

# Science for Policy

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## Science advice at the time of science's crisis

- Prevailing models of science for policy and in society; The 'demarcation' model' for the use of science in policy is implausible. The problems with the double legitimacy system;
- 2) Policy advice impacted by concurrent crises: crisis of citizens' trust in institutions, crisis of science's (including economics') own practice and governance (reproducibility); Hybridization of styles;
- 3) Concerned institutions discount the severity of the crisis.

## Science advice at the time of science's crisis

4) Persistent critique from philosophers first and from scholars of science and technology studies later;

5) Is the present crisis an opportunity to investigate alternative epistemologies and governance arrangements?

## Science advice at the time of science's crisis

6) Quantification in the context of evidence based policy. The special place of mathematical and statistical modelling as master tools of science advice.

7) The crises of science (reproducibility, quality control, skills) and economic thought (loss of diversity, physics envy, 'mathiness') although apparently unrelated are in fact twin crises. Guimarães Pereira, Â., and Funtowicz, S., Eds., 2015, The end of the Cartesian dream, Routledge's series: Explorations in Sustainability and Governance.

Saltelli, A., and Giampietro, M., 2015, What is wrong with evidence based policy? Draft, Submitted for a special issue on FUTURES, August 2015. http://www.andreasaltelli.eu/file/repository/FUTURES\_Saltelli\_Giampietro\_3.pdf

Rommetveit K Strand R Fjelland R & Funtowicz S, 2013 What can history teach us about the prospects of a European Research Area? Study procured by the Joint Research Centre EUR report 2612 (http://www.ubno/sites/w3uibno/files/attachments/histera\_final\_report\_25\_2pdf)

See also: The Rightful Place of Science: Science on the verge, An anthology by Alice Benessia, Mario Giampietro, Silvio Funtowicz, Jerome Ravetz, Angela Pereira, Andrea Saltelli, Roger Strand, Jeroen P. van der Sluijs, With a preface of Dan Sarewitz, Published by the Consortium for Science, Policy and Outcomes at Arizona State University, to appear winter 2015.

Ravetz, J. R. and Saltelli, A., 2015b. "Policy: The future of public trust in science", Nature, 524: p. 161.

EDITED BY ÂNGELA GUIMARÃES PEREIRA AND SILVIO FUNTOWICZ

SCIENCE, PHILOSOPHY AND SUSTAINABILITY THE END OF THE CARTESIAN DREAM

ROUTLEDGE EXPLORATIONS IN SUSTAINABILITY AND GOVERNANCE

Carthscan

Demarcation: facts separate from values

# On demarcation:

"the incoming commission must find better ways of separating evidencegathering processes from the 'political imperative'", A. Glover, former Chief Science Adviser of President Barroso (Wildson, 2014).

Wilsdon, J. 2014. Evidence-based Union? A new alliance for science advice in Europe. In The Guardian. Available at: http://www.theguardian.com/science/political-science/2014/jun/23/evidencebased-union-a-new-alliance-for-science-advice-in-europe.



Anne Glover

Evidence based policy – in the prevailing positivistic narrative – is predicated on a separation of facts from values, of scientists from their customers, on demarcation of roles. 'Demarcation model' of science's input to policy

- Protecting science from the political interference…
- Preventing possible abuse of science...
- ... and scientific information driven by agendas...
- Prescribes a clear demarcation between the institutions (and individuals) who provide the science, and those where it is used.

Funtowicz, S. 2006. What is Knowledge Assessment? In Guimarães Pereira, Â., Guedes Vaz, S. and Tognetti, S. (eds) Interfaces between Science and Society. Greenleaf Publishers, Sheffield. The demarcation model is challenged in more recent epistemologies:

'Post Normal Science' (Funtowicz and Ravetz, 1993), 'Co-production of knowledge' model (Jasanoff, 1996).

Funtowicz, S. O. & Ravetz, J. R. 1993. Science for the post-normal age. Futures, 25(7), 739-755.

Jasanoff, S. 1996, Beyond Epistemology: Relativism and Engagement in the Politics of Science. Social Studies of Science. 26(2) 393-418.



