URBDP 498/598 ENVIRONMENTAL PLANNING

Lecture 5: Assessment of Resilience: Theories and Models

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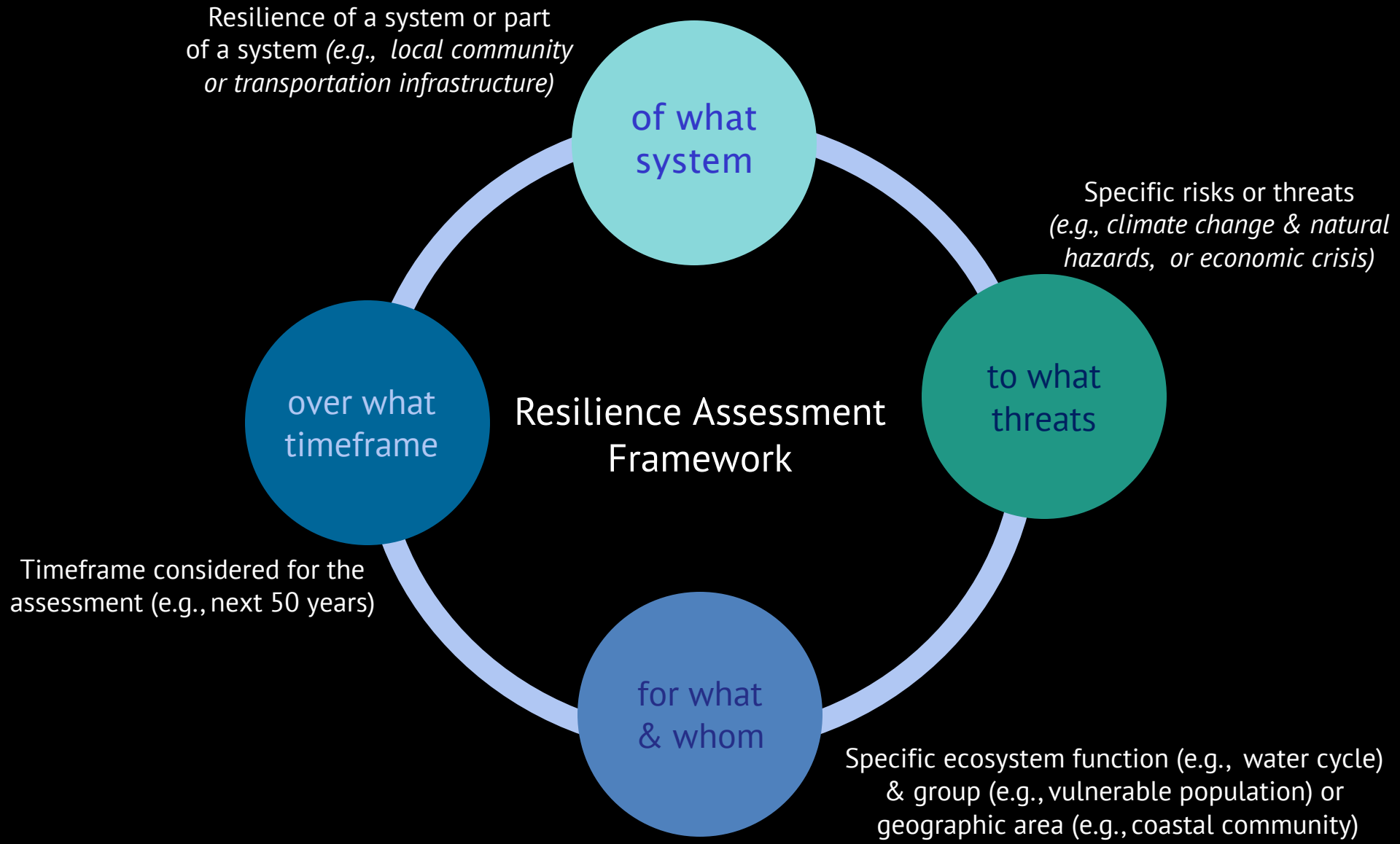
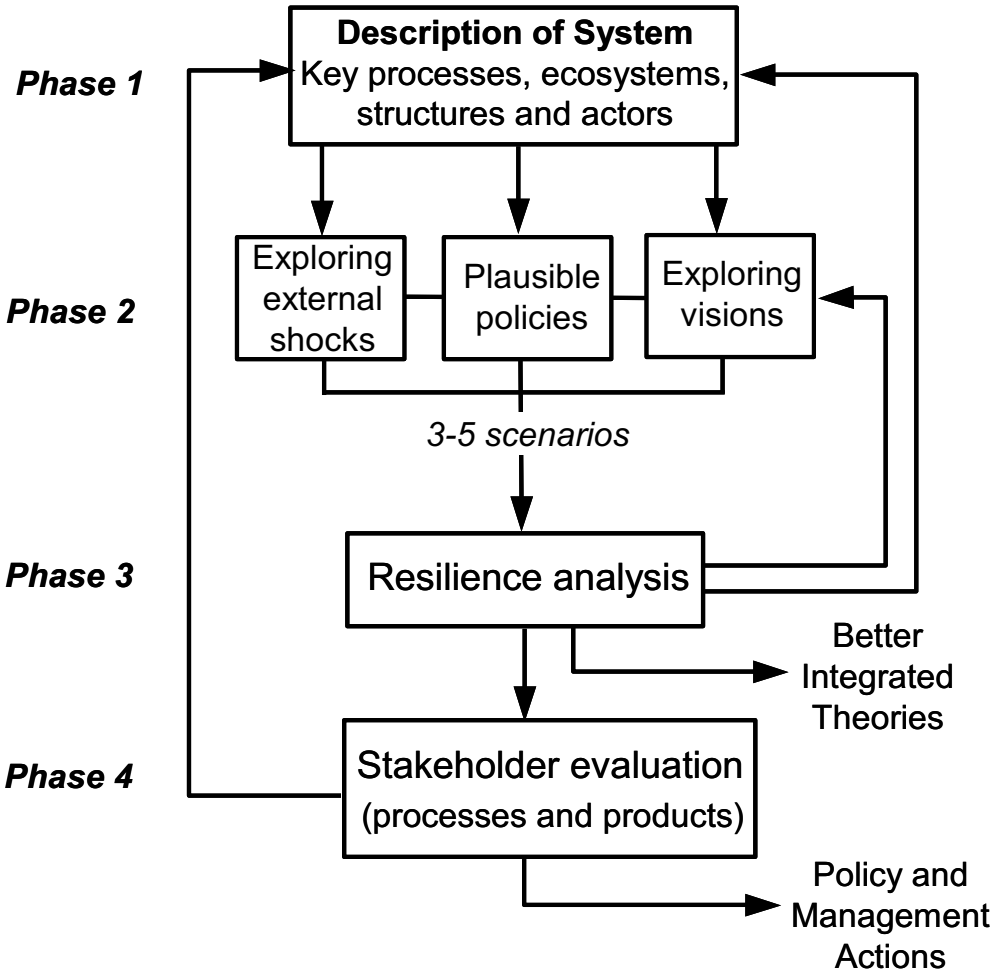

