

Climate numbers and climate wars

Andrea Saltelli
Centre for the Study of the
Sciences and the Humanities
(SVT), University of Bergen
(UIB)

Bergen, September 14, 2017

Andrea **Saltelli**

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



Ecological Economics 10 (1994) 197-207

The worth of a songbird: ecological economics as a post-normal science

Silvio O. Funtowicz ^a, Jerome R. Ravetz ^{b,*}

^a CEC-Joint Research Centre, Institute for Systems Engineering and Informatics, 1-21020 Ispra (Va), Italy ^b The Research Methods Consultancy Ltd., Gresham House, 144 High Street, Edgware, Middx HA8 7EZ, UK

(Received 21 December 1992; accepted 30 July 1993)

An old paper, a PNS 'classic'



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(Received 21 December 1992; accepted 30 July 1993)

Cited by 317 (Scopus) or by 715 (Google Scholar) March 2016

Funtowicz and Ravetz pick a paper on the economics of the greenhouse effect "since the paper displays considerable sophistication in the handling of uncertainties in data."

They note:

"the paper by Nordhaus is liberally sprinkled with caveats..."



One such caveat is – in the words of William Nordhaus – the difficulty to move from the "terra infirma of climate change to the terra incognita of the social and economic impacts of climate change" … but:



Having duly acknowledged Nordhaus' careful wording on uncertainty F&R proceed to deconstruct his work using the freshly minted NUSAP.



ECOLOGICAL ECONOMICS

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"[Although] in his rhetoric at least, the author shows a clear awareness of the presence of the various sorts of uncertainty, [...he] does not successfully manage the problems of uncertainty."

Table 1 Impact estimates for different sectors, for doubling of CO₂, U.S. (positive number indicates gain; negative number loss) (Nordbaus 1991 Table 6 p. 932)

Sectors	Billions (1981 \$)
Severely impacted sectors	
Farms	
Impact of greenhouse warming and CO2	-10.6 to $+9.7$
fertilisation	
Forestry, fisheries, other	Small + or
Moderately impacted sectors	
Construction	+
Water transportation	?
Energy and utilities	
Energy (electric, gas, oil)	
Energy demand	-1.65
Non-electric space heating	1.16
Water and sanitary	<u>-</u> ?
Real estate	
Land-rent component	
Estimate of damage from sea-level rise	
Loss of land	- 1.55
Protection of sheltered areas	-0.90
Protection of open coasts	- 2.84
Hotels, lodging, recreation	?
Total	
Central estimate	
Billions, 1981 level of national income	-6.23
Percentage of national income	-0.26

Sources for Table 6: Underlying data on impacts are summarised in EPA (1988). Translation into national-income accounts by author. Details are available on request.

"The hyper-precision in the expression of the key number - 0.26% [...] shows that this is one of those 'magic numbers' designed to produce confidence in the existence of a hard core of objective fact deep inside the mass of intuitive fuzz."

For Nordhaus - based on a 'hunch' this -0.26% could become -2% ...

Table 1
Impact estimates for different sectors, for doubling of CO₂, U.S. (positive number indicates gain; negative number loss) (Nordhaus, 1991, Table 6, p. 932)

Sectors	Billions (1981 \$)
Severely impacted sectors	
Farms	
Impact of greenhouse warming and CO ₂ fertilisation	-10.6 to $+9.7$
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Contents lists available at ScienceDirect

Global Environmental Change





Sensitivity analysis didn't help. A practitioner's critique of the Stern review Andrea Saltelli*, Beatrice D'Hombres

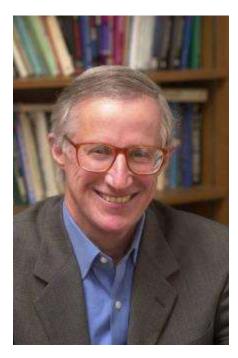
Joint Research Centre, Institute for the Protection and Security of the Citizen, Ispra, Italy

A more recent paper ...

... but only 13 citations in Scopus & 29 in Google Scholar 😊



The case of Stern's Review – Technical Annex to postscript



William Nordhaus, University of Yale

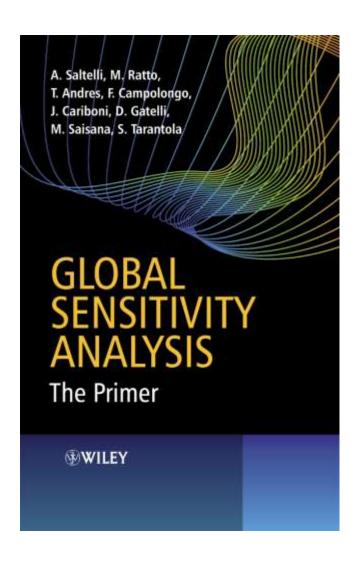


Nicholas Stern, London School of Economics

Stern, N., Stern Review on the Economics of Climate Change. UK Government Economic Service, London, www.sternreview.org.uk. Nordhaus W., Critical Assumptions in the Stern Review on Climate Change, SCIENCE, 317, 201-202, (2007).

