

# What can sensitivity analysis contribute to a sociology of quantification?

Monica Di Fiore<sup>(1)</sup>, Arnald Puy<sup>(2,3)</sup>, Andrea Saltelli<sup>(1,3,4)</sup>

SAMO Conference

Sensitivity Analysis of Model Output Conference

March 14–16, 2022, Florida State University

Tallahassee, Florida 32306–1640



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- (2) Department of Ecology and Evolutionary Biology, University, New Jersey, (US)
- (3) Centre for the Study of the Sciences and the Humanities (SVT), University of Bergen, (NO)
- (4) UPF Barcelona School of Management, Barcelona, (ES)

## Sociology of quantification

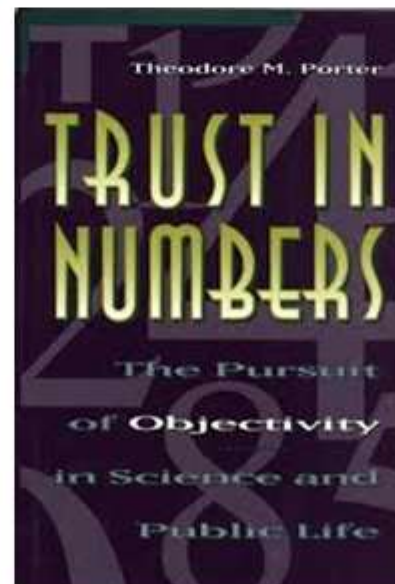
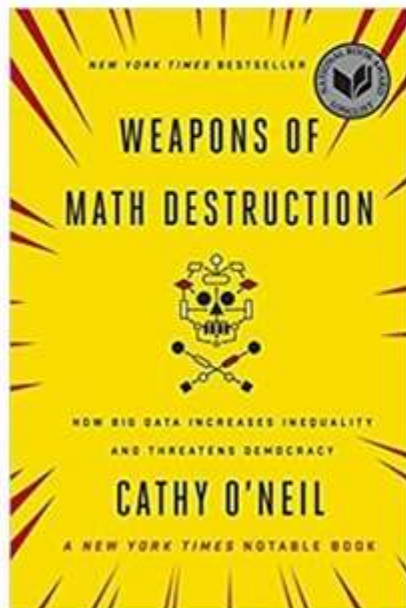
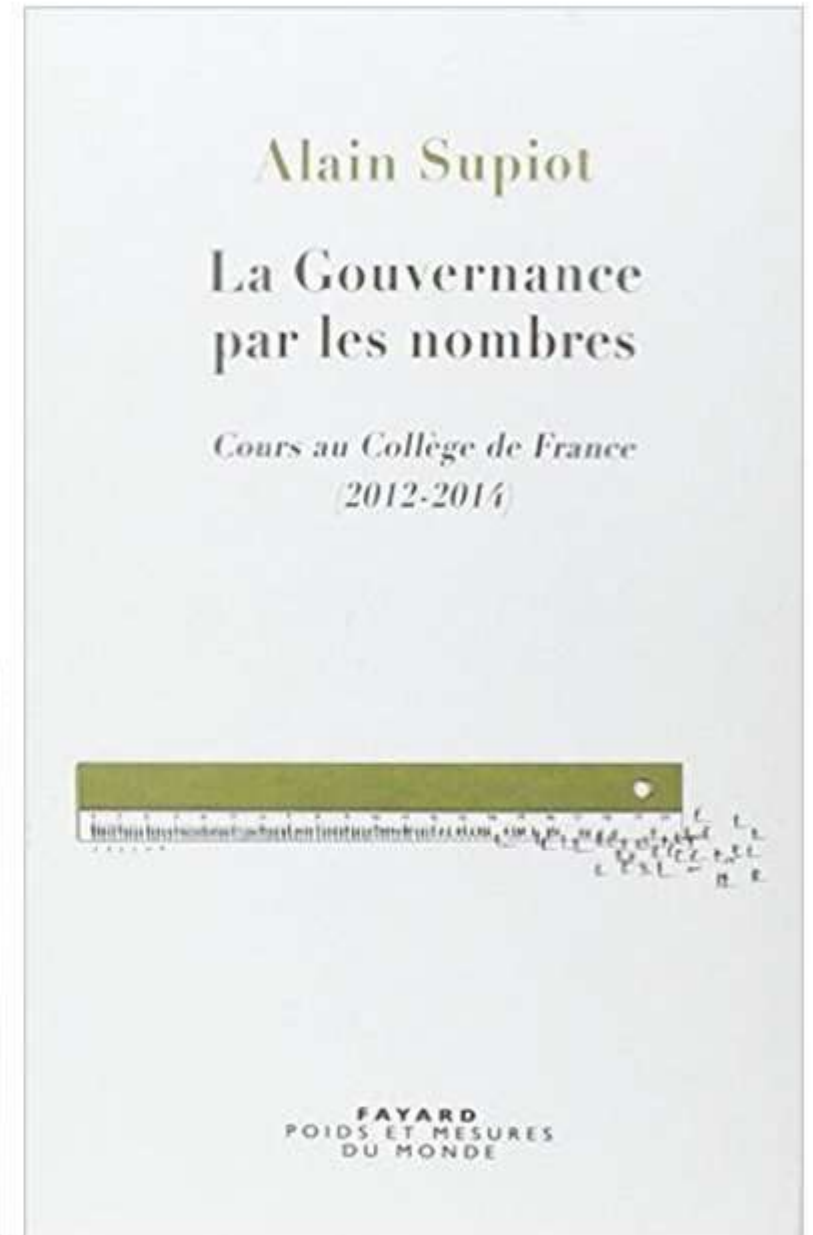
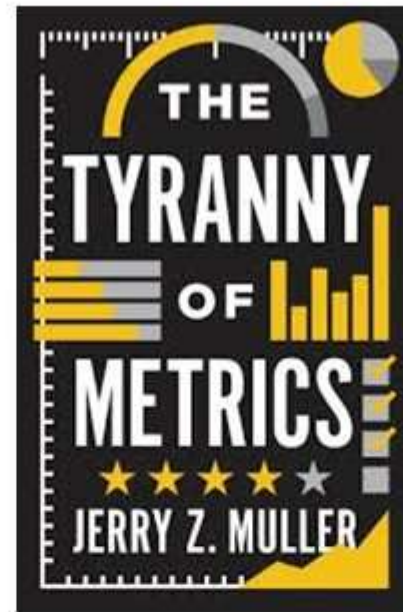
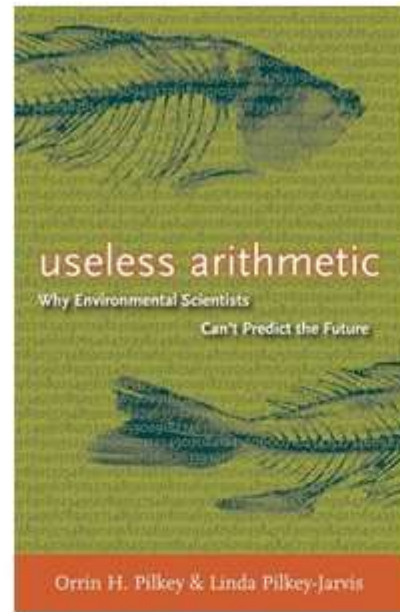
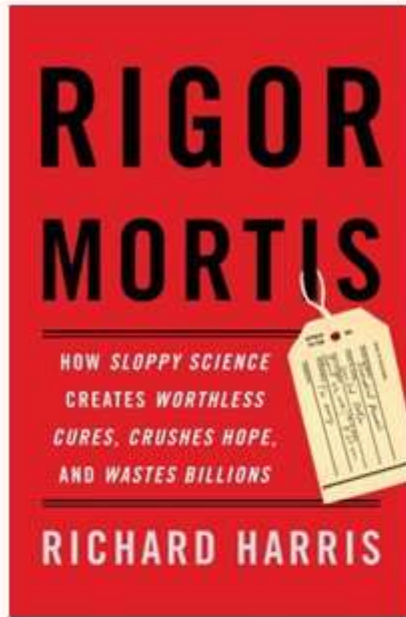
Expanding (exploding?) field studying the many **disciplinary fields** where numbers are produced