Resilience of a system or part of a system (e.g., local community or transportation infrastructure)
of what system
Specific risks or threats (e.g., climate change & natural hazards, or economic crisis)
to what threats
over what timeframe
Resilience Assessment Framework
Timeframe considered for the assessment (e.g., next 50 years)
for what & whom
Specific ecosystem function (e.g., water cycle) & group (e.g., vulnerable population) or geographic area (e.g., coastal community)

Resilience Analysis



Phase 1

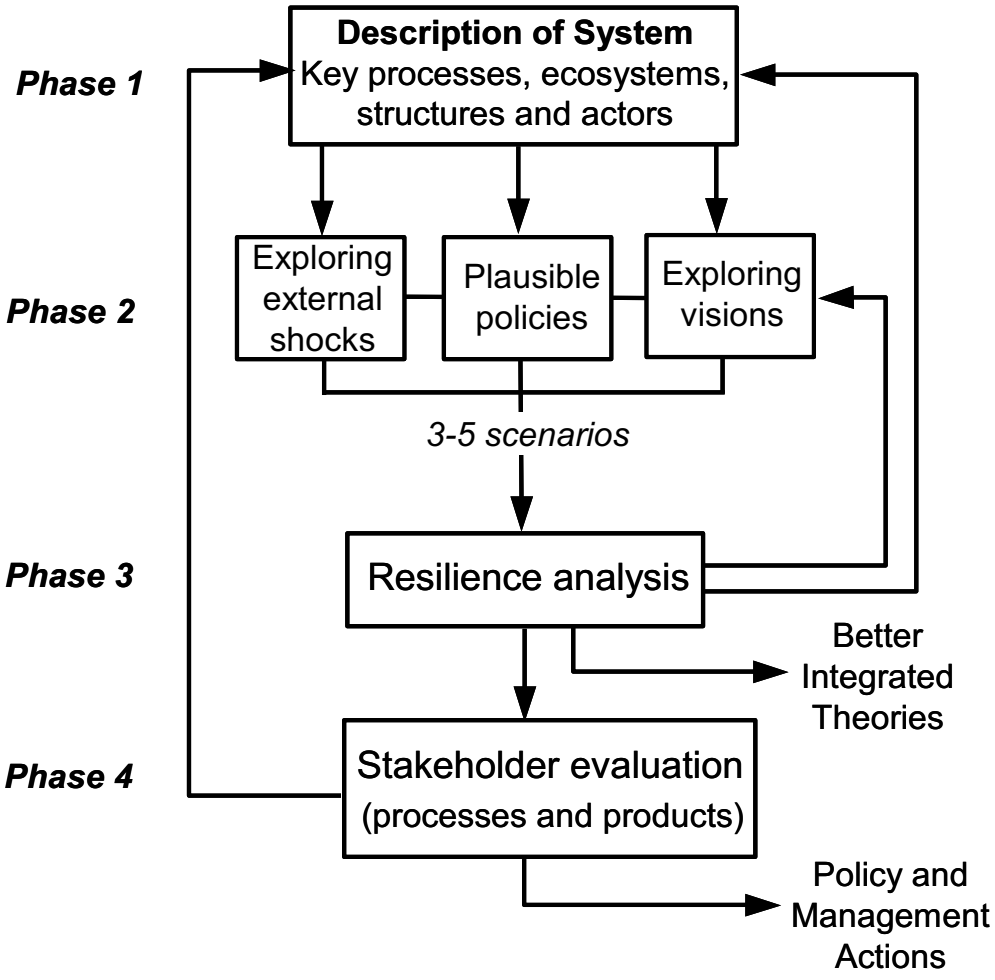
- Conceptual models of system
- Historical development
- Processes affecting delivery/maintenance of key ecosystem goods and services

Phase 2

- Disturbances and adaptive cycle
- Visions -> scenarios

Walker et al. 2002

Resilience Analysis



Phase 3

- Iterative: how will system respond under various scenarios
- Explorations with simple models of underlying dynamics, non-linearities, thresholds
- Adaptive capacity – foresight – behavioural feedbacks

Phase 4

- Evaluation and Policy Development

Walker et al. 2002

Step 1. Resilience of what?

- What are the boundaries of the socio-ecological system (SES)?
- What are the key ecosystem services of concern to people in the SES? What do they value?
- Who are the stakeholders?
- What are the key components of the SES, what are the spatial and time scales over which they operate? And to what extent are their dynamics endogenous vs. influenced by exchange across the boundaries of the SES?
- What is the historical profile of the system? How did it get to be what it is now—what changes occurred through its history in terms of ecosystem, technology, society, and economy?

Step 2. Resilience to what? Visions and scenarios

Step 2 examines the external disturbances and the development processes (policy drivers and stakeholder actions) to which the desirable configurations are expected to be resilient.

Its aim is to develop a limited set of possible future scenarios that includes the outcome of uncontrollable and ambiguous external drivers.