What follows is a sensitivity analysis based on a reverse engineering of Stern's results

Also invoked one of the rules of 'sensitivity auditing'



Sensitivity analysis



An engineer's vision of UA, SA

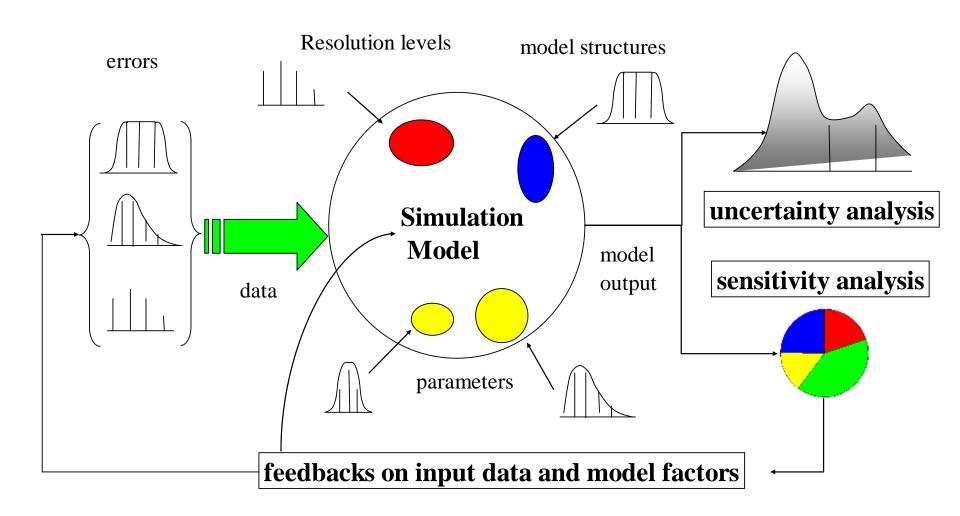




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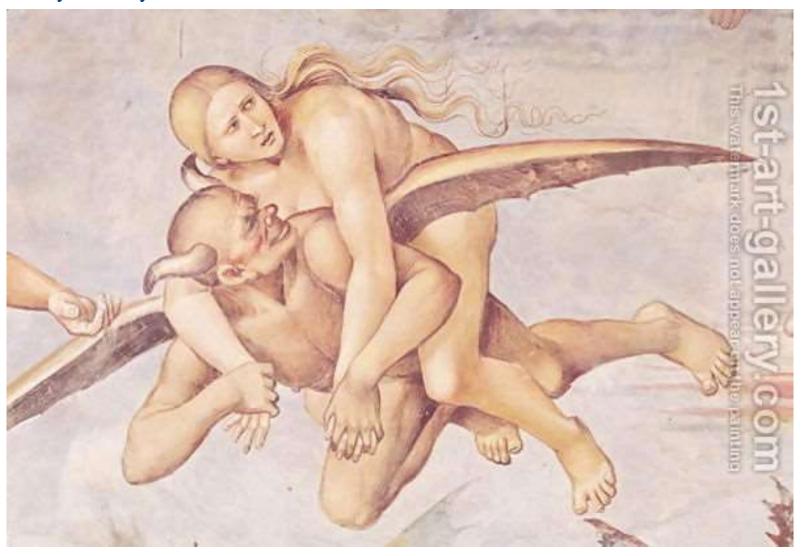
Volume XXX Issue 2, Winter 2014

When All Models Are Wrong

by Andrea Saltelli, Silvio Funtowicz

More stringent quality criteria are needed for models used at the science/policy interface, and here is a checklist to aid in the responsible development and use of models.

Rule 4: Find sensitive assumptions before these find you; do not publish the result of a modelling study before having done your sensitivity analysis



RULE FOUR: find sensitivities before sensitivities find you; Stern is in violation of this rule as he did his sensitivity analysis <u>after</u> being criticized by Nordhaus





The terms of the dispute



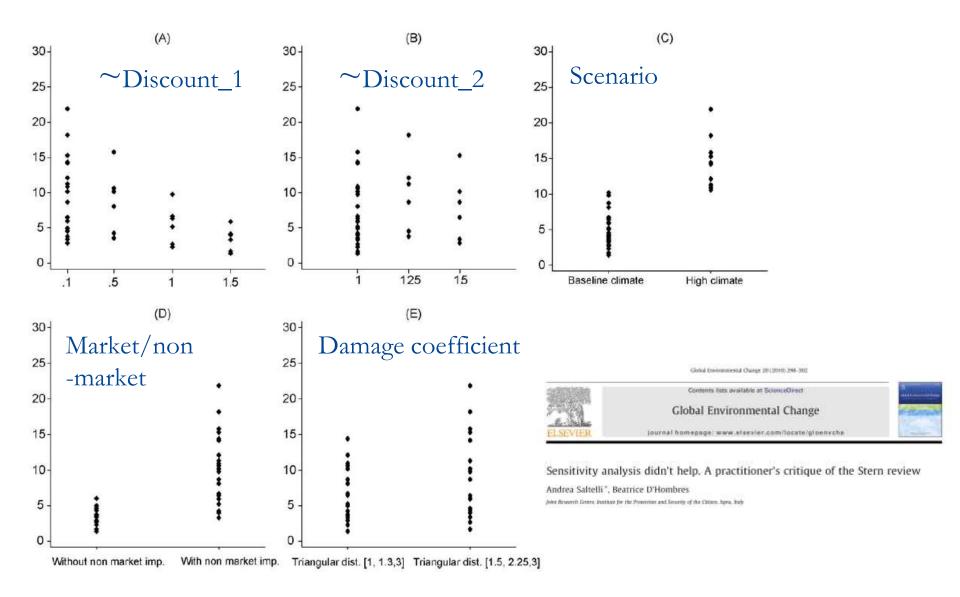
Falsifies Stern based on 'wrong' range of discount rate