➔ from statistical and mathematical modelling to data science, algorithms, big data, quantified self, ratings rankings and indicators, official statistics ...

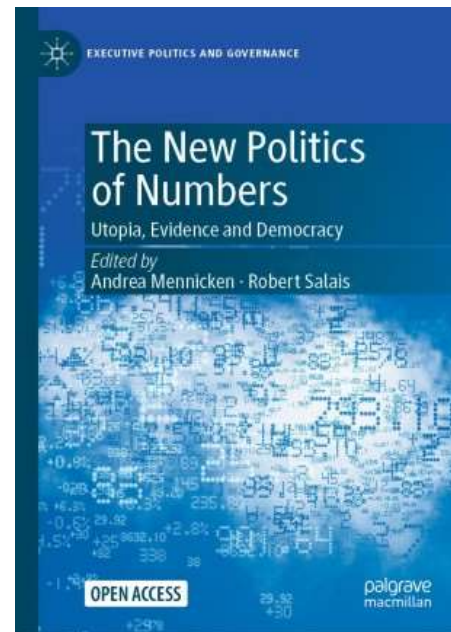
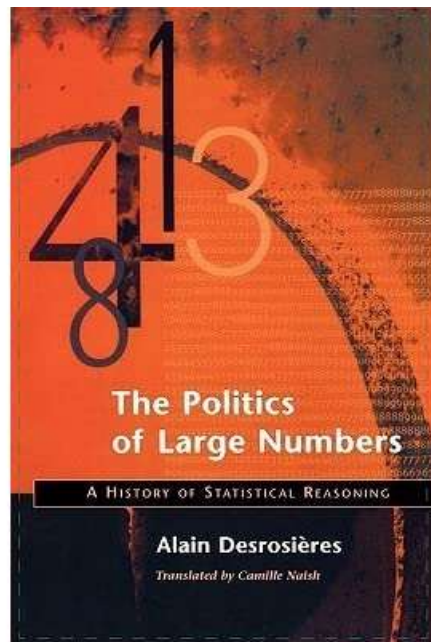
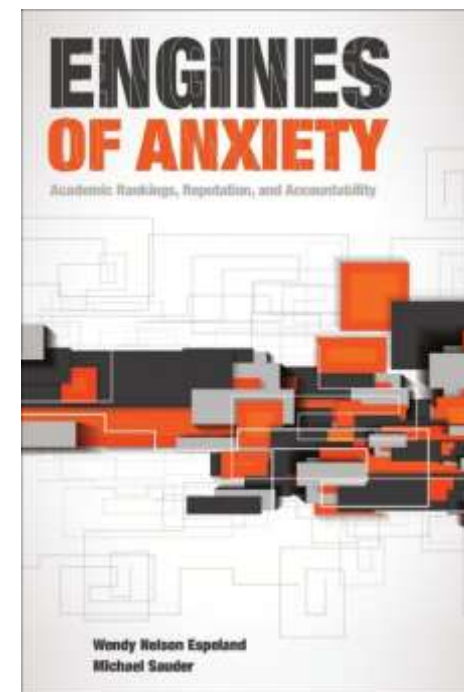
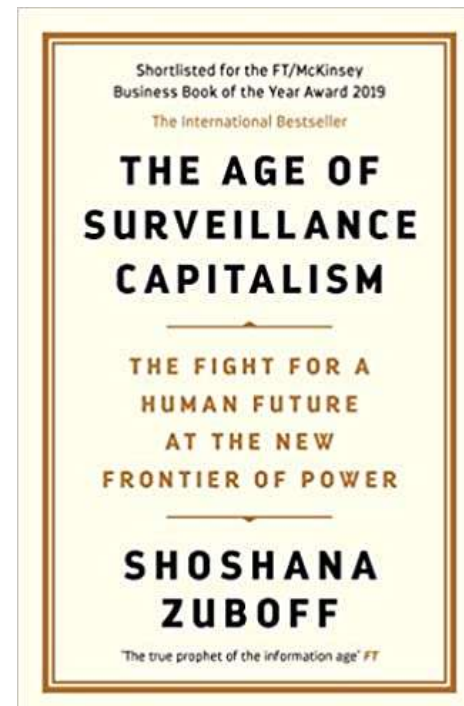
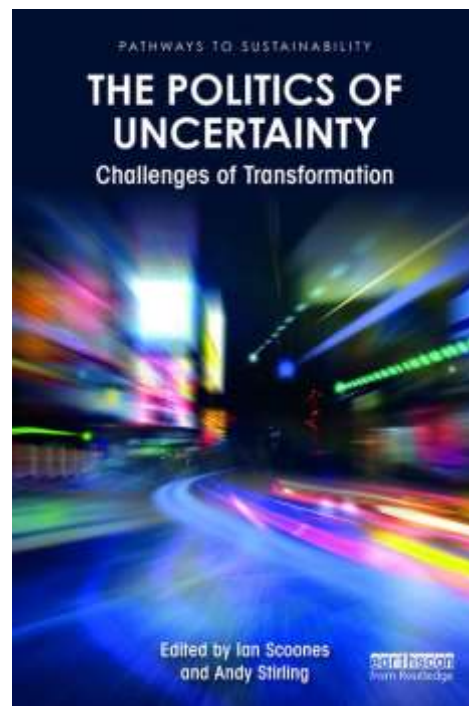
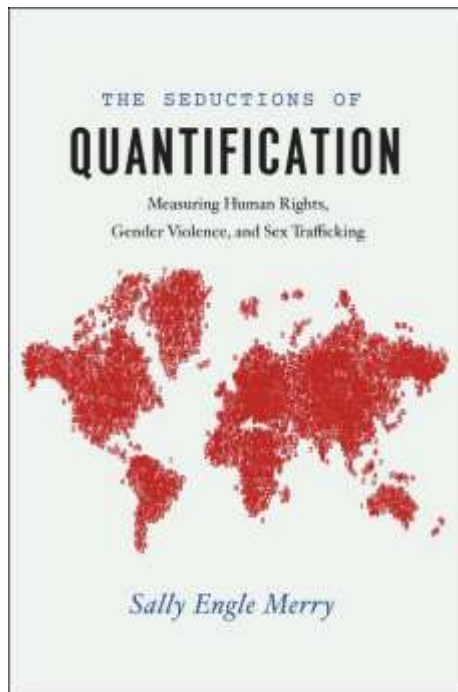
E. Popp Berman and D. Hirschman, “The Sociology of Quantification: Where Are We Now?,” *Contemp. Sociol.*, vol. 47, no. 3, pp. 257–266, 2018.

