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Editorial

Post-normal science in practice



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ABSTRACT

This special issue contains a selection of papers presented during the 2014 Bergen meeting, complemented with short perspectives by young PNS-inspired scholars, presented at a mini-symposium “Post-normal times? New thinking about science and policy advice” held on 21 October 2016 in celebration of Silvio Funtowicz’ 70th birthday, also in Bergen. In addition, the issue includes two more extended commentaries on the present crisis in science and the post-fact/post-truth discourse, one from Europe (Saltelli and Funtowicz, this issue) and one from Japan (Tsukahara, this issue). Far from being a complete representation of the discussions at both symposia, the six papers, three short perspectives on PNS and two extended commentaries on the present crisis, represent relevant reflections on the current state and possible future scope of PNS in the context of the rapidly changing role of science in governance.

1. Introduction and Context: Bergen December 2014 meeting

In 1993, Silvio Funtowicz and Jerome Ravetz published their seminal work “Science for the Post-Normal Age” in this journal. It is now by far the best cited paper ever published in *Futures* (with 1471 citations according to scopus.com, and 3420 citations according to Google Scholar; May 2017). A quarter of a century after its publication, the number of citations received per year is still increasing, with 317 citations in 2016 (source: Google Scholar, May 2017), illustrating the growing relevance and influence of the concept of post-normal science (PNS). In their editorial to a later *Futures* special issue on PNS, Ravetz and Funtowicz (1999: 644) emphasized that PNS is “an insight rather than a theory”, and as such “allows different aspects to be emphasized as the occasion suggests, and as our own understanding develops”. This means that PNS can flexibly accommodate a number of different approaches, as we increasingly see. These approaches to science for governance have in common that they are critical and reflective, uncertainty-aware, quality-focused, foster plurality in scientific and normative perspectives on complex issues, and actively engage extended peer communities in the production, appraisal and use of knowledge.

Most recently, post-normal scholar Roger Strand from the University of Bergen revisits PNS both as a critical concept and as an inspiration for a new style of research practice. The dichotomous nature of PNS can be described as both *descriptive* (describing urgent decision problems – post-normal issues – characterized by incomplete, uncertain or contested knowledge and high decision stakes and how these characteristics change the relationship between science and governance) and *normative* (proposing a style of scientific inquiry and practice that is reflexive, inclusive and transparent in regards to scientific uncertainty and moving into a direction of democratisation of expertise) (Strand, 2017)

In December 2014, the Centre for the Study of the Sciences and the Humanities of the University of Bergen, Norway, hosted an international symposium on “Post-Normal Science in Practice”. It became the first of a new annual series of international symposia on PNS, organised by an emerging international community of PNS-inspired scholars, with gravitational centres at the University of Bergen and Universitat Autònoma de Barcelona. The purpose of this meeting was to gather practitioners and theorists of PNS to reflect upon and critique past post-normal scholarship and to gain a collective bearing for future work. At this meeting, various complimentary descriptions of PNS in practice arose. First, many scholars underscored the importance and role of empowering and engaging diverse groups of relevant lay people, experts and decision-makers, commonly called “extended peer communities”. Furthermore, scholars agreed that post-normal problems require a continuous dialogue within these extended peer communities. Another idea foregrounded at this symposium was that post-normal

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science can also be considered as a heuristic device, allowing citizens and decision-makers to consider problems from different perspectives and bypass common but perhaps ineffective methods in order to arrive at a mutually satisfactory approach to complex science-policy issues.

This special issue contains a selection of papers presented during the 2014 Bergen meeting, complemented with short perspectives by young PNS-inspired scholars, presented at a mini-symposium “Post-normal times? New thinking about science and policy advice” held on 21 October 2016 in celebration of Silvio Funtowicz’ 70th birthday, also in Bergen. In addition, the issue includes two more extended commentaries on the present crisis in science and the post-fact/post-truth discourse, one from Europe (Saltelli and Funtowicz, [this issue](#)) and one from Japan (Tsukahara, [this issue](#)). Far from being a complete representation of the discussions at both symposia, the six papers, three short perspectives on PNS and two extended commentaries on the present crisis, represent relevant reflections on the current state and possible future scope of PNS in the context of the rapidly changing role of science in governance.

