CIA Uncertainty

Gaps and Challenges in CIA applications

Greater North
Sea Basin Initiative

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Background

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- Growing competition for space
- Need for ecosystem-based management
- CIA supports decision-making, but always uncertainty

- GOAL: understanding uncertainty
  - What is it?
  - Where does it come from?
  - How to handle it?

Two perspectives on uncertainty

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- Modellers' view

  – Focus on model structure, inputs, outputs
  – Analytical & technical

- Policymakers' view

  – Includes political values, strategy, governance context
  – Uncertainty not only from the model

Modellers' uncertainty

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- Not just "lack of information"
- New knowledge can *increase* uncertainty

- "Any departure from the ideal of full determinism"

Walker et al., 2003

Modellers' uncertainty

- **Location** of uncertainty

Location	Description
System boundary	What is included/excluded
Conceptual model	How processes are represented
Computer model	Technical implementation, structure, parameters
Input data	Species maps, sensitivities, baselines
Model implementation	Bugs, technical errors
Processed output	Accumulated uncertainties

Kwakkel et al., 2010

Modellers' uncertainty

- **Level** of uncertainty

Level	Description
Level 1: Shallow uncertainty	Alternatives known, probabilities possible
Level 2: Medium uncertainty	Alternatives known, probabilities not possible
Level 3: Deep uncertainty	Multiple plausible futures with unclear likelihood
Level 4: Recognised ignorance	Cannot enumerate alternatives, surprises expected

Kwakkel et al., 2010

Modellers' uncertainty

- **Nature** of uncertainty

Nature	Description
Epistemic	Reducible through research
Stochastic/ Ontological	Inherent natural or human variability
Ambiguity	Different actors have different frames or interpretations

Walker et al., 2003
Kwakkel et al., 2010

Modellers' uncertainty

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- The uncertainty matrix

Combines:

- Location
- Level
- Nature

Location	Level				Nature		
	1	2	3	4	Epis.	Stoc.	Amb.
System boundary							
Conceptual model							
Computer model							
Input data							
Model implementation							
Processed output							

- Helps systematically describe uncertainty
- Useful communication tool

Policymakers' uncertainty

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- Three types that influence environmental governance:

Type	Description
Substantive uncertainty	About the problem itself
Strategic uncertainty	Political motives, interests, social support
Institutional uncertainty	Rules, laws, governance structure

Dewulf and Biesbroek, 2018

Policymakers' uncertainty

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- Uncertainty throughout the political cycle:

  - Addressed at the start, not only at the end
  - Early identification helps avoid surprises later
  - Enables selecting appropriate methods and setting realistic expectations
  - Encourages dialogue between scientists and policymakers

Policymakers' uncertainty

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- Decision-making under uncertainty
- Different levels → different approaches:

Level	Assumption	Approach	Application
Level 1	Current system well known Future is clear	Single forecast + sensitivity analysis	Explore sensitivity of policy results
Level 2	Context, system, weights well understood	Model each future + Monte Carlo simulation, ensembles analysis, decision analysis	Estimate outcome future policies; preferred policy can be chosen based on outcomes
Level 3	Policy is robust. Likelihood future unknown, plausible futures can be specified	Scenario analyses + large number of simulations and Bayesian decision analysis	Explore uncertain aspects of future, implications of global change, possible strategies
Level 4	Unknowns can impact decisions and their effectiveness	Robust and flexible strategies; Adaptation pathways	Develop mitigating actions; identify opportunities, no-regret strategies and vulnerabilities

Walker and Haasnoot, 2011

Key lessons for CIA

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- Uncertainty is unavoidable, but manageable
- It should not delay MSP decisions
- Understanding sources and types improves communication
- CIA outcomes should be seen as guidance, not predictions
- Combine screening tools (policymakers) and analytical tools (scientists)

Recommendations

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- General
  - Always state which type of uncertainty you are discussing

- For modellers
  - Use the uncertainty matrix to classify uncertainty
  - Acknowledge all types, not just input-data uncertainty

- For policymakers
  - Integrate uncertainty from the beginning
  - Include political, institutional and strategic uncertainties
  - Aim for robust, flexible strategies, not precision

To discuss

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- What are uncertainties in the application of CIA in MSP?
- Which should be addressed/prioritised?

- What is the potential of scenario-based approaches for CIA in MSP?
- How to deal with uncertainty in scenarios?

- How can we eventually ensure good measures to be taken?

(when uncertainty is properly addressed)