A. Mennicken and W. N. Espeland, “What’s New with Numbers? Sociological Approaches to the Study of Quantification,” *Annu. Rev. Sociol.*, vol. 45, no. 1, pp. 223–245, 2019, doi: 10.1146/annurev-soc-073117-041343.

# Algorithms, models, metrics, statistics...







Humanities & Social Sciences  
Communications

ARTICLE

<https://doi.org/10.1057/s41599-020-00557-0> OPEN

**From sociology of quantification to ethics  
of quantification**

Andrea Saltelli <sup>1</sup> & Monica Di Fiore <sup>2</sup>

Check for updates

“what qualities are specific to rankings, or indicators, or models, or algorithms?”



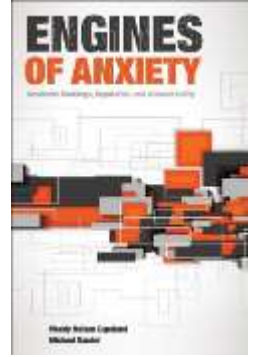
Elizabeth  
Popp Berman

E. Popp Berman and D. Hirschman, **The Sociology of Quantification**: Where Are We Now?, *Contemp. Sociol.*, vol. in press, 2017.



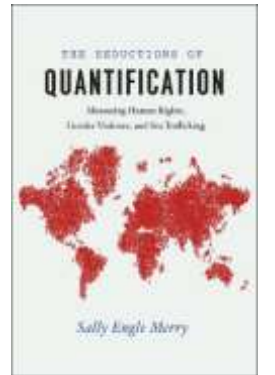
Wendy Espeland

Numbers and their 'reactivity'  
(Espeland and Sauder, 2016)



Sally Engle Merry

Incumbent numbers affect what  
society will measure in  
the future (Merry 2016)

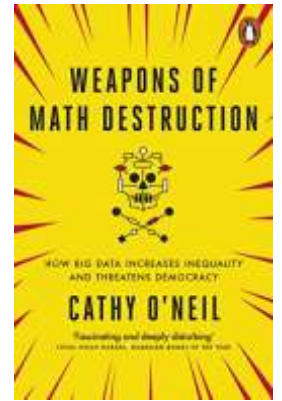






Cathy O'Neil

Numbers “create the environment that justifies their assumptions” (O’Neil, 2016)



Numbers are seductive, performative, confer to their masters epistemic power and legitimacy



Saltelli, A., Andreoni, A., Drechsler W., Ghosh, J., Kattel, R., Kvangraven, I. H., Rafols, I., Reinert, E. S., Stirling, A. and Xu, T. (2021). Why ethics of quantification is needed now. UCL Institute for Innovation and Public Purpose, Working Paper Series (IIPP WP 2021/05).f

# Exploring the *hidden* quality of numbers

Reactivity

Performativity



Epistemic authority



Access & production of numbers reflect and reinforce power imbalances; Numbers illuminate a part of reality, and push into the background that part which comes without them



Why ethics of quantification is needed now

**Andrea Saltelli**

Open Evidence Research, Universitat Oberta de Catalunya, Barcelona, Spain

**Antonio Andreoni**

UCL Institute for Innovation and Public Purpose;  
South African Research Chair in Industrial Development, University of Johannesburg, South Africa

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Tallinn University of Technology, Estonia;  
UCL Institute for Innovation and Public Purpose;  
Davis Center at Harvard University, United States

**Jayati Ghosh**

University of Massachusetts Amherst, United States;  
UCL Institute for Innovation and Public Purpose

**Rainer Kattel**

UCL Institute for Innovation and Public Purpose

**Ingrid H. Kvangraven**

Department of Politics, University of York

**Ismael Rafols**

Centre for Science and Technology Studies, Leiden University, the Netherlands

**Erik S. Reinert**

Tallinn University of Technology, Estonia;  
UCL Institute for Innovation and Public Purpose

**Andy Stirling**

Science Policy Research Unit, University of Sussex

**Ting Xu**

School of Law at the University of Essex



UCL Institute for  
Innovation and  
Public Purpose

WORKING PAPER  
WP 2021/05



Are models a way of producing numbers that is poorly explored (\*). But for how long?

(\* ) With respect e.g. to statistics, big data and algorithms ... there are statistical wars, not modelling wars

Andrea Saltelli, 2019, A short comment on statistical versus mathematical modelling, Nature Communications, 10, Article number: 3870, <https://doi.org/10.1038/s41467-019-11865-8>.

Eker, S. et al. (2018) 'Practice and perspectives in the validation of resource management models', Nature Communications, 9(1), p. 5359. doi:10.1038/s41467-018-07811-9.



## Cargo-cult statistics and scientific crisis

Written by Philip B. Stark and Andrea Saltelli on 05 July 2018. Posted in [Science](#)

A. Saltelli (Guest post): What can we learn from the debate on statistical significance?

Posted on November 22, 2019 by Mayo

**Professor Andrea Saltelli**  
Centre for the Study of the Sciences and the Humanities (SVT), University of Bergen (UIB, Norway),  
&  
Open Evidence Research, Universitat Oberta de Catalunya (UOC), Barcelona

What can we learn from the debate on statistical significance?



Statistics in the  
wake of the  
reproducibility  
crisis

Statistical wars on hypothesis testing



## Five ways to ensure that models serve society: a manifesto

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



Illustration by David Parkins





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

**3 modellers** Lo Piano, Puy, Saltelli

**2 experts models and**

**society** Pielke, van der Sluijs

**3 statisticians** Mayo, Stark, Portaluri

**2 statactivistes** Bruno, Didier

**2 economists** Kay, Raynert

**1 epidemiologist** Vineis

**2 sociologists of quantification**

Espeland, Porter

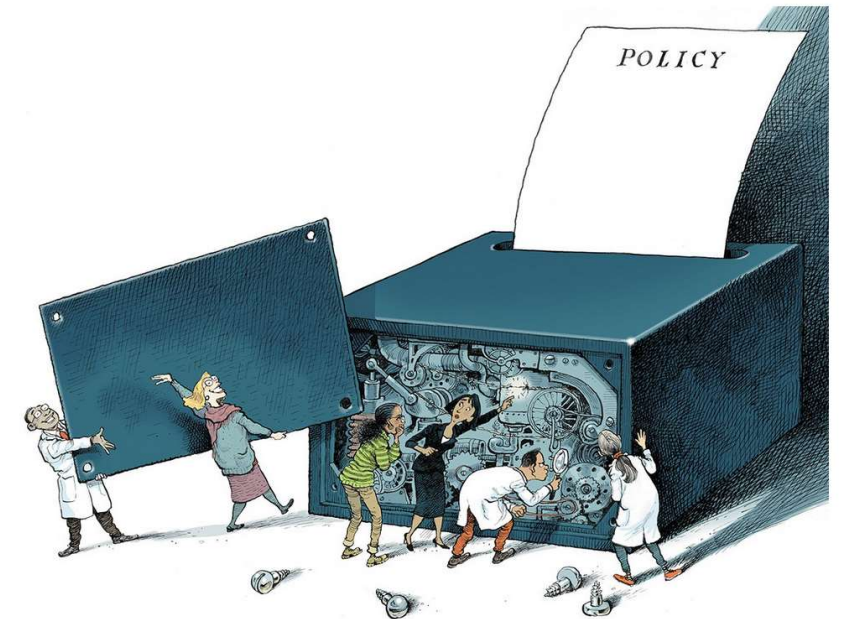
**3 STS scholars** Bammer, Sarewitz, Stirling

