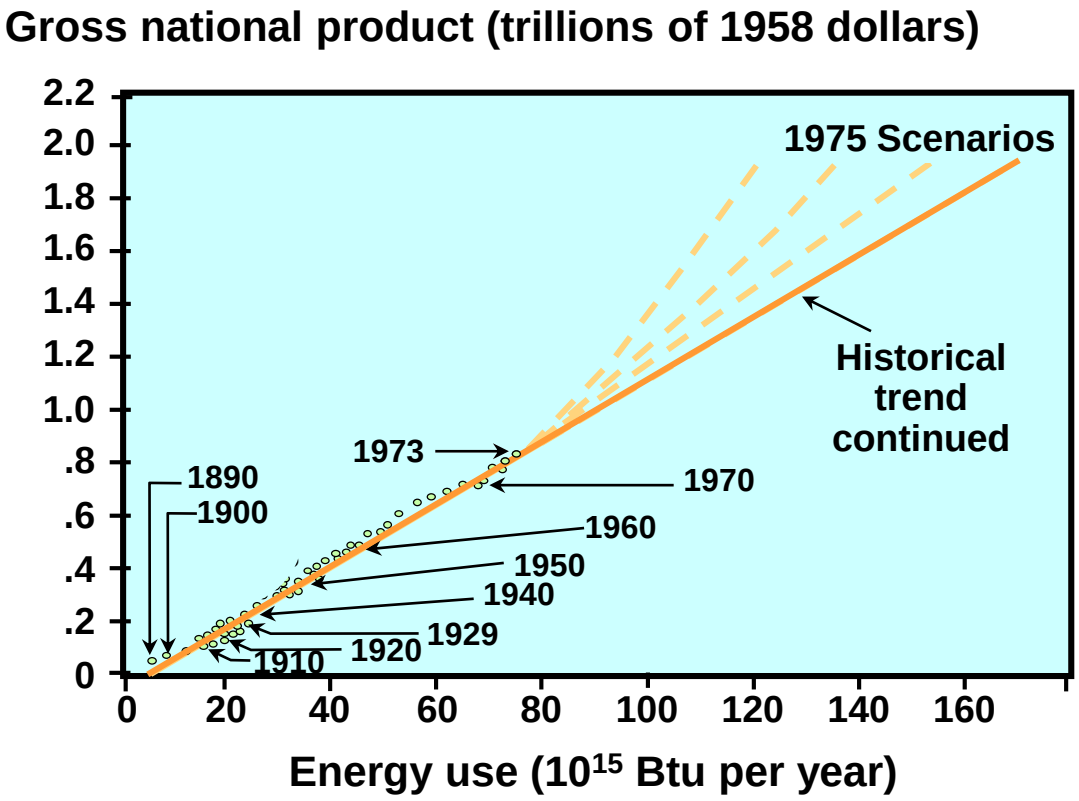
Committee for a Study of the Future Interstate Highway System
TRB
December 20, 2016

Scenarios Can Help Support Development of Flexible and Robust Plans

- Your committee tasked with:
  - Recommending actions needed to upgrade and restore the interstate highway system
  - Building on methodologies examined and recommended in the NCHRP report
- Under conditions of fast-paced and disruptive change, often useful to pursue flexible and robust plans
- New approaches for developing and using scenarios can:
  - Augment methodologies in NCHRP report
  - Help identify robust and flexible responses to deep uncertainty

Believing forecasts of the unpredictable can contribute to bad decisions

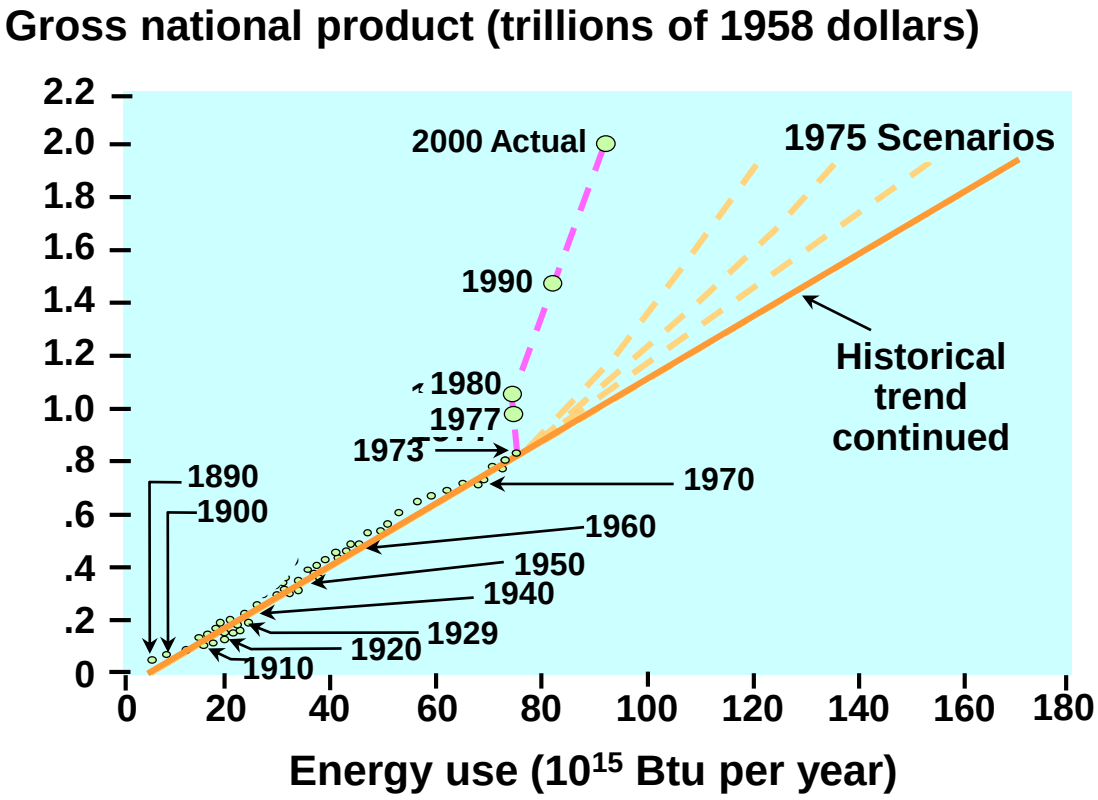
In the early 1970s forecasters made projections of U.S energy use based on a century of data



