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Climate science and climate change: Epistemological and methodological issues

Uncertainty management in the IPCC

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1. Outline

- Introductions: what is IPCC AR4 WGIII?
- Typology of ignorance underlying AR4 WGIII
- Agreeing to disagree in a multidisciplinary panel

IPCC (= GIEC in French)

OMM

GROUPE D'EXPERTS INTERGOUVERNEMENTAL
SUR L'ÉVOLUTION DU CLIMAT

PNUE

Intergovernmental Panel on Climate Change

- Reports to UNFCCC the state of scientific knowledge
- Formal review process, academic and more
- Intergovernmental, multidisciplinary
- Highly exposed

IPCC organization

- Plenary, Permanent bureau, Technical Support Unit

Working Groups

- WG I: Past, present and future climates
- WG II: Impacts and adaptation
- WG III: Mitigation

Policy relevant, not policy prescriptive

References

- K. Halsnæs, P. Shukla, Dilip Ahuja, G. Akumu, R. Beale, Jae A. Edmonds, Christian Gollier, Arnulf Grübler, Minh Ha-Duong, Anil Markandya, M. McFarland, E. Nikitina, T. Sugiyama, A. Villavicencio, and J. Zou. ***Framing issues***. In B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, and L.A. Meyer, editors, IPCC Fourth Assessment Report, Contribution of the Working Group III, **chapter 2**. Cambridge University Press, 2007.
- Rob Swart, Lenny Bernstein, Minh Ha-Duong, and Arthur Petersen. Agreeing to disagree: ***Uncertainty management in assessing climate change, impacts and responses by the IPCC***. Climatic Change, 92 (1-2):1-29, January 2009.
- Mastrandrea, M.D., C.B. Field, T.F. Stocker, O. Edenhofer, K.L. Ebi, D.J. Frame, H. Held, E. Kriegler, K.J. Mach, P.R. Matschoss, G.-K. Plattner, G.W. Yohe, and F.W. Zwiers, 2010: ***Guidance Note for Lead Authors of the IPCC Fifth Assessment Report on Consistent Treatment of Uncertainties***. Intergovernmental Panel on Climate Change (IPCC). Available at <http://www.ipcc.ch>.

Disclaimer

- Personal views, only what is in IPCC AR4 report has been peer reviewed
- Comments welcomed

2. Types of ignorance

1. Introductions: what is IPCC
2. Typology of ignorance underlying AR4 WGIII
3. Agreeing to disagree in a multidisciplinary panel

Inspired by Smithson (1988) Ignorance and Uncertainty – Emerging Paradigms, Springer

Error vs. Human dimensions

- Error
  - Probability (risk)
  - Imprecision (uncertainty)
  - Incompleteness (unknown unknowns)
- Human dimensions
  - Psychologic and social
  - Strategic

Three degrees of error

- The probabilistic model starts with an exhaustive partition of the future into mutually exclusive states, and assign each state a specific weight:

Risk, standard, classical model

- States are known, weights are imprecise:

Uncertainty, ambiguity

- Exhaustivity is incredible: *structural uncertainty, unknown unknowns, black swans ...*

On probabilities (risk)

Rarely available in climate change science & policy

Expert judgement increasingly accepted, if rigorous

Objective / subjective is NOT precise / imprecise

Objective imprecise probabilities

What is the probability of drawing a red ball from Ellsberg's urn ?

We know the box contains:

- 3 colored balls
- 1 is yellow
- The other 2 are red or black

The probability is between 0 and 2/3.

Subjective imprecise probablities
A mental experiment (de Finetti, Walley)

An investor accepted a risky project paying:

4 in the good case (probability *p*)

-4 in the bad case

Assume that this is a rational investor.

What do we know about *p* ?

Imprecise probabilities an emerging paradigm ?

Probability sets, *e.g.* intervalls $[p^-, p^+]$

- Extends classical precise probability
- Unifies many alternatives (fuzzy, belief)
- Has operational meanings
- Drop axiom 1: Complete preferences

Special cases [0, p^+] or [p^-, 1] (possibility / necessity)

Plausibility level is 0.6 means that
p is lower than 0.6

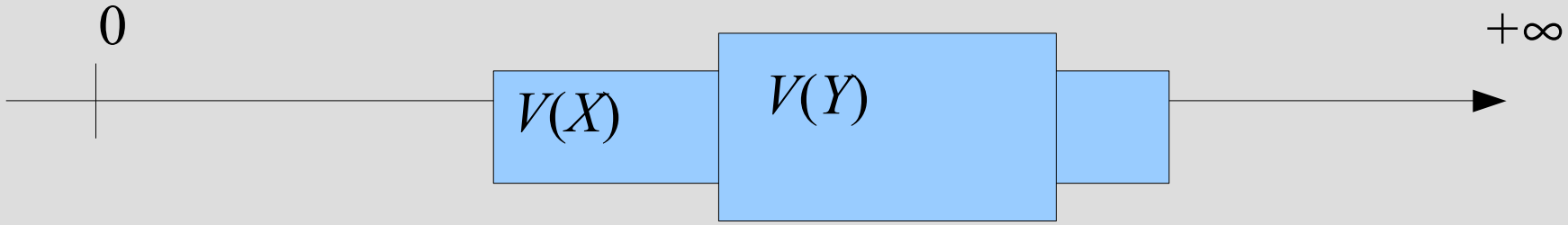
Scenarios are plausible, not probable.