**1 philosopher** Ravetz

**1 historian** Charters

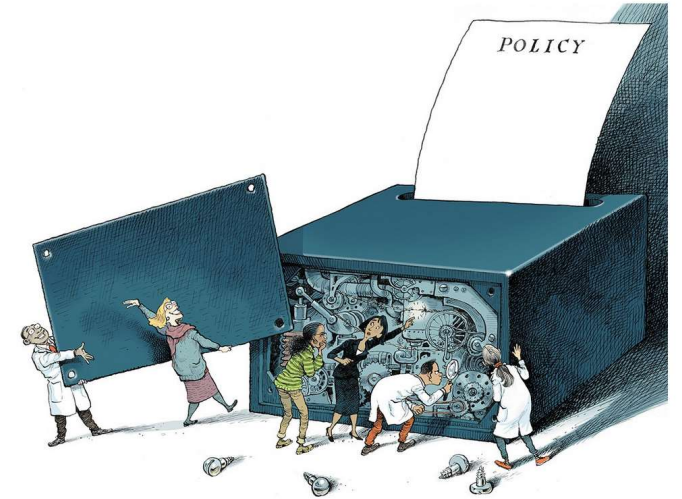
**1 political scientists** Di Fiore

**1 expert RRI - Open Science** Rafols



COVID has put mathematical models in the limelight

→ Power & controversy



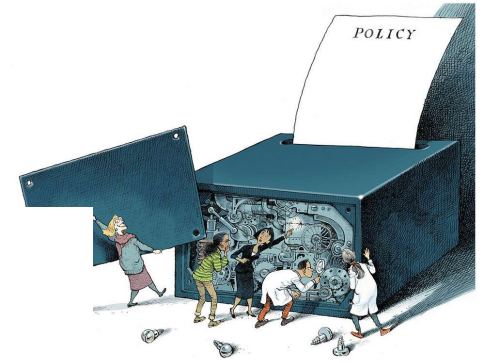
# Power

The New York Times

## *Behind the Virus Report That Jarred the U.S. and the U.K. to Action*

It wasn't so much the numbers themselves, frightening though they were, as who reported them: Imperial College London.

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Landler, Mark, and Stephen Castle. 2020. Behind the Virus Report That Jarred the U.S. and the U.K. to Action – The New York Times.

# Controversy, when questions of urgency, stakes, values and uncertainty collide

Rush Limbaugh

“Wild-Ass Covid numbers  
... The minute I hear  
anybody start talking about  
models and modeling, I  
blanch”



Rhodes, Tim, and Kari Lancaster. 2020. “Mathematical Models as Public Troubles in COVID-19 Infection Control: Following the Numbers”, *Health Sociology Review* 1-18. doi: 10.1080/14461242.2020.1764376





Bob Seely slams Imperial College and modelling

UK, a conservative MEP

A well documented 15 m tirade against Imperial College's model and its track record from foot and mouse disease to COVID-19



<https://www.indigoumbrella.co.uk/bob-seely-slams-imperial-college-and-modelling/>

# Mind the assumptions

Assess uncertainty and sensitivity

# Mind the hubris

Complexity can be the enemy of relevance

# Mind the framing

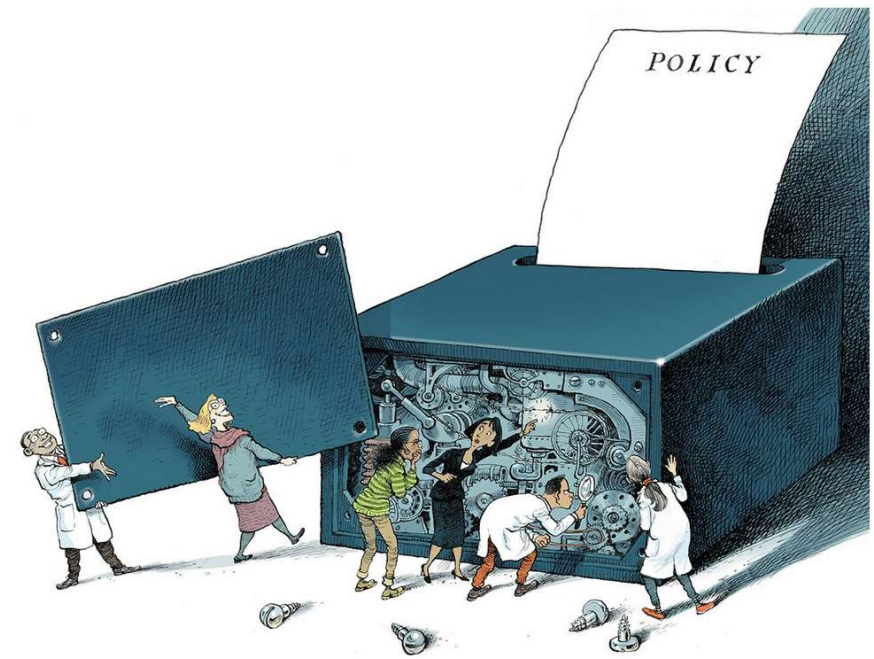
Match purpose and context

# Mind the consequences

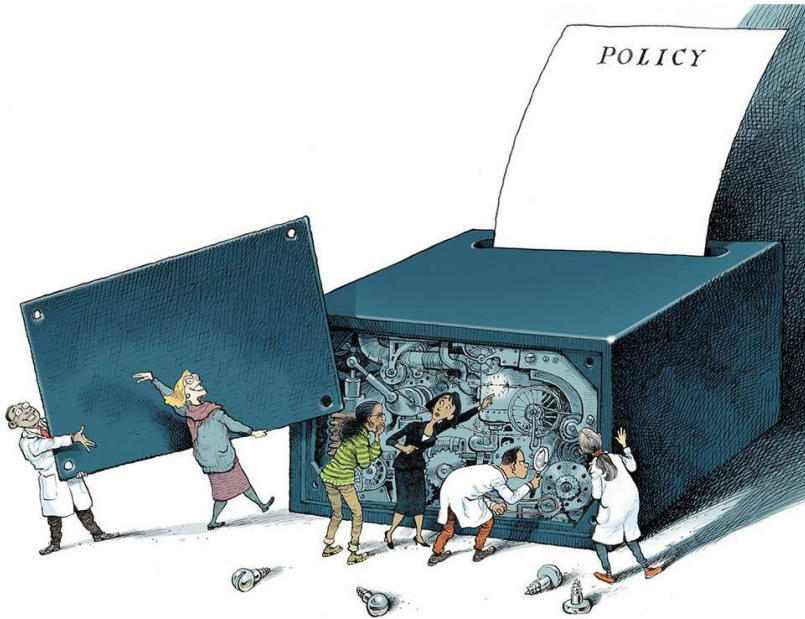
Quantification can backfire.