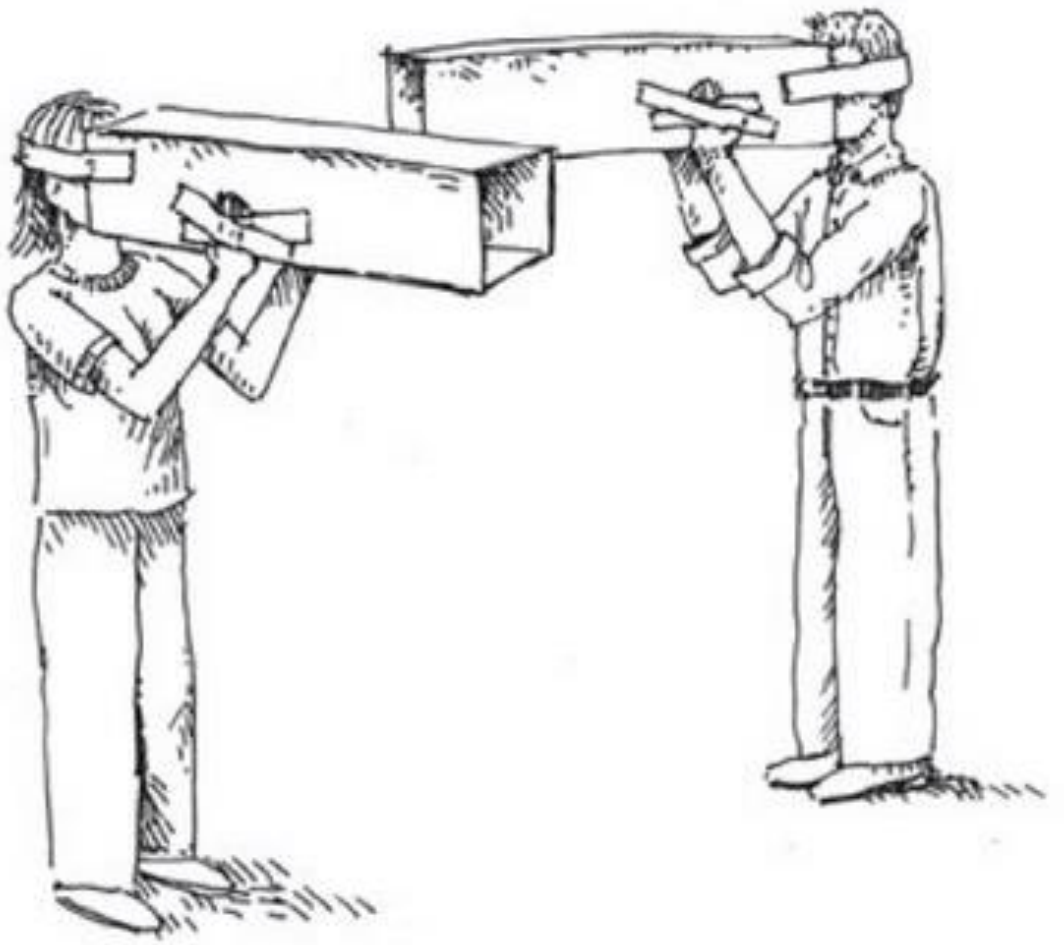
Believing forecasts of the unpredictable can contribute to bad decisions

In the early 1970s forecasters made projections of U.S energy use based on a century of data

… they all were wrong



Optimizing to a single future: what if we're wrong?



Source: http://www.hockscqc.com/articles/tunnelvision/tunnel-vision.jpg

Thanks to Pat Reed

Technology and Other Change May Make Forecasting Even More Difficult Over Next 50 Years

~1960

2010

~1910

2060

?

In many respects, transportation systems changed

- more from 1910 to 1960
- than from 1960 to 2010

What changes will the next fifty years bring?

<u>Deep uncertainty</u> occurs when the parties to a decision do not know, or do not agree on the likelihood of alternative futures or how actions are related to consequences

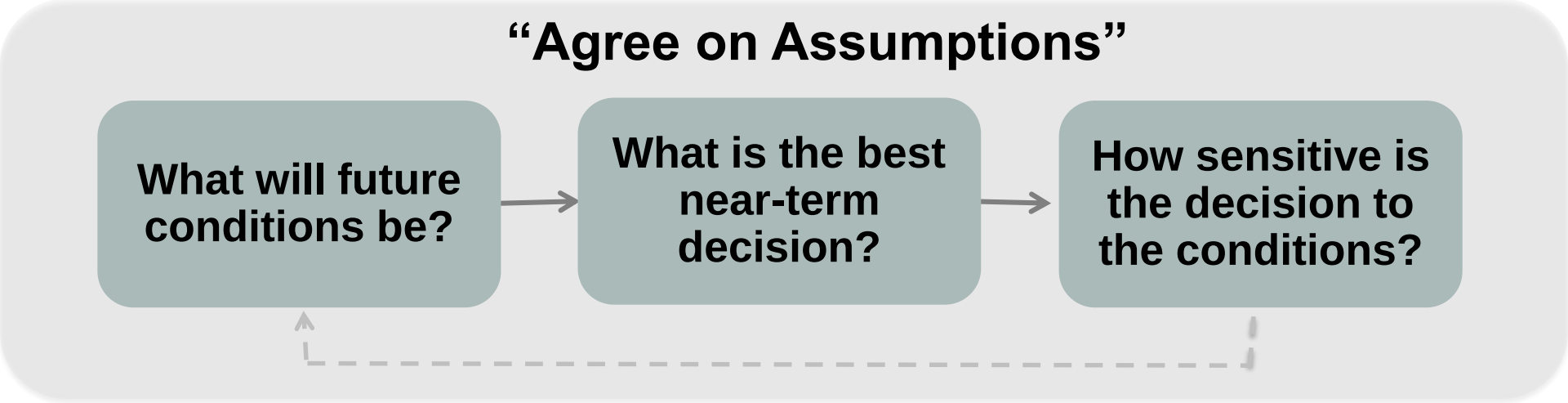
Outline

Scenarios emergent

Robust and flexible plans

Engaging with these ideas

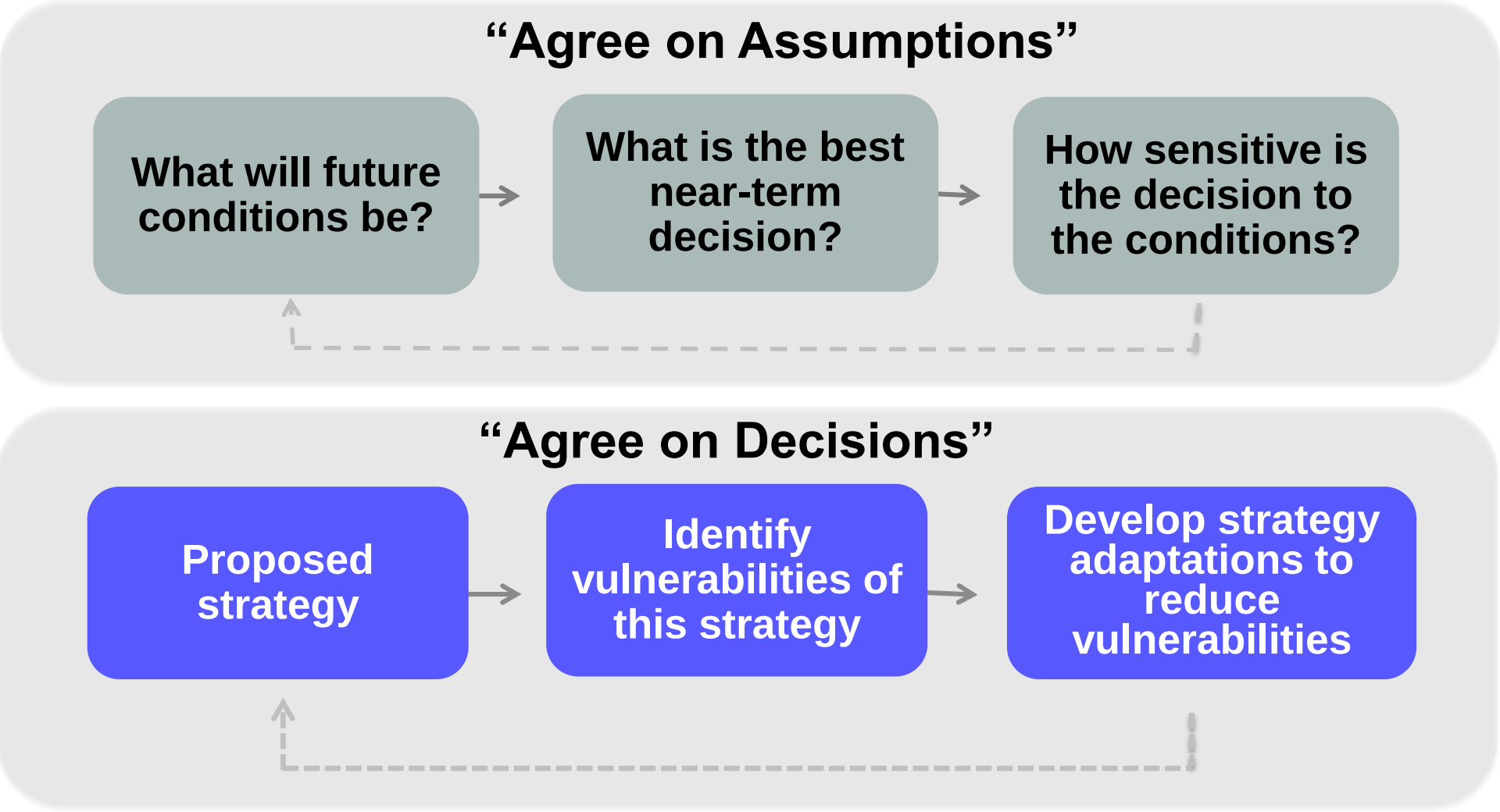
Traditional Planning Methods Work Well When Uncertainty is Limited