Sheila Jasanoff

Post Normal Science's model of Extended Participation across disciplines – acknowledging that different disciplines see though different lenses, and across communities of both experts and stakeholders;

> Jerry Ravetz and Silvio Funtowicz



From 'speaking truth to power' towards 'working deliberatively within imperfections';

Science is but one among a plurality of relevant knowledges;

Facts become 'extended facts'.

Funtowicz, S. O. & Ravetz, J. R. 1993. Science for the post-normal age. Futures, 25(7), 739-755.

Funtowicz, S and Ravetz J 1990, Uncertainty and Quality in Science for Policy, Kluwer Academic Publishers, Dordrecht.

Where did this separation originate?



Francis Bacon (1561-1626)

Demarcation is part of the Cartesian dream of man as master and possessor of nature, of prediction and control, of Bacon's wonders of science and Condorcet's mathematique sociale…



René Descartes (1596-1650)

Magnalia Naturae, in the New Atlantis (1627), 'Wonders of nature, in particular with respect to human use'



Nicolas de Caritat, marquis de Condorcet (1743-1794)

'Sketch for a Historical Picture of the Progress of the Human Spirit' Discourse on Method (1637) Closer to our times Vannevar Bush's dream was couched in the 'Endless Frontier' metaphor (1945):

"One of our hopes is that after the war there will be full employment. […] To create more jobs we must make new and better and cheaper products […] founded on […] basic scientific research. […the] Government […] opened the seas to clipper ships and furnished land for pioneers. Although these frontiers have more or less disappeared, the frontier of science remains."



Vannevar Bush (1890-1974)

Bush, V. (1945) Science: the endless frontier, United States Office of Scientific Research and Development, U.S. Govt. print office.

Science the Endless frontier (1945)

We were nourished (and professionally trained) with the principles of the Cartesian dream.

This has profound governance implications due to the centrality of science in the formulation adjudication of policy (dual legitimacy arrangement).

Crises





More and more issues become 'wicked', meaning by this deeply entangled in a web of hardly separable facts, interests and values… (GMO, climate, the use of statistics in Education (PISA), bees and pesticides, children born to gay couples, culling of badgers, …)







"Science still commands enormous—if sometimes bemused—respect. But its privileged status is founded on the capacity to be right most of the time and to correct its mistakes when it gets things wrong. […] The false trails laid down by shoddy research are an unforgivable barrier to understanding"



Issues with trust / quality in the scientific enterprise

Laboratory experiments cannot be trusted without independent verification (Sanderson 2013), rules are proposed to spot "suspected work […in] the majority of preclinical cancer papers in top tier journals" (Begley 2013).

Begley CG 2013 Reproducibility: Six red flags for suspect work Nature 497 433-434.Ioannidis J P A 2005 Why Most Published Research Findings Are False PLoS Medicine 2(8) 696-701.Sanderson K 2013 Bloggers put chemical reactions through the replication mill Nature 21 January 2013.

Issues with trust / quality in the scientific enterprise

In a landmark study of results in cancer science Begley and Ellis were able to reproduce only 11 per cent of the original findings (2012).

Begley, C. G., and Lee M. E., 2012, Drug Development: Raise Standards for Preclinical Cancer Research, Nature, 483, 531–533.

"Shoddy science" is not confined to natural sciences: social sciences are also affected; "I see a train wreck looming" warns Daniel Kahneman; Joseph Stiglitz condemns perverse incentives in the modelling of financial products at the hearth of the present crisis.



Daniel Kahneman



Joseph Stiglitz

Yong, E., Nobel laureate challenges psychologists to clean up their act, Nature, News, 03 October 2012. Stiglitz, J. (2010) Freefall, Free Markets and the Sinking of the Global Economy, Penguin, London. Another landmark effort to reproduce the findings of 100 recent papers in psychology failed in more than half the cases – and the effects were smaller (Brian Nosek's work).



Brian Nosek Professor, Department of Psychology University of Virginia

Baker, M., 2015, Over half of psychology studies fail reproducibility test. Largest replication study to date casts doubt on many published positive results, Nature, 27 August 2015.

