

Examples

Andrea Saltelli, November 28 2022

JRC course on sensitivity analysis, Brussels, November 28–29 2022 First part – 28 Nov

9:30- 10.00 Round table with participants

10:00 -10:30 Welcome, introduction, the use of evidence in the Better Regulation context, models, models in impact assessment (Paul)

10:30 – 11:10 Models, uncertainty and model quality assurance (Andrea, 40m)

11:10-11:45 Uncertainty analysis & Sensitivity analysis concept and brief history, Basics of statistics, Monte Carlo method (Stefano)

11.45-12 (break 15 mins)

12:00-12:30 Uncertainty and sensitivity analysis in impact assessment (Andrea 30m: stress on OAT vs GSA)

12:30-13:15 Steps of a sensitivity analysis I part (Rossana: OAT example/scatterplot/introduction to SI)

Closure All

Second part – 29 Nov am

9:15-9:45 Steps of a sensitivity analysis II part: variance-based and Sobol' method (Stefano)

9:45-10:20 Use of Siml@b tool for global sensitivity analysis (Rossana)

10:20-10:50 Examples of sensitivity analysis results (Andrea 30m)

10:50-11.05 (break 15 mins)

11.05 11.30 Examples of sensitivity analysis results (Stefano)

11:30 -12:30 Sensitivity Auditing (Andrea 60m)

Conclusions (with Paul) 12:30 - 12:45

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ABOUT ME

Mastodon Toots by @AndreaSaltelli



PUBLICATIONS

2022/11/25 18:27

RESOURCES

Fantastic! Thanks to a clever web-expert I now have a Mastodon window on my own web site!



ndropCaltelli

Don't go public with your results without having seen your SA

Find SA before SA finds you

Try to Find God before God Finds You. Global Environmental Change 20 (2010) 298-302



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

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



Nicholas Stern, London School of Economics

Stern, N., Stern Review on the Economics of Climate Change. UK Government Economic Service, London, <u>www.sternreview.org.uk</u>.

William Nordhaus, University of Yale Nobel 'Economics' 2018

Nordhaus W., Critical Assumptions in the Stern Review on Climate Change, SCIENCE, 317, 201–202, (2007).

The Stern – Nordhaus exchange on *SCIENCE*



Nordhaus → attacks Stern based on 'wrong' range of discount rate (~ you are GIGOing)



Stern → Perform a sensitivity analysis and retorts: 'My analysis shows robustness'



... but foremost Stern says:
changing assumptions → important effect
when instead he should admit that:
changing assumptions → all changes a lot



How was it done? A reverse engineering of the analysis

Missing points



% loss in GDP per capita

Conclusion:

Model prediction are too uncertain to adjudicate the dispute about the urgency of action on climate change;

Both assertion (Stern) and refutation (Nordhaus) are indefensible Same criticism applies to Nordhaus – both authors frame the debate around numbers which are \cdots



Peter Kennedy, A Guide to Econometrics.

One of the ten commandments of applied econometrics according to Peter Kennedy:





"Thou shall confess in the presence of sensitivity. Corollary: Thou shall anticipate criticism "



"One reason these methods [global sensitivity analysis] are rarely used is their honesty seems destructive;"

"or, to put it another way, a fanatical commitment to fanciful formal models is often needed to create the appearance of progress"

Tantalus on the Road to Asymptopia, Edward E. Leamer, 2010 *Journal of Economic Perspectives*, **24**, (2), 31–46.

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RESEARCH ARTICLE MATHEMATICS



Models with higher effective dimensions tend to produce more uncertain estimates



Lessons for policy: regulatory limits for nuclear waste disposal



A typical nuclear waste disposal concept: the waste is separated from humans by a series of barriers.