But under conditions of deep uncertainty:

- Uncertainties are often underestimated
- Competing analyses can contribute to gridlock
- Misplaced concreteness can blind decisionmakers to surprise

Under Deeply Uncertain Conditions, Often Useful To Run the Analysis "Backwards"



Kalra, N., S. Hallegatte, R. Lempert, C. Brown, A. Fozzard, S. Gill and A. Shah (2014). Agreeing on Robust Decisions: A New Process fo Decision Making Under Deep Uncertainty. WPS-6906, World Bank.

Scenarios Often Chosen As Part of an "Agree on Assumptions" Process

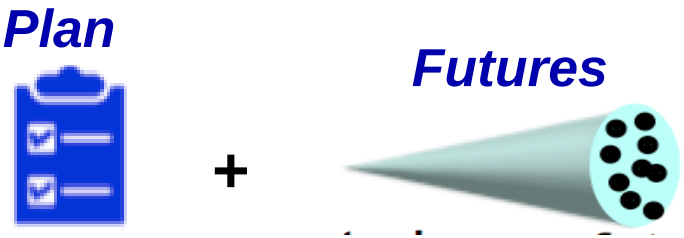
- Scenarios provide power means to characterize deep uncertainty, helping to:
  - Expand range of futures considered
  - Avoid over-confidence

- But scenarios often developed as inputs to the analysis, risking:
  - Ambiguity, bias, and inconsistencies
  - Disconnect between scenarios and decisions
  - Surprise

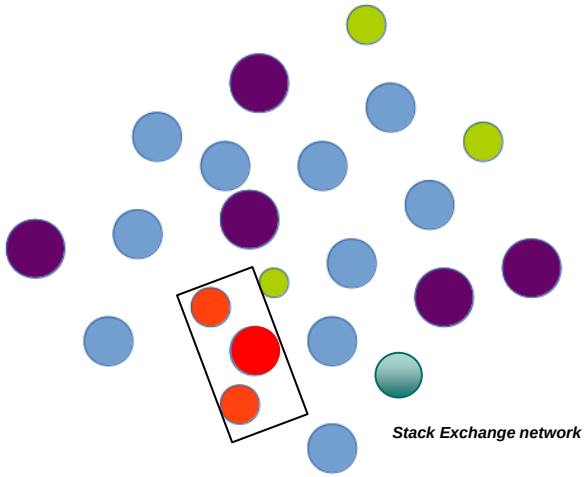
Challenge is choosing the best small set of decision-relevant scenarios from a multiplicity of plausible futures

Within an "Agree on Decision" Process, Policy-Relevant Scenarios Emerge From Analysis

1. Run model to stress test proposed policy over many plausible futures

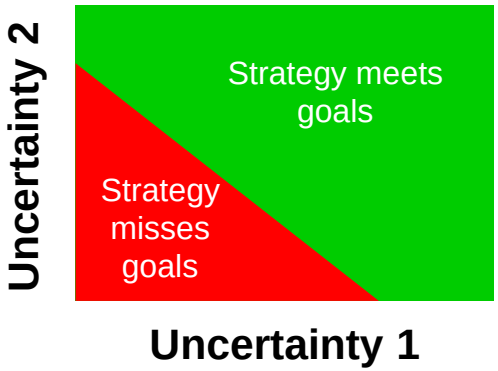


2. Generate large, multi-dimensional database



3. Use statistical algorithms to find interpretable (low dimensional) clusters of policy-relevant cases

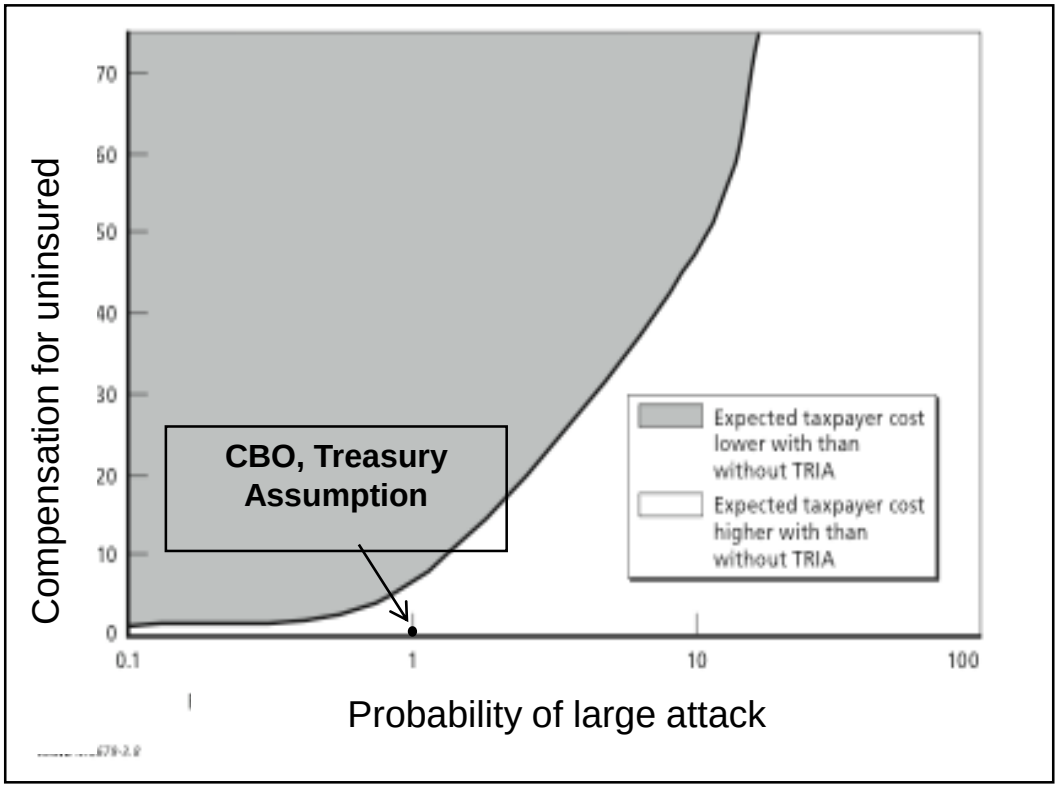
4. Display as policy-relevant scenarios



Such Scenarios Proved Useful in Study of Terrorism Insurance

In 2007, US Congress debated re-authorizing U.S. Terrorism Risk Insurance Act (TRIA). RAND study and its scenarios:

- Cited on floor of US Senate by a proponent
- Called “insidious” by opponents
- Usefully informed Congressional debate



Note that this scenario:

- Remains consistent with official US Government forecasts, but suggests why other answers are (more than) possible
- Mixes uncertainty regarding states of the world with uncertainty regarding probabilities
- Mixes external and internal drivers

Scenario discovery identified these parameters as most important among over a dozen uncertain model parameters

Outline

Scenarios emergent

Robust and flexible plans

Engaging with these ideas

What is a Robust Strategy?