We define a scenario as a plausible exploration of the future, to be used in combination with other scenarios to explore the robustness of diverse models and choices.

Step 3. Resilience analysis

Step 3 consists of exploring the interactions of these two sets through a combination of modeling and non-modeling methods.

The aim is to identify possible driving variables and processes in the system that govern the dynamics of those variables stakeholders deem to be important (the ecosystem goods and services), looking especially for threshold effects and other non-linearities.

The process of discovery is necessarily iterative and begins with discussions among stakeholders, policy makers, other local experts, and scientists aimed at examining how the system will respond and change under the various scenarios so as to identify possible groups of interacting variables where non-linearities are likely.

Step 4. Resilience management

The final step involves a stakeholder evaluation of the whole process and the implications of the emerging understanding for policy and management actions.

Resilience analysis identifies the processes that determine critical levels of the system's important control variables.

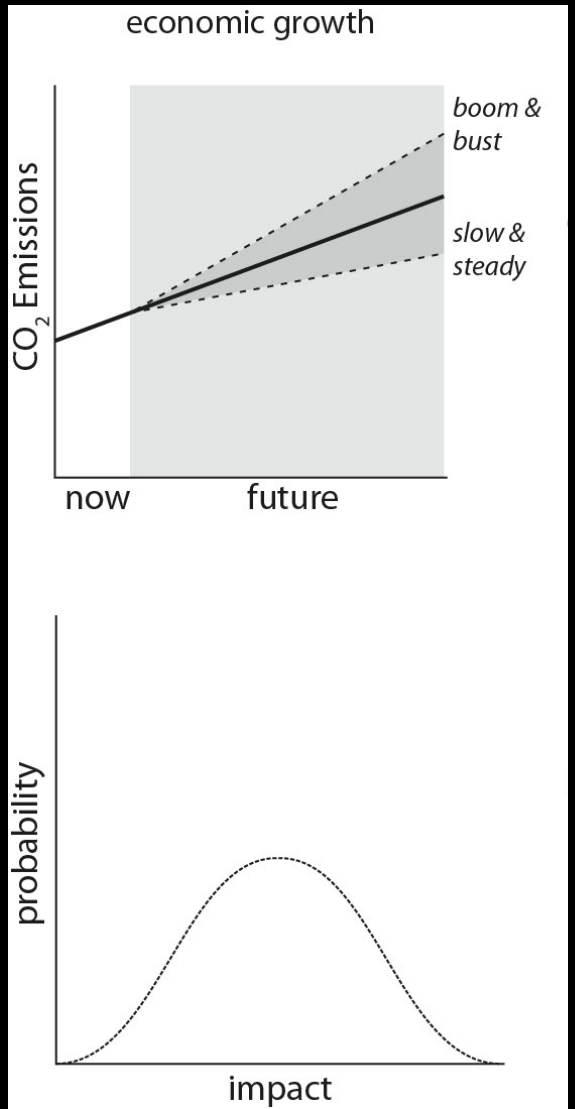
This set of processes leads to a corresponding set of actions that can enhance or reduce resilience and that, therefore, form the basis for resilience management and policy.

The policies are aimed at a set of rules (incentives and disincentives) that enhance the system's ability to reorganize and move within some configuration of acceptable states, without knowing which particular path the system might follow

Models and Scenarios

Predictive Models under Uncertainty

Single Driver



Predictive Models under Uncertainty

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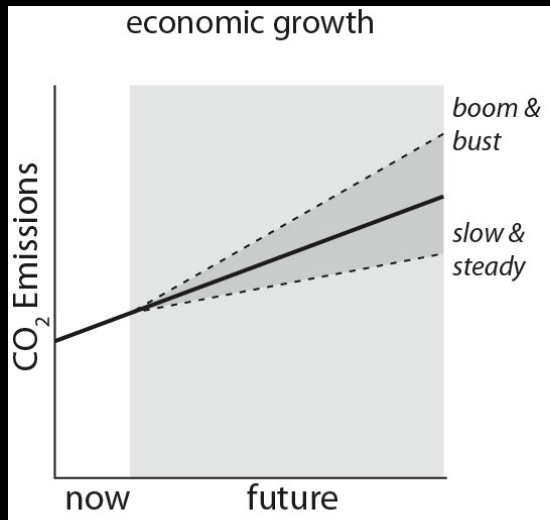
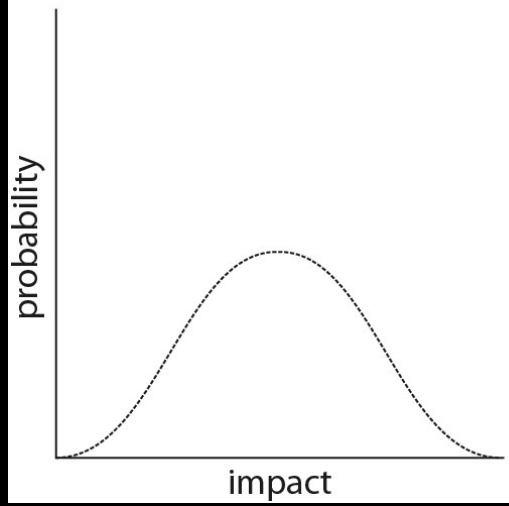
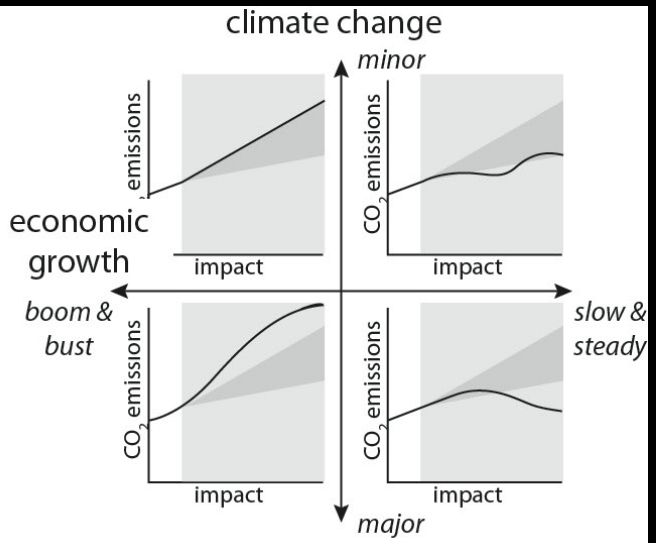
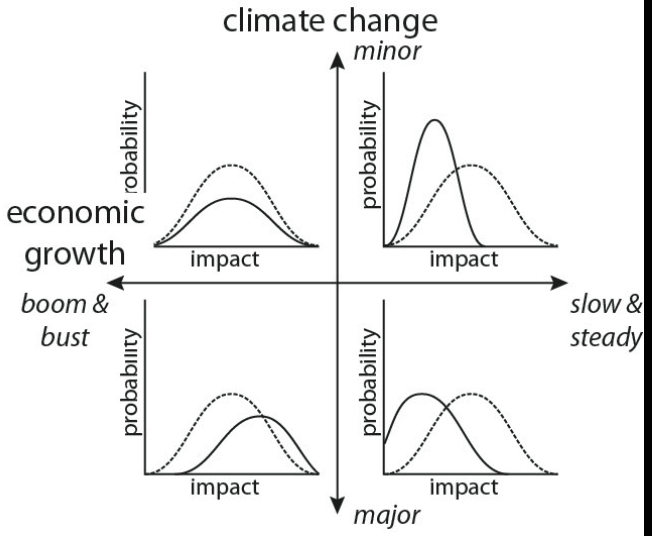




