



# Post normal model validation? Surely you must be joking

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iEMSs Conference 2020, International Environmental  
Modelling and Software Society



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C o a u t h o r s

Validation and verification of mathematical models?  
Both a positivistic and a relativistic approach are possible

Article | [Open Access](#) | Published: 18 December 2018

# Practice and perspectives in the validation of resource management models

Sibel Eker , Elena Rovenskaya, Michael Obersteiner & [Simon Langan](#)

*Nature Communications* **9**, Article number: 5359 (2018) | [Cite this article](#)

**2089** Accesses | **9** Citations | **16** Altmetric | [Metrics](#)

**nature communications**



Positivist and relativist?

A window of dialogue between number crunchers,  
sociologists and the post normal science crowd?

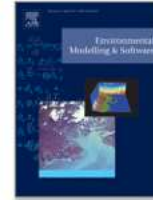


Normally these incursions are met with diffidence



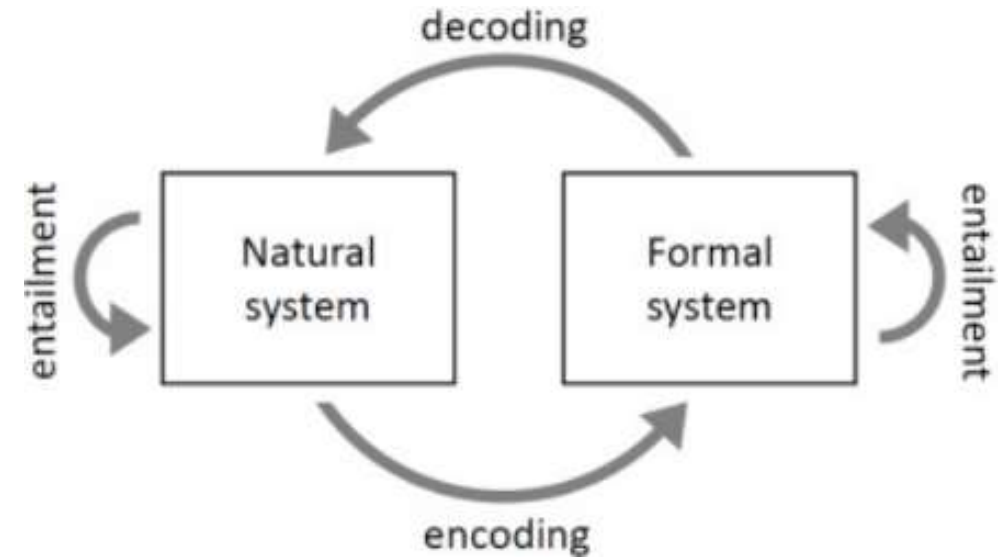
Environmental Modelling & Software

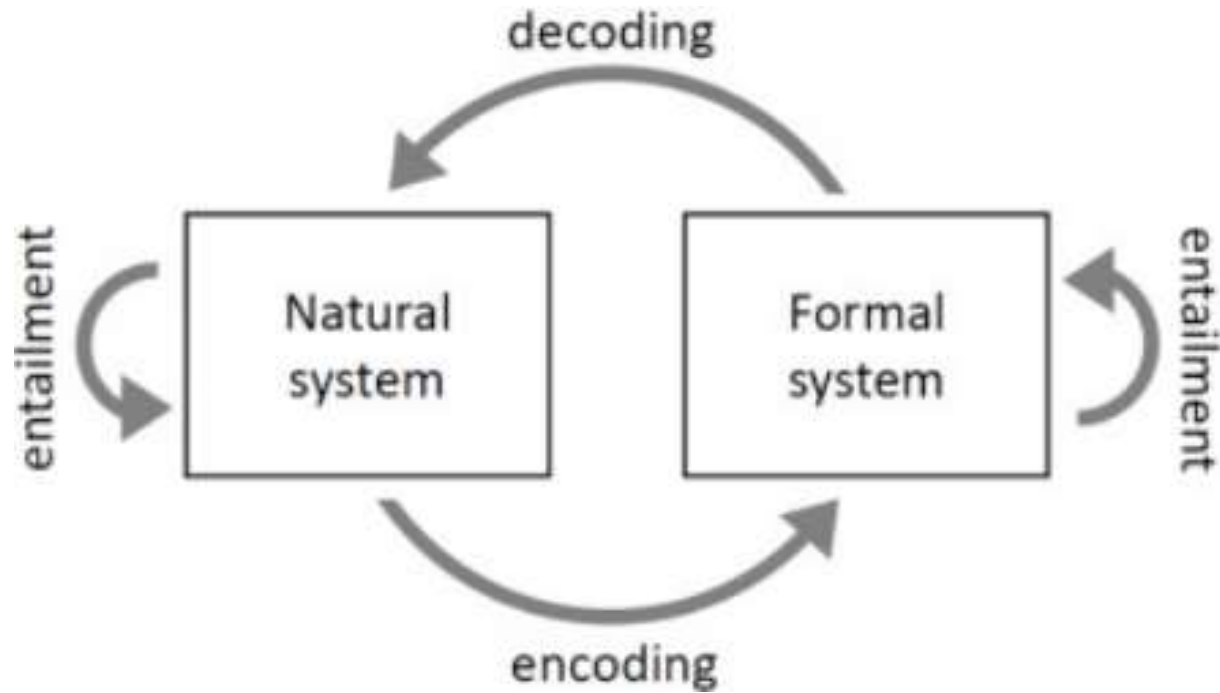
Volume 114, April 2019, Pages 29-39



## Why so many published sensitivity analyses are false: A systematic review of sensitivity analysis practices

Andrea Saltelli <sup>a, b</sup> ✉, Ksenia Aleksankina <sup>c</sup>, William Becker <sup>d</sup>, Pamela Fennell <sup>e</sup>, Federico Ferretti <sup>d</sup>, Niels Holst <sup>f</sup>, Sushan Li <sup>g</sup>, Qiongli Wu <sup>h</sup>





Robert Rosen  
(1934– 1998),  
a theoretical biologist

Robert Rosen's modelling relationship; modelling as a craft/art; the missing causality link between systems