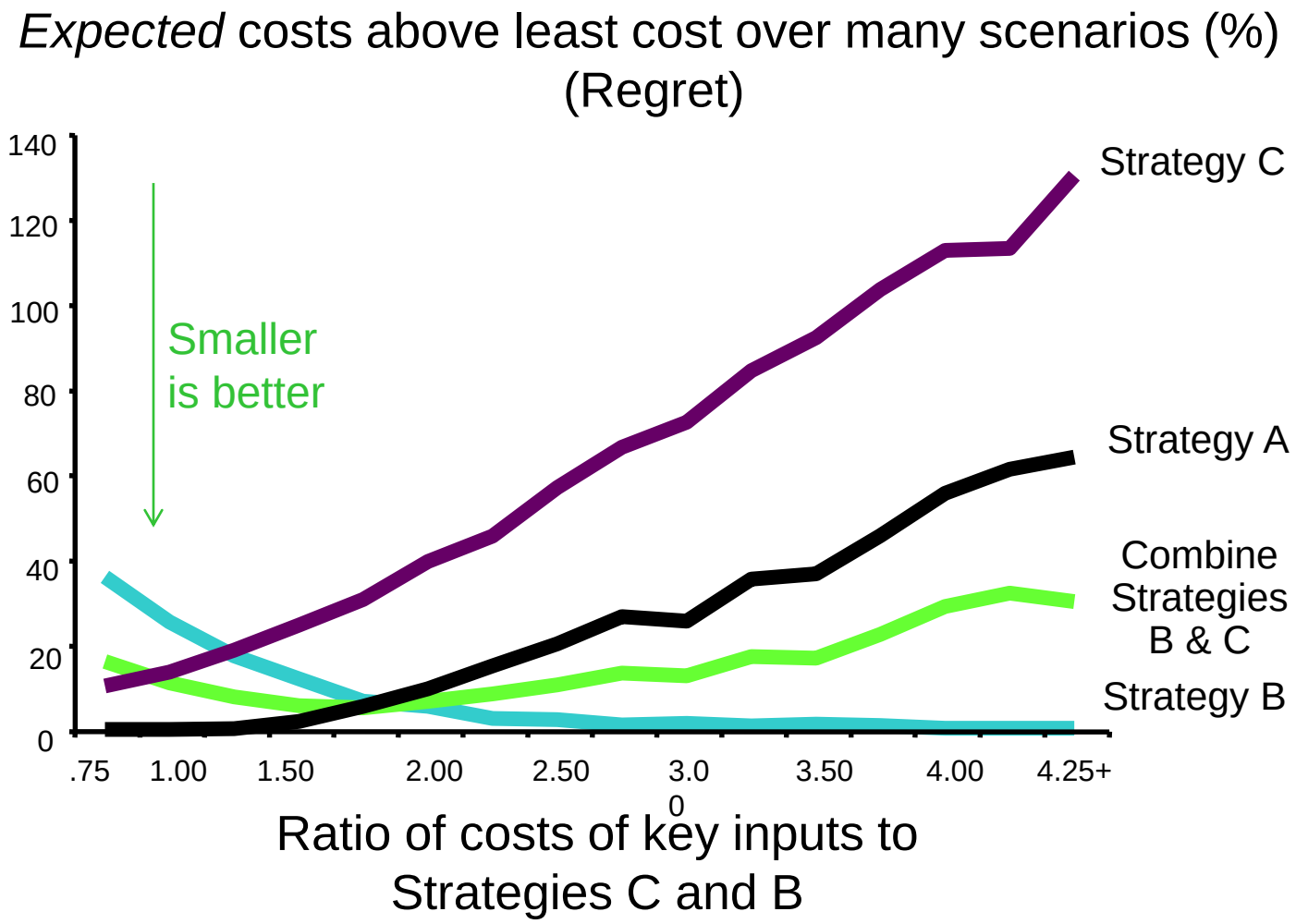
Propose initial strategies

↓

Identify vulnerabilities

↓

Identify strategies that reduce vulnerabilities

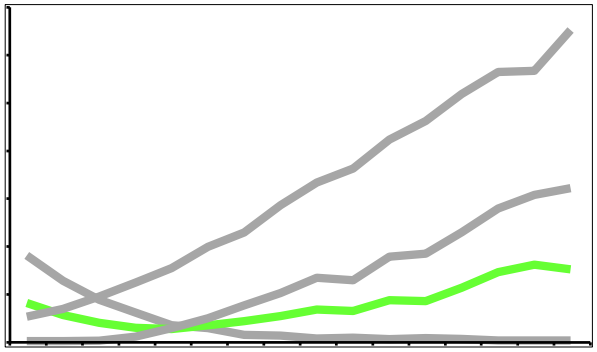


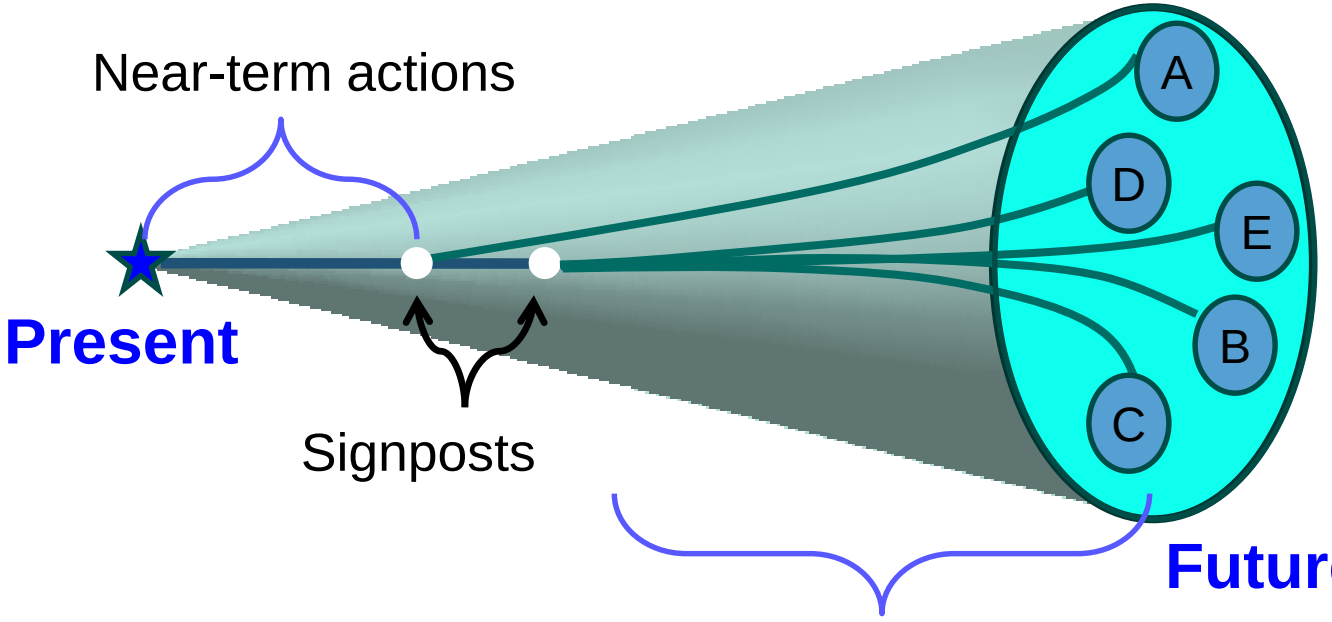
Popper et. al (2009)