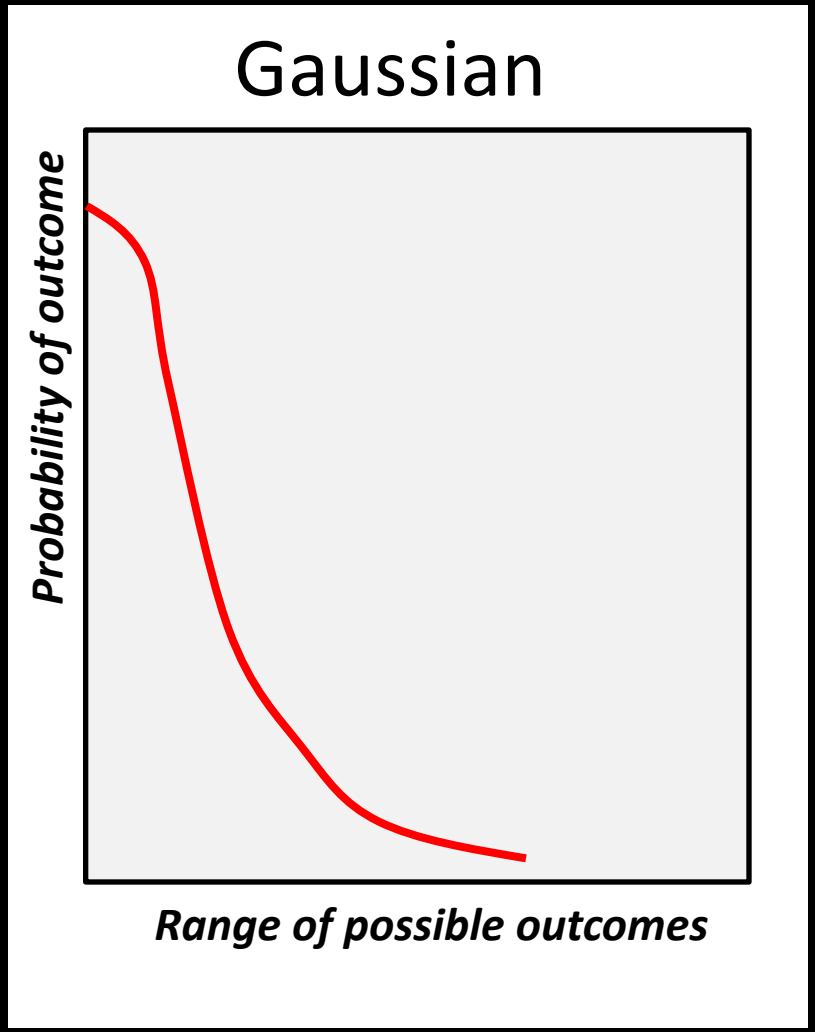
Multiple Drivers





Low Probability High Impact

Scenarios explore the interactions among significant uncertain drivers

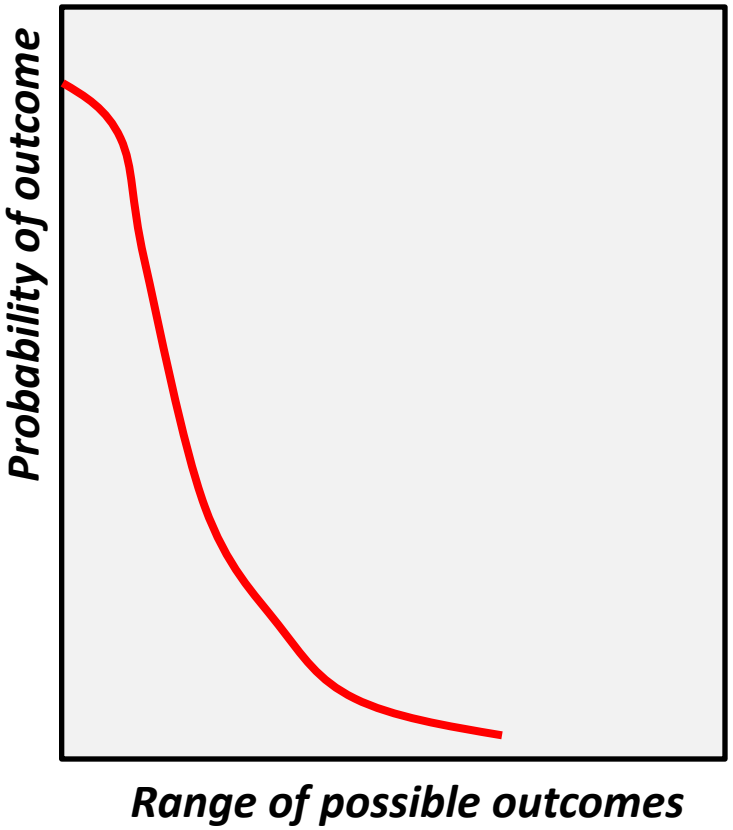


Snowden 2010

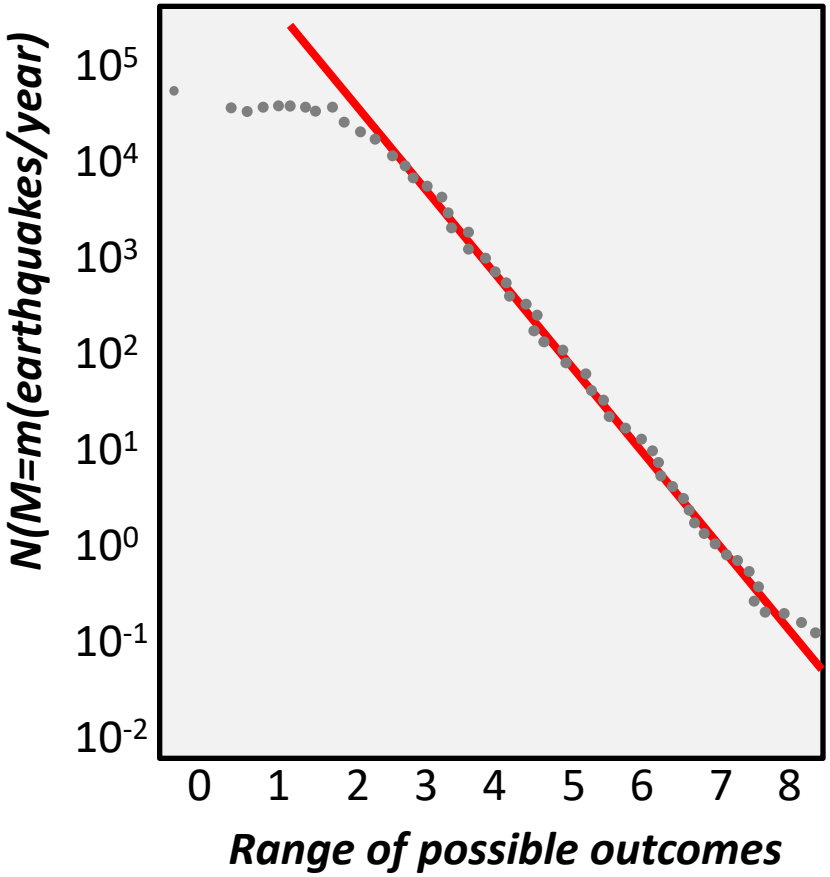