# Mind the unknowns

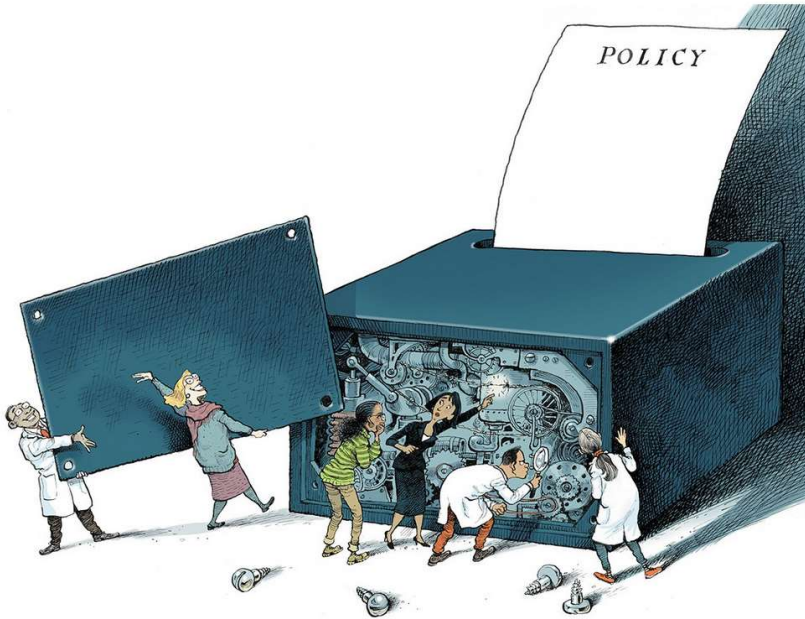
Acknowledge ignorance



If the Manifesto = sociology of quantification talking to modelling, what could modelling say to sociology of quantification?



# SA for an **hermeneutics** of quantification?



The five rules;  
+ Specifically SA calls for attention to

- assumptions and frames
- hubris
- design of experiment
- ignorance
- ...

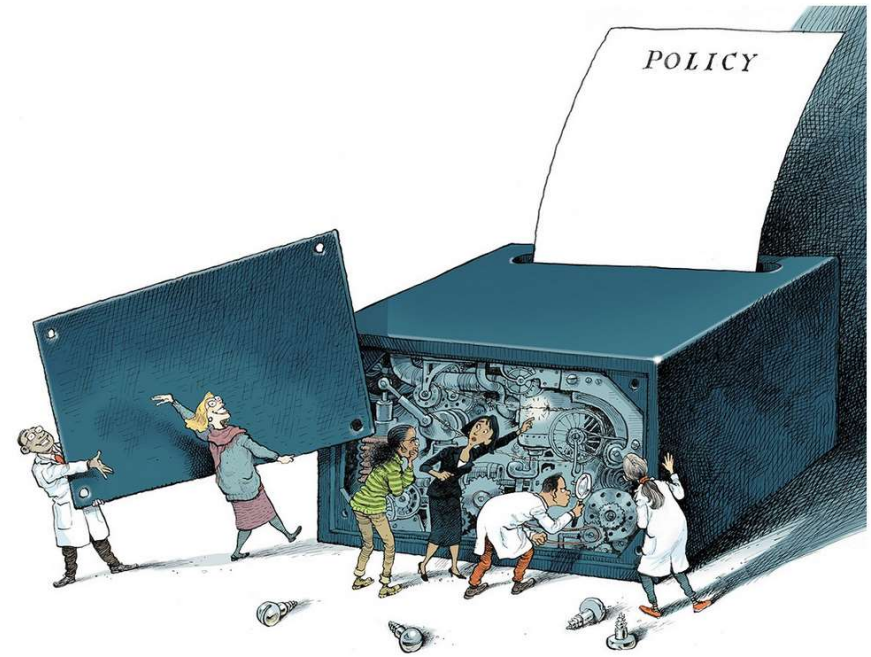


# Mind the assumptions

Assess uncertainty and sensitivity



... may lead to interesting discoveries ...



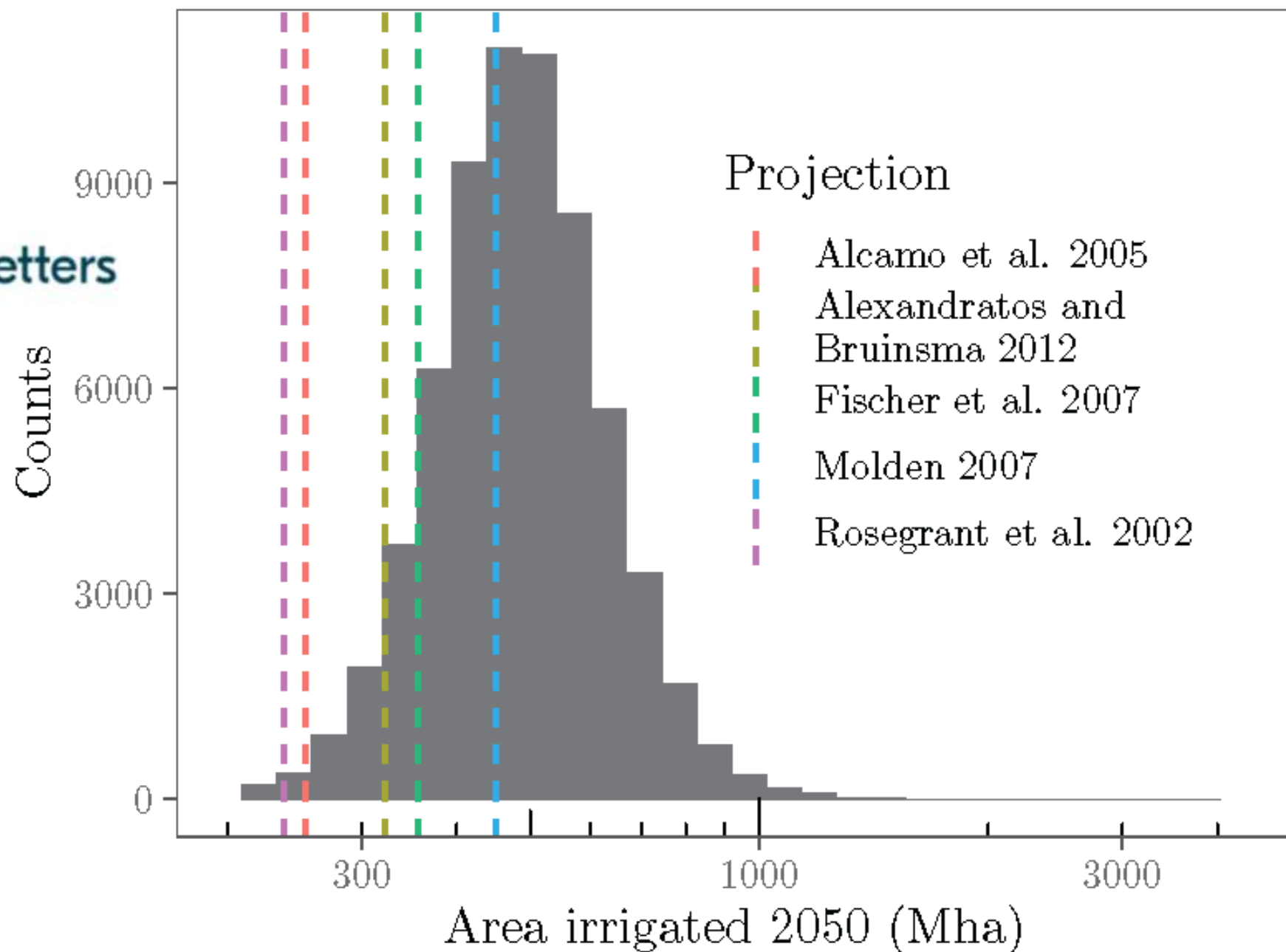
# Current Models Underestimate Future Irrigated Areas