OSC, Open Science Collaboration, 2015, Estimating the reproducibility of psychological science, SCIENCE, 349(6251) aac4716. DOI: 10.1126/science.aac4716

Issues with trust / quality in the scientific enterprise

Initiatives: http://retractionwatch.wordpress.com http://www.reproducibilityinitiative.org

Fixing the mess is not easy: 'Sluggish data sharing hampers reproducibility effort', (Van Noorden, 2015).

Nature biotechnology. Further Confirmation Needed, Editorial, Nature Biotechnology 30, 2012, 806.

Van Noorden, R., Sluggish data sharing hampers reproducibility effort, Nature, News, June 3rd 2015.

Begley, C.G., Buchan A.M., and Dirnagl, U., 2015, Institutions must do their part for reproducibility, Nature, 525, p. 25-27.



# 'Scientists Who Cheat'





# Misplaced faith. The public trusts scientists much more than scientists think. But should it?'

New York Times, 2015, Scientists Who Cheat, Editorial, June 1. Nature, 2015, Misplaced faith, Editorial, June 2. The public trusts scientists much more than scientists think. But should it? "Currently, many published research findings are false or exaggerated, and an estimated 85% of research resources are wasted"

For Lancet (2015) an estimated US\$200 billion were wasted in the US in 2010.

Ioannidis, J. P. (2014). How to Make More Published Research True. PLoS medicine, 11(10), e1001747

Lancet, Editorial, 2015, Rewarding true inquiry and diligence in research, 385, p. 2121.



Solutions from within:

Four international conferences have already been held on science integrity between 2007 and 2015 (May 31, 2015, about 600 delegates from over 50 countries and all continents, Rio de Janeiro)

San Francisco declaration, (2012), as of June 2015 signed by 12,000 individuals, and 570 organizations.

"Do not use journal-based metrics, such as Journal Impact Factor, as a surrogate measure of the quality of individual research articles to assess an individual scientist's contributions, or in hiring, promotion, or funding decisions."

Declaration: <u>http://am.ascb.org/dora/</u>, drafted by publishers, with separate recommendations for institutions, publishers, organizations that supply metrics and researchers. Lancet, Editorial, 2015, Rewarding true inquiry and diligence in research, 385, p. 2121. Wilsdon, J., 2015, We need a measured approach to metrics, Nature, 523, 129. Ioannidis, J. P. (2014). How to Make More Published Research True. PLoS medicine, 11(10), e1001747. Brave efforts from within:

Jeffrey Beall, librarian, University of Colorado, Denver. Monitors predatory open access publishers.

http://scholarlyoa.com/2015/01/02/bealls-list-of-predatorypublishers-2015/#more-4719.

"Misleading metrics list includes companies that "calculate" and publish counterfeit impact factors […] The Hijacked journals list includes journals for which someone has created a counterfeit website, stealing the journal's identity and soliciting articles submissions using the author-pays model (gold open-access)"



# Brave efforts from within:

Timothy Gowers, mathematician, Fields medalist, boycott of Elsevier, slogans: 'Academic Spring', 'Occupy Elsevier'.



Whitfield, J., 2012, Elsevier boycott gathers pace: Rebel academics ponder how to break free of commercial publishers, Nature, doi:10.1038/nature.2012.10010

Larivière V, Haustein S, Mongeon P (2015) The Oligopoly of Academic Publishers in the Digital Era. PLoS ONE 10(6): e0127502, http://journals.plos.org/plosone/article?id=10.1371%2Fjournal.pone.0127502 A perspective from science and technology studies There were rare anticipations of this crisis. In 1963 Derek J. de Solla Price prophesized that Science would reach saturation (and in the worst case senility) under its own weight, victim of its own success and exponential growth (pp 1–32).





Derek J. de Solla Price

de Solla Price, D.J., 1963, Little science big science, Columbia University Press.

# Science/knowledge degenerates when it becomes a commodity for Ravetz (1971), Lyotard (1979) and Mirowski (2011).

Ravetz, J., 1971, Scientific Knowledge and its Social Problems, Oxford University Press, p. 22.

Lyotard, J.-F. 1979. La Condition postmoderne. Rapport sur le savoir, Paris : Minuit, Chapter 10.

