

# Curriculum vitae and research interests of Andrea Saltelli, March 2016

## CURRICULUM VITAE

### PERSONAL INFORMATION

Family name, First name: Saltelli, Andrea

Researcher unique identifier <http://orcid.org/0000-0003-4222-6975>

<https://scholar.google.com/citations?user=vqhLsGkAAAAJ>

<http://www.scopus.com/authid/detail.url?authorId=7003770842>

Nationality: Italian, Date of birth: 26 August 1953

URL for web site: [www.andreasaltelli.eu](http://www.andreasaltelli.eu), Twitter @andreasaltelli

### • EDUCATION

1976 Doctor Degree in Inorganic Chemistry (first of his course)

Roma La Sapienza University, Italy

1976–1979 Studies in Physics

Roma La Sapienza University, Italy

### • CURRENT POSITIONS

2016 (Nov)-present: Adjunct Professor, Centre for the sciences and the Humanities, University of Bergen, Norway

2015–present Guest researcher Universitat Autònoma de Barcelona: Bellaterra, Catalunya, Spain

### • PREVIOUS POSITIONS

1982–2015 Researcher, then Head of Unit (Econometrics and applied statistics), European Commission Joint Research Centre, Ispra, Italy

1980–1981 Fellow at the Argonne National Laboratory (Illinois, USA)

1977–1979 Fellow of the Italian Nuclear Authority, Rome

### • FELLOWSHIPS AND AWARDS

2005 JRC best paper award (with three collaborators)

2006 JRC prize for best support activity.

2014 Delivered the Commencement speech at the faculty of Statistics, Berkeley

### • COLLABORATIVE RESEARCH PROJECTS LED BY APPLICANT

I led about twenty activities of “Competitive Support”. These are projects funded by a Commission service (e.g. employment or education of internal market) and executed by the JRC. At the time of leaving the JRC the average turnover of these projects exceeded M€2. I was also responsible for several Framework Programme projects (funded by the European Commission – DG Research) in the fourth, fifth, sixth, and seventh framework programmes (on business cycle analysis, flash GDP estimates, innovation measurements, etc.). In Spring 2016 I obtained a procurement from the European Commission to work on an econometric analysis of a regional statistics databases and in winter 2016 I submitted as coordinator a COST action on sensitivity analysis, evaluation pending.

### • TEACHING ACTIVITIES

1995–2015 Ca. 30 summer schools on sensitivity analysis for international students

2005–2015 Ca. 10 summer schools on composite indicators (where I taught the content of the JRC-OECD handbook that I authored on the subject)

- 2009–2015 Sensitivity auditing courses twice a year for colleagues in the European Commission (part of a syllabus delivered by the EC Secretariat General).
- 2007–2009 Module on “Sensitivity Analysis” in PhD Courses Statistics University Bicocca of Milan (I)

- **ORGANISATION OF SCIENTIFIC MEETINGS**

Key organiser and creator of the series: International Conferences on Sensitivity Analysis (attendance from about 60 to about 150 in the time span)

- Belgirate, Italy (25–27 September 1995),
- Venice, Italy (19–22 April 1998),
- Madrid, Spain (18–19 June 2001)
- Santa Fe, New Mexico, USA (8–11 March 2004)
- Budapest, Hungary (18–22 June 2007)
- Milan, Italy (19–22 July 2010)
- Nice, France (1–4 July 2013)
- Reunion Island (1–4 November 2016)

Organiser of courses on sensitivity analysis (1995–present) and composite indicators (2005–2014).