Formal links here with Fuzzy/Vagueness theory

Imprecision and decision

Expected value is an intervall too

$$V(X)=[\underline{P}(X),\overline{P}(X)]$$



We may not always compare options

Structural uncertainty
unknown unknowns

Hasards beyond the limits of the frame of reference?

- Whose limits ?
- Stability of theories and models in the field ?

- Need formal theories
  - Conditioning & updating
  - Learning
  - Robustness
  - $p(\{}) > 0$

Human dimensions of ignorance

Error: missing information, a desire to get it right

i. Active ignorance

ii. Strategic

Active ignorance

Elements excluded from the discourse for psychologic or social reasons

- Surprises
- Metaphysics
- Taboos

Surprise

Unexpected event

Mismatch between a stimulus and pre-established knowledge networks

Surprise $\neq$ abrupt change

Scenarios can help !

Metaphysics

Things that are not assigned a truth level because it is generally agreed that they cannot be verified, such as the mysteries of faith, personal tastes or belief systems.

Represented in models by parameters such as discount rates or risk-aversion coefficients.

While these cannot be judged to be true or false they can have a bearing on both behaviour and environmental policy-making.

Taboos

- What the members of a social group must not know or even question
- Essential to the identity of any group, IPCC too
- Plenty of opportunity for interference with Scientific Truth
- Fixes must come from outside

Strategic Ignorance

- Conflicts
- Trust and et coordination

- Example:
  - Free riding
  - Information asymmetries

Conclusions

Under uncertainty,
use probability intervalls or bounds.

Maximize expected utility
when probabilities are precise

Scenarios are useful tools to analyze the human dimensions of ignorance.

Uncertainty management in IPCC

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Method: participative observation and corpus analysis

Challenges

- Large, > 1000 scientists
- Interdisciplinary
- Much harder than Ozone layer protection

Diverse framings for ”What is the issue ?”

- Assessing the degree of urgency
- Reaching targets efficiently
- Cooperating
- Orienting technological change

Uncertainty management in IPCC

- Four assessment reports: 1990, 1996, 2001, 2007

- Increasing coordination
- Persistent differences between the working groups

First report: urgent start up

- Question 1: Is it a real problem ? → WG I's place
- Political pressure on WG I to adress uncertainties rigorously, with peer review.
- Subjective perspective: certainties, degrees of confidence. Predictions (!).
- No central inter-WG coordination
- Review and formulation of uncertainties less systematic in WG II and III.

Second report: issue identified

- WG I: No specific vocabulary. An “uncertainties“ section.
  Projection instead of prediction.
- WG II: Vocabulary for degrees of confidence.
- WG III: Reports intervalls, conditional cost scenarios

- Need for coordination is recognized

Reports 3, 4, 5: a process

- Directive note common to the 3 WG
  - Offers a common approach and vocabulary
  - Educate the authors
  - Critical for key messages
- State of the art
  - Pragmatic
  - Iterative: Workshop → Guidance note → Report → Research → Workshop...
- WG III harmonizes at AR4 only, but...

Uncertainty vocabulary used by WG I and II

Terminology	Likelihood of the occurrence/ outcome
Virtually certain	$>$ 99% probability of occurrence
Very likely	$>$ 90% probability
Likely	$>$ 66% probability
About as likely as not	33 to 66% probability
Unlikely	$<$ 33% probability
Very unlikely	$<$ 10% probability
Exceptionally unlikely	$<$ 1% probability

2005 Guidance 2005 (page 4)

Uncertainty vocabulary used by WG III

Table 2 considers both the amount of evidence available in support of findings and the degree of consensus among experts on its interpretation. The terms defined here are intended to be used in a relative sense to summarize judgments of the scientific understanding relevant to an issue, or to express uncertainty in a finding where there is no basis for making more quantitative statements. A finer scale for describing either the amount of evidence (columns) or degree of consensus (rows) may be introduced where appropriate, however, if a mid-range category is used authors should avoid over-using that as a 'safe' option that communicates little information to the reader. Where the level of confidence is '*high agreement much evidence*', or where otherwise appropriate, describe uncertainties using Table 3 or 4.

Table 2. Qualitatively defined levels of understanding

Level of agreement or consensus →			
	High agreement limited evidence	...	*High agreement much evidence*
	...	...	...
	Low agreement limited evidence	...	*Low agreement much evidence*

Amount of evidence (theory, observations, models) →

2005 Guidance notes (page 3)

Agreeing to disagree ?

- No to unify in a single (quantified) framework, but to organize the rigorous application of a diversity of methods. Recognize that disciplinary traditions are generally good to deal with the kind of ignorance in their domain. Take care of the key dimensions:
- 1. Objective fact / subjective belief
- 2. Precise / imprecise evidence
- 3. Causal / intentionnal systems
- Describe the pedigree of important results: the nature of uncertainties, sources of evidence.