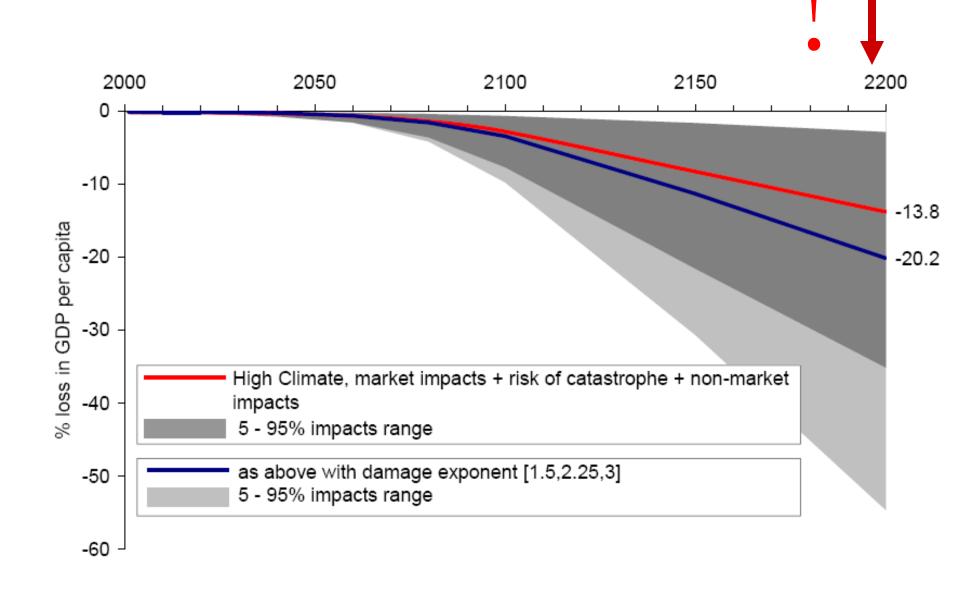
Prepares a postscript to his eponymous review: a sensitivity analysis of his own cost benefit analysis and claims: 'my analysis shows robustness'



Sensitivity analysis



My problems with it:

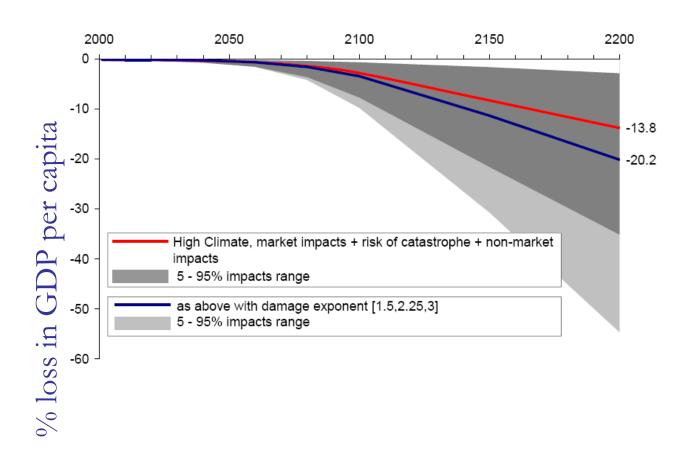


... but foremost Stern says:

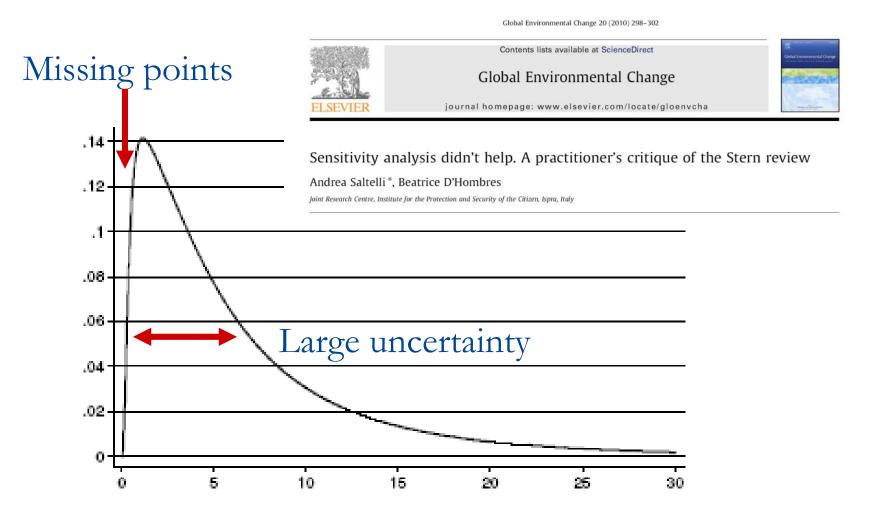
Even changing assumptions \rightarrow still important effect

when instead he should admit that:

Changing assumptions \rightarrow results change a lot

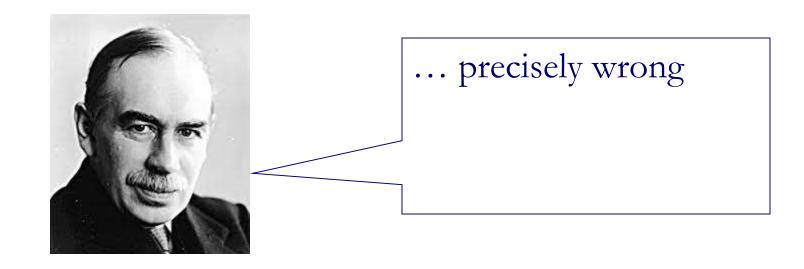


Why do we say so? A reverse engineering of Stern's analysis

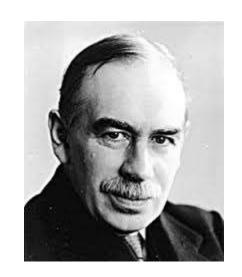


% loss in GDP per capita

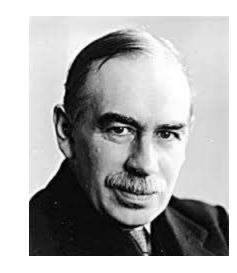
Not to say that Stern is wrong while Nordhaus is right, as both authors frame the debate around numbers which are ...