Low Probability High Impact

Scenarios explore the interactions among significant uncertain drivers

Gaussian



Pareto



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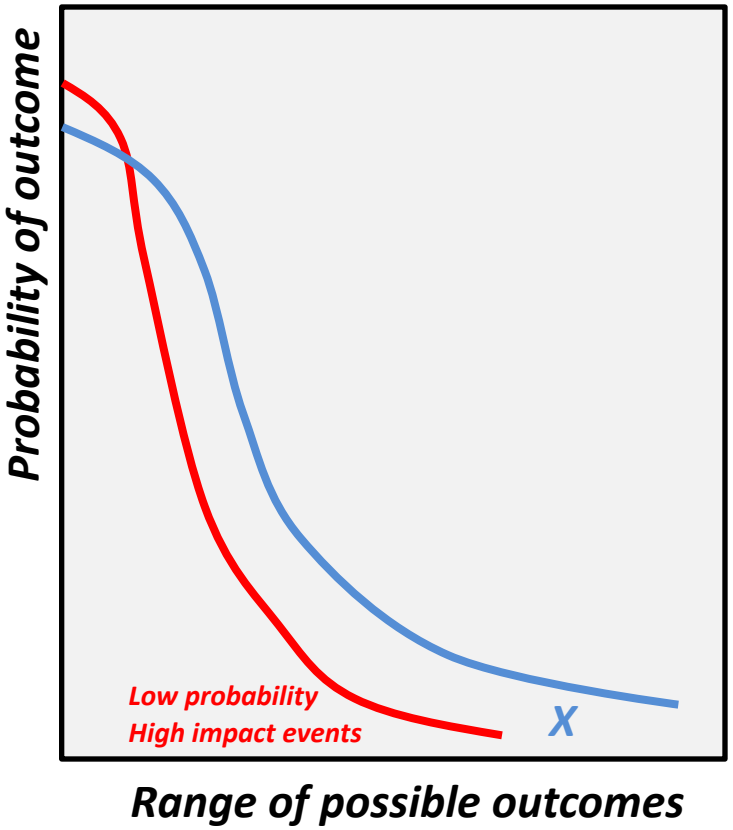
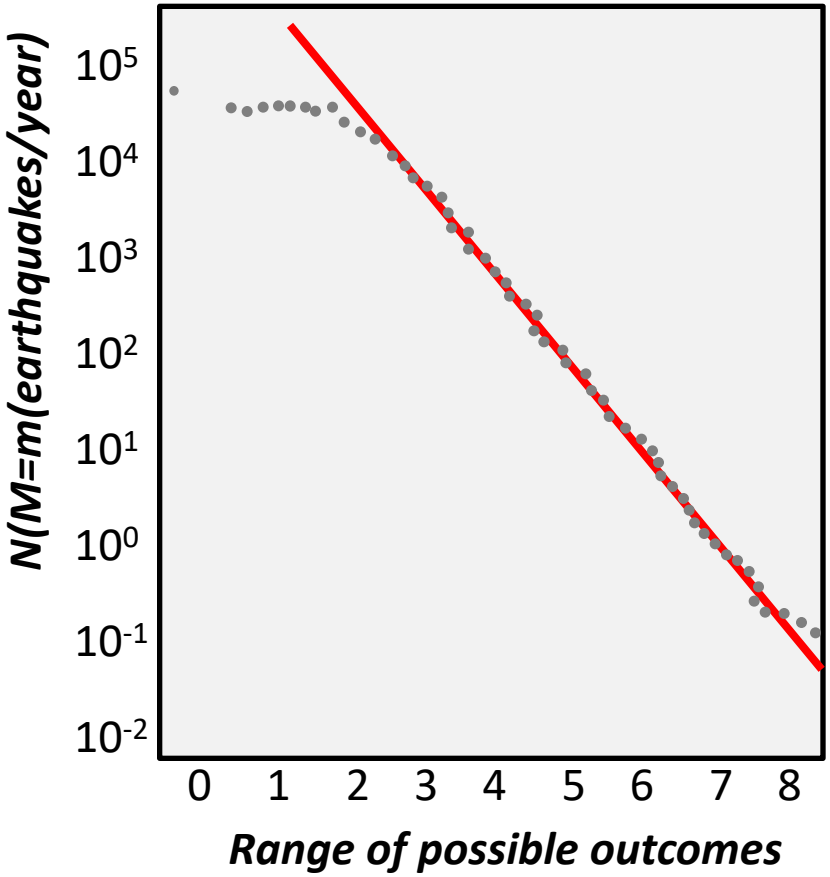


