Why Philosophy-of-Science Is Important When Assessing the Outlook for the Ice Sheets*

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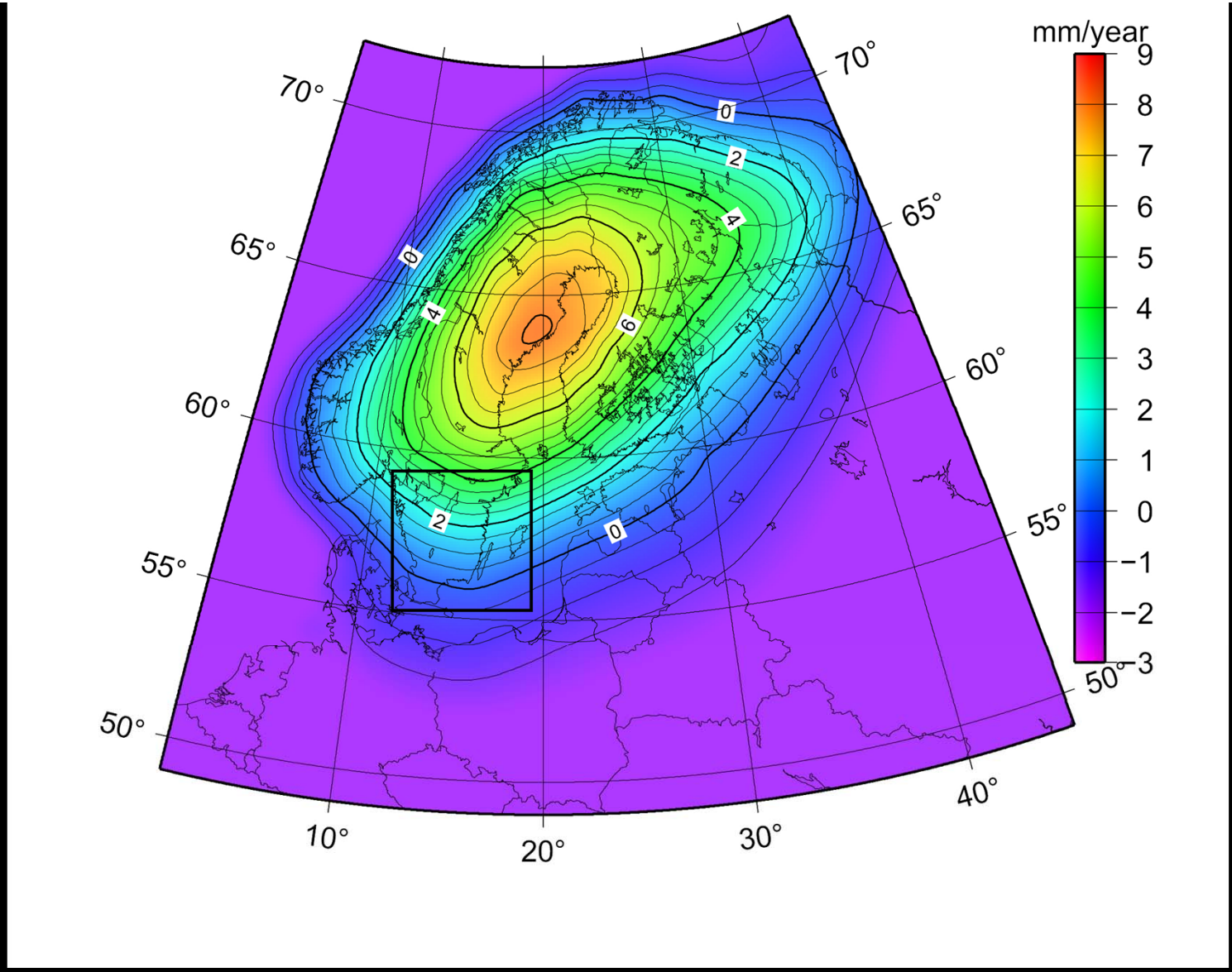
*This work derives from previous research



Contour lines for the apparent uplift (change relative to the mean sea level) for Fennoscandia based on the model from Ågren & Svensson (2007). The black rectangle shows the approximate area of our study. Modified from: Lantmäteriet, Sweden.