Robust Strategies Are Often Designed to Evolve Over Time in Response to New Information

Robust strategy consists of:

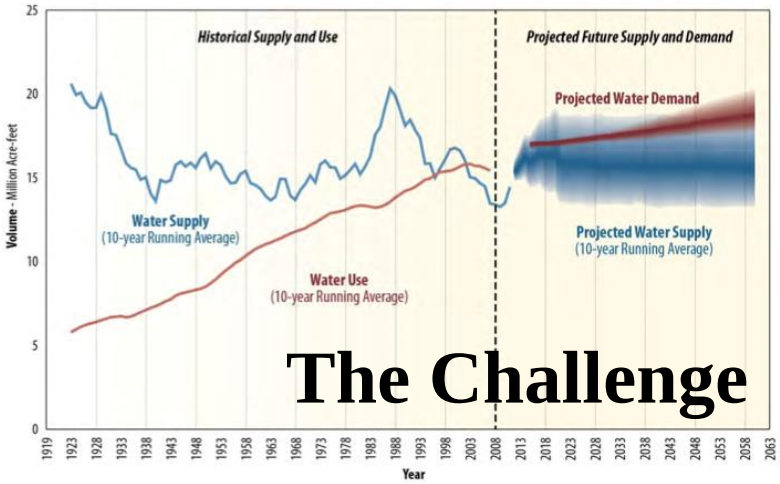
- Near-term actions
  - Shaping
  - Hedging
- Signposts
- Contingent actions





Thanks to Laurna Kaatz

Emergent Scenarios Helped Identify Robust and Flexible Plans for Colorado River Basin



In 2012 Bureau of Reclamation study, parties to the Colorado Compact:

- Generated consensus on potential risks to system
- Identified flexible contingency plan, with
  - High priority near-term actions &
  - Future actions contingent on how the future unfolds

Groves, Fischbach, Bloom, Knopman & Keefe (2013). Adapting to a Changing Colorado River:. RAND RR242

Analysis identified Scenarios That Illuminate Vulnerabilities of Current River Management

Current River Management Plan

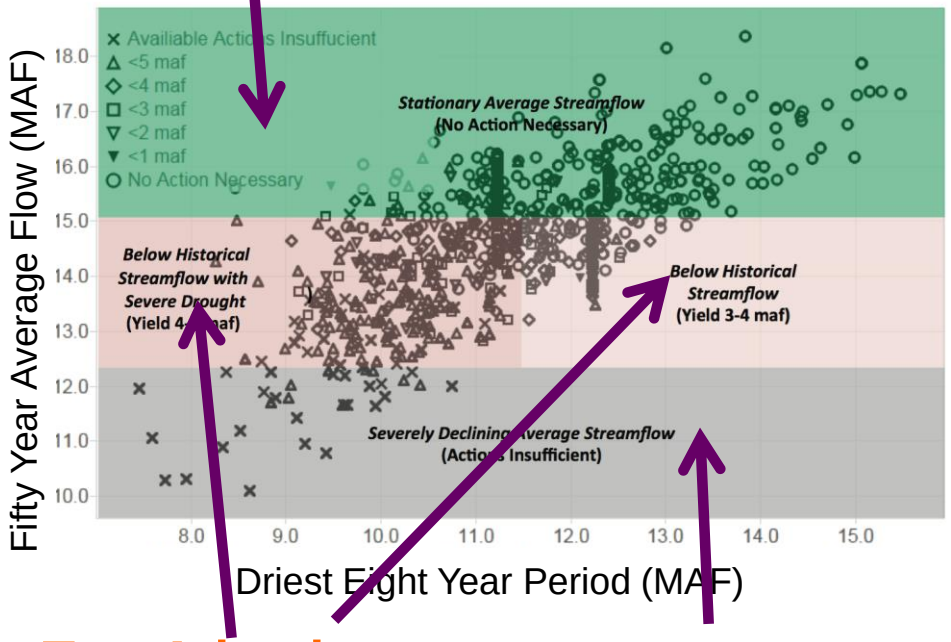
24,000 Plausible Futures

Basin Simulation Model

Database of cases

Four policy-relevant scenarios emerge from analysis

Business as Usual



Two Adaptive

Transformative

Two key drivers of vulnerability for current river management plan:

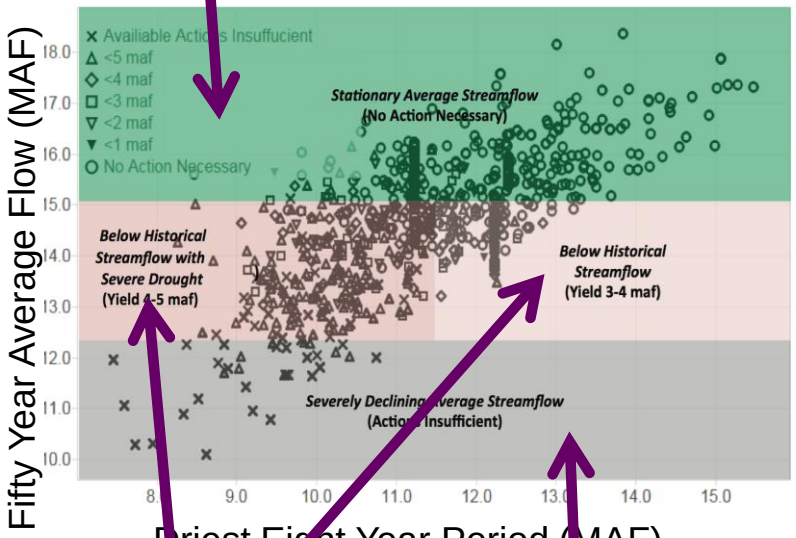
- Fifty year average river flow
- Driest eight year period

Bloom, E. (2015). Changing Midstream: Providing Decision Support for Adaptive Strategies Using Robust Decision Making, RAND: RGSD-348