- **INSTITUTIONAL RESPONSIBILITIES**

- 1994–1996 Member of the Scientific Committee of the Environment Institute of JRC
- 2002–2003 Member of the Scientific Committee of the Institute for the Protection and Security of the Citizen, JRC
- 1996–2005 Head of Sector the European Commission Joint Research Centre (Sensitivity Analysis)
- 2005–2015 Head of Unit in the European Commission Joint Research Centre (Econometrics and Applied Statistics)

- **COMMISSIONS OF TRUST**

Ex-Member of Editorial board for *Reliability engineering and system safety*, Elsevier

- **MAJOR COLLABORATIONS**

- OECD Statistics Division (Paris), in 2000–2006 on composite indicators and well-being measures.
- Scholars in sensitivity analysis worldwide (1995–present)
- Mario Giampietro, ICTA-ICREA, University Autònoma of Barcelona (2013–present)
- Silvio Funtowicz and Roger Strand, University of Bergen (2000–present)
- Jerome R. Ravetz, University of Oxford (2000–present)
- Erik S. Reinert, Tallinn University of Technology (2013–present)
- Philip Stark, University of Berkeley (2015–present)

**Ten-year track record**

I established and led a unit at the Joint Research Centre (JRC) of the European Commission (EC) for **Econometrics and applied statistics**. My leadership resulted the a growing number of staff, which led to the unit being split into two in 2012 and continuing a dynamic growth afterwards (80 people in the two units when I left in March 2015). Both units acquired half of their budget from competitive funding from other services of the EC involved in Employment, Education, Internal Market and others (average turn over ~M€ 2). In March 2015 I retired to continue my research activity. Since retiring I published twelve among articles on academic and non-academic outlets, see <http://www.andreasaltelli.eu/Articles>. Since November 2016 I am adjunct professor at the University of Bergen. I am presently working on a project of the EC (Regional Policies directorate).

In these last ten years I continued developing the discipline of **sensitivity analysis**, for which I wrote with my collaborators the most popular text books. In the same period I developed **sensitivity**

**auditing** with Silvio Funtowicz and trained colleagues from the EC in it, combining it with impact assessment methodologies. Sensitivity auditing has its root in sensitivity analysis, which I set out to unify through international conferences (so far there have been eight) and about ten summer schools mostly directed to young practitioners. Both series – organised in the last twenty years – are attracting increasing numbers of delegates. Together with my collaborators at the JRC and with the assistance of the OECD we systematised the **theory of construction of composite indicators**, linking them to such fields as multi criteria and decision analysis, and publishing an official guideline with the OECD, endorsed by the OECD High Level Statistical Committee (composed of 35 member states’ official statisticians) in 2005. Two articles were published on the topic in the *Journal of the Royal Statistical Society*. My role in this undertaking was to provide the link between indicators and policy, the use of Multi Criteria Analysis, and the drive to obviate the most evident shortcoming of composite indicators by creating a toolbox of existing and new statistical practices. University ranking was one of the often cited examples.

The interplay between evidence and policy was a constant concern, leading to the development of sensitivity auditing as a discipline for the appraisal of evidence based on mathematical or statistical modelling feeding into the policy process. I am currently continuing my work of analytic critique of quantification, with three recent papers on the Ecological Footprint, and one on evidence based policy (see references). I am one of the principal investigator in REApprise, a project for the Norwegian SFF which passed phase one selection on March 15, 2016, see <http://goo.gl/Nfra1C>.

#### Summary of production and impact

In total I have authored:

- **99 peer-reviewed articles**, of which
- **37 in the last 10 years**, of which
- **5 papers are highly cited** (in **top 1%** of field & publication year; *ISI Essential Science Indicators*)



	Scopus	Google Scholar
<b>h-index</b>	<b>41</b>	<b>53</b>
<b>i10-index</b>	<b>64</b>	<b>100</b>
<b>Absolute impact</b>	<b>9,119</b> cites	<b>22,986</b> cites
<b># co-authors</b>	<b>132</b>	


*Performance indicators Saltelli (Nov 2015)*

- I published recently two letters (correspondence) in *Nature*. One on the crisis of Science. (Ravetz R & Saltelli A, 2015 Policy: The future of public trust in science, *Nature* 524:161), and another in 2016 entitled ‘Modelling: Climate costing is politics not science’, *Nature*, 532, 177.
- I wrote a **book** “*Science on the Verge*” (2016) with Jerry Ravetz, Mario Giampietro and other scholars mostly from SVT Bergen.