Pareto



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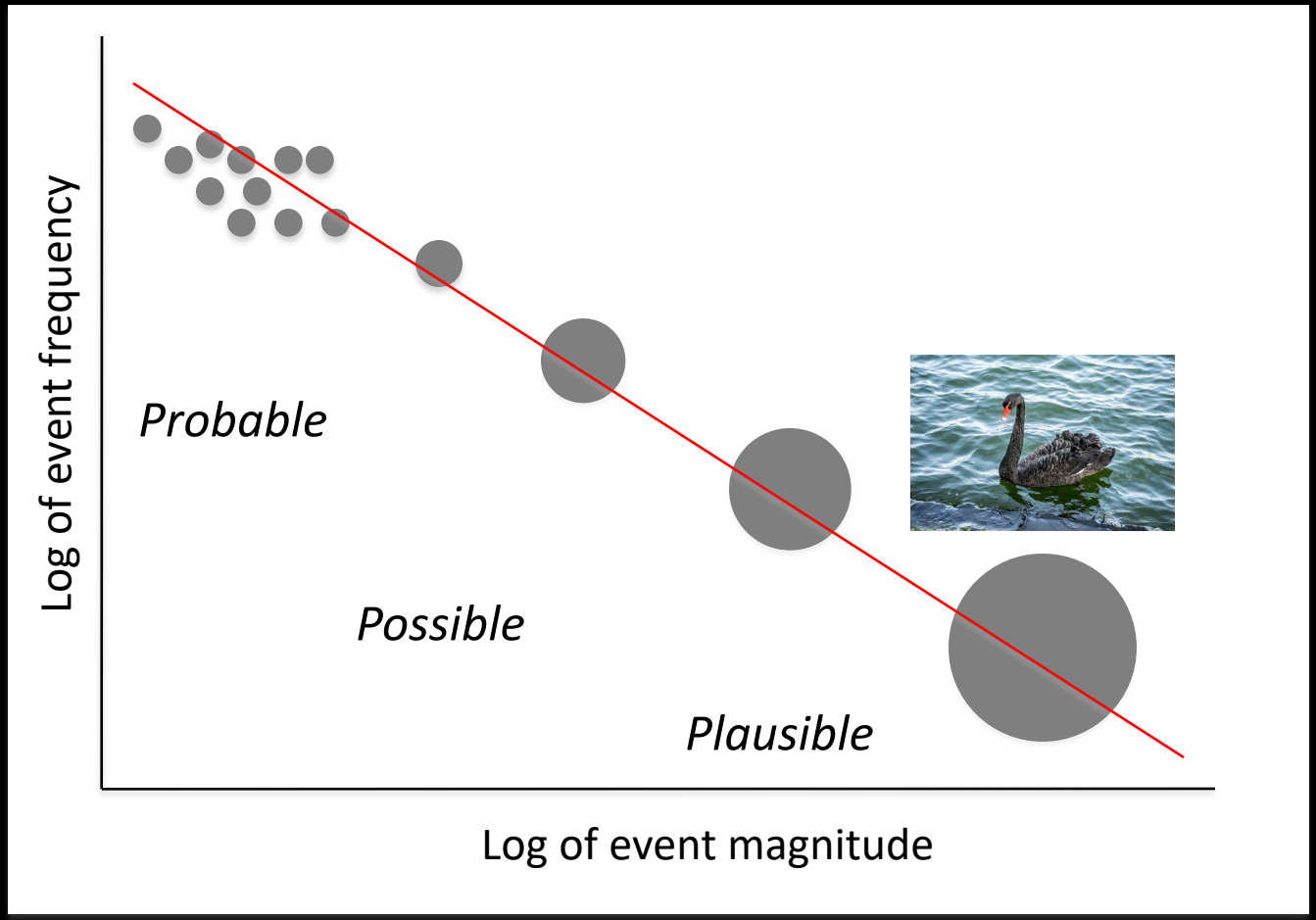