Robust Responses to These Vulnerabilities Follow Adaptive Pathways

Vulnerability analysis for Colorado Basin generates four scenarios

Business as Usual



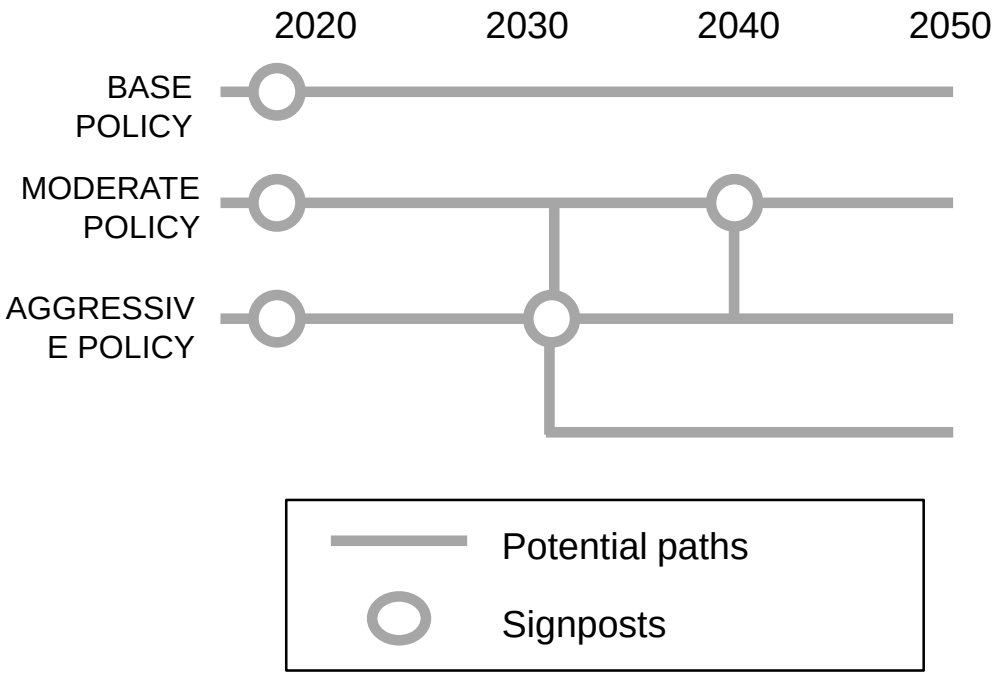
Two Adaptive

Transformative

Bloom (2015)

Adaptive Pathways Map describes potential paths through these scenarios

- Initial actions
- Signposts
- Contingent actions



Haasnoot, M., et. al. (2013)

Robust Responses to These Vulnerabilities Follow Adaptive Pathways

Vulnerability analysis for Colorado Basin generates four scenarios

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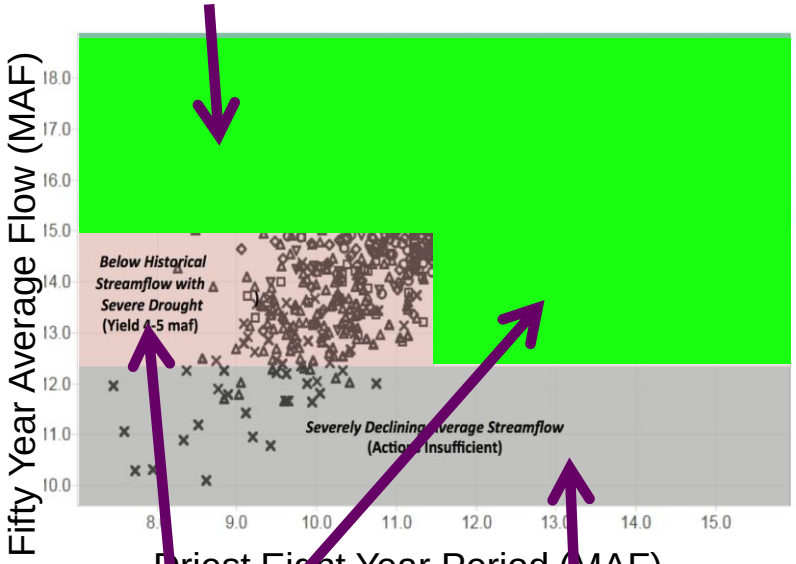
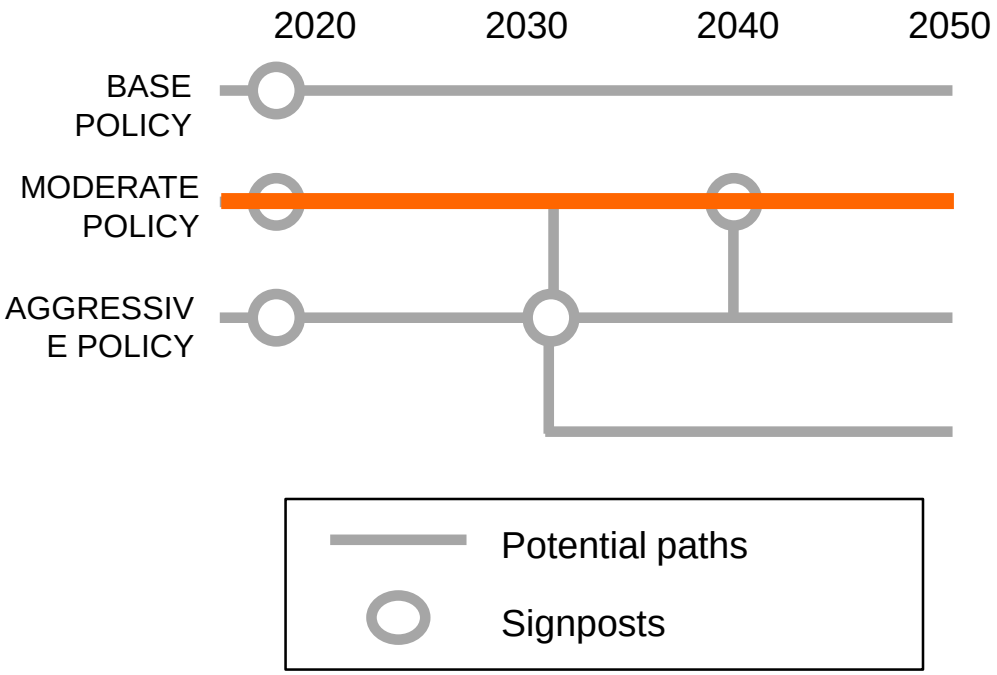