#### *Up to ten representative publications, from the last ten years, as main author*

1. Saltelli, A. and Giampietro, M., 2017, What is wrong with evidence based policy, and how can it be improved? *Futures*, DOI: <http://dx.doi.org/doi:10.1016/j.futures.2016.11.012>.
2. Saltelli, A., Funtowicz, S., Giampietro, M., Sarewitz, D., Stark, P.B., van der Sluijs, J.P., 2016, Climate costing is politics not science, *Nature*, 14 April, 532, 177.
3. Saltelli, A., 2016, "Young Statistician, You shall live adventurous times", *SIGNIFICANCE* (The Royal Statistical Society), December 2016, Volume 13, Issue 6, (pages 38–41)
4. Giampietro, M., and Saltelli, A., 2014, Footprints to nowhere, *Ecological Indicators* 46, 610–621. **Cited 7x Scopus; 15x Google Scholar**
5. 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. **Cited 2x Scopus; 24x Google Scholar**
6. Saltelli, A., van der Sluijs, J., Guimarães Pereira, Â., 2013, Funtowiz, S.O., What do I make of your Latinorum? Sensitivity auditing of mathematical modelling, *International Journal Foresight and Innovation Policy* 9 (2/3/4), 213–234. **Cited 5x Scopus; 12x Google Scholar**
7. Paruolo, P., Saisana, A., Saltelli, A., 2013, Ratings and rankings: Voodoo or Science? *Journal Royal Statistical Society A* 176 (3), 609–634. **Cited 17x Scopus; 72x Google Scholar**

8. Saltelli, A., M. Ratto, S. Tarantola and F. Campolongo, 2012 (Perennial Review of our 2005 paper), Sensitivity Analysis for Chemical Models, *Chemical Reviews*, 112 (5), pp PR1–PR21. **Cited 246x Scopus; 378x Google Scholar** (2005 paper) 
9. Saltelli, A., Annoni, P., 2010, How to avoid a perfunctory sensitivity analysis, *Environmental Modeling and Software* 25, 1508-1517. **Cited 177x Scopus; 248x Google Scholar** 
10. Saltelli, A., D'Hombres, B., 2010, Sensitivity analysis didn't help. A practitioner's critique of the Stern review, *Global Environmental Change* 20, 298-302. **Cited 8x Scopus; 18x Google Scholar**

 = received enough citations to place it in the top 1% of its academic field based on a highly cited threshold for the field and publication year. (ISI Essential Science Indicators)

### **Books**

Saltelli, A., Ratto, M., Andres, T., Campolongo, F., Cariboni, J., Gatelli, D. Saisana, M., Tarantola, S., 2008, *Global Sensitivity Analysis. The Primer*, John Wiley & Sons publishers.

Benessia, A., Funtowicz, S., Giampietro, M., Guimarães Pereira, A., Ravetz, J., Saltelli, A., Strand, R., van der Sluijs, J., 2016, *Science on the verge*, Published by The Consortium for Science, Policy and Outcomes at Arizona State University.

## **RESEARCH INTERESTS**

My interest is to develop practical methods to improve of the quality of scientific evidence, foremost in cases where the evidence feeds into social or political ends. Hence I am interested in the development of best practices and individual techniques: from mathematical modelling and statistics to sensitivity analysis and sensitivity auditing; from impact assessment to the appraisal of evidence. I am also very interested in the investigation of the context of application of these techniques, when to use what, and, from there, my interests span into the conceptual and philosophical underpinning of research and the use of history and philosophy of science as a guide to understand the present and its problems. Currently I'm giving considerable reflection to the twin crisis in the authority of expertise and the quality control of science, while at the same time continuing to study technical issues in quantification.

**Sensitivity analysis** (SA) is the field where I have invested the most in the last thirty years. It is a cross-cutting statistical discipline that examines the sensitivity of mathematical models to changes in their assumptions. It is capable of meeting a broad set of functions related to the quality of a model – including model validation, calibration, simplification, emulation, falsification and many others. Mathematical and statistical models – besides being at the core of practically every industrial process or product - are also at the core of important science-advice functions, e.g. in evidence-based or evidence-informed policy. The use of sensitivity analysis in regulatory setting – e.g. in impact assessment studies – is prescribed in guidelines both in Europe and the United States (European Commission, 2015, p. 390-393; Office for the Management and Budget, 2006, p. 17-18; Environmental Protection Agency, 2009, p.26).