Mirowski, P. 2011. Science-Mart: Privatizing American Science, Harvard University Press.





Jerome R. Ravetz







### Philip Mirowski



#### NATURE | RESEARCH HIGHLIGHTS: SOCIAL SELECTION

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### A call to deal with the data deluge

Researchers debate whether an 'overflow' of data is straining biomedical science.

#### **Chris Woolston**

18 September 2015

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As the number of biomedical research papers continues its relentless growth, the quality and credibility of science is buckling under the weight of all the data. That is the conclusion of an article in the journal *eLife*<sup>1</sup> that triggered discussion online this week. The piece, which is based on interviews with 20 anonymous US senior scientists, suggests a radical rethinking of the peer-review system to deal with the 'overflow' of data. Erik Müllers, a cell biologist at the Karolinska Institute in Stockholm, summed up the issue on Twitter:



Too many journals, too many researchers, too low quality: Overflow in #science and its implications for trust shar.es/17bNjo @elife

Siebert, S., Machesky, L. M., and Insall, R. H. (2015) Overflow in science and its implications for trust. eLife, 4, e10825. (doi:10.7554/eLife.10825)



Derek J. de Solla Price's prophecy ...

## Abstract

To explore increasing concerns about scientific misconduct and data irreproducibility in some areas of science, we interviewed a number of senior biomedical researchers. These interviews revealed a perceived decline in trust in the scientific enterprise, in large part because the quantity of new data exceeds the field's ability to process it appropriately. This phenomenon—which is termed 'overflow' in social science—has important implications for the integrity of modern biomedical science.

Siebert, S., Machesky, L. M., and Insall, R. H. (2015) Overflow in science and its implications for trust. eLife, 4, e10825. (doi:10.7554/eLife.10825)

"Springer and Université Joseph Fourier release SciDetect to discover fake scientific papers"

"The open source software discovers text that has been generated with the SCIgen computer program and other fake-paper generators like Mathgen and Physgen [...]

SciDetect  $[\cdots]$  is a valuable building block for the future of academic publishing"

https://www.springer.com/gp/about-springer/media/pressreleases/corporate/springer-and-universit%C3%A9-joseph-fourier-releasescidetect-to-discover-fake-scientific-papers--/54166







See Ravetz's warning "If there were not a test of each paper ..."

So far a about science's own governance crisis … how about science for policy and science's advice?

Do institutions chose to ignore the connection between science's crisis and science advice?

The OECD report on Science Advice 2015; not a single mention of science's crisis. Only 'crisis situations' ignoring that science itself is into one.

http://www.oecd-

ilibrary.org/docserver/download/5js33l1jcpwb.pdf?expires=14 42656356&id=id&accname=guest&checksum=AF1467AD25FF 8BE6516083077CCEE31A **OECD** publishing

Please cite this paper as:

OECD (2015), "Scientific Advice for Policy Making: The Role and Responsibility of Expert Bodies and Individual Scientists", *OECD Science, Technology and Industry Policy Papers*, No. 21, OECD Publishing, Paris. <u>http://dx.doi.org/10.1787/5js33l1jcpwb-en</u>

OECD Science, Technology and Industry Policy Papers No. 21

### Scientific Advice for Policy Making

#### THE ROLE AND RESPONSIBILITY OF EXPERT BODIES AND INDIVIDUAL SCIENTISTS

OECD



Those aspect of science most used in policy (mathematical and statistical modelling) are also those more problematic.

Sarewitz, D., 2015, Reproducibility will not cure what ails science, Nature, 525, p. 159.

Saltelli, A. and Funtowicz, S., 2014, When all models are wrong: More stringent quality criteria are needed for models used at the science-policy interface, Issues in Science and Technology, vol. winter, pp. 79-85.

Leek J.T., and Peng, R.D., 2015, P values are just the tip of the iceberg, Nature, 520, p. 612.

"Growing concerns about the quality of published scientific results have often singled out bad statistical practices and modelling assumptions, and have typically focused on the very types of science that often underlie regulations  $[\cdots]$ ".



## Daniel Sarewitz, Arizona State University

Sarewitz, D., 2015, Reproducibility will not cure what ails science, Nature, 525, p. 159.