Two Adaptive

Transformative

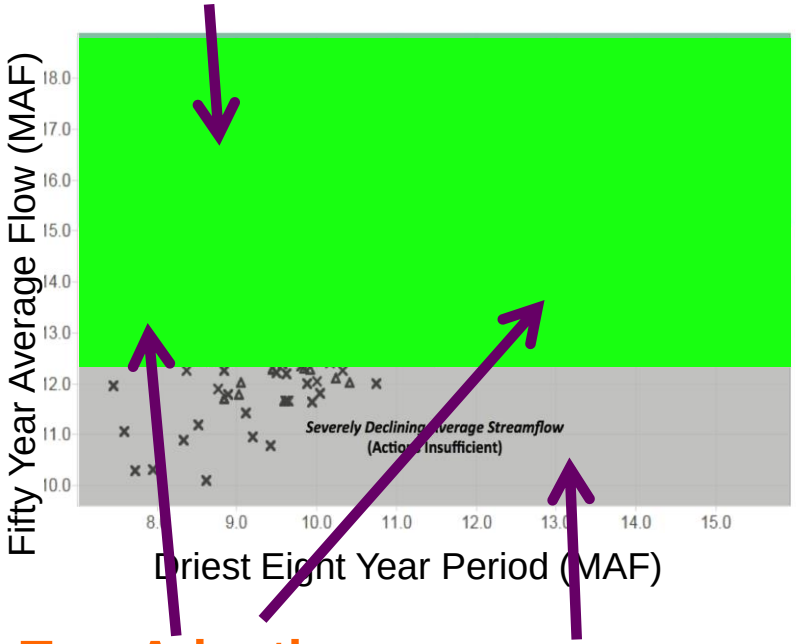


Pathway A succeeds in two scenarios

Robust Responses to These Vulnerabilities Follow Adaptive Pathways

Vulnerability analysis for Colorado Basin generates four scenarios

Business as Usual



Two Adaptive

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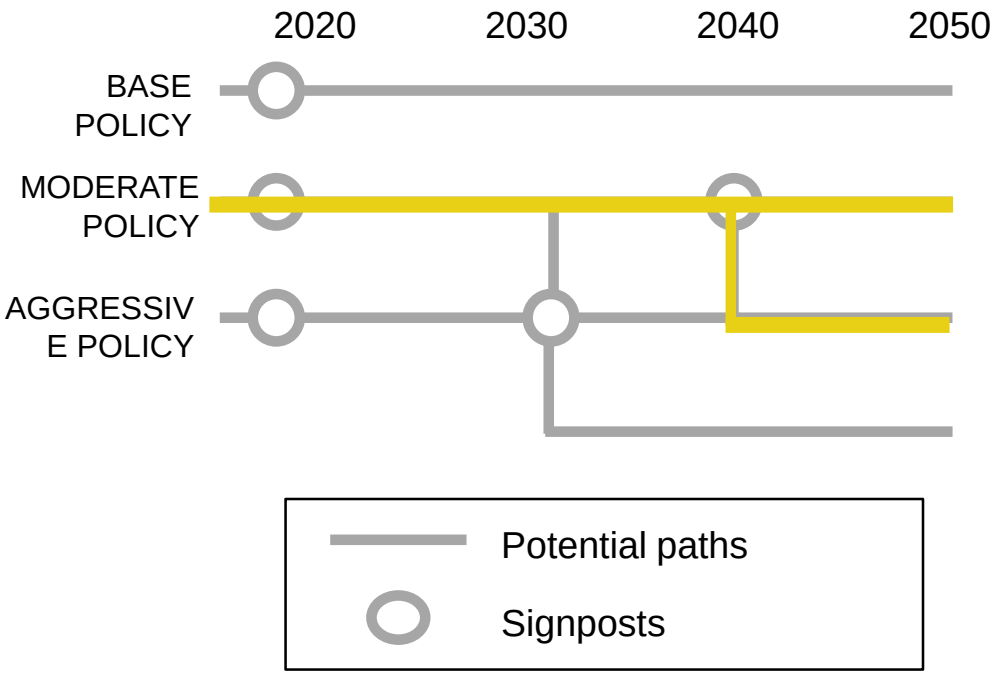
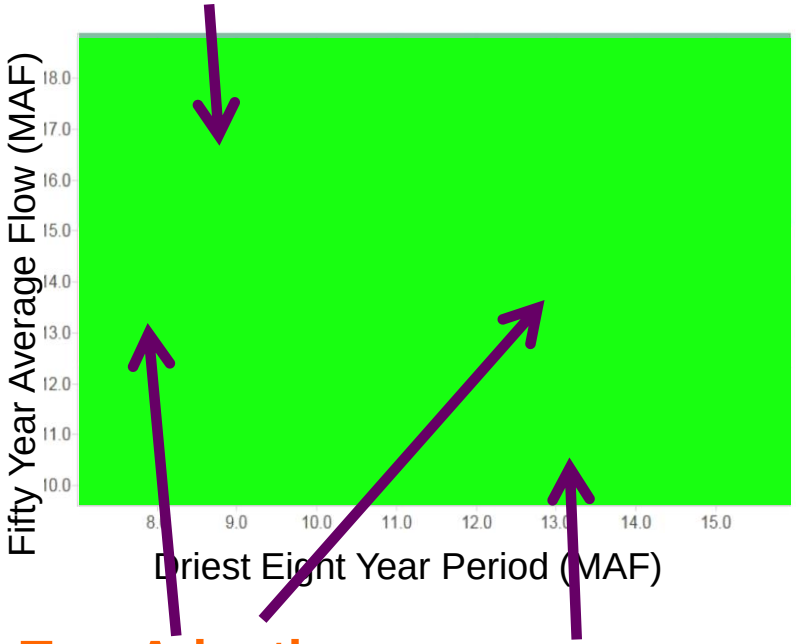


Pathway B succeeds in three scenarios, but costs more

Robust Responses to These Vulnerabilities Follow Adaptive Pathways

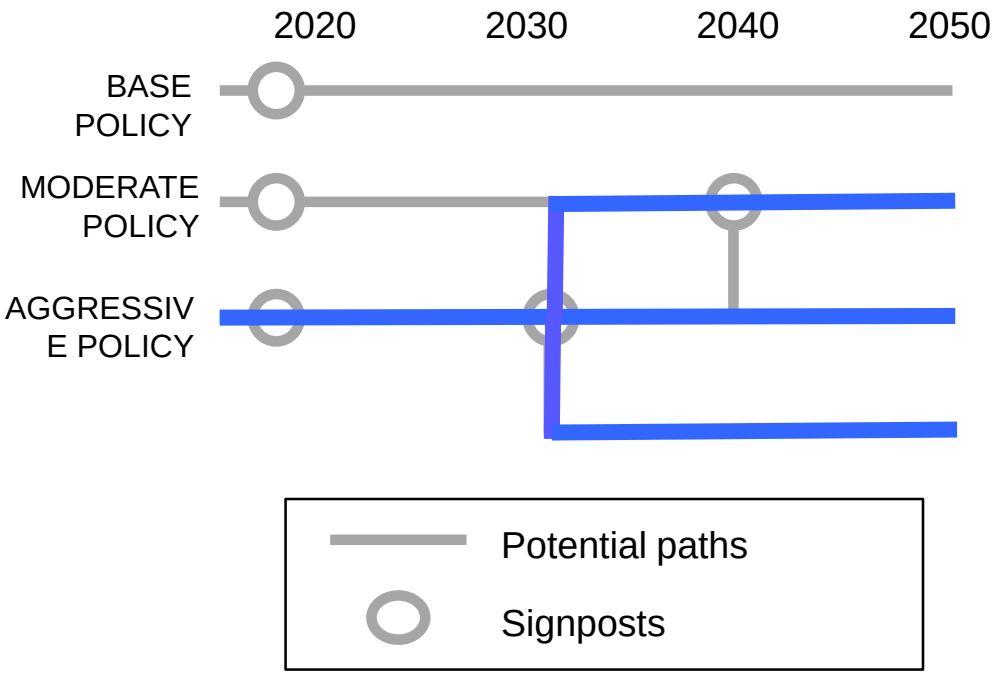
Vulnerability analysis for Colorado Basin generates four scenarios