My contribution to this discipline has been methodological, didactic and organizational. I have established the SAMO conference series running without interruption since 1995 (eight conferences so far, see CV) and the SAMO summer school series. With various collaborators I have written three books (2000, 2004, 2008) on the subject which are considered as textbooks. Finally I have developed and continue to develop methodological papers. At present I just submitted a COST action of sensitivity analysis (evaluation pending) whose text is available here:

[http://www.andreasaltelli.eu/file/repository/OC\\_2016\\_2\\_21490\\_FULLPROPOSAL\\_PROPOSER12.pdf](http://www.andreasaltelli.eu/file/repository/OC_2016_2_21490_FULLPROPOSAL_PROPOSER12.pdf)

My recent research activity in SA aims to improve the estimation procedures for variance based sensitivity indices (paper in progress), stress the usefulness of quasi-random numbers rather than

plain (pseudo) random numbers in sensitivity calculations (<http://arxiv.org/abs/1505.02350>) and finally to produce a paper for PLOS-ONE which makes the point that “Most Sensitivity Analysis are wrong” (see [http://www.andreasaltelli.eu/file/repository/draft\\_0.pdf](http://www.andreasaltelli.eu/file/repository/draft_0.pdf)). This latter analyses a sample of about 270 papers to prove that most sensitivity analyses do not explore properly the space of the input factors/assumptions, and hence their results are simply irrelevant. The argument is described in detail in previous papers, see e.g.

<https://www.growkudos.com/publications/10.1016%252Fj.scitotenv.2016.02.133>. Finally I am completing a paper on the use of SA for variable selection in regression, a theme dear to econometricians (see <https://arxiv.org/pdf/1401.5617.pdf>).

**Indicators and Composite indicators.** While at the econometrics and applied statistics (Joint research Centre of the European Commission) unit of the JRC I have worked on many type of indicators, from financial to environmental. With Mario Giampietro I recently wrote three articles on the Ecological Footprint (see

[http://www.andreasaltelli.eu/file/repository/Footprints\\_to\\_nowhere\\_Giampietro\\_Saltelli\\_Ecol\\_ind\\_2014\\_PagesNumbers.pdf](http://www.andreasaltelli.eu/file/repository/Footprints_to_nowhere_Giampietro_Saltelli_Ecol_ind_2014_PagesNumbers.pdf),

[http://www.andreasaltelli.eu/file/repository/Footworking\\_In\\_Circles\\_PageN.pdf](http://www.andreasaltelli.eu/file/repository/Footworking_In_Circles_PageN.pdf),

<http://www.oecd.org/std/42495745.pdf>)

I have given a decisive contribution to systematize the theory of constructing composite indicators, co-authoring in 2008 with OECD and JRC colleagues an official OECD handbook (approved by all 35 members of the high level statistical committee of the OECD; see

<http://www.oecd.org/std/42495745.pdf>). On the same topic I co-authors two articles on the Journal

of the Royal Statistical Society, see [http://www.andreasaltelli.eu/file/repository/JRSS\\_2005.pdf](http://www.andreasaltelli.eu/file/repository/JRSS_2005.pdf),

and [http://www.andreasaltelli.eu/file/repository/rssa\\_1059.pdf](http://www.andreasaltelli.eu/file/repository/rssa_1059.pdf).

**Sensitivity auditing and quantitative story telling.** Sensitivity auditing is recommended by the European Commission guidelines for impact assessment (European Commission, 2015, p. 392-393, see [http://ec.europa.eu/smart-regulation/guidelines/docs/br\\_toolbox\\_en.pdf](http://ec.europa.eu/smart-regulation/guidelines/docs/br_toolbox_en.pdf)). It originates from a series of papers I wrote with collaborators while at the JRC (see <http://issues.org/30-2/andrea/> and [http://www.andreasaltelli.eu/file/repository/IJFIP0902\\_0408\\_SALTELLI.pdf](http://www.andreasaltelli.eu/file/repository/IJFIP0902_0408_SALTELLI.pdf)).