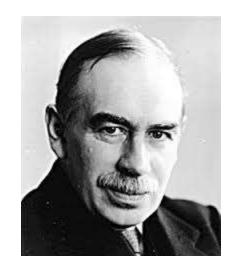
Since we are at John Maynard Keynes: what does he say of cost benefit analysis in his 1936 work 'The General Theory of Employment, Interest, and Money'?



"If we speak frankly, we have to admit that our basis of knowledge for estimating the yield ten years hence of a railway, a copper mine, a textile factory, the goodwill of a patent medicine, an Atlantic liner, a building in the City of London amounts to little and sometimes to nothing; or even five years hence..."



"... In fact, those who seriously attempt to make any such estimate are often so much in the minority that their behaviour does not govern the market."



ANDREA SALTELLI PHILIP B. STARK WILLIAM BECKER PAWEL STANO



NATIONAL ACADEMY OF SCIENCES NATIONAL ACADEMY OF ENGINEERING INSTITUTE OF MEDICINE THE UNIVERSITY OF TEXAS AT DALLAS

Clean Energy Diplomacy from Bush to Obama Physics Envy: Get Over It

The Limitations of Climate Models as Guides for Policy

Welcome to the Anthropocene

Empowering Social Science

An Excess of Research Space?

First Science Fiction Contest Winner

A New **Model** for the American Research University



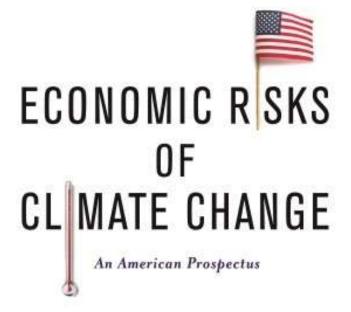
Climate Models as Economic Guides Scientific Challenge

Quixotic Quest?

The uncertainties associated with mathematical models that assess the costs and benefits of climate change policy options are unknowable. Such models can be valuable guides to scientific inquiry, but they should not be used to guide climate policy decisions.

... targeting an audacious study:

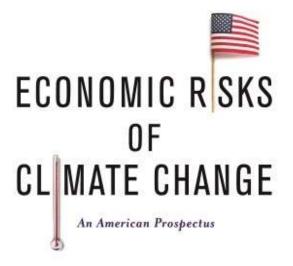
Foreword by Michael R. Bloomberg, Henry M. Paulson, and Thomas F. Stever



TREVOR HOUSER, SOLOMON HSIANG, ROBERT KOPP, AND KATE LARSEN

Contributions by Karen Fisher-Vanden, Michael Greenstone, Geoffrey Heal, Michael Oppenheimer, Nicholas Stern, and Bob Ward "[...] the report forecasts—at the level of individual counties in the U.S.—energy costs and demand, labor supply, mortality, violent crime rates, and real estate property prices up to the year 2100 [...]"

Climate Models as Economic Guides Scientific Challenge or Quixotic Quest? Foreword by Michael R. Bloomberg, Henry M. Paulson, and Thomas F. Steyer



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Foreword by Michael R. Bloomberg, Henry M. Paulson, and Thomas F. Stever

ECONOMIC R SKS

OF

CL MATE CHANGE

An American Prospectus

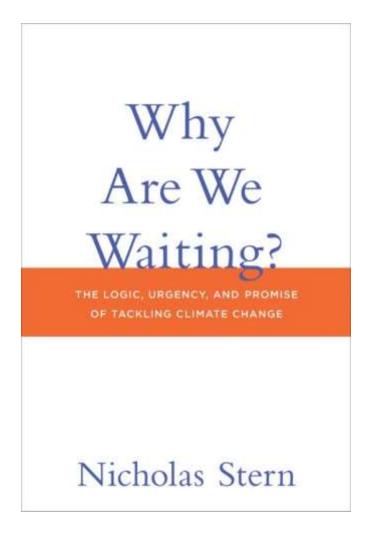
TREVOR HOUSER, SOLOMON HSIANG, ROBERT KOPP, AND KATE LARSEN

Contributions by Karen Fisher-Vanden, Michael Greenstone, Geoffrey Heal, Michael Oppenheimer, Nicholas Stern, and Bob Ward

"The report presents the amount of computer power and data generated as evidence of the scientific legitimacy of the enterprise. The authors note, however, that out of an abundance of caution they did not model deterioration in cognitive performance as temperatures rise"

Climate Models
as
Economic Guides
Scientific Challenge
or
Ouisotic Quest?

Next comes the latest (2015) book of Nicholas Stern ...



... advocating for better integrated assessment models (IAM)

THE LOGIC, URGENCY, AND PROMISE OF TACKLING CLIMATE CHANGE

Excerpts

"Integrated assessment models have produced valuable insights" p. 139

"In Chapter six of the Stern review we made use of the PAGE model" p. 345

THE LOGIC, URGENCY, AND PROMISE OF TACKLING CLIMATE CHANGE

... After a list of criticism moved to the realism of Integrated Assessment Models:

"[...] the point is that estimates based on these models are very sensitive to assumptions and are likely to lead to gross underestimation" p.139

Things to be incorporated in 'formal modelling' [sic]

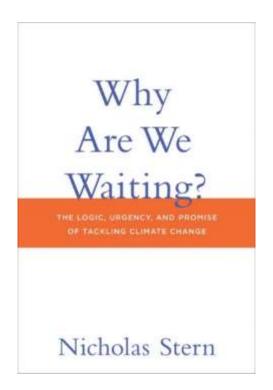
"Damage to social, organizational or environmental capital [...]

Damage to stock of capitals and land [...]

Damage to overall factor productivity [...]