Values and value judgments in science

- Some choices made within science are seen as representing ”value judgments” by philosophers of science.
- A value judgment is an evaluation based on “values”.
- Common values in science include: *coherence, simplicity, explanatory power, fruitfulness, conservative burden of proof*, etc.
- These types of values are called “epistemic values” by philosophers (Etymology: from Greek *episteme* = knowledge or learning*)*

Non-epistemic values

- But other types of values also influence science, called “non-epistemic values”
- Examples: type of experiments that are allowed on human or animal test subjects, prioritization of funding of research, etc.
- Non-epistemic values clearly have an *external* influence on science, but do they also have an *internal* influence?

Existence proof of non-epistemic values internal to science?

Richard Rudner (1953):

1. A scientist accepts or rejects hypotheses
2. No scientific hypothesis is ever completely verified with 100% certainty
3. The decision to reject or accept a hypothesis depends on the evidence being “sufficiently strong”
4. But what is “sufficiently strong” depends on the importance, in the typically ethical sense, of making a mistake in rejecting or accepting the hypothesis.

Example

Compare two hypotheses (H1 & H2)

H1: ”a toxic ingredient of a drug is not present in lethal quantity”

H2: ”a certain lot of pencils is not defective”

- The level of evidence needed to accept H1 or H2 can be valued differently.
- Whether the evidence is sufficiently strong, is different because of the consequences of being wrong (”Inductive Risk”).

(Bayesian) Response: Make uncertainties explicit?

- Providing (value-laden) answers for hypotheses is not necessary. Instead, scientists can provide careful statements communicating what is more or less uncertain.

Table 1. Likelihood Scale	
Term*	**Likelihood of the Outcome**
Virtually certain	99-100% probability
Very likely	90-100% probability
Likely	66-100% probability
About as likely as not	33 to 66% probability
Unlikely	0-33% probability
Very unlikely	0-10% probability
Exceptionally unlikely	0-1% probability

Guidance Note for Lead Authors of the IPCC Fifth Assessment Report on Consistent Treatment of Uncertainties.

IPCC projections

Table SPM.2 [TABLE SUBJECT TO FINAL COPYEDIT]

		2046–2065		2081–2100	
Variable	**Scenario**	mean	*likely* range [c]	mean	*likely* range [c]
Global Mean Surface Temperature Change (°C) [a]	RCP2.6	1.0	0.4 to 1.6	1.0	0.3 to 1.7
	RCP4.5	1.4	0.9 to 2.0	1.8	1.1 to 2.6
	RCP6.0	1.3	0.8 to 1.8	2.2	1.4 to 3.1
	RCP8.5	2.0	1.4 to 2.6	3.7	2.6 to 4.8
		mean	*likely* range [d]	mean	*likely* range [d]
Global Mean Sea Level Rise (m) [b]	RCP2.6	0.24	0.17 to 0.32	0.40	0.26 to 0.55
	RCP4.5	0.26	0.19 to 0.33	0.47	0.32 to 0.63
	RCP6.0	0.25	0.18 to 0.32	0.48	0.33 to 0.63
	RCP8.5	0.30	0.22 to 0.38	0.63	0.45 to 0.82

IPCC (2013) AR5 WGI SPM

SLR ranges are "*likely*" with "*medium confidence*"

Value judgment: “how to communicate uncertainty”

The choice of using the “likely” range is a value-judgment

Other choices could have been made. They could perhaps have said the following of the global mean sea level rise by 2100…

- “it will be less than 80 meters (high confidence)”?
- “it is *virtually certain* to be less than 10 meters (high confidence)”?
- “it is *very likely* to be less than 2 meters (medium confidence)”? (compare to NOAA 2012)

Not to say anything is also a value judgment

Saying only certain things, or hedged statements may be misinterpreted by decisionmakers.