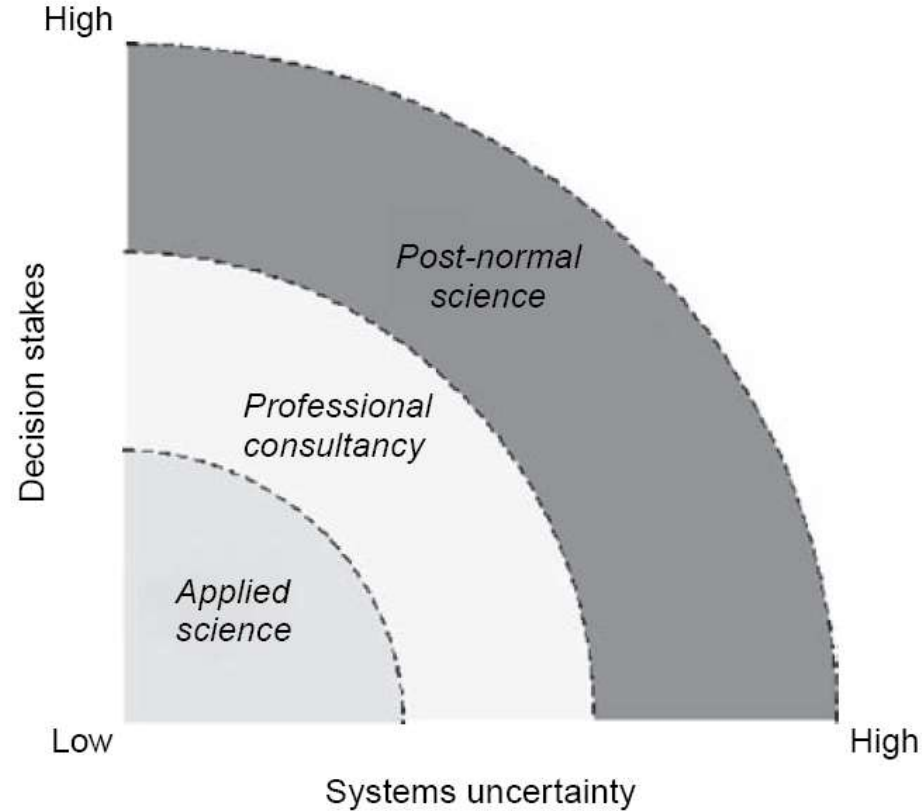
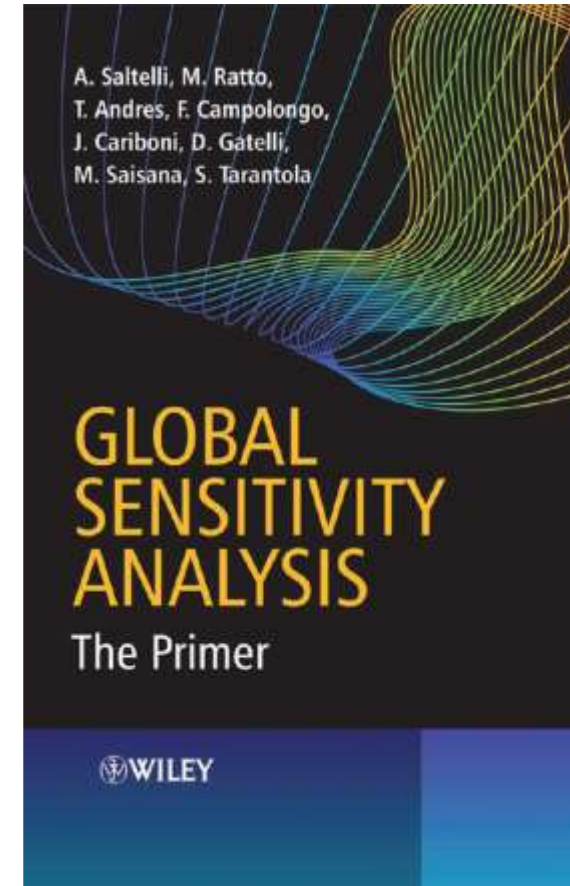
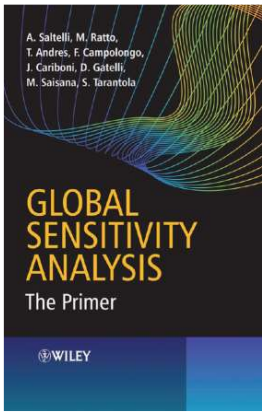


Figure 1.2 Uncertainty/stakes diagram after Funtowicz and Ravetz (1990)



“...models are part of the scientific method and hence subject to epistemological debate...” (The primer, 2008)