Damage to learning and endogenous growth", p. 145

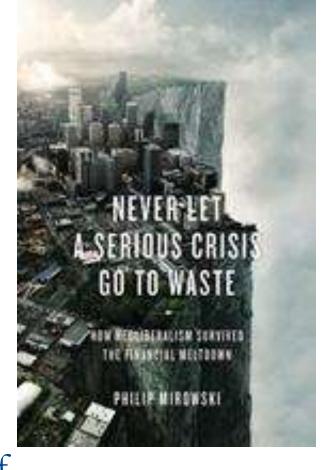
'formal modelling' as to produce 'numbers'?



The book of N. Stern suggests using different mathematical models, including dynamic stochastic general equilibrium models.

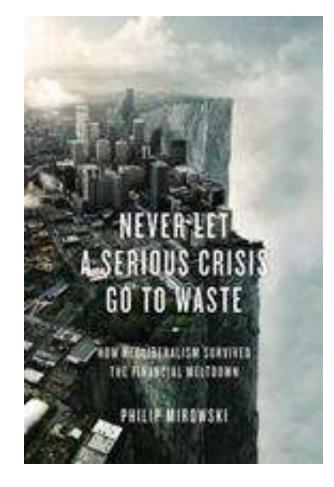


Philip Mirowski



See Philip Mirowski's book for a critique of DSGE as used in economics ... inquiries by the US senate and the Queen of the England about their failure to predict the crisis ...

Everybody in the profession knows that DSGE work under the economists' standard 'caeteris paribus' hypothesis (=all the rest being equal)



Caeteris are never paribus

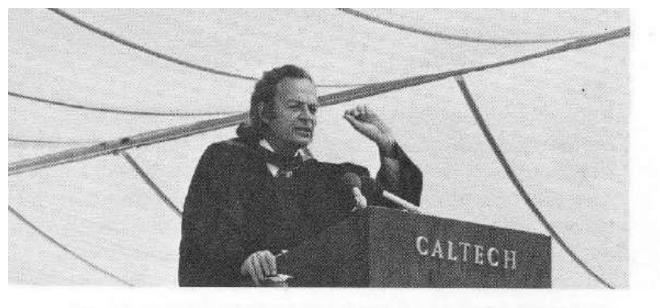
Economics?

The Mathiness discussion in Economics

"The style that I am calling mathiness lets academic politics masquerade as science. Like mathematical theory, mathiness uses a mixture of words and symbols, but instead of making tight links, it leaves ample room for slippage between statements in natural versus formal language and between statements with theoretical as opposed to empirical content."



Paul Romer Since July 18 2016 Chief Economist of the World Bank



Cargo Cult Science

by RICHARD P. FEYNMAN

Some remarks on science, pseudoscience, and learning how to not fool yourself. Caltech's 1974 commencement address.



Appeals to Richard Feynman's famous speech

https://paulromer.net/feynman-integrity/



The Trouble With Macroeconomics

Paul Romer
Stern School of Business
New York University

Wednesday 14th September, 2016

- 2 Post-Real Models
- 6 Questions About Economists, and Physicists
- 7 Loyalty Can Corrode The Norms of Science
- 9.1 The Norms of Science
- 10 The Trouble Ahead For All of Economics

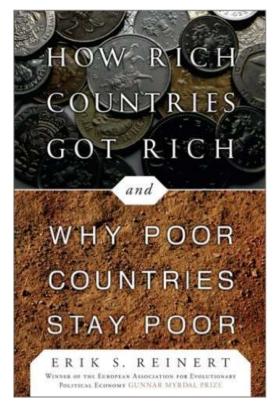
A different diagnosis for a diseased economics: for Erik Reinert's: economics has reverted to scholasticism

- ··· forgetting an important continental tradition
- ··· implications for developments

http://www.andreasaltelli.eu/file/repository/Full_Circle_scholasticism_2.pdf



Erik Reinert



Should natural sciences enroll economics in their advocacy to save the planet?

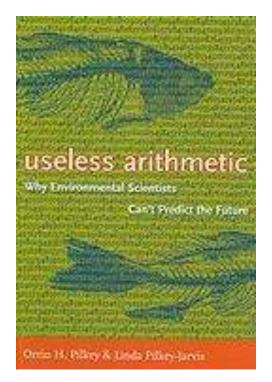


Mathematical modelling of climatic change (terra infirma) versus its cost to society (terra incognita):



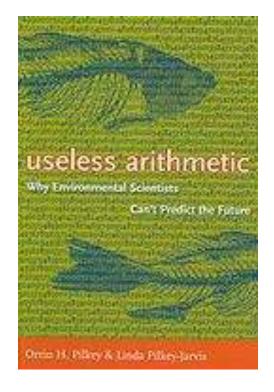
Pilkey and Pilkey-Jarvis (2007:86) climatesceptics' work would be harder if:

"[...] the global change modeling community would firmly and publicly recognize that its efforts to truly quantify the future are an academic exercise and that existing field data on atmospheric temperatures, melting glaciers, [...] and other evidence should be relied on to a much greater degree to convince politicians that we have a problem."



Pilkey, O.H. and Pilkey-Jarvis, L., 2007. Useless Arithmetic. Why Environmental Scientists Can't Predict the Future, Columbia University Press, New York.

"[...] A serious societal debate about 'solutions' can never occur as long as modellers hold out the probability, just around the corner, of accurate projections of future climates and seal-level position."



How about indicators of man's pressure on the planet?

The case of the Ecological Footprint





1.6 planets?16?

16 hundred?

16 thousand?

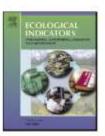
Infinity?



Contents lists available at ScienceDirect

Ecological Indicators





Footprints to nowhere





b Institute for the Protection and Security of the Citizen (IPSC), The European Commission, Joint Research Centre, TP 361, 21027 Ispra, VA, Italy



Highlights

- The EF is inconsistent with its stated purpose of measuring demand on ecosystems.
- The EF depends mostly from a dimensionally flawed energy emissions assessment.
- The EF is optimistic at the global scale and policy-misleading at the local one.
- One cannot accept EF's flaws on the ground that the EF has normative virtues.
- EF's rhetoric trivializes bio-economics and muddles the sustainability debate.