Shanks et al. (2015) JEP:General

J Exp Psychol Gen. 2015 Oct 26. "Romance, Risk, and Replication: Can Consumer Choices and Risk-Taking Be Primed by Mating Motives?", Shanks DR, Vadillo MA, Riedel B, Clymo A, Govind S, Hickin N, Tamman AJ, Puhlmann LM.: http://www.ncbi.nlm.nih.gov/pubmed/26501730

We must accept the persistence in our modernity of what Collingridge and Reeve (1986) call the twin myths of rationality (policy action is predicated on the accumulation of facts and the taming of uncertainty) and the power of science (whereby science is there to provide dispassionate facts to adjudicate controversies).

Collingridge, D. and Reeve, C., 1986, Science Speaks to Power: The Role of Experts in Policy Making. London: Frances Pinter.

# Collingridge and Reeve advocate as model for policy decision one of least dependence on science.

Collingridge, D. and Reeve, C., 1986, Science Speaks to Power: The Role of Experts in Policy Making. London: Frances Pinter.

Science Speaks to Power: The Role of Experts in Policymaking

Collingridge, David

Science Speaks to Power: The Role of Experts in Policymaking Hardcover – 31 Dec 1986 by David Collingridge (Author), Colin Reeve (Author)

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Note: This is not the actual book cover

The myth of scientific quantification via risk or cost benefit analyses, including of the impact of new technologies, has been at the hearth of the critique of the ecological moment (e.g. Winner, 1986; Funtowicz and Ravetz, 1994a)

Winner, L., 1986. The Whale and the Reactor: a Search for Limits in an Age of High Technology. The University of Chicago Press, 1989 edition.

Funtowicz, S.O. and Ravetz, J.R. (1994a). The worth of a songbird: Ecological economics as a post-normal science. Ecological Economics 10(3), 197-207.

Trust

"Is industry funding undermining trust in science? How valid are fears that financial conflicts of interest are damaging confidence in academic research? [...] In economics, medicine, energy and a host of other subjects, there are fears that financial conflicts of interest give the impression that academic findings are up for sale."

Film 'Inside Job'. Interview with Frederic Mishkin, a banking professor at Columbia University, praising Iceland's "strong" banking regulation system two year before it went bust.

Matthews, D., 2015, Is industry funding undermining trust in science?, Times Higher Education, https://www.timeshighereducation.com/features/is-industry-funding-undermining-trust-in-science

"medical paradigms found, then lost, then regained, then placed in a kind of scientific limbo occur in the field of nutrition"

- dietary cholesterol and
- trans-fats
- caffeine
- wine
- sugar
- gluten…

Barash, D.P., 2015, Paradigm Lost, EON, http://aeon.co/magazine/science/why-scientific-paradigms-keep-changing/

Ancel Keys 'seven nations' study showed a correlation between a diet with animal fats and heart disease. Soon flaws emerged, but it was already entrenched with the major charities and the medical profession.

"About a half-century elapsed before the situation was corrected, and the experts began to change their advice. As in almost any epidemiological issue, the case is complex, and there is confusion between 'the lipid hypothesis' about the cause of high-cholesterol, and the explanation of coronary heart disease by a high-animal-fat diet. However, there is little doubt that the focus on fat combined with the ignoring of sugar had indeed claimed thousands of victims. Nutrition, always a controversial science, was further damaged." (Ravetz, 2015, work in progress)

A commentator notes recently: "Mistrust of medical science is not merely the product of ignorance" (Evans, 2015).

Evans, R.J., 2015, Mistrust of medical science is not merely the product of ignorance, www.opendemocracy.net /, October 23.



# Problematic quantifications

p. 8: "The appeal of numbers is especially compelling to bureaucratic officials who lack the mandate of a popular election, or divine right. Arbitrariness and bias are the most usual grounds upon which such officials are criticized. A decision made by the numbers (or by explicit rules of some other sort) has at least the appearance of being fair and impersonal."