Business as Usual



Two Adaptive

Transformative

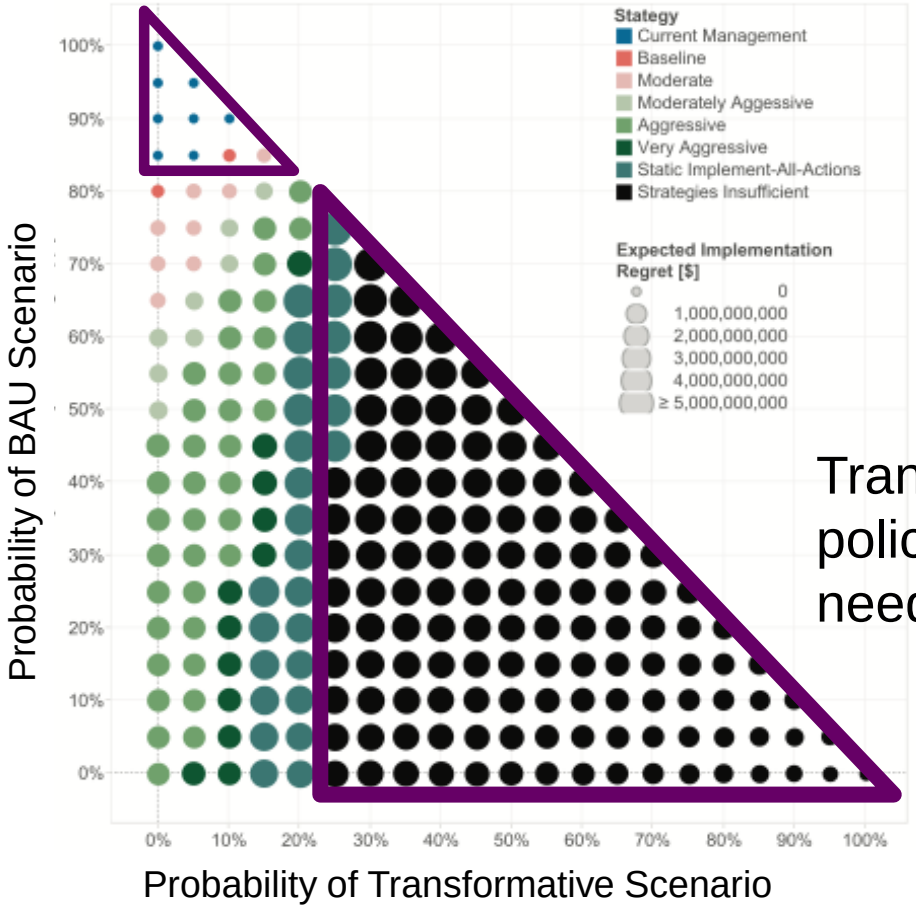


Pathway C succeeds in all scenarios, but costs the most

Analysis Identify Probability Thresholds That Suggest Alternative Strategies

Map shows probabilistic expectations about the future that favor alternative strategies

Management best here



Transformative policies may be needed here

Outline

Scenarios emergent

Robust and flexible plans

Engaging with these ideas

These Methods for Decision Making Under Deep Uncertainty Have Been Increasingly Employed

RAND and non-RAND engagements

THE SOCIETY FOR Decision Making under Deep Uncertainty

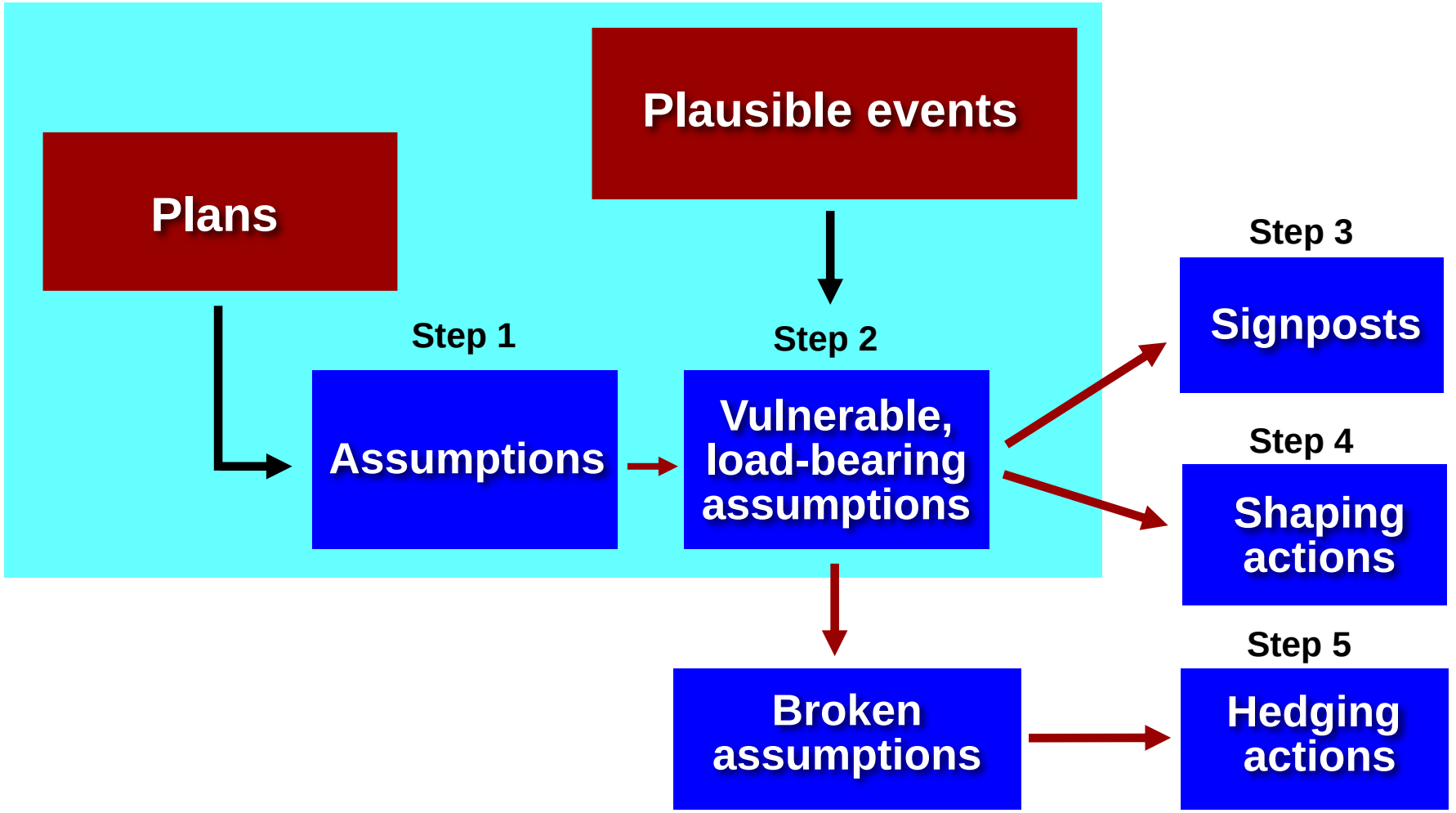
www.deepuncertainty.org

See:

- **RAND Water and Climate Resilience Center—www.rand.org/water**

Can Also Implement These Ideas Qualitatively

Assumption Based Planning offers one such qualitative process



Dewar, J. A. (2002). Assumption-Based Planning - A Tool for Reducing Avoidable Surprises. Cambridge

Scenarios and the Future Interstate Highway System

Ensuring the future of the US highway system may require:

- Embracing deep uncertainties facing transportation
- Robust and flexible plans
- Scenarios that emerge from analysis to help identify such plans

Quantitative and qualitative approaches exist to develop such scenarios and plans

Encourage policymakers to change the question from

"What will the future bring?"

to

"What steps can we take today to most assuredly shape the future to our liking?"

Lempert, Popper, and Bankes (2003). Shaping the Next One Hundred Years : New Methods for Quantitative, Long-term Policy Analysis. RAND MR-1626

More Information

http://www.rand.org/pardee/

http://www.rand.org/methods/rdmlab.html

www.deepuncertainty.org

Thank you!