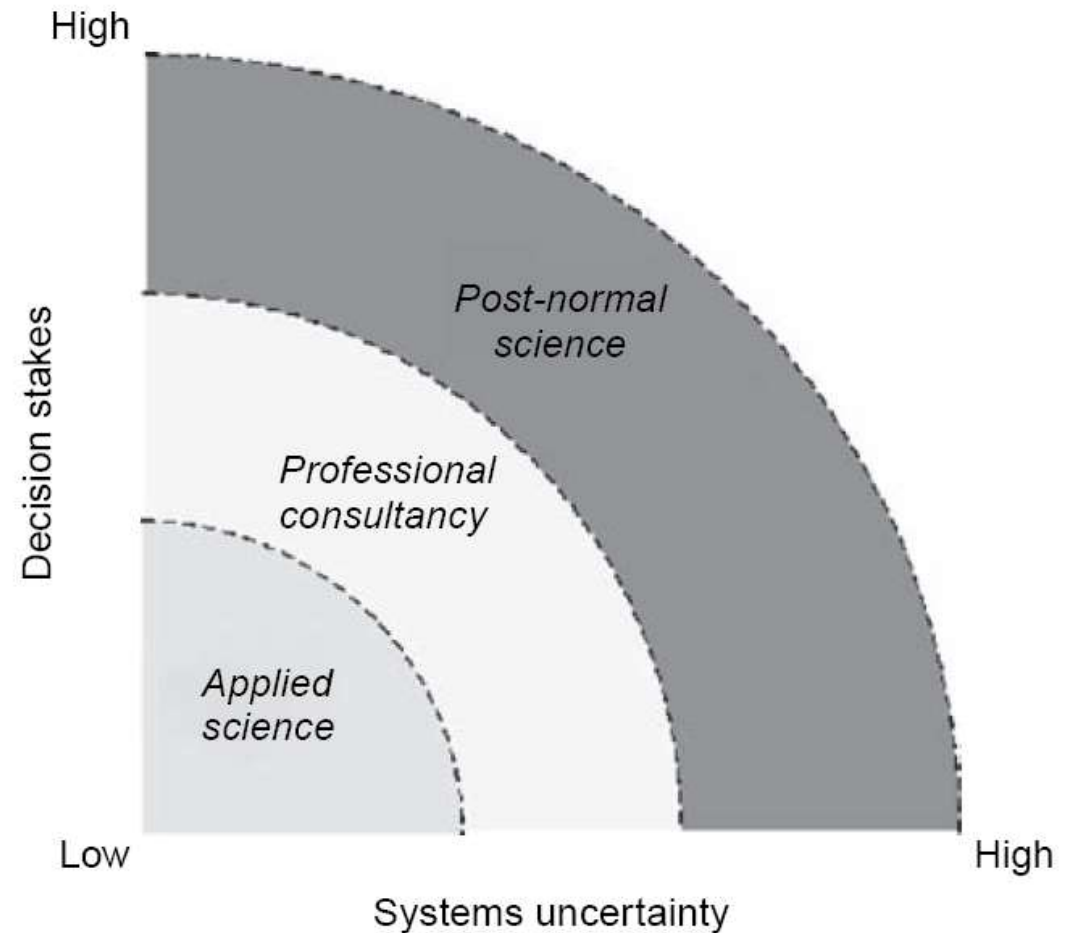




“A way of framing present-day debate on the scientific method is offered by Post-Normal Science...”

Different modelling validation procedures for:

- applied science
- ‘consultancy’ work
- high stakes/uncertainty/disputes/urgency settings





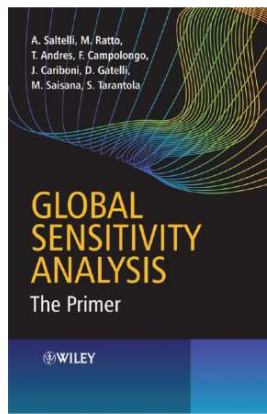
The book also refers to ‘Models as Metaphors’, by Jerry Ravetz (2006)

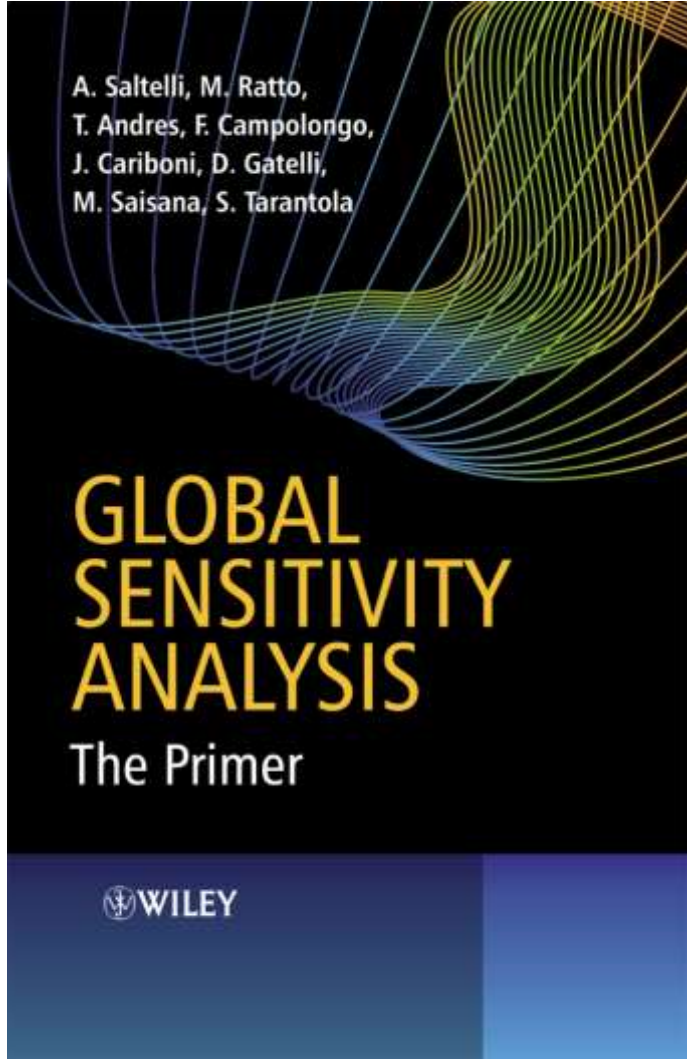
“Model” is a word with many meanings ...

Models are used in the cases where neither theoretical understanding, experimental verification, or statistical analysis are available in sufficient strength...

“Metaphor” is a rhetorical device, meaning “carrying beyond.” It refers to the denotation of an idea by a term which literally refers to something else.”

[http://www.andreasaltelli.eu/file/repository/Models\\_Metaphors\\_with\\_Cover.pdf](http://www.andreasaltelli.eu/file/repository/Models_Metaphors_with_Cover.pdf)







# Could sensitivity analysis & PNS go to Hollywood?



Is it possible now to use some elements of sociology/epistemology/philosophy to discuss modelling issues?