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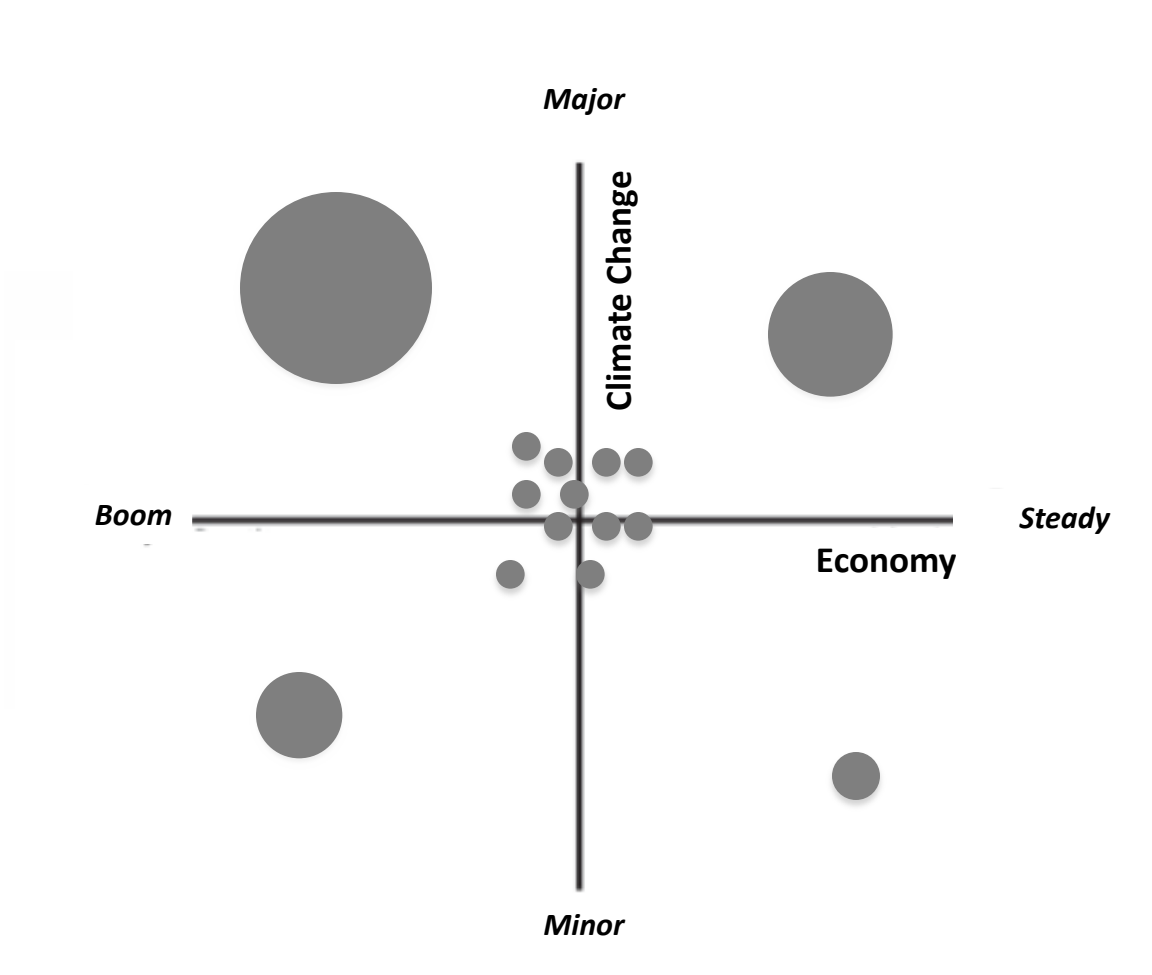
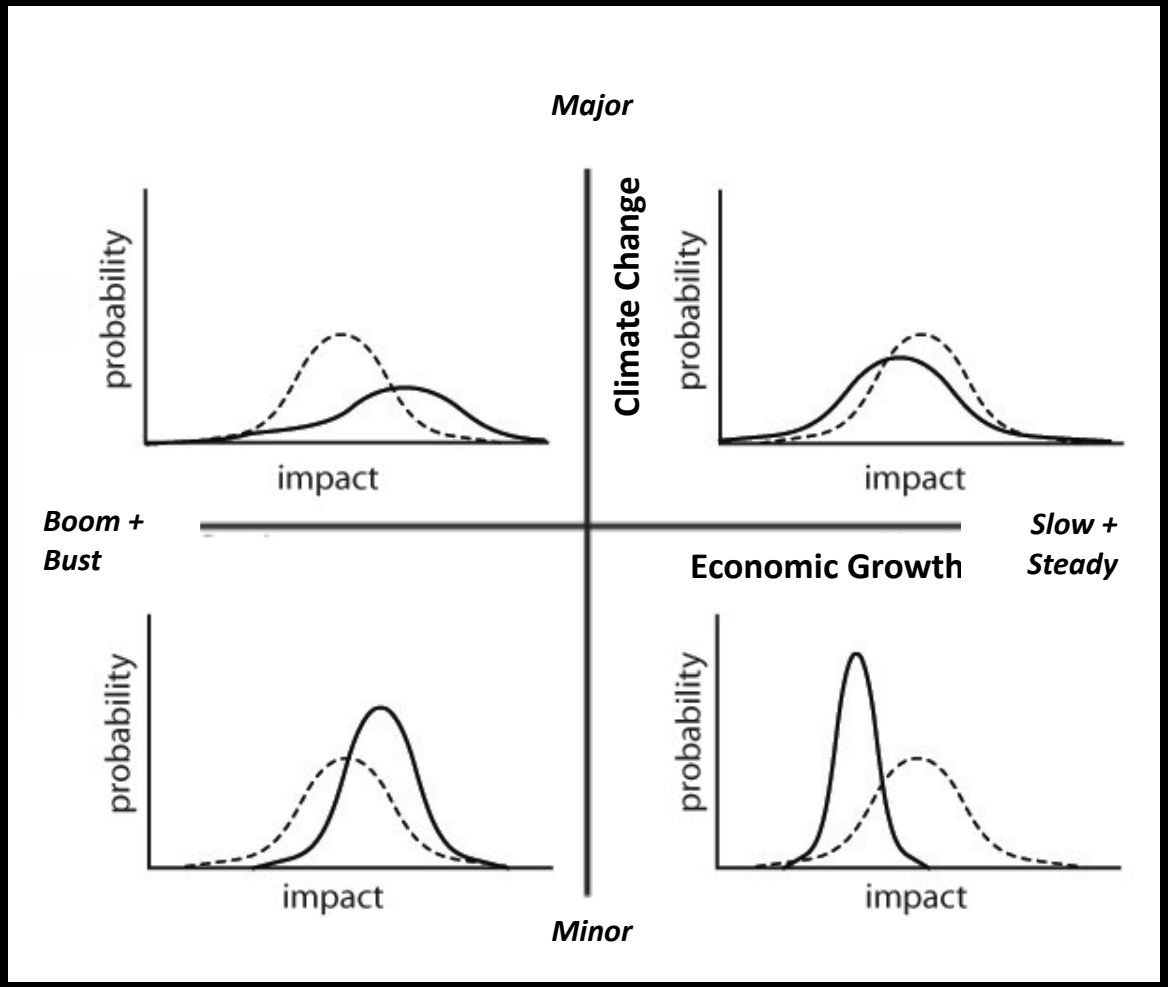


Potential Shifts in Distributions of Impacts



HOW CAN MODELS SUPPORT SCENARIO PLANNING?