Catalan Institution for Research and Advanced Studies (ICREA), Passeig Lluís Companys, 23, 08010 Barcelona, Spain

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

Goldfinger, S., Wackernagel, M., Galli, A., Lazarus, E., Lin, D., 2014, Footprint facts and fallacies: A response to Giampietro and Saltelli (2014) "Footprints to Nowhere", 46, 622–632.

Giampietro, M., and Saltelli, A., 2014, Footworking in Circles, Ecological Indicators, 46 (2014) 260–263.

Alessandro Galli, Mario Giampietro, Steve Goldfinger, Elias Lazarus, David Lin, Andrea Saltelli, Matthis Wackernagel, Felix Müller, 2016, Questioning the ecological footprint, Ecological Indicators, 69, 224–232.





How many Chinas does it take to support China?



What about some other countries?



















JAPAN 7.1

A JAPAN 7.1

Based on two "accounts (biocapacity and footprint) representing the supply and demand of renewable biological resources, and the area of forest required to offset human carbon emissions (the carbon footprint)" the EF tells mankind how many planets are being used



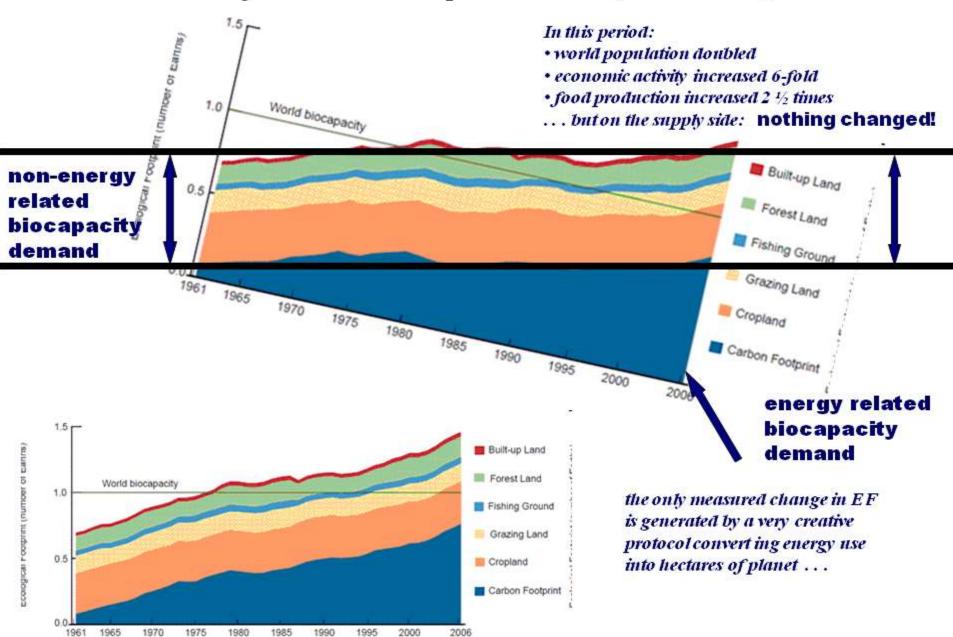








The change of world footprint in time (1961-2006)



The footprint is almost entirely driven by energy consumption, which corresponds to carbon emission which are in turn sequestrated by forests; [...] Carbon sequestration rate is hence what drives the results

But this number could be made negative as well as infinity depending on what number one picks ... it is totally volatile

Is the EF a rhetorical device?

- The implausible accuracy (Earth overshoot day = August 2!)
- Offsetting a flow with a stock (Kg of CO2 per year versus square meters of land)
- The anti-trade bias (CMEPSP, 2009, p. 71)
- The total dependence upon energy related pressures
- Paradoxical policy implications (e.g. in Agriculture)

Giampietro and Saltelli, Op. cit.

CMEPSP (2009). Commission on the Measurement of Economic Performance and Social Progress, URL: http://www.stiglitz-sen-fitoussi.fr/documents/rapport_anglais.pdf last accessed June 2014.

Is the EF a rhetorical device?

- The EF is inconsistent with its stated purpose of measuring demand on ecosystems
- The EF depends mostly from a dimensionally flawed energy emissions assessment
- One cannot accept EF's flaws on the ground that the EF has normative virtues; EF's rhetoric muddles the sustainability debate

"EF measurements, as currently constructed and presented, are so misleading as to preclude their use in any serious science or policy context.[...], less than half the area of the United States planted with eucalypts could essentially give us an EF equal to one Earth—an approach that no ecologist would recommend."

Blomqvist L, Brook BW, Ellis EC, Kareiva PM, Nordhaus T, et al. (2013a) Does the Shoe Fit? Real versus Imagined Ecological Footprints. PLoS Biol 11(11): e1001700. doi:10.1371/journal.pbio.1001700.

See also follow up:

Rees WE, Wackernagel M (2013) The Shoe Fits, but the Footprint is Larger than Earth. PLoS Biol 11(11): e1001701. doi:10.1371/journal.pbio.1001701

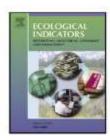
Blomqvist L, Brook BW, Ellis EC, Kareiva PM, Nordhaus T, et al. (2013b) The Ecological Footprint Remains a Misleading Metric of Global Sustainability. PLoS Biol 11(11): e1001702. doi:10.1371/journal.pbio.1001702.