Comment

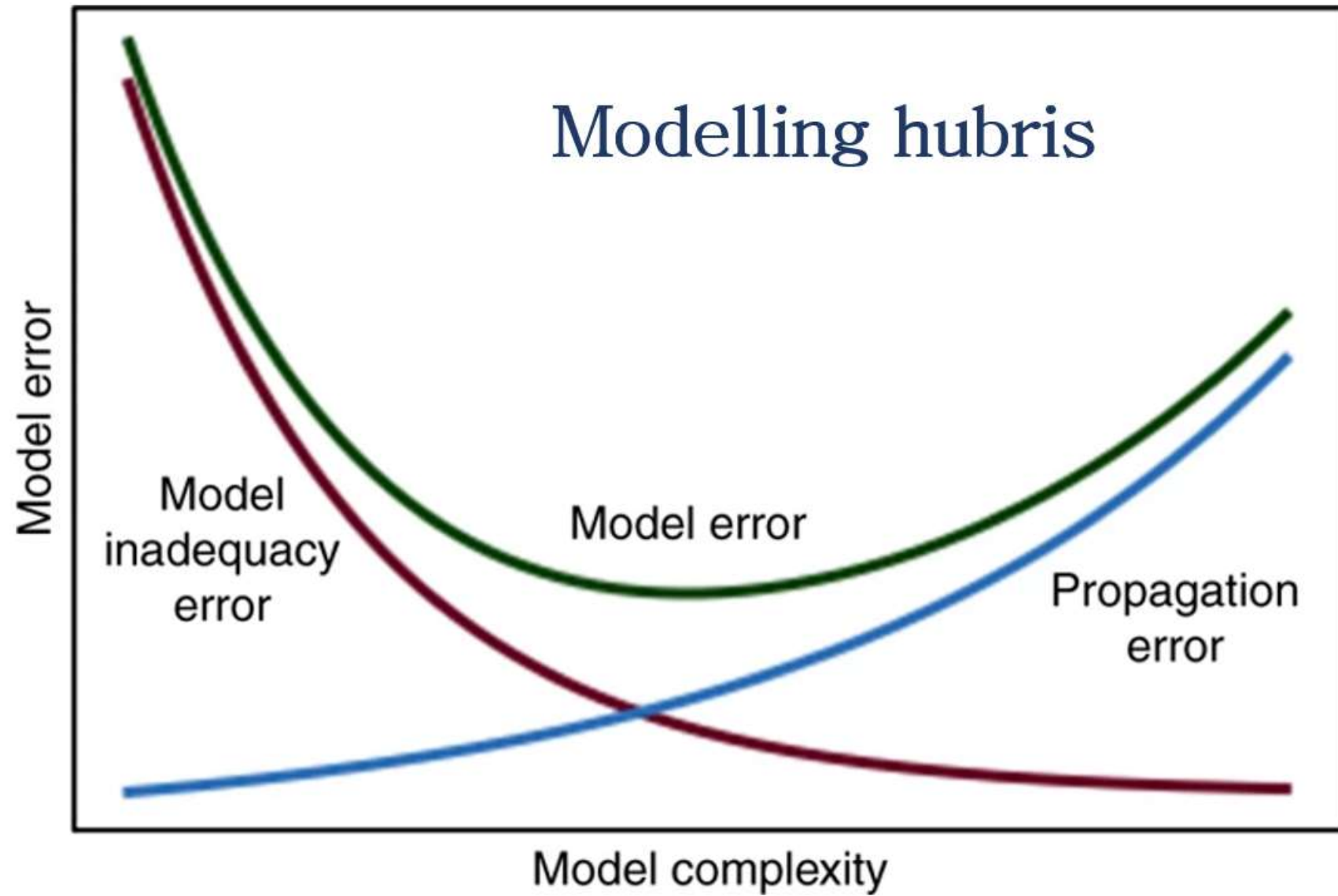
Open Access

Published: 27 August 2019

# A short comment on statistical versus mathematical modelling

Andrea Saltelli 





“To put the prescriptions into practice a movement of resistance is needed, perhaps along the lines of the so-called statistical activism<sup>12</sup>. This kind of resistance is familiar to scholars gathered around post-normal science (PNS)<sup>13</sup>”



“A new ethics of quantification must be nurtured, which takes inspiration from a long tradition of sociology of numbers; Pierre Bourdieu<sup>12</sup> and Theodor Porter<sup>16</sup> come to mind”