“this report does not assess the likelihood, nor provide a best estimate or an upper bound for sea level rise” (IPCC 2007, SYR SPM)

Value judgment: “how to value different methods and models”

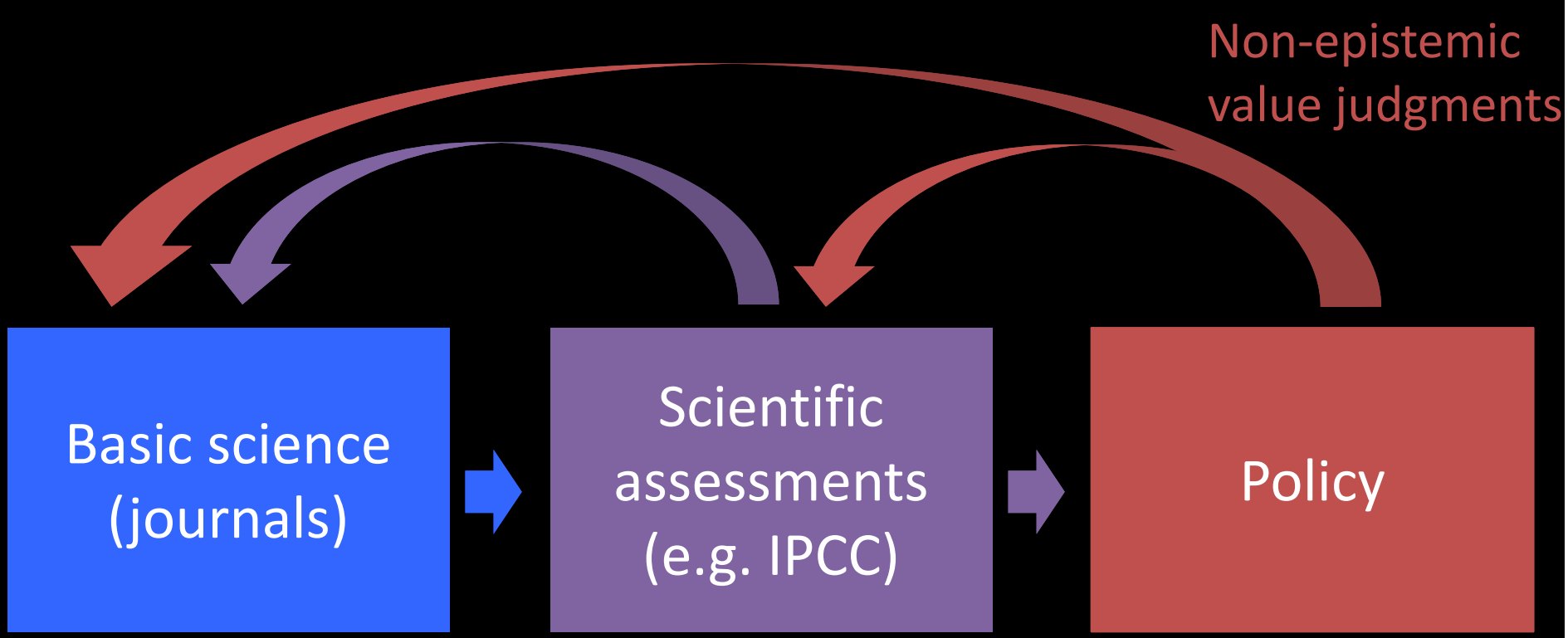
To choose what methods and models to take into account is a value judgment

“Many semi-empirical model projections of global mean sea level rise are higher than process-based model projections (up to about twice as large), but there is no consensus in the scientific community about their reliability and there is thus low confidence in their projections.” (IPCC 2013, WG1 SPM)

What does this mean?

- In theory, it might be possible to provide statements on all levels of confidence, but this is often not practical due to constraints (money, time, space, cognition, communication etc).
- This means that scientific assessments have to take non-epistemic values into account
- Especially social consequences of being wrong (Rudner's argument for the necessity of non-epistemic values)

The same argument holds for value judgments in basic science (recursively)