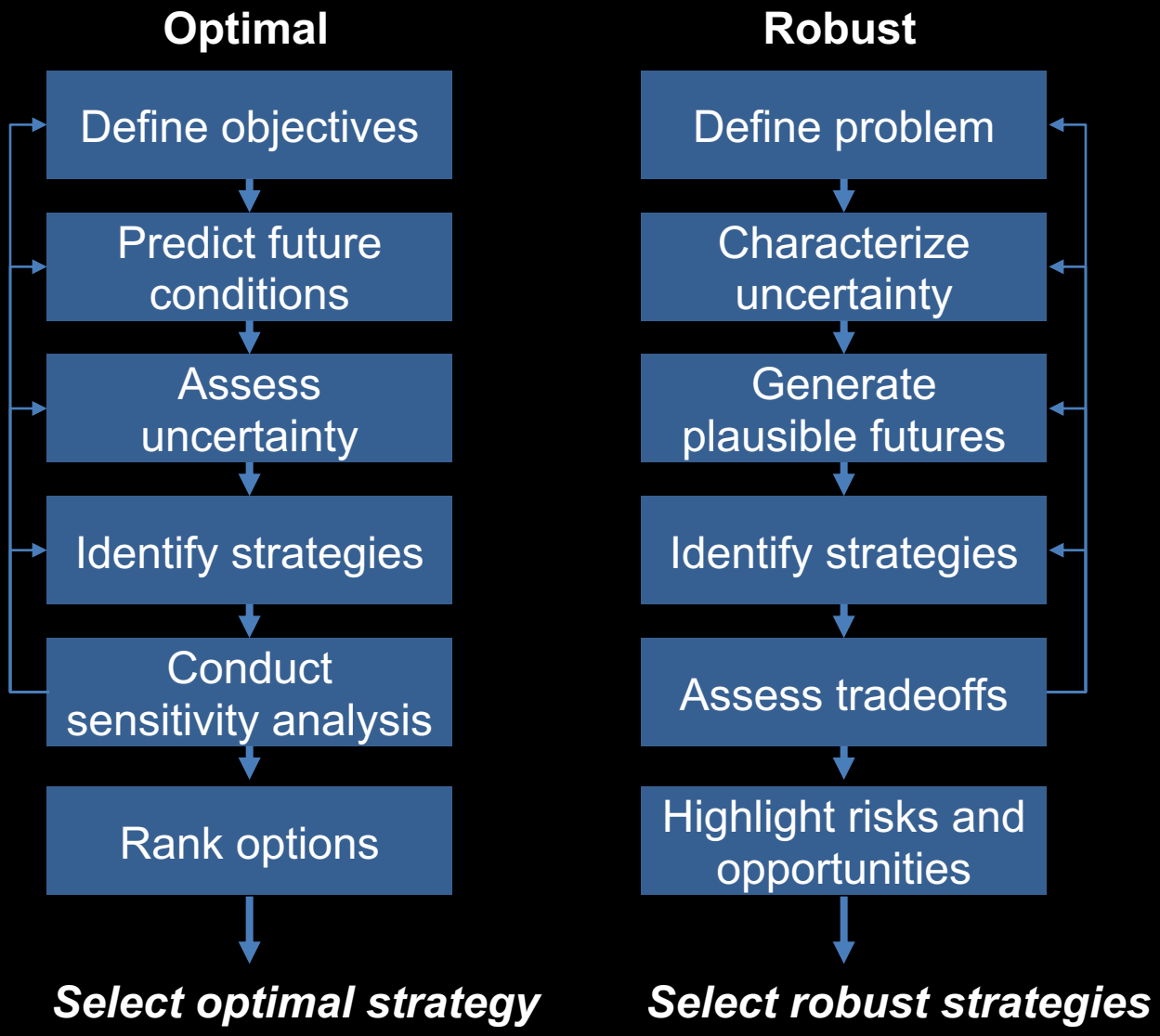
Why multiple scenarios

- Strategies aimed to maintain ecosystem services over the long term require looking beyond current baseline conditions.
- Scenarios highlight potential threats and opportunities that can emerge from interactions among uncertain driving forces
- Alternative scenarios challenge our assumptions about how the future can play out to help identify plausible futures
- *'the objective of good scenarios is better decisions not better predictions' (Dearlove 2002)*

How do scenarios help make better decisions

- Characterize **uncertainties** of future conditions
- Identify **sensitivity** of strategies to uncertainties
- Seek **robust** rather than optimal policies: Select robust strategies (performance is insensitive to uncertainties)
- Facilitate developing adaptive plans and strategies by highlighting warning conditions of failure scenarios
- Provide algorithms for inference that can complement models with incomplete data

Decisions under uncertainty



Scenarios and Models

- Scenarios
  - Define alternative, plausible, and most divergent futures
  - Characterize uncertain trajectories that affect ecosystem services over the long term
- Models
  - Use scenarios as hypotheses to expand boundary conditions
  - Predict impacts of alternative futures on ecosystem services

Potential Relationships

Models -> Scenarios

- Refine relationships among key variables
- Test hypothesized trajectories and interactions
- Assess potential impacts
- Identify potential feedback

Scenarios -> Models

- Expand boundary conditions and assumptions
- Characterize uncertainties
- Explore inclusion of additional variables
- Identify gaps in knowledge