AFINO Webinar: Risks, uncertainties and resilience
Responsible Research and Innovation after the Covid-19 crisis

Science for policy under deep uncertainty

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How does science-policy interface cope with uncertainties

Two strategies dominate:

- **Overselling certainty**
  - to promote political decisions (enforced consensus)
- **Overemphasising uncertainty**
  - to prevent political action

- Both promote decision strategies that are **not fit for meeting the challenges** posed by the uncertainties and complexities faced.

- Need for a third voice next to alarmists and skeptics: Coping with uncertainty, scientific dissent & plurality in science for policy.

https://dspace.library.uu.nl/handle/1874/386038

A practical problem:

Protecting a strategic fresh-water resource

5 scientists addressed same question:

"which parts of this area are most vulnerable to nitrate pollution and need to be protected?"

(Refsgaard, Van der Sluijs et al, 2006)
https://dspace.library.uu.nl/handle/1874/21696

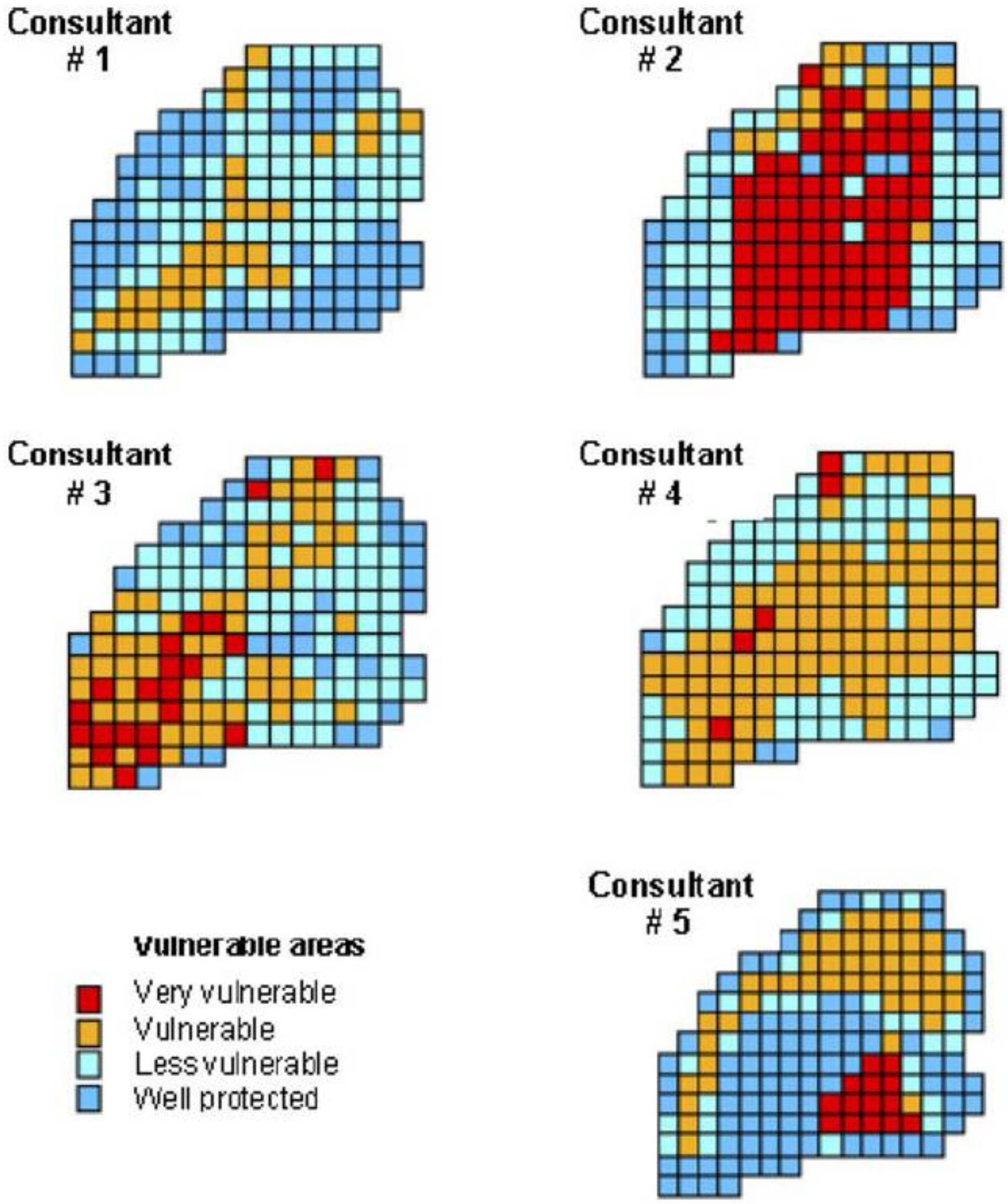


Fig. 1. Model predictions on aquifer vulnerability towards nitrate pollution for a 175 km^2 area west of Copenhagen [11].