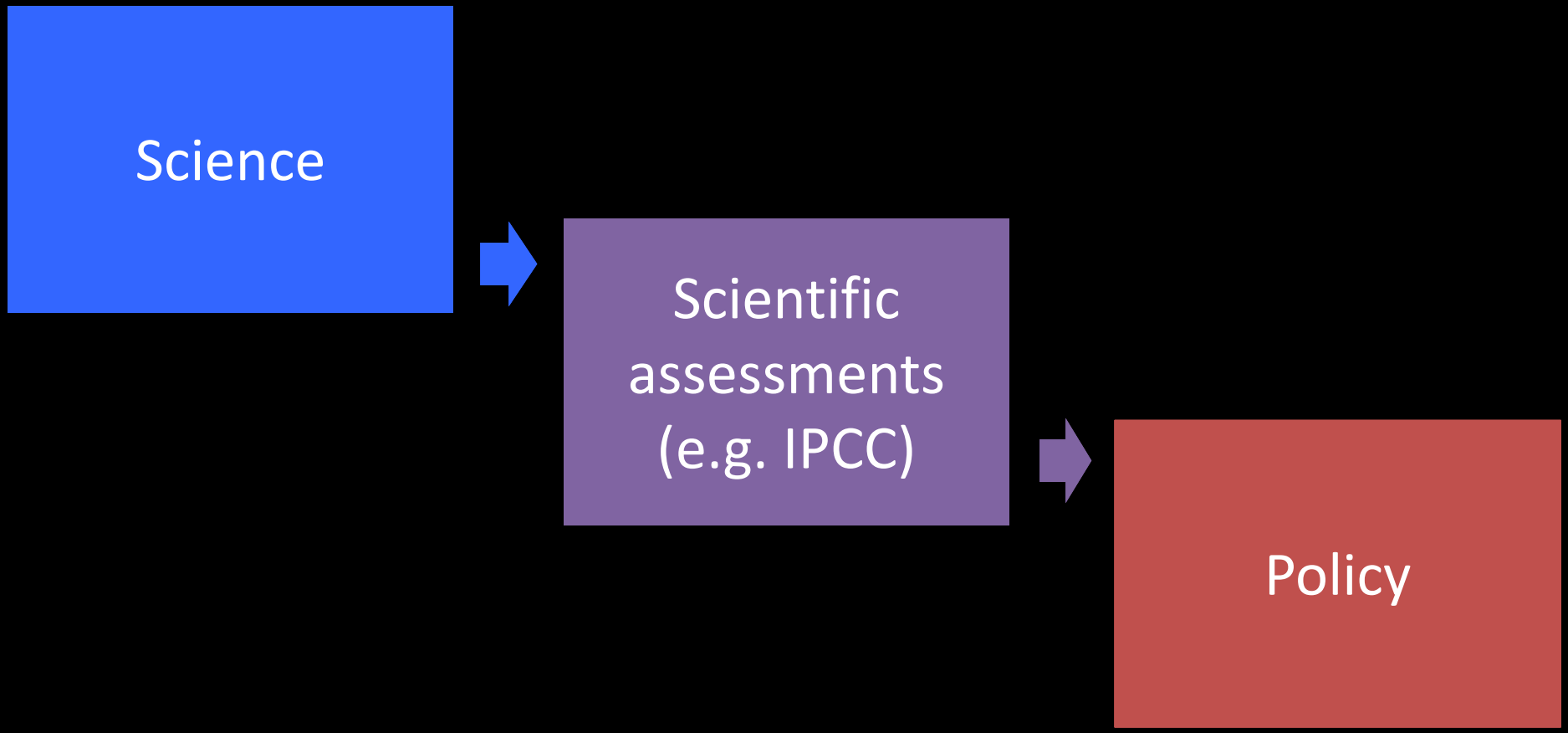
Basic science (journals)

How is uncertainty communicated?