Guidance for AR5
post-IAC review

Two metrics for communicating the degree of certainty in key findings:

- Confidence in the validity of a finding, based on the type, amount, quality, and consistency of evidence (e.g., mechanistic understanding, theory, data, models, expert judgment) and the degree of agreement.
  Confidence is expressed qualitatively.
- Quantified measures of uncertainty in a finding expressed probabilistically (based on statistical analysis of observations or model results, or expert judgment).

Confidence basis

New in AR5: mandatory use, traceability, evidence metrics

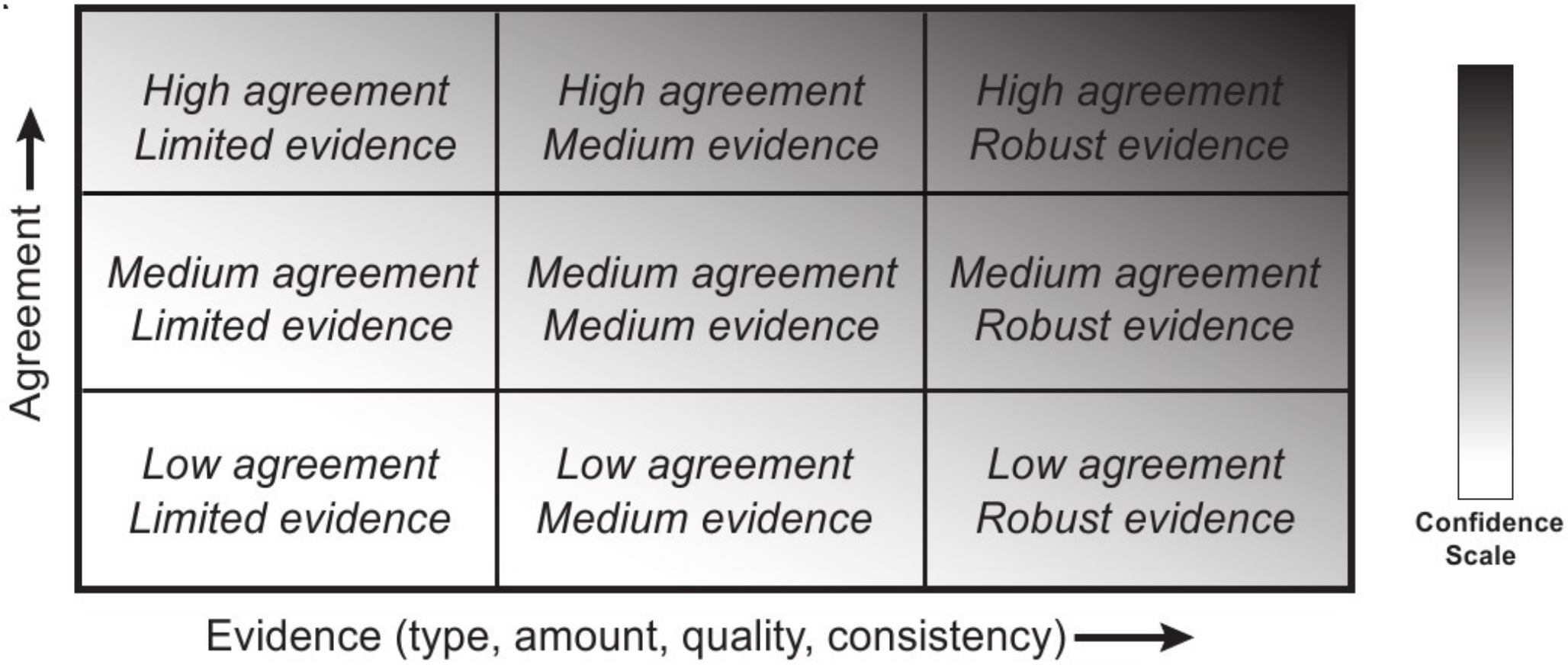

Figure 1: A depiction of evidence and agreement statements and their relationship to confidence. Confidence increases towards the top-right corner as suggested by the increasing strength of shading. Generally, evidence is most robust when there are multiple, consistent independent lines of high-quality evidence.

Confidence scale

- A level of confidence is expressed using five qualifiers: “very low,” “low,” “medium,” “high,” and “very high.”
- It synthesizes the author teams’ judgments about the validity of findings as determined through evaluation of evidence and agreement.
- Figure 1 depicts summary statements for evidence and agreement and their relationship to confidence

New in AR5: scale is qualitative

Quantified measures

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

* Additional terms that were used in limited circumstances in the AR4 (*extremely likely* – 95-100% probability, *more likely than not* – >50-100% probability, and *extremely unlikely* – 0-5% probability) may also be used in the AR5 when appropriate.

New in AR5: require quantitative analysis, more precise better

Conclusions

IPCC guidance note:

- Deal only with Error-type ignorance
- Uses imprecise probabilities (new paradigm ?)
- Maturing, AR5 revisions marginal

Communication also a question of trust, procedures extending to conflicts of interest disclosure policy

Comments welcome, IPCC is currently assessing the uncertainty literature

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