Contents lists available at ScienceDirect

Ecological Indicators

journal homepage: www.elsevier.com/locate/ecolind



Questioning the Ecological Footprint



Alessandro Galli^{a,1}, Mario Giampietro^{b,c}, Steve Goldfinger^d, Elias Lazarus^{d,2}, David Lin^{d,2}, Andrea Saltelli^{e,c}, Mathis Wackernagel^{d,2}, Felix Müller^{f,*}

2. How is the research question underlying the Ecological Footprint relevant or irrelevant to policy concerns?⁵

Giampietro and Saltelli	Lin, Wackernagel, Galli, Goldfinger and Lazarus
When it comes to policy concern, one should bear in mind: (i) "make	If we are to live within the ecological constraints of our planet,

⁴ Global Footprint Network, 7-9 Chemin de Balexert, 1219 Geneva, Switzerland

b Institució Catalana de Recerca i Estudis Avançats (ICREA), Passeig Lluís Companys 23, 08010 Barcelona, Spain

Elnstitut de Ciència i Tecnologia Ambientals (ICTA), Universitat Autònoma de Barcelona (UAB), 08193 Bellaterra, Spain

d Global Footprint Network, 312 Clay Street, Suite 300, Oakland, CA 94607-3510, USA

c Centre for the Study of the Sciences and the Humanities (SVT) - University of Bergen (UIB) Norway

Institute for Natural Resource Conservation, University of Kiel, Olshausenstrasse 75, D 24118 Kiel, Germany

See also:

Blomqvist, L., Brook, B.W., Ellis, E.C., Kareiva, P.M., Nordhaus, T., Shellenberger, M.,2013. Does the shoe fit? Real versus imagined ecological footprints. PLoS Biol.11 (11), e1001700, http://dx.doi.org/10.1371/journal.pbio.1001700

van den Bergh, J., Grazi, F., 2015. Reply to the first systematic response by the Global Footprint Network to criticism: A real debate finally?, http://dx.doi.org/10.1016/j.ecolind.2015.05.007.

Post-truth, science and climate wars and their context

- 1. Science is in a deep existential crisis which has ethical, epistemological, methodological and even metaphysical dimensions
- 2. Likewise democracy which has with science a legitimacy arrangement
- 3. Science and its institutions are committed to the status quo & attempt to evade a critical reflection
- 4. Solutions aren't forthcoming anytime soon
- 5. There are few areas of 'Reformation' where science and society work together



THE RIGHTFUL PLACE OF SCIENCE:

SCIENCE ON THE VERGE

CONTRIBUTORS

Alice Benessia Silvio Funtowicz Mario Giampietro Ângela Guimarães Pereira Jeroen P. van der Sluijs

lerome R. Ravetz Andrea Saltelli Roger Strand



https://www.amazon.co.uk/Rightful-Place-Science-Vergeebook/dp/B01CJ0GLK6/ref=sr_1_1?ie=UTF8&qid=1473933311&sr=8-1&keywords=saltelli

http://www.andreasaltelli.eu/science-on-the-verge



Academic rigour, journalistic flair

Arts + Culture Business + Economy Education Environment + Energy Health + Medicine Politics + Society Science + Technology Brexit

Science in crisis: from the sugar scam to Brexit, our faith in experts is fading

September 27, 2016 7.43am BST



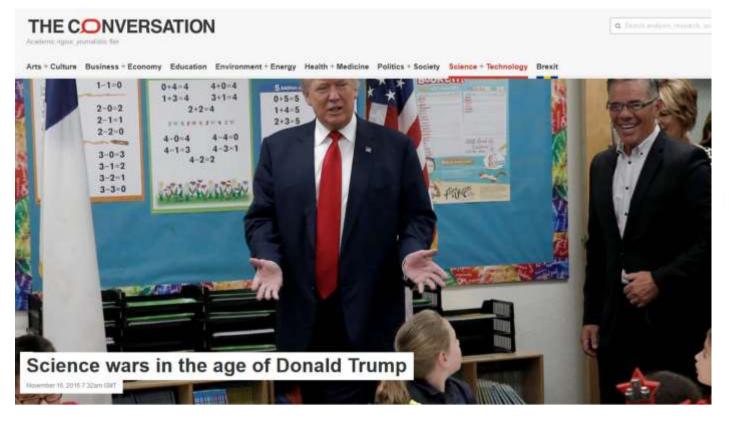
Author



Andrea Saltelli

Researcher at the Centre for the Study of the Sciences and the Humanities (SVT), University of Bergen

An ongoing diversion strategy: "There is a problem, and this is due to an ongoing war on science between the educated liberal left and the ignorant conservative right"



Authors



Andrea Saltelli

Adjunct professor, University of Bergen



Silvio Oscar Funtowicz

Adjunct Professor Centre for the Study of the Sciences and the Humanities, University of Bergen

An ongoing displacement strategy: "This is the posttruth era"

THE CONVERSATION

Academic rigour, journalistic flair

Arts + Culture Business + Economy Education Environment + Energy Health + Medicine Politics + Society Science + Technology

To tackle the post-truth world, science must

reform itself

January 27, 2017 7:33am GMT



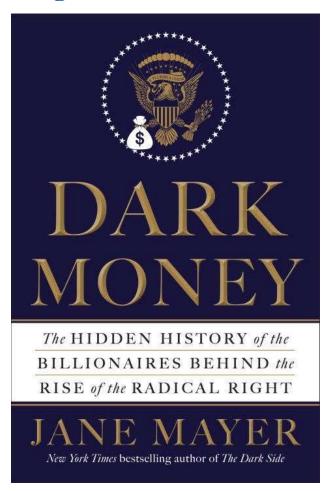
Authors



Andrea Saltelli Adjunct professor, University of



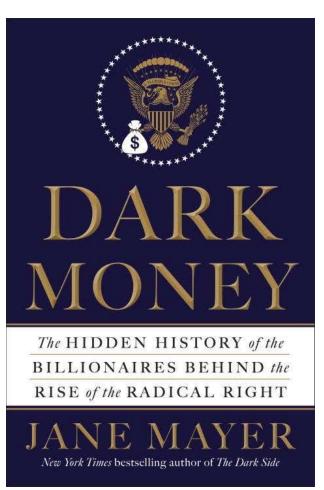
Silvio Oscar Funtowicz Adjunct Professor Centre for the Study of the Sciences and the Humanities, University of Bergen The skirmishes on misuse or abuse of modelling are likely to get lost in the all out war on climate



