Decision-Making Under Uncertainty in the FEW System

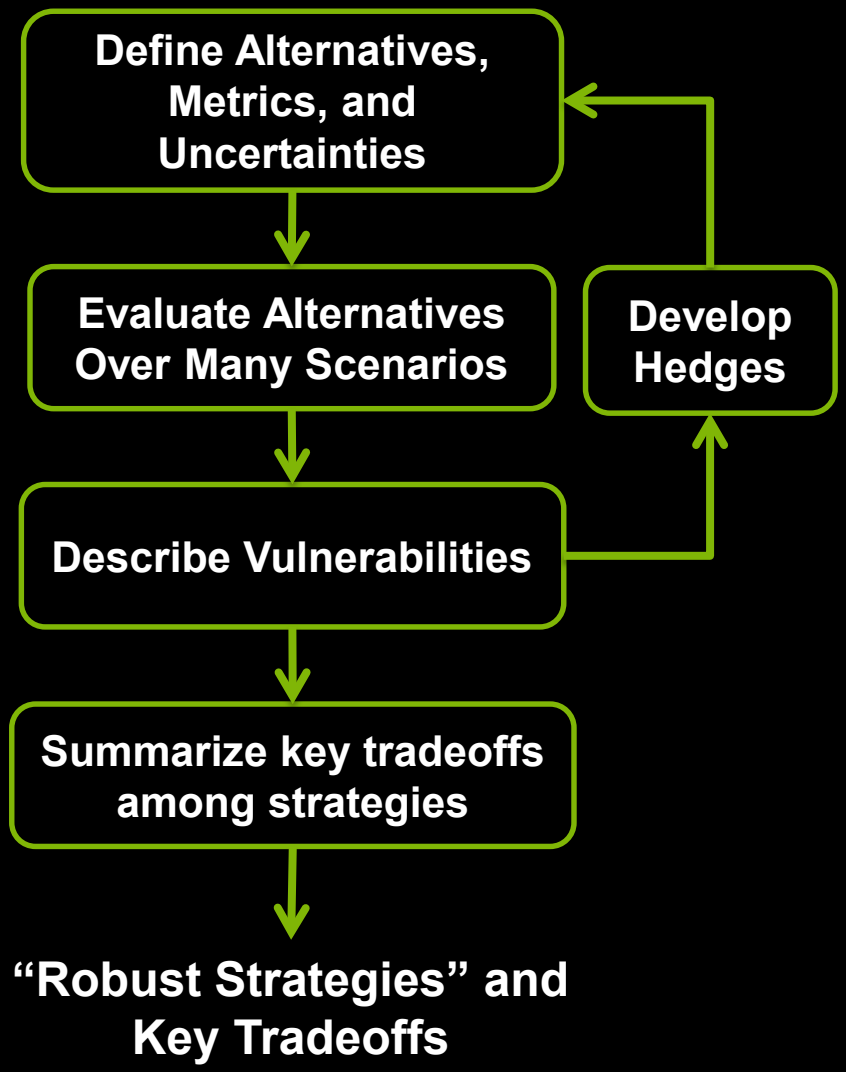
Presentation by David Johnson

In Decision-Making Under Uncertainty, We Talk a Lot About Robustness

- **Robustness – the insensitivity of system design to errors, random or otherwise, in the estimates of those parameters affecting design choice**
  (Matalas and Fiering, 1977)

- **Decision makers balance expected performance against robustness to uncertainty all the time**
  - **Decision-making under deep uncertainty (DMDU) attempts to systematize this process that typically is done intuitively**

Some DMDU Processes "Run the Analysis Backwards" to Stress-Test Policies



- Robust Decision Making (RDM)
  - Identifies key vulnerabilities
  - Tests strategies to address risks
  - Yields "robust strategies" and the information to choose among them
- Does not require agreement on likelihoods of future states of the world
- Supports substantial stakeholder and decision-maker participation
- Characterizes uncertainty, and the tradeoffs among alternative policy choices, in ways that
  - Decision makers find credible
  - Contribute usefully to contentious debates

Our Initial Analyses Will Be Policy-Driven, Focusing on Single Levers

- **Focus on identifying key tradeoffs, then look for ways to mitigate negative externalities without giving up too much performance on a primary objective**

- **Emphasize policy relevance**
  - **Example: analysis of wetland restoration**

Backup Slides After This

An "XLRM" Chart Defines Our Scope and Helps to Structure the Problem

- **X – eXogenous uncertainties – the uncertainties beyond our control that act on the system**
- **L – policy Levers – the set of actions that, in various combinations, describe the strategies decision makers can implement to affect the system**
- **R – Relationships – the simulation models and other computational tools used to evaluate system performance under different strategies and uncertainty scenarios**
- **M – Measures – the metrics used to assess the quality of a particular model outcome**

What Would Our XLRM Chart Look Like?

(X) Uncertainties

- Environmental
  - Climate conditions
- Demographic, economic, technological
  - Population
  - Income
  - Biofuels demand
- Operational (e.g., reservoirs)
- Effectiveness of policies
- Model uncertainties

LEVERS			GHGs	
Hydrological infrastructure	+	+	–	?
Artificial recharge of aquifers	+	?	–	?
Irrigation efficiency	+	+	?	?
Groundwater restrictions	+	–	?	?
R&D in ag productivity	+	–	?	?
Irrigation expansion	–	+	?	?
Bioenergy production	–	–	+	–
Carbon pricing	?	–	+	–
Nitrogen leaching charge	?	–	+	+
Tile/controlled drainage	?	–	?	+
Increased nitrogen efficiency	?	+	+	+
Wetland restoration	+	–	–	+
Non-ag nitrogen removal	?	–	?	+
Conservation rotation	?	–	+	+

(R) Relationships

- Agro-IBIS
- Envisage
- SIMPLE-G (US, CS, etc.)
- WBM
- GCMs (RCPs and SSPs)

(M) Measures

- Crop outcomes
  - Demand, price, land use
- Water scarcity/sustainability
- N usage, leaching, runoff