Sensitivity auditing aims to extend sensitivity analysis to contexts where models are at play and their outcome feeds into the public discourse, be it in the context of a policy assessment (ex-ante or ex-post), or in the public arenas where policies are contested. Sensitivity auditing starts from the awareness that in an adversarial context not only the nature of the evidence, but also the degree of certainty and uncertainty associated to the evidence, and the power relations underlying model selection and construction will be the subject of partisan interests. It include a concept of quality assurance by an extended peer community - consisting not merely of persons with some form or other of institutional accreditation, but of all those with a desire and/or interest to participate in extended peer review processes for the resolution of a specific issue. The consideration and inclusion of actors' specific knowledge ultimately adds to the plausibility of model based inference. Sensitivity auditing's checklist includes items such as checking for rhetorical use of mathematical modelling, detecting undeclared or hidden assumptions, ensuring the relevance of the model prediction to the issue being analysed (framing). An application of sensitivity auditing to the PISA study for students literacy is in press. A recent extension of sensitivity auditing is Quantitative Story Telling, which aims to widen to quantitative exploration of a given issue to a plurality of different frames, see [http://www.andreasaltelli.eu/file/repository/FUTURES\\_Saltelli\\_Giampietro\\_draft.pdf](http://www.andreasaltelli.eu/file/repository/FUTURES_Saltelli_Giampietro_draft.pdf).

**Ethics of quantification.** Since 2015 I am teaching twice a year in Utrecht (NL) and about the same times in Bergen (NL) a lesson on ethics of quantification (see [http://www.andreasaltelli.eu/file/repository/Saltelli\\_Bellaterra\\_Ethics.pdf](http://www.andreasaltelli.eu/file/repository/Saltelli_Bellaterra_Ethics.pdf)). This can be combined with sensitivity analysis and sensitivity auditing in a three- or five-day syllabus (see <http://www.uib.no/en/svt/103559/numbers-policy-practical-problems-quantification>). I am particularly interested in [talking to young practitioners](#) about these issues.

**Issues of trust in science's expertise and of science's quality control system.** Since 2015 I am working with several scholars on issues linked to the crisis of science's reproducibility. A book entitled 'Science on the Verge' was published in early 2016 (see <http://www.andreasaltelli.eu/science-on-the-verge>). On the topic of the loss of trust in expertise (the so called post-truth debate) we published on The Guardian ([https://www.theguardian.com/science/political-science/2016/jul/14/six-leading-scientists-give-perspectives-on-uk-science-after-brexit?CMP=share\\_btn\\_tw](https://www.theguardian.com/science/political-science/2016/jul/14/six-leading-scientists-give-perspectives-on-uk-science-after-brexit?CMP=share_btn_tw)), on New Scientist (<https://www.newscientist.com/letter/mg23030791-600-7-a-new-community-for-science/>) and on Nature (<http://www.nature.com/nature/journal/v524/n7564/full/524161d.html>). Our contribution was to highlight how this crisis was predicted by philosophers and how its solution will call for help from outside the house of science, i.e. from civil society. In relation to the discussion of the post-truth we contributed three articles on the online journal The Conversation to critique the present brouhaha and try to re-centre the discussion on the responsibility of scientists and of their institutions in the present situations (<https://theconversation.com/uk/search?utf8=%E2%9C%93&q=saltelli>).

**Climate change and climate models.** In the nineties I did some work on climate (see e.g. <http://link.springer.com/article/10.1007/BF00696755>) and since then I maintained an interest on the topic, in particular in relation to the use of models for climate change and the cost benefit analysis associated to it. I published in a climate specific journal (<http://www.andreasaltelli.eu/file/repository/JGEC750.pdf>), in Nature (<http://www.nature.com/nature/journal/v532/n7598/full/532177a.html>) and elsewhere (<http://issues.org/31-3/climate-models-as-economic-guides-scientific-challenge-or-quixotic-quest/>). My position is that models for climate (and a fortiori models for the cost of acting or non acting on climate) are too uncertain and should be used to study climate but not to decide on climate policies.