3 understandings of uncertainty

'deficit view' *[truth with error bars]*

- Uncertainty is provisional
- Reduce uncertainty, make ever more complex models
- *Tools:* quantification, Monte Carlo, Bayesian belief networks
    - ***Speaking truth to power***

'evidence evaluation view' *[multiple contradictory truths]*

- Comparative evaluations of research results
- *Tools:* Scientific consensus building; multi disciplinary expert panels
- focus on robust findings
    - ***Speaking [consensus] to power***

'complex systems view / *PNS*-view' *[irreducible ignorance]*

- Uncertainty is intrinsic to complex systems
- Openly deal with deeper dimensions of uncertainty
- *Tools:* Knowledge Quality Assessment
    - ***Working deliberatively within imperfections***

Van der Sluijs, 2016 http://www.andreasaltelli.eu/file/repository/Science_on_the_Verge_FINAL_.pdf#page=165

482 | Nature | Vol 582 | 25 June 2020

Five ways to ensure that models serve society: a manifesto

Andrea Saltelli, Gabriele Bammer, Isabelle Bruno, Erica Charters, Monica Di Fiore, Emmanuel Didier, Wendy Nelson Espeland, John Kay, Samuele Lo Piano, Deborah Mayo, Roger Pielke Jr, Tommaso Portaluri, Theodore M. Porter, Arnald Puy, Ismael Rafols, Jerome R. Ravetz, Erik Reinert, Daniel Sarewitz, Philip B. Stark, Andrew Stirling, Jeroen van der Sluijs & Paolo Vineis

Pandemic politics highlight how predictions need to be transparent and humble to invite insight, not blame.

The COVID-19 pandemic illustrates perfectly how the operation of science changes when questions of urgency, stakes, values and uncertainty collide – in the 'post-normal' regime.

Well before the coronavirus pandemic, statisticians were debating how to prevent malpractice such as *p*-hacking, particularly when it could influence policy[1]. Now, computer modelling is in the limelight, with politicians presenting their policies as dictated by 'science'[2]. Yet there is no substantial aspect of this pandemic for which any researcher can currently provide precise, reliable numbers. Known unknowns include the prevalence and fatality and reproduction rates of the virus in

- **Mind the assumptions**
  perform global uncertainty & sensitivity analyses
- **Mind the hubris**
  Avoid over-complexity
- **Mind the framing**
  Recognise value ladenness & bias
- **Mind the consequences**
  Opacity about uncertainty damages trust
- **Mind the unknowns**
  Acknowledge ignorance, be honest about model limits

https://www.nature.com/articles/d41586-020-01812-9

Unrealistic assumptions about scientific evidence

- **Illusion of certainty**: making policymakers more confident about knowing the future than is justified
- **Illusion of transferability**: making policymakers overconfident that certainty in one aspect of the problem applies to all other aspects as well;
- **Illusion of 'absolute' truth**: making policymakers overconfident with respect to the truthfulness of evidence;
- **Illusion of ubiquitous applicability**: making policymakers overconfident in generalising results from one context to another context;
- **Illusion of a linear relationship between evidence and problem-solving**: making policymakers believe that science will offer right solutions to complex problems.