Source: World Nuclear Organization, https://world-nuclear.org/information-library/nuclear-fuelcycle/nuclear-waste/storage-and-disposal-of-radioactive-waste.aspx



Propagating uncertainty across the barriers increases variability (CV=mean/std), effective dimension $(k_{t}),$ and the importance of interactions (S_{ij}, S_{ijk})



RESEARCH ARTICLE MATHEMATICS

About ~

Models with higher effective dimensions tend to produce more uncertain estimates

HOME > SCIENCE ADVANCES > VOL. 8, NO. 42 > MODELS WITH HIGHER EFFECTIVE DIMENSIONS TEND TO

ARNALD PUY ⁽⁶⁾, PIERFRANCESCO BENEVENTANO, SIMON A. LEVIN ⁽⁶⁾, SAMUELE LO PIANO ⁽⁰⁾, TOMMASO PORTALURI, AND ANDREA SALTELLI ⁽⁰⁾ Authors Info & Affiliation

The regulation should not set limits on doses to humans in the biosphere, as done e.g. in the US, since these are impossible to predict with any certainty

A more realistic and defensible safety standard could be set as a maximum level of radioactivity leaving the buffer



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The delusive accuracy of global irrigation water withdrawal estimates

<u>Arnald Puy</u> [└], <u>Razi Sheikholeslami</u>, <u>Hoshin V. Gupta</u>, <u>Jim W. Hall</u>, <u>Bruce Lankford</u>, <u>Samuele Lo Piano</u>, <u>Jonas</u> <u>Meier</u>, <u>Florian Pappenberger</u>, <u>Amilcare Porporato</u>, <u>Giulia Vico</u> & <u>Andrea Saltelli</u>

Miscalculating the volumes of water withdrawn for irrigation, the largest consumer of freshwater in the world, jeopardizes sustainable water management.





Why Irrigation Water
Withdrawal (IWW) estimates
produced by large-scale
hydrological models are
unreliable? They neglect
uncertainty

The crop specific evotranspiration ET_c depends upon which formula (PM or PT) is used for ET_0



Irrigation efficiency for China as used by most models (red line) and with uncertainty plugged in:

→ Non conservative



Large-scale models neglect uncertainties. Each model runs under **one** irrigated area map, **one** crop evapotranspiration equation, **one** precipitation dataset and a **fixed** irrigation efficiency value per country or region

More computational power to increase resolution & reduce uncertainty?

Characterize uncertainty and act on it



There is substantial uncertainty in the estimates for the need of irrigated land at the year 2050





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Geophysical Research Letters*

This uncertainty is mostly irreducible as it is driven by either population-related parameters or the assumptions behind the model design

Sensitivity analysis by factors and by sets of factors

PLOS ONE

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RESEARCH ARTICLE

Improving the reliability of cohesion policy databases

PUBLISH

ABOUT

Samuele Lo Piano 🖾, Emanuele Borgonovo, Arnald Puy, Andrea Saltelli, John Walsh, Daniele Vidoni

Published: April 22, 2022 • https://doi.org/10.1371/journal.pone.0266823

Modelling expenditures on the ground based on expenditures invoiced, in order to test the impact of the funds on the economy

PLOS ONE

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RESEARCH ARTICLE

Improving the reliability of cohesion policy databases

Samuele Lo Piano 🖾, Emanuele Borgonovo, Arnald Puy, Andrea Saltelli, John Walsh, Daniele Vidoni

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Reconstructing the temporal pattern for time-lagged statistical monetary figures from the European Regional Development Fund (ERDF)

Tackling the time-lag between the local expenditures of ERDF by beneficiaries and those reported in the EC database (invoice-based)

Problem setting

• Payments from the EC to e.g. regional authorities may not corresponds to the actual expenditures incurred by the same authorities toward the beneficiaries. Thus, any analysis of the impact of the cohesion programmes is confronted with a time-lag problem.



Seminar on Robustification of the Regional Payments Databases, Universitat Oberta de Catalunya PUBLISH ABOUT

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Improving the reliability of cohesion policy databases

Samuele Lo Piano 🖾, Emanuele Borgonovo, Arnald Puy, Andrea Saltelli, John Walsh, Daniele Vidoni

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An example of modelling of the modelling process, as the analysis is 'Monte Carlo' by design. Modelling choices can become a trigger. All choices are activated simultaneously.

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The model is to shift back in time (Monte Carlo) invoiced expenditures as to generate a more realistic pattern of when this money reached the economy

Boxplots of distributions of yearly cumulative distance between modelled and reported expenditures.



The End