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
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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 20th century than in the last fifty years

What changes will the next fifty years bring?
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 over-confidence
- Expand the range of futures and decision options considered

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

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

- Robust decision making (RDM)
- Scenario discovery
Traditional Risk Management Methods Work Well When Uncertainty is Limited

“Agree on Assumptions”

What will future conditions be?
What is the best near-term decision?
How sensitive is the decision to the conditions?

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”

“Agree on Assumptions”

What will future conditions be? → What is the best near-term decision? → How sensitive is the decision to the conditions?

“Agree on Decisions”

Proposed strategy → Identify vulnerabilities of this strategy → Develop strategy adaptations to reduce vulnerabilities

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

Diagram:

1) Decision Framing

2) Evaluate strategies in many futures

3) Vulnerability analysis

4) Tradeoff Analysis

5) New futures and strategies

Robust Strategies

Scenarios that Illuminate Vulnerabilities
Policy-Relevant Scenarios Emerge from RDM Analyses

1) Decision Framing
4) Tradeoff Analysis
5) New futures and strategies
2) Evaluate strategies in many futures
3) Vulnerability analysis

Robust Strategies

Scenarios that Illuminate Vulnerabilities
Scenario Discovery Identifies Factors That Best Differentiate Futures in Which Policies Meet and Miss Goals

Run model to stress test proposed policy over many plausible futures

Generate large, multi-dimensional database

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

Display as policy-relevant scenarios
Scenario Discovery algorithms interact with user by reporting many alternative clusters, each with an alternative mix of:

- Coverage
- Density
- Interpretability

**Summary of Alternative Clusters**

- Any number of parameters constrained
- 3 parameters constrained
- 2 parameters constrained
- 1 parameter constrained
Scenario Discovery Links
Quantitative Analysis and Human Insight

Summary of Alternative Clusters

Each clusters described by different combinations of driving forces
Policy makers and analysts can choose best clusters for their decision

McJeon et. al. (2011)
Scenario Discovery Links
Quantitative Analysis and Human Insight

Summary of Alternative Clusters

Parameters describing clusters represent key driving forces for vulnerable scenarios.
In 2012 Study,* parties to Colorado Compact considered:

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

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

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- Vulnerabilities of the system and the key factors creating those vulnerabilities
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**Business as Usual**

**The Challenge**

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

Bloom (2014)
When to use RDM and Scenario Discovery?

Uncertainty vs. Complexity

Hedging opportunities

RDM & Scenario Discovery

Scenario planning

Agree on Assumptions approach

Well-characterized

High

Low

Deep

Many

Few
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 Environmental Modeling and Software on new quantitative methods for scenario development
Thank you!

http://www.rand.org/pardee

www.rand.org/methods/rdmlab

http://www.deepuncertainty.org
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

Supported by:

What is a Robust Strategy?

Expected costs above least cost over many scenarios (%)

- Strategy C
- Strategy A
- Combine Strategies B & C
- Strategy B

Ratio of costs of key inputs to Strategies C and B

Popper et. al (2009)