## Geophysical Research Letters

A. Puy✉, S. Lo Piano, A. Saltelli

### Citation:

Puy, A., Lo Piano, S., & Saltelli, A. (2020). Current models underestimate future irrigated areas. *Geophysical Research Letters*, 47, e2020GL087360. <https://doi.org/10.1029/2020GL087360>



ENVIRONMENTAL RESEARCH  
LETTERS

## LETTER

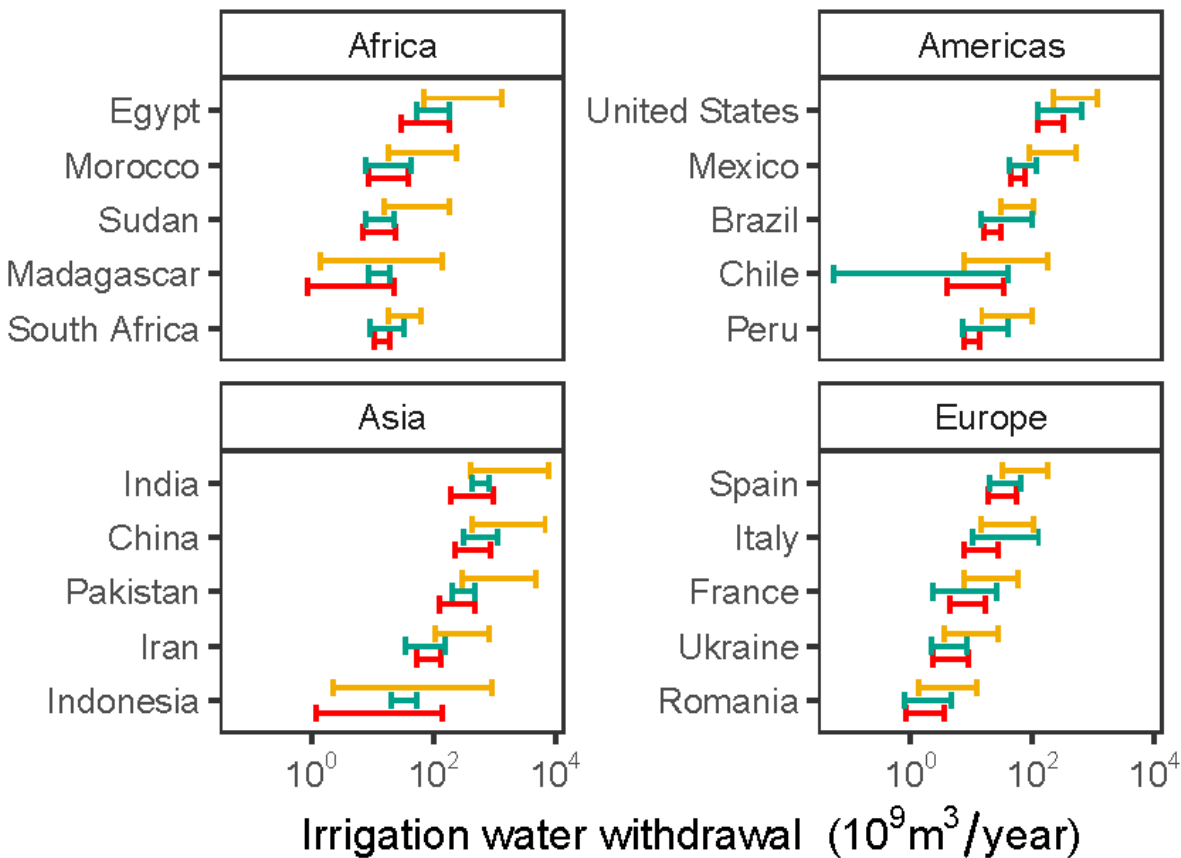
## Large variations in global irrigation withdrawals caused by uncertain irrigation efficiencies

Arnald Puy<sup>1,2,\*</sup>, Bruce Lankford<sup>3</sup>, Jonas Meier<sup>4</sup>, Saskia van der Kooij<sup>5</sup> and Andrea Saltelli<sup>6</sup>