Theodor M. Porter



Theodore M. Porter, Trust in Numbers, The Pursuit of Objectivity in Science and Public Life, Princeton 1995

Theodore M. Porter **TRUSTIN SUBJUE SUBJUE The Pursuit of Objectivity in Science and Public Life**  p. 8: "Scientific objectivity thus provides an answer to a moral demand for impartiality and fairness. Quantification is a way of making decisions without seeming to decide. Objectivity lends authority to officials who have very little of their own."

Quantification: the discrete charm of bureaucracies?



Charles Goodhart

p. 44 "Any … measures necessarily involve a loss of information … [and distorts behavior]" (Porter, 1995)

This is what we normally call Goodhart's law, from Charles Goodhart. "When a measure becomes a target, it ceases to be a good measure."

http://cyberlibris.typepad.com/blog/files/Goodharts\_Law.pdf



Workshop 'Significant digits. Responsible Use of Quantitative Information', Brussels, 11,9–10 June 2015, organized by the Joint Research Centre of the European Commission.

John Kay, Financial Times

Mario Giampietro, ICREA-ICTA, Barcelona





https://ec.europa.eu/jrc/en/event/conference/use-quantitative-information

# Evidence based policy or policy based evidence?

"This need [for evidence] has been reified in the UK and elsewhere, as routines of 'evidence-based policy'-making have been hardwired into the business of Government. […]such approaches are fundamentally flawed [because] Government […] seeks to capture and control the knowledge producing processes to the point where this type of 'research' might best be described as 'policy-based evidence'."

Boden, R. and Epstein D., 2006, Managing the Research Imagination? Globalisation and Research in Higher Education. *Globalisation, Societies and Education*, 223-236.





OFFICE OF THE PRIME MINISTER'S CHIEF SCIENCE ADVISOR

Professor Sir Peter Gluckman, ONZ KNZM FRSNZ FMedSci FRS Chief Science Advisor

"evidence informed" rather than "evidence based"

"I have come to understand that the primary functions and greatest challenges for a science adviser are providing advice not on straightforward scientific matters, but instead on issues that have the hallmarks of what has been called post-normal science"

Gluckman, P., 2014, The art of science advice to government, Nature, 507, 163-165.

Recipes?

Ethical, epistemological, and methodological elements of the interlinked crises of science governance and science for policy

Elements of solutions may include:

-Unlearn what needs to be unlearned

- -Foster skills to spot socially constructed ignorance (\*)
- -Reconsidering the role of economics to adjudicate

Elements of solutions may include:

- -From Latin to vernacular (\*)
- -Foster skills for responsible use of quantitative information (\*)
- -Quantitative story-telling as opposed to spurious quantification (\*)-Work deliberatively within imperfections (\*)
- -Engage with new forms of science and citizens generated content

# (\*) Sensitivity auditing

Saltelli, A., Guimarães Pereira, Â., Van der Sluijs, J.P. and Funtowicz, S., 2013, What do I make of your latinorum? Sensitivity auditing of mathematical modelling, Int. J. Foresight and Innovation Policy, 9, 2/3/4, 213-234.

Saltelli, A., Funtowicz, S., When all models are wrong: More stringent quality criteria are needed for models used at the science-policy interface, Issues in Science and Technology, Winter 2014, 79-85.http://issues.org/30-2/andrea/



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ARTICLES

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#### 2015

Saltelli, A., Stark, P.B., Becker, W., and Stano, P., 2015, Climate Models as Economic Guides. Scientific Challenge or Quixotic Quest? Issues in Science and Technology (IST), Volume XXXI Issue 3, Spring 2015.

#### 2014

Giampietro, M., and Saltelli, A., 2014, Footprints to nowhere, Ecological Indicators, 46, 610-621.

Giampietro, M., and Saltelli, A., 2014, Footworking in Circles, Reply to Goldfinger at al. (2014) 'Footprint Facts and Fallacies: A Response to Giampietro and Saltelli (2014) Footprints to nowhere", Ecological Indicators, 46, 260-263.

Saltelli, A., Funtowicz, S., 2014, When all models are wrong. More stringent quality criteria are needed for models used at the science-policy interface, issues in Science and Technology, Winter 2014, 79-85.

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sensitivity analysis, sensitivity auditing, science for policy, impact assessment, ...