Some excerpts of chapter 8, The Fossils, here: http://www.andreasaltelli.eu/file/repository/Chapter_8sr.pdf



"While Obama's health-care bill was useful in riling up Tea Party protesters, his environmental and energy policies were the real Target of Many of the multimillionaires and billionaires in the Koch circle."



THE HOUSE SCIENCE COMMITTEE'S ANTI-SCIENCE RAMPAGE

By Lawrence M. Krauss, SEPTEMBER 14, 2016



SST Committee Members Introduce the Honest and Open New EPA Science Treatment Act of 2017, EPA Science Advisory Board Reform Act of 2017

Mar 6, 2017 | Press Release

WASHINGTON – U.S. Rep. Lamar Smith (R-Texas), chairman of the House Science, Space, and Technology Committee, today introduced the Honest and Open New EPA Science Treatment Act of 2017 (HONEST Act). Simultaneously, U.S. Rep. Frank Lucas (R-Okla.), and



There has always been tension between scientists and Congress. But Lamar Smith, the chairman of the House Committee on Science, Space, and Technology, has escalated that tension into outright war.

CALL OUT THE CLIMATE CHANGE DENIERS

97%

OF CLIMATE SCIENTISTS AGREE

that climate change is real and man-made, and affecting communities in every part of the country.

Yet too many of our elected officials deny the science of climate change. Along with their polluter allies, they are blocking progress in the fight against climate change.

Find the deniers near you—and call them out today.

ADD YOUR NAME TO JOIN THE FIGHT

ENTER YOUR EMAIL

ENTER YOUR ZIP

I'M IN

https://www.of a.us/climatechange-deniers/

https://en.wikipedia.org/wiki/ Organizing_for_Action

FIND DENIERS

OR CHOOSE YOUR STATE



DENIER

Sen. Mitch McConnell

Call Them Out

DENIER

THE DENIERS



Sen. Joni Ernst

Call Them Out

DENIER



Rep. Paul Ryan WI-1

Call Them Out

The Next Genocide

By TIMOTHY SNYDER SEPT. 12, 2015

"New Haven — BEFORE he fired the shot, the Einsatzgruppe commander lifted the Jewish child in the air and said, "You must die so that we can live." As the killing proceeded, other Germans rationalized the murder of Jewish children in the same way: them or us."

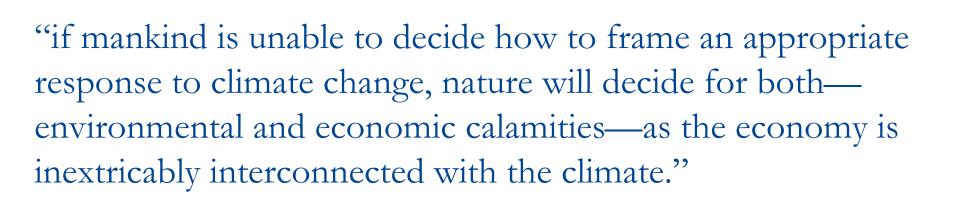
The New York Times

The Next Genocide

By TIMOTHY SNYDER SEPT. 12, 2015

"Hitler spread ecological panic [...] the United States has done more than any other nation to bring about the next ecological panic [...] deniers [...] intellectual stance that is uncomfortably close to Hitler's."

The New York Times



Gabriele Gramelsberger and Johann Feichter Modelling the Climate System: An Overview, in Climate Change and Policy, DOI 10.1007/978-3-642-17700-2_2, # Springer-Verlag Berlin Heidelberg 2011.

Climate change scepticism

World court should rule on climate science to quash sceptics, says Philippe Sands

International Court of Justice ruling would settle the scientific dispute and pave the way for future legal cases on climate change, says high-profile lawyer

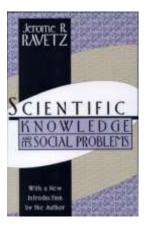




Philippe Sands QC says a court ruling would carry more weight with public opinion than science alone. Photograph: Antonio Zazueta Olmos/Antonio Olmos

Hold on a second!

p. 22-23: "Two separate factors are necessary for the achievement of worthwhile scientific results: a community of scholars with a shared knowledge of the standards of quality appropriate for their work and a shared commitment to enforce those standards by the informal sanctions the community possesses; and individuals whose personal integrity sets standards at least as high as those required by their community..."





Jerome R. Ravetz

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

Utopia or dystopia?

A community of scholars with shared commitment to enforce standards by informal sanctions (Ravetz 1971)





Versus

Warring parties where both scientists and/cum advocates throw at one another anti-racketeering legislation (FOIA)



Saving the planet is not a sufficient justification to produce fantastic numbers

Chapter 8, On Not Hitting the Tar-Baby, p. 138, of Winner, L., 1986. The Whale and the Reactor: a Search for Limits in an Age of High Technology. The University of Chicago Press.

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

Saltelli, A., D'Hombres, B., Sensitivity analysis didn't help. A practitioner's critique of the Stern review, 2010, Global Environmental Change, 20, 298-302.

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.

Pieces on The Conversation, see https://theconversation.com/uk/search?utf8=%E2%9C%93&q=saltelli