OPEN ACCESS

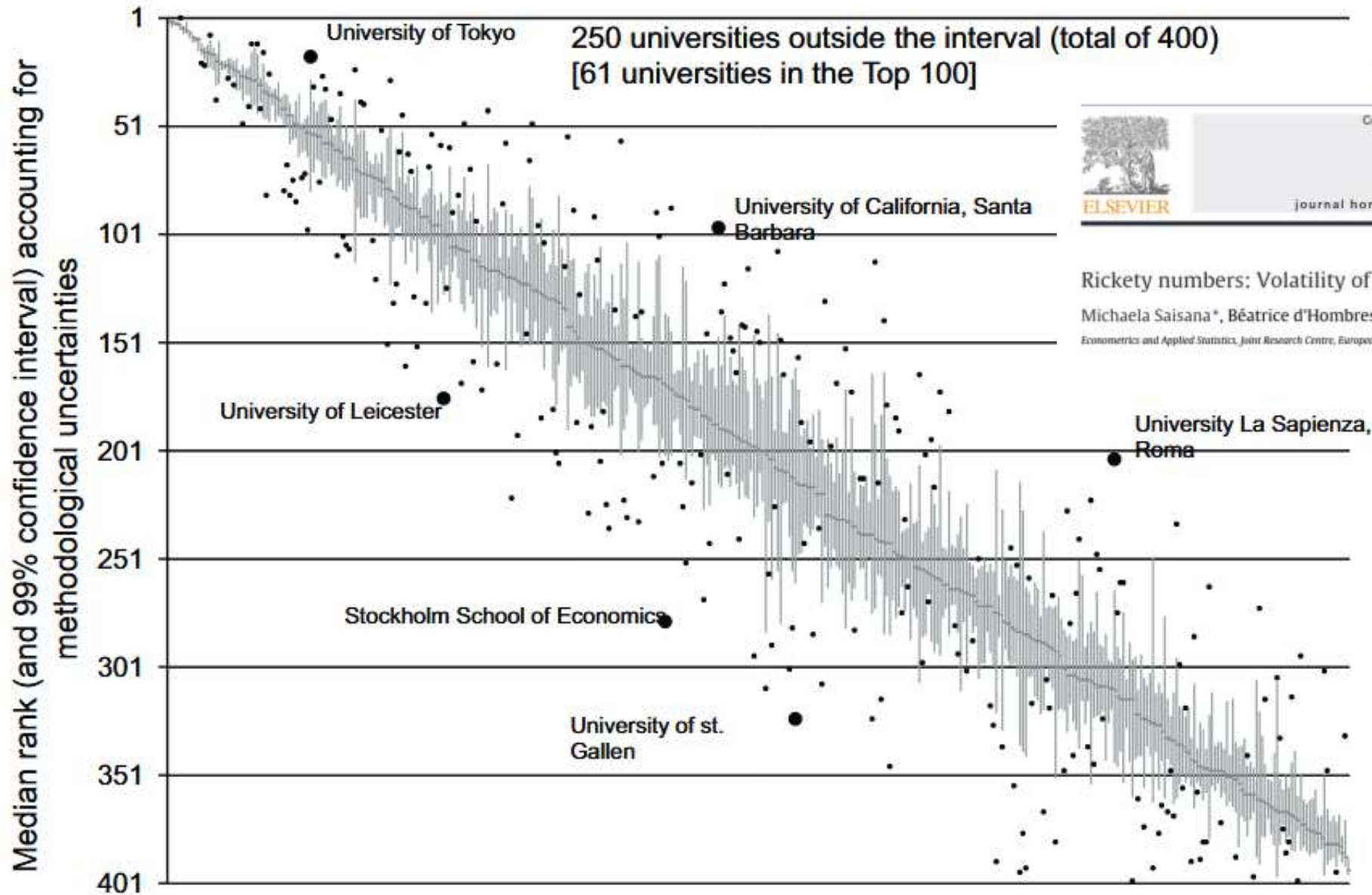
RECEIVED  
10 November 2021  
REVISED

- GMs
- GMs** — GMs + uncertainty in climate change
- GMs + uncertainty in irrigation efficiency



“a largely overlooked source of uncertainty (irrigation efficiency) impact **irrigation water withdrawal** more than climate change uncertainties, which are much sexier” (A. Puy)

# Volatility of ranks of universities as measured by THES (2008)



Research Policy 40 (2011) 165–177



Contents lists available at ScienceDirect

Research Policy

journal homepage: [www.elsevier.com/locate/respol](http://www.elsevier.com/locate/respol)

Rickety numbers: Volatility of university rankings and policy implications

Michaela Saisana\*, Béatrice d'Hombres, Andrea Saltelli

Econometrics and Applied Statistics, Joint Research Centre, European Commission, Enrico Fermi 2749, 21027 Ispra, Italy



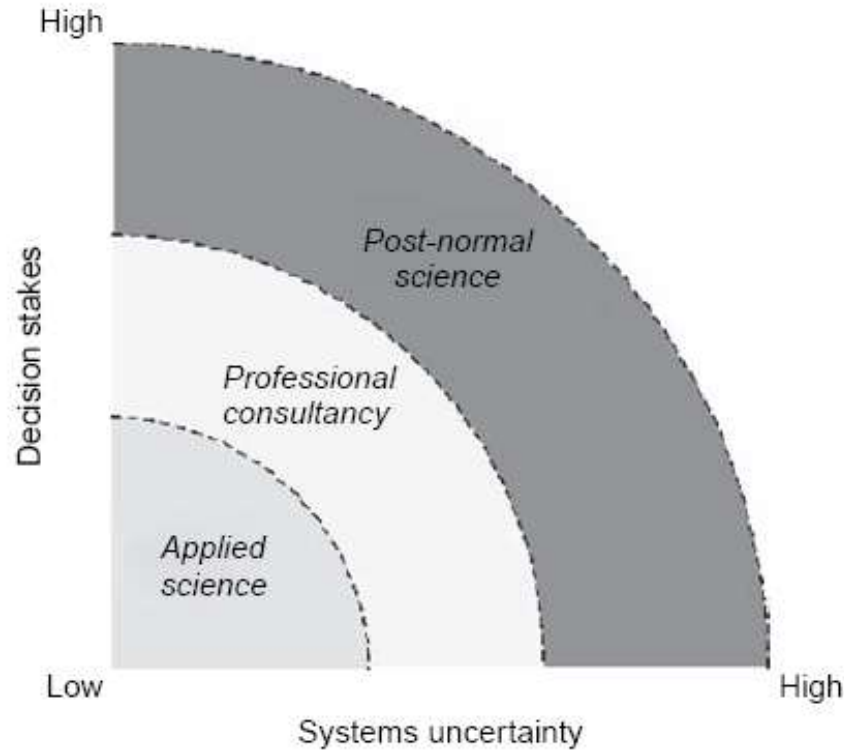
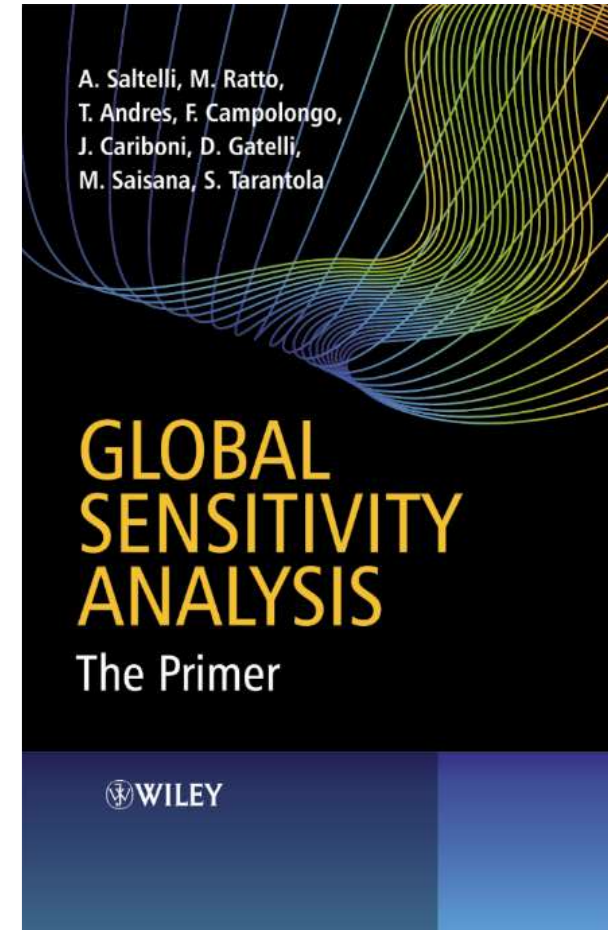