Science is in crisis. It faces major problems related to science’s reproducibility, science’s governance, and the use of science for policy (Benessia et al., 2016). In their commentary “**What is science’s crisis really about?**” Andrea Saltelli and Silvio Funtowicz ([this issue](#)) explore the present debate about ‘post-factual’ democracy following BREXIT in the UK and the election of president Trump in the US. Both indicate a rapidly changing role of evidence and expertise in contemporary societies. The present crisis in science did not come as a surprise, it was anticipated almost half a century ago in the book “Scientific Knowledge and its Social Problems” by one of the founding fathers of post-normal science (Ravetz, 1971). Now that the long anticipated crisis in science has manifested itself, this special issue is a timely effort to increase awareness of the descriptive and normative theories and philosophies of post-normal science as well as reflections on the current practice of PNS-inspired approaches to science for policy regarding post-normal issues.

König, Børsen, and Emmeche’s ([this issue](#)) Nicolas König, Tom Børsen, and Claus Emmeche’s article ([this issue](#)), “**The ethos of Post-normal science**”, gives an overview of important concepts of PNS, and investigates the norms and values of PNS through a structured literature review. The authors refer to Funtowicz and Ravetz’s (1993, 2008) development of PNS from the mid-1980s onwards, and describe the conditions characterizing a post-normal situation: Irreducible complexity, deep uncertainties, multiple legitimate perspectives, value dissent, high stakes, and urgency of decision-making. PNS seeks to cope with such situations through extended peer communities encompassing broader notions of knowledge, uncertainty management, and acknowledgement and management of multiple valid perspectives. Unlike normal science, the goal is not to attain certain knowledge. The goal of PNS is *quality*, a more robust ‘science for policy’. Inspired by the legacy of the Mertonian norms of CUDOS (Communalism, Universalism, Disinterestedness, and Organized Skepticism), the authors point to how politicization of science renders Merton’s norms invalid. Through their analysis of 33 norms and values found in 397 PNS-related documents, they identify an ethos for PNS which they denominate TRUST (Transparency, Robustness, Uncertainty management, Sustainability, and Transdisciplinarity), considered as a nexus for reflexivity practices. They propose that the public trust in science advice can be restored through the PNS ethos.

Kjellrun Hiis Hauge and Richard Barwell ([this issue](#)) make the connection from best practices in the field to best practices in teaching and education in their paper “**Post-normal science and mathematics education: educating future citizens for extended peer communities.**” The concept of the extended peer community and engaged citizenry is central in post-normal science, but arguably requires an education in critical thinking, and in particular, critical mathematics, the authors argue. The focus on critical mathematics comes at a time where we increasingly see numbers as a focus in public rhetoric and argumentation, even when their derivatives are based on shaky grounds (Benessia et al., 2016; Saltelli and Giampietro, [this volume](#)). One of the values of bringing critical mathematics into the classroom is to also merge a philosophy of mathematics with an understanding of the epistemological dialogues that take place within peer communities of science, society and decision-making. The main focus of this paper is on three specific types of uncertainty that citizens are routinely faced with (technological, methodological and epistemic uncertainty), with examples from traffic safety and climate change. The authors argue that critical mathematics skills have the potential for leveraging a new level of citizenship that is prepared to deal with post-normal, complex questions that inevitably arise in our modern technological society.

You cannot predict earthquakes. But you can communicate uncertainty. This is one of the upshots of Alice Benessia and Bruna De Marchi’s ([this issue](#)) descriptive paper “**When the earth shakes ... and science with it. The management and communication of uncertainty in the L’Aquila earthquake**”. It presents a recent dramatic narrative that unfolded after over 300 people died in the earthquake in Italy on April 9, 2009. In an unprecedented turn of events, an Italian court sentenced scientists to prison based on a lack of communication on the scientific uncertainty related to earthquake predictions. Their fault was informing the public that there was “no danger” of an earthquake that a local claimed to be able to predict. Benessia and De Marchi (2017) analyse this controversy in light of the multi-dimensionality of uncertainty. If uncertainty was only epistemic, than it would suffice to remind the public that earthquakes cannot be reliably predicted. But Benessia and De Marchi (2017) provide evidence that uncertainty in the L’Aquila case was also time- and path-dependent; it is true that earthquakes and other mass emergencies cannot be predicted, and as such, *could happen at any time*. The tragedy of the fatalities and injuries could have been mitigated by a public reminder of emergency procedures and upstream engagement instead of a high-profile negation of the earthquake warning. The L’Aquila case is thus a good example of how a post-normal concept of science, its uncertainties, and society interact and intertwine, and a sobering reminder of the communication responsibilities, not only of results, but of possibilities, that scientists carry in the face of unavoidable catastrophic events and resulting mass emergencies.

