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Ethical implications of scientific uncertainty in the context of climate change and sustainable development

Johan Hattingh
Department of Philosophy
Stellenbosch University
South Africa

Member of COMEST (UNESCO)

Point of departure

- The scientific knowledge we need to ensure successful mitigation and adaptation to climate change

  and

  The scientific knowledge we need to ensure sustainable development are of a similar kind

- Similarly, the uncertainties in and around this knowledge are of a similar kind

  As well as the ethical implications of these uncertainties

Overview

- Problem statement
  - Scientific uncertainty, confidence, probabolity, risk, risk management
- Different kinds of scientific uncertainty in the context of climate change / sustainable development
- The response of scientists to uncertainty
- The precautionary principle
  - History
  - Defintion and application
  - PP as ethical responsibility
  - Implications for risk management and adaptation / SD

A simple typology of scientific uncertainties

Type	**Sources**	
Unpredict-ability	Projections of human behaviour not easily amenable to prediction (e.g. evolution of political systems). Chaotic components of complex systems.	
Structural uncertainty	Inadequate models, incomplete or competing conceptual frameworks, lack of agreement on model structure, ambiguous system boundaries or definitions, significant processes or relationships wrongly specified or not considered.	
Value uncertainty	Missing, inaccurate or non-representative data, inappropriate spatial or temporal resolution. Poorly known or changing model parameters.	

Quantitatively calibrated levels of confidence

Terminology	**Degree of confidence in being correct**
Very High confidence	At least 9 out of 10 chance of being correct
High confidence	About 8 out of 10 chance
Medium confidence	About 5 out of 10 chance
Low confidence	About 2 out of 10 chance
Very low confidence	Less than 1 out of 10 chance

Likelihood scale

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

Uncertainties: Africa and the Sahel

Warming is *very likely* to be larger than the global annual mean warming throughout the continent and in all seasons, with drier subtropical regions warming more than the moister tropics. Annual rainfall is *likely* to decrease in much of Mediterranean Africa and the northern Sahara, with a greater likelihood of decreasing rainfall as the Mediterranean coast is approached. Rainfall in southern Africa is *likely* to decrease in much of the winter rainfall region and western margins. There is *likely* to be an increase in annual mean rainfall in East Africa. It is unclear how rainfall in the Sahel, the Guinean Coast and the southern Sahara will evolve.

AR 4, Prt I, Ch 11, p. 850, 866

Another typology of uncertainty

- Observation gaps / lack of data
  - Rainfall
  - Wind patterns
  - Water volume in rivers
  - Ground water levels
  - Soil moisture
  - Vegetation cover
  - Land use
  - Interaction between land and ocean temperature
- Science problems
  - Different models yield different predictions for same area
  - Global models break down in regions
  - Combination of models
- Theory problems – different assumptions of models

One possible response of science

- More research until uncertainty is overcome
- Putting together multi-model ensembles
- Efforts to quantify uncertainties and risks
- Ranking of the importance of uncertainties

- Falling back on computation and modelling

- Only successful up to a point

The problem of unpredictability of future behaviour of complex systems

- The problem of stationarity
  - Whether the statistical relationships are valid under future climate regimes
  - The issue is that of non-stationarity (the system itself changes)

- Unpredictability characterizes the very system that is studied, so that little if anything can be said about probability as well

- Our understanding of uncertainty is uncertain

How to overcome this dead-end

- Acknowledging that decisions sometimes cannot be postponed until science has reached certainty about an issue, both scientists and decision-makers in many circles (not all) has developed and applied the Precautionary Principle

Decision-making and action in the face of uncertainty

- PP emerged against the background of the
  - Polluter pays principle (curative model)
  - The Prevention principle (preventative model)
- Precautionary principle is an anticipatory model
  - Assessment and management of unpredictable, uncertain and unquantifiable, but potentially catastrophic risk

PP in international documents

- Rio Declaration on Environment and Development - 1992
- United Nations Framework Convention on Climate Change.
- Article 5.7 of the World Trade Organization's (WTO) Agreement on Sanitary and Phytosanitary Measures (SPS Agreement) of 1994
- Biosafety Protocol (January 2000)
- …

What does the PP require – early formulations

- Damages done to the natural world (which surrounds us all) should be avoided in advance, and in accordance with opportunity and possibility.
- The early detection of dangers to health and environment by comprehensive, synchronized (harmonized) research, in particular about cause and effect relationships ...,
- It also means acting when conclusively ascertained understanding by science is not yet available.
- Precaution means to develop, in all sectors of the economy, technological processes that significantly reduce environmental burdens, especially those brought about by the introduction of harmful substances.'
    - (Bundesministerium des Innern, 1984).

Early definitions and concepts

- '… timely preventive measures …' given 'insufficient state of knowledge' (1984)
- '… a precautionary approach is necessary which may require action … even before a causal link has been established by absolutely clear scientific evidence...' (1987)
- '…apply the precautionary principle … even when there is no scientific evidence to prove a causal link…' (1990)
- '…the guiding principle ... is the precautionary principle … - … the goal of reducing discharges and emissions … with the aim of their elimination'. (1995)

Rio Declaration (United Nations 1992)

- *'In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing costeffective measures to prevent environmental degradation.'*

- Note the tripple negative in this formulation

PP – the working definition of COMEST

- When human activities may lead to morally unacceptable harm that is scientifically plausible but uncertain, actions shall be taken to avoid or diminish that harm.

