

## Scenarios Emergent!

New Analytic Methods to Help Choose Scenarios Under Conditions of Deep Uncertainty

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> Best Practices in Scenario Development and Usage: Present and Future Sept 6, 2017

1

#### Scenarios Can Usefully Inform Decisions Under Conditions of Deep Uncertainty

Deep uncertainty 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

One example of deep uncertainty – the next fifty years of evolution in energy and transportation systems



Energy and transportation systems changed more in the first half of the 20<sup>th</sup> century than in last fifty years

What changes will the next fifty years bring?

#### Scenarios Can Usefully Inform Decisions Under Conditions of Deep Uncertainty

Deep uncertainty 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

Scenarios can help:

Reduce overconfidence





Expand the range of futures and decision options considered

Scenarios are often chosen, using expert judgment, as inputs to discussions and analysis

# Computer-assisted decision aids can improve choice of scenarios

- Expert-driven scenario approaches can fall short due to:
  - Ambiguity, bias, and inconsistencies
  - Illusion of communication
  - Scenarios disconnected from decisions
  - Surprise
  - Failure to choose the best small set of decision-relevant scenarios





• Which can often be corrected with decision aids

Decision aids can help scenarios *emerge* from analysis, not be assembled as inputs to it



- Robust decision making (RDM)
- Scenario discovery

## Traditional Risk Management 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.

#### Robust Decision Making (RDM) Represents One "Backwards" Analysis Approach

RDM is an iterative analytic process, often used in engagements with stakeholders, designed to support decision making under deep uncertainty

Key idea -- conduct the analysis "backwards":

- Start with strategy
- Use analytics to identify scenarios where strategy fail to meet its goals
- Use these scenarios to identify and evaluate responses



#### Policy-Relevant Scenarios Emerge from RDM Analyses



## Scenario Discovery Identifies Factors That Best Differentiate Futures in Which Policies Meet and Miss

Run model to stress test proposed policy over many plausible futures

Generate large, multidimensional database

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

> Display as policyrelevant scenarios



#### Scenario Discovery Links Quantitative Analysis and Human Insight

#### **Summary of Alternative Clusters**



Scenario Discovery algorithms interact with user by reporting many alternative clusters, each with an alternative mix of:

- Coverage
- Density
- Interpretability

#### Bryant & Lempert (2010)

### Scenario Discovery Links Quantitative Analysis and Human Insight



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#### Bureau of Reclamation Used RDM to Help Address Colorado Basin Supply and Demand Imbalance

In 2012 Study,\* parties to Colorado Compact considered:

- Vulnerabilities of the system and the key factors creating those vulnerabilities
- Potential responses to those vulnerabilities



\* Results here from Bloom, E. (2015). <u>Changing Midstream: Providing Decision</u> <u>Support for Adaptive Strategies Using Robust Decision Making</u>, RAND: 271.

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#### **Business as Usual**





Reclamation's river management models run over 24,000 futures:

- Climate projections
- Demand
- Political response to crisis conditions

Scenario maps identify key drivers of vulnerability

Clustered into scenarios describing different magnitude of response required

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#### Policy-Relevant Scenarios Emerged From This Analysis

Map shows expectations about the future that favor alternative strategies

Current Management Only best here



Transformative policies may be needed here

Probability of Transformative Scenario

#### When to use RDM and Scenario Discovery?



# In the Future, Analytics Increasingly Available to Help Choose Policy-Relevant Scenarios

- Scenario discovery
  - Choose scenarios that best differentiate futures in which proposed policies meet and miss their goals
- Scenario diversity
  - Choose a small set of maximally different scenarios
- Scenario consistency
  - Measure the internal consistency of scenario logics
- Scenarios on Demand
  - On-line tools that help implement these methods

See recent special issue of <u>Environmental</u> <u>Modeling and Software on new quantitative</u> methods for scenario development



## More Information

# Thank you!

http://www.rand.org/pardee

www.rand.org/methods/rdmlab

http://www.deepuncertainty.org





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### Experimental Evaluations Support the Utility of Such Scenario Methods

Experiment tested whether decision support should use scenarios or forecasts.

Participants given:

- Multiple-objective fishery management challenge with significant uncertainty and a large set of management options (some adaptive).
  - Only 25% of options near a Pareto surface and only 5% robust to worst cases.
- Decision support tool with Scenario or Forecast Condition

Participants in Scenario Condition:

- **Chose Robust Strategies More Often**
- Paid more attention to worse cases



Supported by:



Gong et. al. (2017). "Testing the Scenario Hypothesis: An Experimental Comparison of Scenarios and Forecasts for Decision Support Under Deep Uncertainty." Environmental Modeling and Software

#### What is a Robust Strategy?

*Expected* costs above least cost over many scenarios (%)



Ratio of costs of key inputs to Strategies C and B