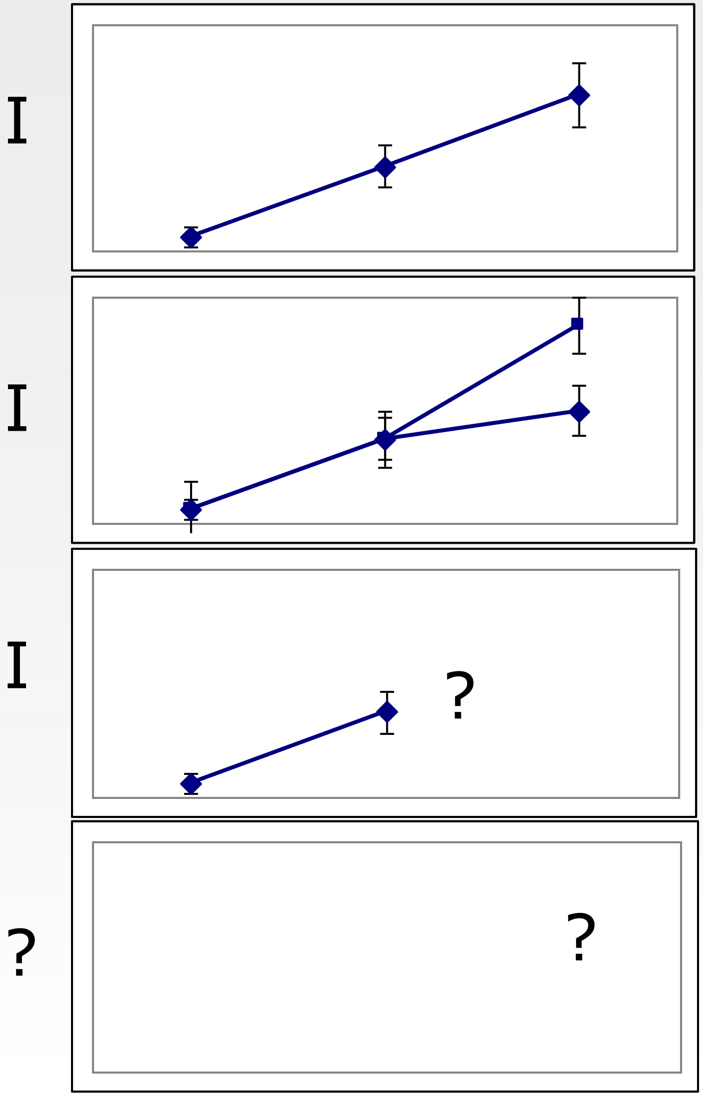
http://sapea.info/masos

Integration of different types of knowledge in the policy process

- Distinguish what is known, what is uncertain and what is unknown
- Impact on different aspects of human life must be made clear
- precautionary principle must be taken in account
- Clarify the values involved
- Involve expertise outside academia (local knowledge, know-how, citizen science etc.)

http://sapea.info/masos

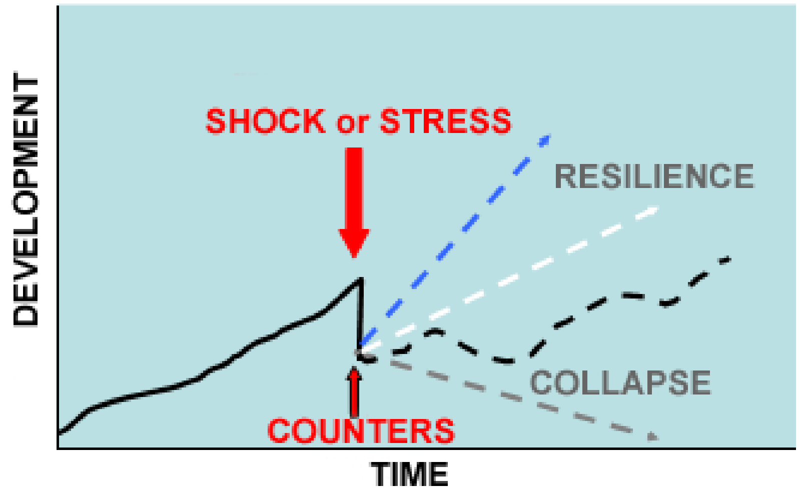
Decision making under what uncertainty?



- Statistical
  - *Act on best prediction with safety margin*
- Scenario
  - *Search for robust policy options*
- Surprise/ignorance
  - – Recognized ignorance (‘known unknowns’)
  - – Total ignorance (‘unknown unknowns’)
  - Increase resilience of impacted systems

Resilience

Figure 1 - Concept of resilience



- If uncertainties about COVID19 are large, one can still know how the resilience of social-ecological systems can be enhanced
- Resilience is the capacity of a system to tolerate disturbance without collapsing into a qualitatively different, usually undesired, state

Principles:

- Homeostasis
- Omnivory
- High flux
- Flatness
- Buffering
- Redundancy

www.resalliance.org
Wardekker e.a. 2010 doi:10.1016/j.techfore.2009.11.005

Resilience principles

- **Omnivory**: vulnerability is reduced by diversification of resources and means.
- **Redundancy**: overlapping functions; if one fails, others can take over.
- **Homeostasis**: multiple feedback loops counteract disturbances and stabilize the system.
- **High flux**: a fast rate of movement of resources through the system ensures fast mobilization of these resources to cope with perturbations.
- **Flatness**: the hierarchical levels relative to the base should not be top-heavy. Overly hierarchical systems are too inflexible and too slow to cope with surprise.
- **Buffering**: essential capacities are over-dimensioned such that critical thresholds are less likely to be crossed.

Watt & Craig 1986; Wardekker et al, 2010

Qualitative Resilience Assessment Framework

	Homeostasis	Omnivory	High flux	Flatness	Buffering	Redundancy
Option 1		-	+	-	++	-
Option 2	+		-	+	-	++
Option 3	-	++	+	-	+	+
….						
Option *n*	++	-	+	--	+	-

https://link.springer.com/article/10.1186/s40064-016-2408-x

Further reading:

Making Sense of Science for Policy report

https://www.sapea.info/topics/making-sense-of-science/ twitter: @SAPEAnews

Nature comment: Five ways to ensure that models serve society

https://www.nature.com/articles/d41586-020-01812-9 twitter #ModelResponsibly

Operationalising a resilience approach to adapting an urban delta to uncertain climate changes https://www.sciencedirect.com/science/article/pii/S0040162509001899

Screening regional management options for their impact on climate resilience: an approach and case study in the Venen-Vechtstreek wetlands in the Netherlands https://link.springer.com/article/10.1186/s40064-016-2408-x

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