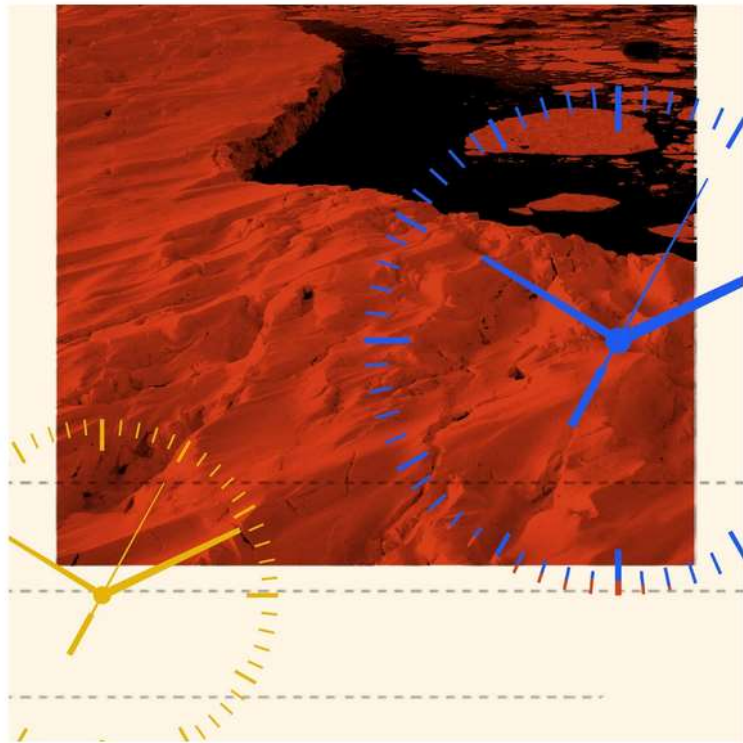
Figure 1.2 Uncertainty/stakes diagram after Funtowicz and Ravetz (1990)



SA and post normal science to oppose instrumental use of uncertainty and the production of fantastic numbers

# ‘The Most Important Number You’ve Never Heard Of’

Sept. 17, 2021



“social cost of carbon:

=\$56 a ton on average at a 3 percent discount rate

=\$171 a ton on average at a 2 percent discount rate”

**The New York Times**

# The Social Cost of Carbon: Advances in Long-Term Probabilistic Projections of Population, GDP, Emissions, and Discount Rates

Kevin Rennert, Brian C. Prest, William A. Pizer, Richard G. Newell, David Anthoff,  
Cora Kingdon, Lisa Rennels, Roger Cooke, Adrian E. Raftery, Hana Ševčíková,  
and Frank Errickson

Working Paper 21-28  
October 2021

Averaged till year 2300

Feeds into policy design

We have perhaps reached a complex epistemic state, where on the one hand ‘everybody knows’ that some numbers are pseudo-precise and that numbers can be gamed, while the game works only because most people don’t know about it



Jerome R. Ravetz



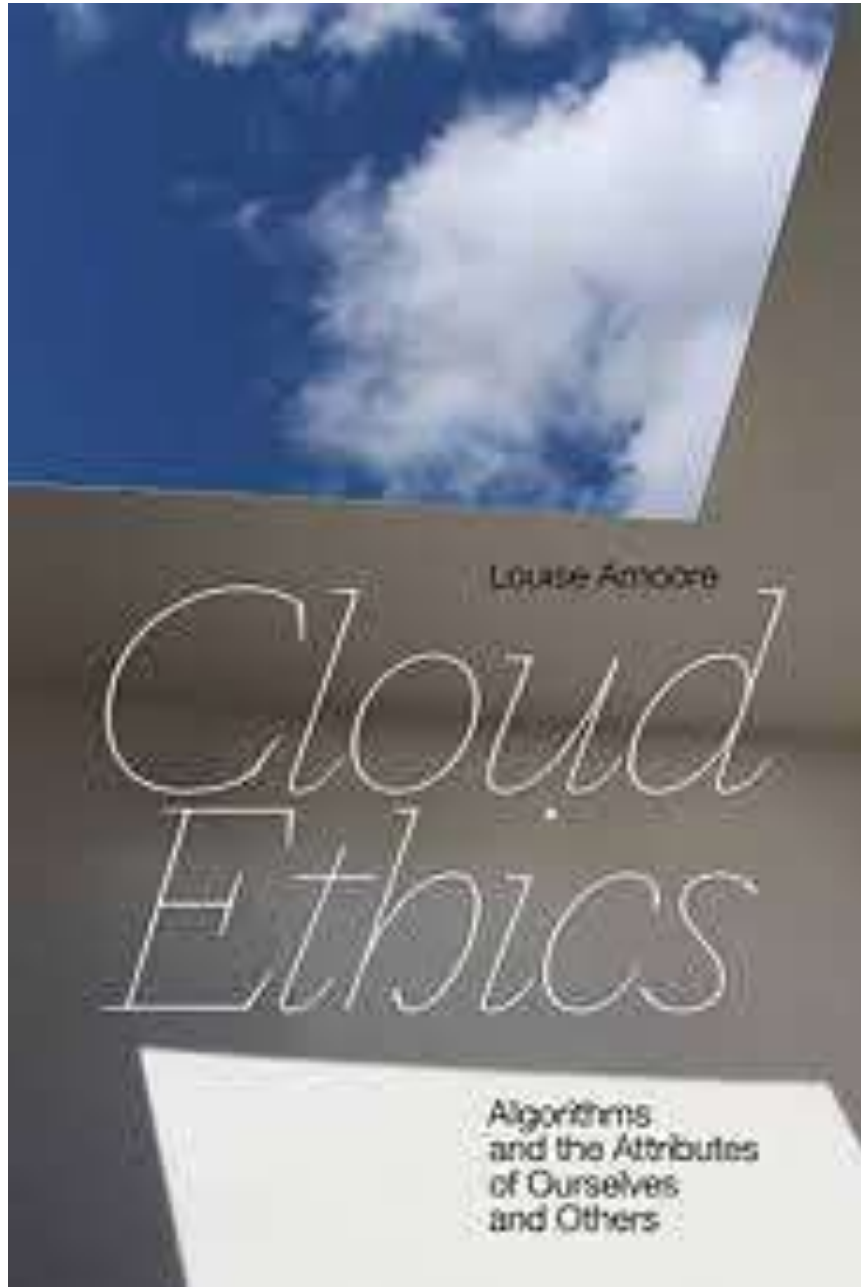
→ talk of Samuele Lo Piano Wednesday



Understanding the modelling process and model use

16<sup>th</sup> March 2022

Samuele Lo Piano



Making algorithms  
'good' or 'transparent'  
is beyond the point.  
Algorithms create new  
norms of good or bad,  
define what is normal  
and acceptable



Louise Amoore



Engage with opacity instead of pretending transparency ...

Oppose the violence in the algorithmic foreclosure of alternative futures ...

... opening onto the open and distributed forms of the writings of algorithms

Ethics of quantification, Video curated by the Open University of Catalonia, September 2021.



## Ethics of quantification

# Ethics of quantification

Andrea  
Saltelli



[http://materials.cv.uoc.edu/cdocent/PID\\_00284929/](http://materials.cv.uoc.edu/cdocent/PID_00284929/)



The End



@andreasaltelli