- Morally unacceptable harm refers to harm to humans or the environment that is
  - threatening to human life or health, or
  - serious and effectively irreversible, or
  - inequitable to present or future generations, or
  - imposed without adequate consideration of the human rights of those affected.
    - (COMEST 2005, 14)

The judgement of plausibility

- The judgement of plausibility should be grounded in scientific analysis. Analysis should be ongoing so that chosen actions are subject to review. Uncertainty may apply to, but need not be limited to, causality or the bounds of the possible harm. (COMEST 2005, 14)

The Precautionary Principle Applies when …

- There exist considerable scientific uncertainties;
- There exist scenarios (or models) of possible harm that are scientifically reasonable (that is based on some scientifically plausible reasoning);
- Uncertainties cannot be reduced in the short term … ;
- The potential harm is sufficiently serious or even irreversible for present or future generations or otherwise morally unacceptable;
- There is a need to act now, since effective counteraction later will be made significantly more difficult or costly at any later time.
    - COMEST 2005, 31

Actions taken i.t.o. the PP principle

- Actions are interventions that are undertaken before harm occurs that seek to avoid or diminish the harm. Actions should be chosen that are proportional to the seriousness of the potential harm, with consideration of their positive and negative consequences, and with an assessment of the moral implications of both action and inaction. The choice of action should be the result of a participatory process. (COMEST 2005: 15)

Concerns about the precautionary principle

- It will stifle innovation and scientific progress
- It will be applied too easily (when it is not necessary)

- Counterarguments
  - PP can, and has stimulated innovation and the development of alternative, less risky technologies
  - In some cases the precautionary principle has been under-used (as a result of the belief that nothing is wrong with an activity)

  - Which means that all very strong claims that an activity is dangerous (or safe) need to be approached with a healthy scepticism

What the PP is not

- Not based on the ideal of “no risk” – strives to lower risks
- Not based on emotion or fear – based on rational decision-making
- Not a decision algorithm, with guaranteed outcomes – it need to be applied on a case by case basis

The precautionary principle as moral responsibility

- The duty of scientists / decision-makers to overcome ignorance and share knowledge
  - To acknowledge where uncertainties exist
  - To actively do something about it
- The duty of scientists / decision-makers to disseminate information about uncertainties to decision-makers and the public
- Equity considerations
  - The PP entails the prevention of future risks
  - The PP entails the prevention of risks to others living now
- Environmental protection – risks to ecosystems and non-human living entities
- The moral right to have a say (of those affected by risks)
  - Adequate information; participation; transparency

The abuse of uncertainty in high-stake decision-making contexts

- Uncertainties can be down-played or over-emphasized
  - To delay action
  - To undermine the process of scientific assessment
  - To promote a certain policy-decision
  - To promote a vested interest
  - To ban certain technologies (playing up to the fear factor)

Further considerations

- The precautionary principle is applied in
  - Contexts characterized by complexity
  - Contexts where uncertainties cannot be quantified
  - Where the usual tools of cost-benefit analysis and probabilistic calculus are not helpful

The precautionary principle and complex systems

- Complex systems are characterized by threshold or non-linear behaviour
  - Future conditions may not resemble past conditions
  - Relative stasis may suddenly give way to rapid changes
  - Unexpected outcomes can emerge (negative or positive)

  - Gradual changes require different forms of adaptation than a system that can flip over into a new state
  - Which will require a different paradigm of policy and management responses: Robust and resilient

Resilience in management and governance

- Experimental – learning from experience to adapt to changed circumstances (ability to recover from shock)
- The ability to build and increase the capacity of learning
- The ability to self-organize

- [Precautionary governance]

Robust management

- Robust scientific predictions
  - Hold for most known uncertainties
  - But may break down in the presence of surprises
- Robust policies
  - Not affected much by over- or under-estimations of risk

Tentative conclusions and proposals

- Uncertainty is a characteristic of complex systems
  - Uncertainty will not be overcome by more research
  - So, uncertainty calls for wise management

- Wise management include:
  - A precautionary approach
  - Building the resilience of the system that is managed
  - Building resilient knowledge systems
    in which a resilient science of complex systems stands central
  - Building a society that can live with uncertainty, and is sensitive to the limitations of science

- Adaptation to climate change seems to require active, system wide, collective action (networks, new types) to build resilient individuals, households, communities, societies, governments along the lines sketched above

- The implications of the above for environmental (risk) assessment is fairly obvious
  - The resilience of science in this context will depend on how scientific uncertainty and the Precautionary Principle is handled on a case by case basis.

For further reading

Published in 2005
by the United Nations Educational,
Scientific and Cultural Organization
7, place de Fontenoy,
75352 Paris 07 SP

Printed in France
(SHS-2005/WS/21 cld/d 20151)