Diana Wildschut’s ([this issue](#)) paper on “**The need for citizen science in the transition to a sustainable peer-to-peer-society**” is written from the perspective of a practicing citizen scientist. Wildschut is one of the founders of the Amersfoort Cooperative University, a grassroots knowledge society located within a historic factory. As such, she writes from long standing personal experience and argues for the importance of citizens’ engagements in grassroots sustainability initiatives interconnected by peer-to-peer (p2p) networks. Comparing the current situation to the shift that happened in Roman times when slaves were freed because keeping them became more expensive than sharecropping, she states that a growing number of people, for example ones who have lost their paid jobs, are turning to a “p2p economy” of exchange between individuals. She posits that availability of knowledge through digital channels and an increasing dissatisfaction with the governance of the environment is leading to experimental

engagements with local food production, waste management and social innovation. Cheap tools such as the Arduino micro controller board and the Lab-on-a-Chip analysis platforms enable citizen scientists to perform increasingly complex experiments. Wildschut argues that these developments prove that scientist-led citizen science projects that make use only of citizens' time or computer power underestimate the intelligence, creativity and, not least, local knowledge that citizens can contribute to academic science. She relates the experience of the city of Amersfoort, in which the local government chose to give the task of investigating local indicators of climate change to interested citizens. Such projects also entail an informal (self-)education, making use of the growing availability of knowledge shared by open access (OA). OA is vital to the citizen science movement, Wildschut argues, in order for citizens to really engage in the knowledge pool on an equal basis. At the moment, the p2p society exists as a somewhat separate, marginal world from that of the capitalist society that runs on credentials – and the two worlds are mutually skeptical. Collaboration between these “worlds” can bring mutual benefit, she concludes, but requires adjustment from both parties.

In the paper “**Post-normal Institutional Identities: Re-inventing Advice to Policy**”, [Ángela Guimaraes Pereira and Andrea Saltelli \(this issue\)](#) argue for a culture of post-normal scientific advice that would involve a more reflexive, humble approach to scientific governance, as a countermeasure against what they describe as the current crises of legitimacy and quality in science. Departing from the case of the European Commission's Directorate General Joint Research Centre, who term themselves the ‘in-house science service’, the authors argue that the existing plurality of norms and styles of scientific inquiry urgently need to be opened up to more participatory modes of knowledge production, assessment and governance. Such an opening up, through the framework of PNS, would be a measure to confront what the authors term “the ongoing erosion of trust in ‘evidence based policy’”.

In their contribution “**What is wrong with evidence based policy?**” [Andrea Saltelli and Mario Giampietro \(this issue\)](#) critically examine the state-of-the-art in science advice for policy, claiming over-simplification of the world around us, which leads to the phenomenon of “hypocognition.” The paper introduces a strategic method called “Quantitative Story-Telling” which is designed as a quality check of problem framing and policy and decision-making narratives. Quantitative Story-Telling allows one to open up new spaces of narratives as a type of sensitivity analysis not found in purely quantitative studies. This is done by screening available narratives in a way that seeks to refute frames that violate constraints of *feasibility* (compatibility with processes outside human control), *viability* (compatibility with processes under human control), and *desirability* (compatibility with a plurality of normative considerations relevant to the system's actors). This type of analysis can also illuminate other determining factors of quality in science advice, such as power relations, which otherwise fly under the radar of quality.