# 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.

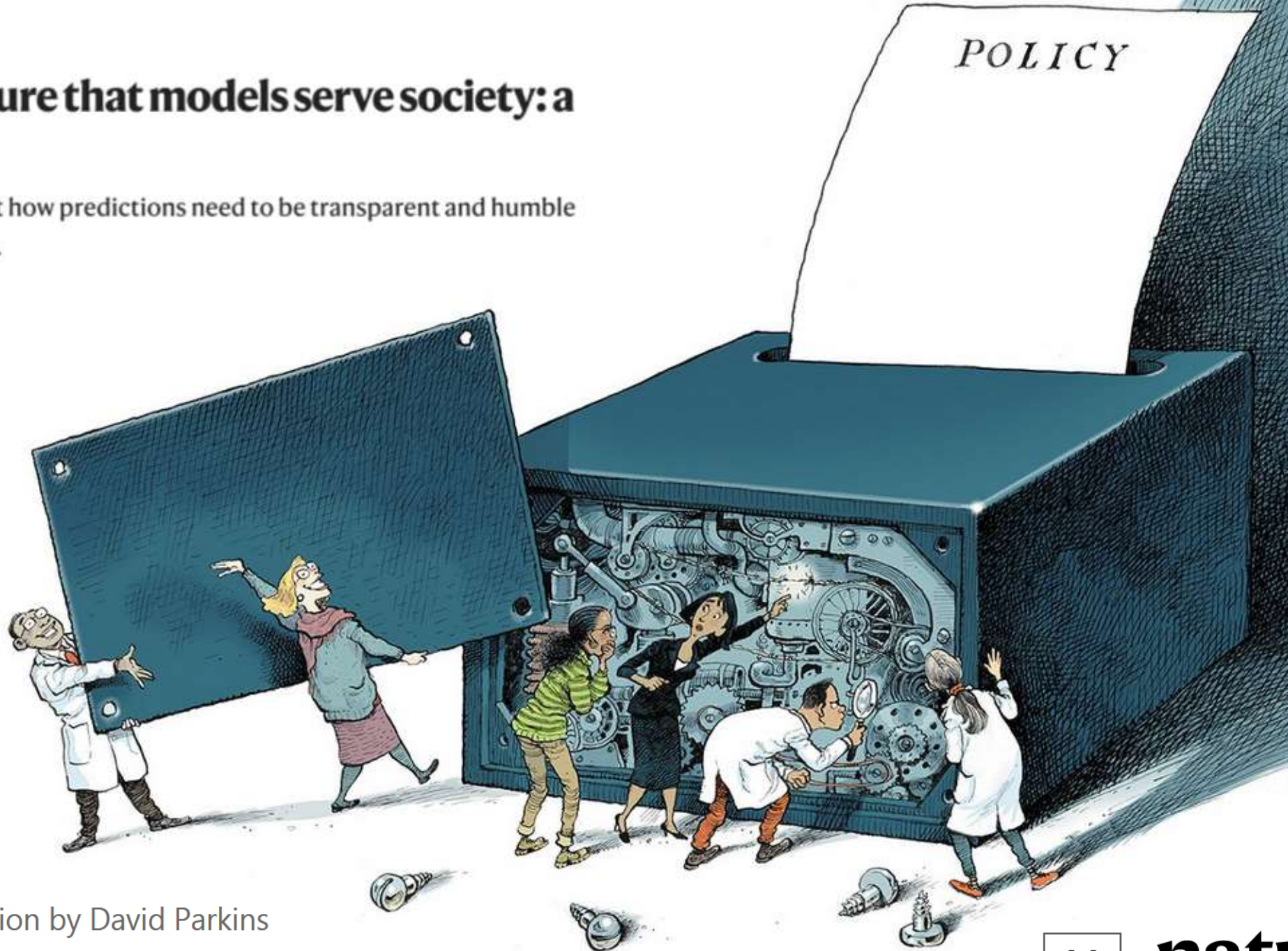


Illustration by David Parkins



**nature**



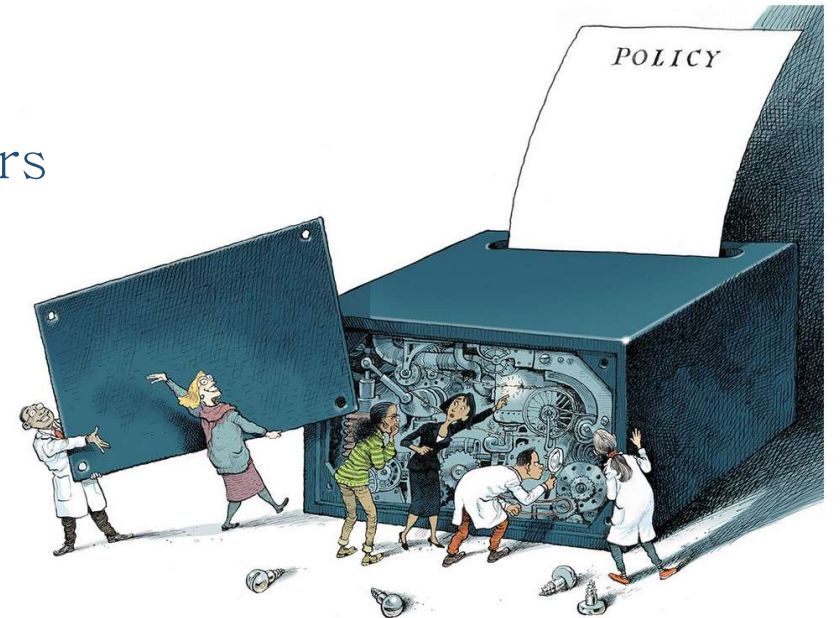
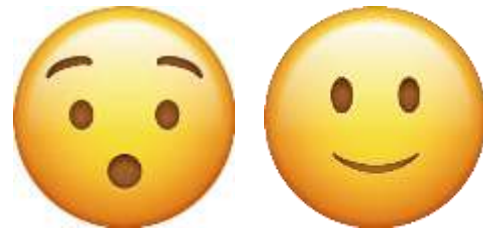


# Five ways to ensure that models serve society: a manifesto

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

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

Jeroen van der Sluijs and Samuele Lo Piano among the authors



# Mind the assumptions

Assess uncertainty and sensitivity



## Mind the hubris

Complexity can be the enemy of relevance

## Mind the framing

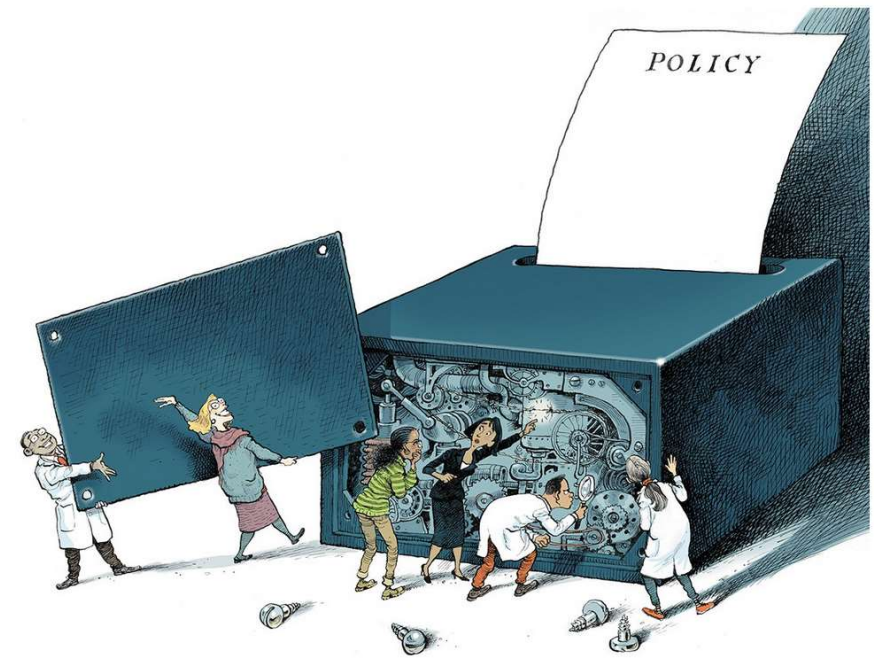
Match purpose and context

## Mind the consequences

Quantification can backfire.