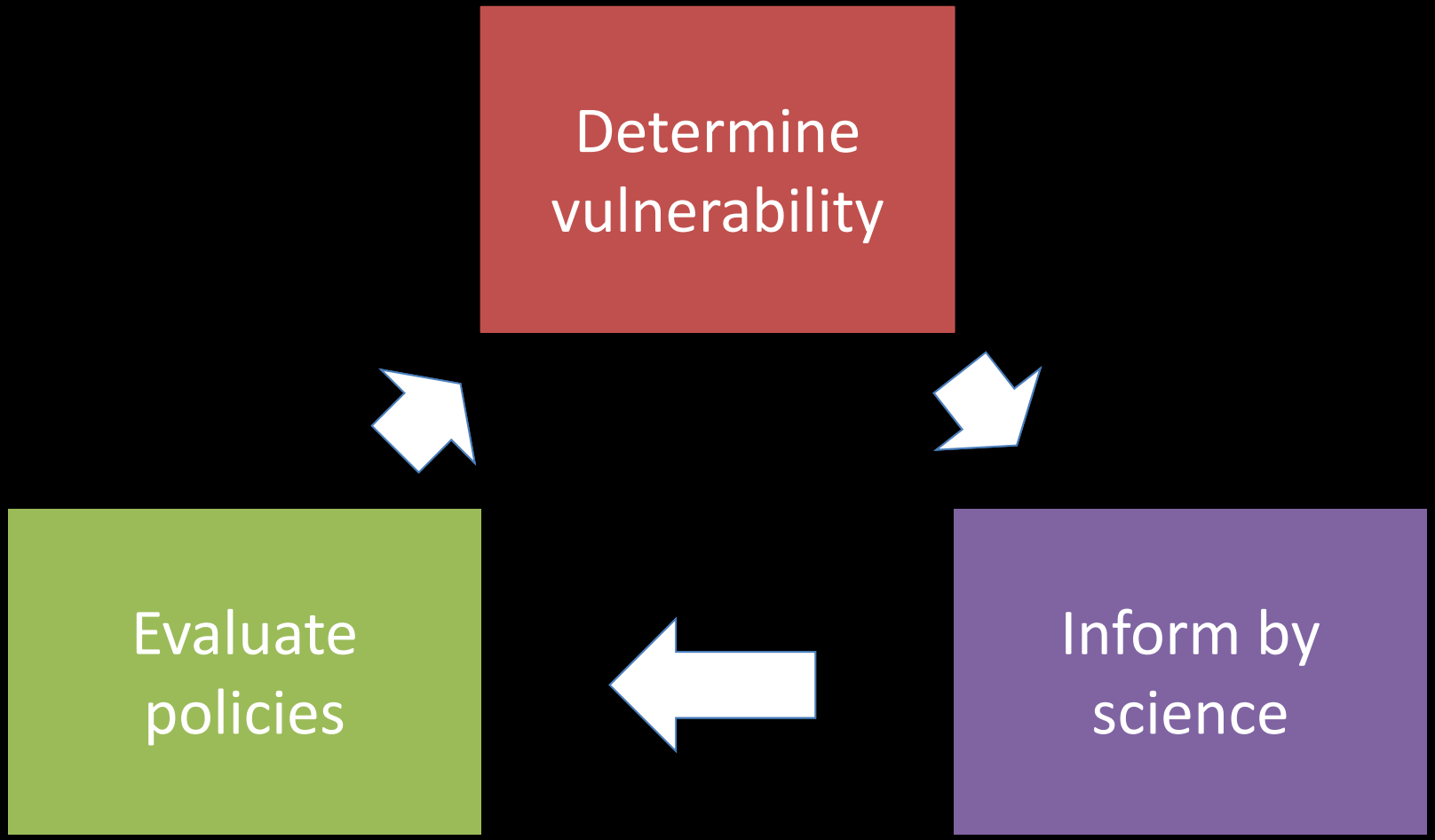
What methods and models are used?

What is not being said?

Problem gets worse by traditional ”Predict then act” model of relation between science & policy



Alternative: Robust Decision Making



”Predict then act” vs ”Robust Decision Making”

”Predict-then-Act”

- Best available prediction drives decision making
- Maximise expected utility
- ”What is most likely to happen?”

”Seek Robust Solutions”

- Identify vulnerabilities across full range of futures and identify policies that perform reasonably well across this range
- Minimize regret
- ”How does my system work and when might my policies fail?”

Weaver, Lempert, Brown, Hall, Revell and Daniel Sarewitz *WIREs Clim Change* 4, 2013.

Recommendations

- Remember that science is not insulated from the rest of the world
  - Actions have consequences
  - ”What are the risks of being wrong?”
- Explore the ”shadowy tails of the dangerous end of the probability distribution”
  - Such information can have very high value for some decision-makers
  - Make sensitivity analyses
- Work with end-users to make expert assessments
  - So they don’t need to rely on IPCC only

Thank you!

Happy for comments or collaboration:

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