Building on experiences with production and use of knowledge for climate change adaptation with communities in northeast Bangladesh, [Scott Bremer's \(this issue\)](#) commentary “**Have we given up too much? On yielding climate representation to experts**” highlights the key importance of non-scientific climate representations in local decision support. The paper emphasises the pre-modern and local representations and knowledge of weather that persist in extended peer communities alongside those of modern science. The Bangladesh experience opens up for post-normal approaches that can improve adaptation decision support by bridging these pre-modern and modern framings through systematic knowledge quality assessment, and with equal regard for the knowledge and the meanings that underpin these representations.

In her commentary “**Engineering ethics and post-normal science: A French perspective**”, [Fanny Verrax \(this issue\)](#) reflects on the reforms in engineering practice that are necessary to meet present day's societal and technical challenges. She explores how a turn to post-normal engineering ethics may help redesign engineering practice to remedy three major failures in present day engineering ethics: its failure to care about the “ordinary”, its failure to engage the public as a relevant partner, and its failure to take power relations into account. The proposed reform requires fundamental changes in culture and training to achieve engineering ethics that is more transparent, aspirational, and concerned with the whole of technologies (from the mundane to the cutting-edge) for all corners of society.

[Zora Kovacic \(this issue\)](#) contributes a commentary on “**Investigating science for governance through the lenses of complexity**” in which she explores the synergies between complexity theory and PNS, building on the concept of irreducible pluralism and proposing complexity as an interface to engage with the multiple epistemologies and corresponding – often contradictory – facts. Building on three cases, ranging from water management and smart electricity grids to slum upgrading in Stellenbosch, South Africa, she shows how the approach of complexity theory explains some of the post-normal challenges, by making sense of multiple representations, multiple definitions of uncertainty, and by providing an interface to engage with multiple facts.

Providing a Japanese perspective on the present crisis in science, examines the **discrepancies and incongruities between Japanese technoscientific policy and the citizens' science movement in Japan after the 11 March 2011 triple disaster** (known as 3/11) of earthquake, tsunami and Fukushima nuclear melt-down accident. Since 3/11 Japanese society has been badly divided and shows many similarities to Trumpian United States, i.e., serious social divide and political populism. In such times, Tsukahara explores the questions: can PNS and a citizen science approach now lead the way to fill the gap? Are there any lessons here that can be applied to post-3/11 Japan?

In all, the collection of papers in this special issue dovetails the common themes of uncertainty communication, engaging and educating extended peer communities and the ethical responsibility of transparency and participatory practices in science for policy and advice.

Since the Bergen 2014 meeting, an increasing amount of practical and empirical work has built on the concept of post-normal science. Additional meetings that have recently been convened to showcase and disseminate this on-going work include the workshop “Significant Digits: Responsible Use of Quantitative Information¹” in Brussels in June 2015, and the March 2016 Ispra meeting “New Currents in Science: The Challenge of Quality” (the second PNS symposium), both hosted by the Joint Research Centre of the European Commission. Both of these meetings were presided over by Vladimir Šucha, Director-General of the JRC, and the latter also

¹ For video selections, see <https://ec.europa.eu/jrc/en/event/conference/use-quantitative-information>

attended by JRC policy-makers. In October 2016, Sir Peter Gluckman, former Chief Science Advisor of New Zealand, provided a keynote analysis on “The realities of scientific advice to governments – why a post-normal perspective really matters” at the University of Bergen, with themselves providing an historical summary of their original thinking and inspiration for their original PNS papers.

At the time of writing, the third international PNS symposium, focused on “‘Post-truth’ and a crisis of trust? Perspectives from post-normal science and extended citizen participation”, is scheduled for 25–26 September 2017 in Tübingen.²

The current conversation among policy makers and advisors presided over by post-normal scholars gives us reason to believe that the “inescapably radical” concept of post-normal science is slowly, but surely, becoming considered less of a mainstream hindrance and more of a mainstream advantage. We should acknowledge the accomplishments of Funtowicz and Ravetz, 1993 Funtowicz and Ravetz (see e.g. 1993, 2008) in laying the groundwork for the proverbial torch of post-normal science and its practice. The papers in this special issue thus remind us of the role and responsibility of the emerging community of PNS “practitioners”, in leading the way for post-normal theories and approaches fit for our present times of crisis.

Author contributions

DJD, NSV and JvdS contributed equally to this editorial

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² For more information, see <http://www.izew.uni-tuebingen.de/aktuelles/pns-3-symposium.html>