## Mind the unknowns

Acknowledge ignorance



### SUPPLEMENTARY INFORMATION

#### 1. Additional information and references

>260 references

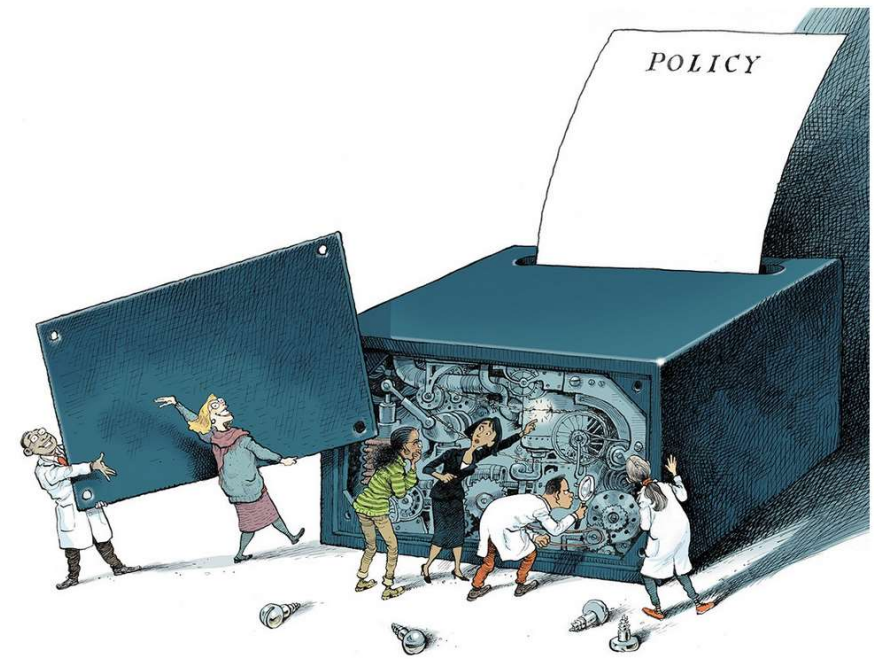
# Mind the assumptions

Assess uncertainty and sensitivity



... assumptions that are reasonable in one situation can become nonsensical in another...

... models require input values for which there is no reliable information.

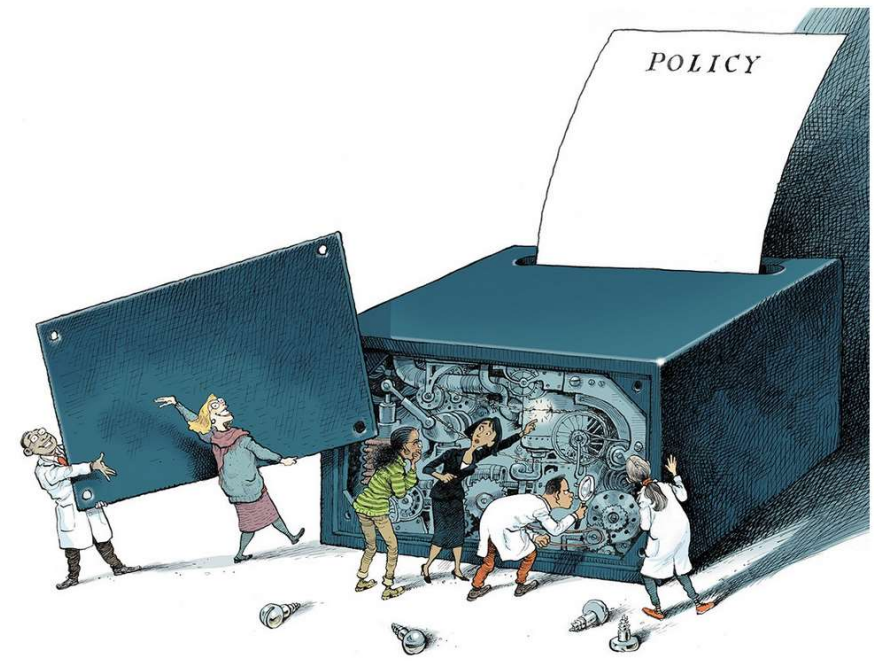


# Mind the assumptions

Assess uncertainty and sensitivity



... to mitigate these issues:  
perform global uncertainty and  
sensitivity analyses ...



This often reveals that the uncertainty in  
predictions is substantially larger than originally  
asserted

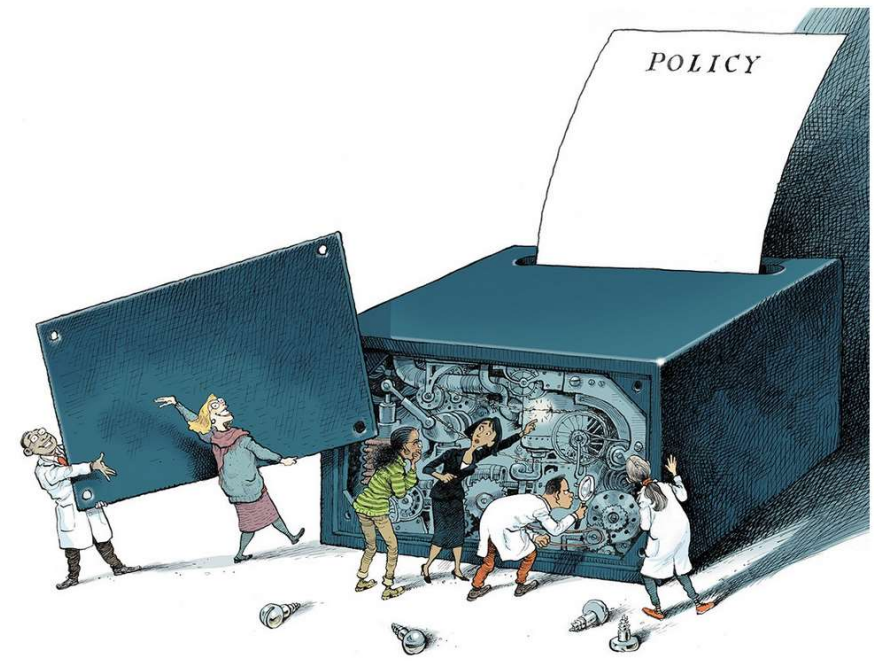


# Mind the assumptions

Assess uncertainty and sensitivity



The manifesto comes with a long supplementary material file (>260 references) where PNS-inspired methods are described: NUSAP and Sensitivity Auditing