**Post normal science and institutional identities.** While at the Joint Research Centre I had a chance to work with Silvio Funtowicz from whom I was initiated to post-normal science. PNS is a set of heuristics for the use of science at the science-policy interface. It was introduced in the nineties by Silvio Funtowicz and Jerome R. Ravetz to address issues where 'facts are uncertain, values are in dispute, stakes are high and decisions urgent' (Funtowicz and Ravetz, 1993; [https://en.wikipedia.org/wiki/Post-normal\\_science](https://en.wikipedia.org/wiki/Post-normal_science)). A key concept in PNS is that of extended peer communities, where both experts and the lay public co-produce the knowledge and decide on the facts of an issue in a deliberative setting. Beside the book 'Science on the Verge' already mentioned this cooperation resulted in several articles ranging from the [application of the precautionary principle](#) to the exploration of a [post-normal identity](#) for the same JRC. I am also familiar with and interested in [NUSAP](#), a notational system to manage and communicate uncertainty in science for policy, based on five categories for characterizing any quantitative statement: Numeral, Unit, Spread, Assessment, and Pedigree (Funtowicz and Ravetz, 1990; van der Sluijs et al., 2008).

**Economics.** While at the JRC I had the opportunity to discuss econometrics and economics in general with my collaborators. Issues which attracted me were inequality and [fairness](#). In particular I advocate for the EC to [move away](#) from strict neoclassical reasoning and embrace input from heterodox economics, bio-economics, and a more open framing of the EU policy discourse. I am still thinking about [fairness](#). Thanks to my collaboration with the Norwegian Economist Erik Reinert I also took interest to the [issue of development](#)– which I had already studied when working on composite indicators in relation to the Human Development Index - and the history of economic thought.

**Bio-economics (in the [sense of Nicholas Georgescu-Roegen](#)).** Thanks to my collaborations with Mario Giampietro I familiarised myself with elements of system ecology, and with [MuSIASEM](#), Multi-Scale Integrated Analysis of Societal and Ecosystem Metabolism. I am interested in the concepts of modelling relationship following [Robert Rosen](#) and in the Hierarchy Theory of [Tim](#)

[Allen](#). I participated to several courses on the subject also in relation to ongoing research on the nexus water energy land-use and natural resources.

**Dissemination, social and new media.** Beside [Twitter](#) and [Research Gate](#) I use Growkudos to complement published articles [with additional material](#) to make their content easier to communicate and keep my works available on a web site [www.andreasaltelli.eu](http://www.andreasaltelli.eu). I am at ease giving [interviews](#), and [communicating with young practitioners](#). I have some experience with lecturing for a Massive Open Online Course.

## References

EPA, 2009, March. Guidance on the Development, Evaluation, and Application of Environmental Models. Technical Report EPA/100/K-09/003. Office of the Science Advisor, Council for Regulatory Environmental Modeling, <http://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1003E4R.PDF>, Last accessed December 2015.

European Commission, Better regulation toolbox, appendix to the Better Regulation Guidelines, Strasbourg, 19.5.2015, SWD(2015) 111 final, COM(2015) 215 final, [http://ec.europa.eu/smart-regulation/guidelines/docs/swd\\_br\\_guidelines\\_en.pdf](http://ec.europa.eu/smart-regulation/guidelines/docs/swd_br_guidelines_en.pdf).

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

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

OMB, Proposed risk assessment bulletin, Technical report, The Office of Management and Budget's – Office of Information and Regulatory Affairs (OIRA), January 2006, [https://www.whitehouse.gov/sites/default/files/omb/assets/omb/inforeg/proposed\\_risk\\_assessment\\_bulletin\\_010906.pdf](https://www.whitehouse.gov/sites/default/files/omb/assets/omb/inforeg/proposed_risk_assessment_bulletin_010906.pdf), pp. 16–17, accessed December 2015.

van der Sluijs, JP, AC Petersen, PHM Janssen, JS Risbey, and JR Ravetz, 2008, Exploring the quality of evidence for complex and contested policy decisions, *Environmental Research Letters*, 3 024008 (9pp)