NUSAP



J. Van del Sluijs: NUSAP



Ângela Guimarães Pereira, Silvio Funtowicz, J. Van del Sluijs and myself: **sensitivity auditing**



Numeral, Unit, Spread

+

Assessment (qualitative judgement on quantification)

Pedigree (qualitative assessment of mode of production and anticipated use)

THEORY AND DECISION LIBRARY

SERIES A: PHILOSOPHY AND METHODOLOGY  
OF THE SOCIAL SCIENCES

SILVIO O. FUNTOWICZ AND JEROME R. RAVETZ

UNCERTAINTY AND QUALITY  
IN  
SCIENCE FOR POLICY

KLUWER ACADEMIC PUBLISHERS



## Example Pedigree matrix parameter strength

Code	Proxy	Empirical	Theoretical basis	Method	Validation
4	Exact measure	Large sample direct mmts	Well established theory	Best available practice	Compared with indep. mmts of same variable
3	Good fit or measure	Small sample direct mmts	Accepted theory partial in nature	Reliable method commonly accepted	Compared with indep. mmts of closely related variable
2	Well correlated	Modeled/derived data	Partial theory limited consensus on reliability	Acceptable method limited consensus on reliability	Compared with mmts not independent
1	Weak correlation	Educated guesses / rule of thumb est	Preliminary theory	Preliminary methods unknown reliability	Weak / indirect validation
0	Not clearly related	Crude speculation	Crude speculation	No discernible rigour	No validation

Slide: courtesy of Jeroen van der Sluijs

<http://www.nusap.net/>



# Sensitivity Auditing

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## **What do I make of your latinorum? Sensitivity auditing of mathematical modelling**

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Saltelli, A., Guimarães Pereira, Â.,  
Van der Sluijs, J.P. and Funtowicz, S.

# The rules of sensitivity auditing

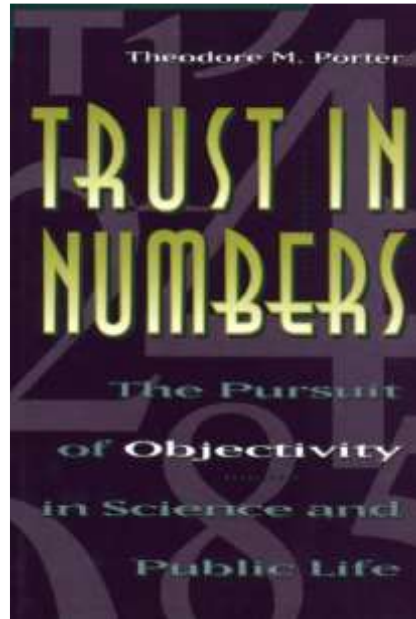
1. Check against rhetorical use of mathematical modelling;
2. Adopt an “assumption hunting” attitude; focus on unearthing possibly implicit assumptions;
3. Check if uncertainty been instrumentally inflated or deflated.

4. Find sensitive assumptions before these find you; do your SA before publishing;
5. Aim for transparency; Show all the data;
6. Do the right sums, not just the sums right;
7. Perform a proper global sensitivity analysis.

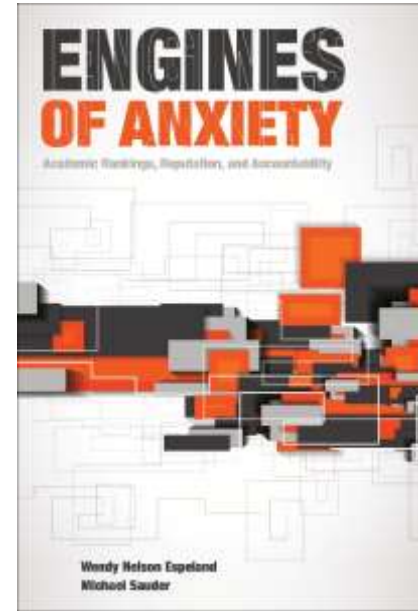
Where to go from here?

An ethics of quantification?





Theodore M. Porter  
UCLA



Wendy Espeland  
Northwestern

Blurring lines:

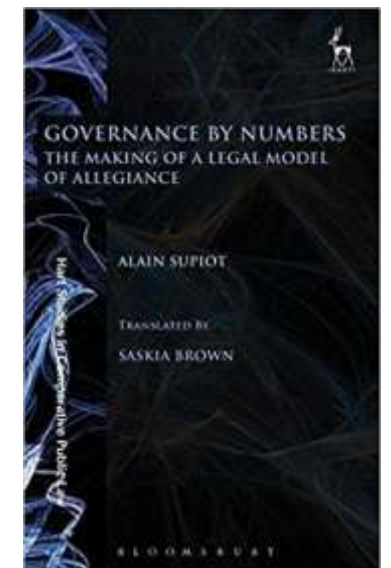
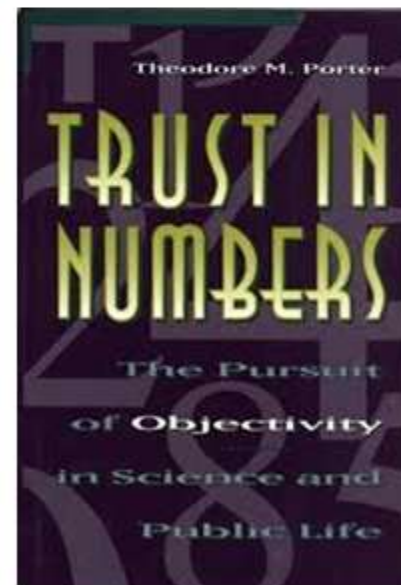
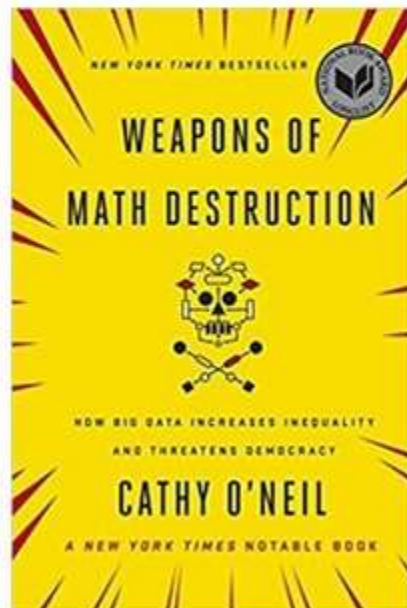
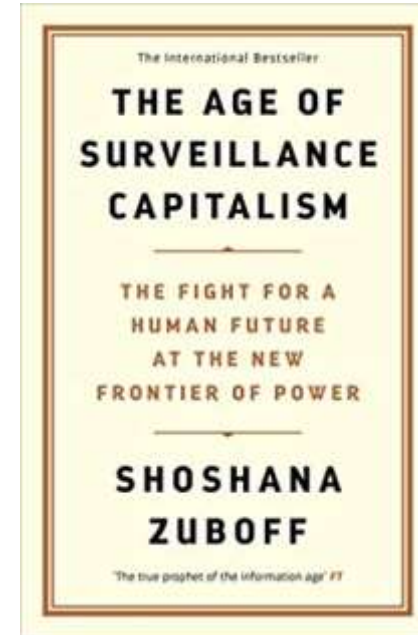
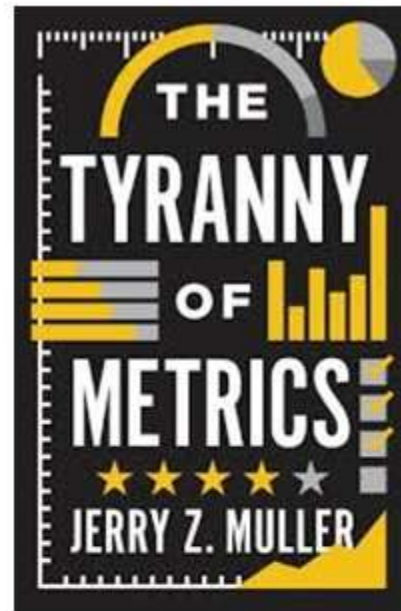
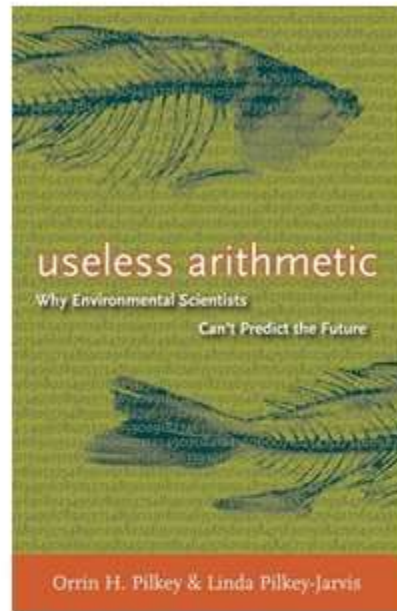
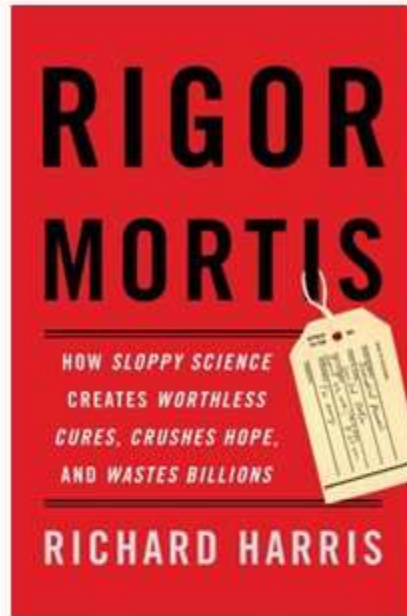
“what qualities are specific to rankings, or indicators, or models, or algorithms?”



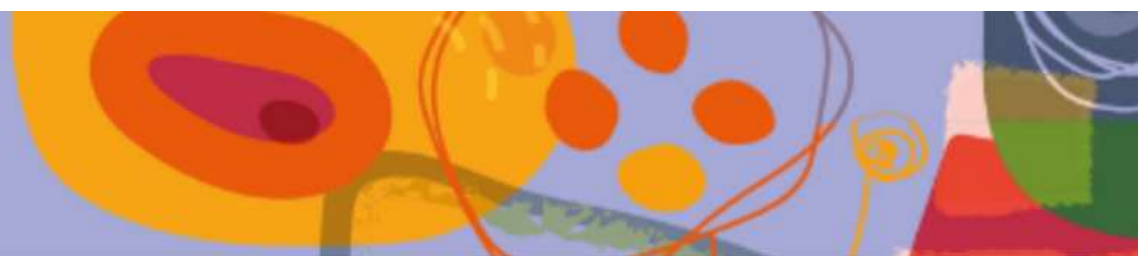
Elizabeth  
Popp Berman

E. Popp Berman and D. Hirschman, **The Sociology of Quantification**: Where Are We Now?, *Contemp. Sociol., Contemporary Sociology*. 2018;47(3):257–266.

# Algorithms, models, metrics, statistics...







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>

# Why an ethics of quantification?

- Symbiotic relationship between quantification and trust
- It is a defense against statistical abuses
- It helps to apportion responsibilities and to act on them when metrics produce unintended or undesirable effects
- to expose the non neutrality of the technique
- to provide an encompassing ethics reaching into different disciplines

# Readings

Eker, S., Rovenskaya, E., Obersteiner, M. & Langan, S. Practice and perspectives in the validation of resource management models. *Nat. Commun.* 9, 5359 (2018).

Espeland, W. N. & Stevens, M. L. A sociology of quantification. *Eur. J. Sociol.* 49, 401–436 (2008).

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

Ravetz, J. R. Models as metaphors. in *Public participation in sustainability science : a handbook* (ed. B. Kasemir, J. Jäger, C. Jaeger, Gardner Matthew T., Clark William C., and W. A.) (Cambridge University Press, 2003),

[http://www.andreasaltelli.eu/file/repository/Models\\_Metaphors\\_with\\_Cover.pdf](http://www.andreasaltelli.eu/file/repository/Models_Metaphors_with_Cover.pdf)

# The End



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