Expert Discussion Workshop Report: Making Sense of Science for Policy under Conditions of Complexity and Uncertainty

Berlin, 11 February 2019

SAPEA

Science Advice for Policy by European Academies

Workshop Report No. 5.

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About SAPEA

Spanning the disciplines of engineering, humanities, medicine, natural sciences and social sciences, SAPEA (Science Advice for Policy by European Academies) brings together outstanding knowledge and expertise from over 100 academies, young academies and learned societies in over 40 countries across Europe.

Working closely with the European Commission Group of Chief Scientific Advisors, SAPEA provides timely, independent and evidence-based scientific expertise for the highest policy level in Europe and for the wider public. SAPEA is part of the European Commission Scientific Advice Mechanism (SAM) which provides independent scientific advice to the College of European Commissioners to support their decision making.

The project is funded through a grant from the European Union Horizon 2020 programme running from November 2016-October 2020. SAPEA comprises the European Academy Networks: Academia Europaea, ALLEA, EASAC, Euro-CASE and FEAM.

For further information about SAPEA visit: www.sapea.info

Executive Summary

1. In 2018, the European Commission's Group of Chief Scientific Advisors agreed to produce a Scientific Opinion on science advice, following a request by the College of Commissioners. It would be addressed primarily to policymakers, who utilise scientific advice across the European Commission, and also of relevance to the governance of scientific advice. The overarching question to be addressed was:

How to provide good science advice to EC policymakers, based on available evidence, under conditions of scientific complexity and uncertainty?

2. The SAPEA Consortium was asked to conduct the evidence review to inform the Scientific Opinion. SAPEA set up an international and interdisciplinary working group, chaired by Professor Ortwin Renn. The Working Group met between September and December 2018. An extensive literature search was undertaken concurrently. The first draft of the SAPEA report was delivered in January 2019.

3. In February 2019, a group of invited experts convened in Berlin to critique the first draft of the SAPEA Evidence Review Report, *Making science of science for policy under conditions of complexity and uncertainty*.

4. Opening the workshop, the SAPEA Working Group Chair highlighted the challenges of producing an evidence report on making sense of science for policy. These include:

a. The diversity of academic thinking on the nature of science and evidence;
b. The large quantity of literature on the topic;
c. The importance of interpretation, in addition to presenting facts and data; and
d. The range of quality criteria applied across different disciplines and fields of study.

In dealing with these challenges, the Working Group sought to be *pragmatic* in its examination of the role of science in advisory mechanisms. In defining *good* science, the Working Group included quality criteria for science *advice*, not for science itself.

5. The keynote speaker provided an overview of the report, making observations on strengths, possible limitations and gaps. Invited discussants then provided feedback on each of the main chapters of the report. Members of the Working Group had the opportunity to respond to the points raised.

A summary of recommendations is presented at the end of each section of this document.

6. The draft Evidence Review Report was revised to take account of the expert feedback and sent for formal peer review in March. The final version of the report was published in July 2019, and the Scientific Opinion in September 2019. The report of the expert workshop is submitted as a Deliverable to the European Commission, under the SAPEA Grant Agreement.

Introduction

In February 2019, a group of invited experts convened in Berlin to critique the first draft of the SAPEA Evidence Review Report, *Making science of science for policy under conditions of complexity and uncertainty.*

The report of the expert workshop is published under the Chatham House Rule, i.e. no attribution is made to any individual present at the workshop. Experts attended in a personal capacity and not as the representative of any institution.

Context

Background to the expert workshop

In 2018, the European Commission's Group of Chief Scientific Advisors (GCSA) agreed to produce a Scientific Opinion, following a request by the College of Commissioners. It would be addressed primarily to policymakers, who utilise scientific advice across the European Commission, as well as being of relevance to the governance of scientific advice in the Commission. The overarching question to be addressed was:

How to provide good science advice to EC policymakers, based on available evidence, under conditions of scientific complexity and uncertainty?

A scoping paper (European Commission Scientific Advice Mechanism, 2018) was published in January 2018. In June, the GCSA led a scoping workshop at the European Commission. The purpose was to highlight areas of debate and sub-topics to be addressed when drafting the Scientific Opinion. An outcome of the workshop was a set of nine sub-questions, developed from the main question (European Commission Group of Chief Scientific Advisors, 2018).
The SAPEA Consortium was asked to conduct the evidence review to inform the Scientific Opinion. SAPEA set up an international and interdisciplinary working group, chaired by Professor Ortwin Renn (IASS, Germany). The Working Group met between September and December 2018. An extensive literature search was undertaken concurrently. The first draft of the SAPEA report was delivered in January 2019.

Purpose of the expert workshop

The aim of the Berlin workshop was to provide critique by the wider expert community on the first draft of the SAPEA report. The invited experts were asked to provide constructive input to the revision of the report, as well as helping to bridge from the evidence review stage to the drafting of the Scientific Opinion. Experts were asked to perform a 'reality check' of the scientific evidence in the report, with particular reference to the scoping questions. They were also asked to identify any evidence gaps in the report.

Format of the expert workshop

11 invited experts participated in the workshop. In addition, members of the SAPEA Working Group and representatives from the GCSA, the SAM secretariat and SAPEA attended. A full list of participants is shown in Appendix 2.

The format of the workshop was as follows:

- An introduction to the Evidence Review Report, by the Chair of the SAPEA Working Group;
- An opening statement by an invited keynote speaker, with general observations on the report;
- A review of each of the main chapters, with a short introduction by the chapter lead, response by discussant(s), followed by closing remarks by the wider group of experts;
- A summing-up and next steps.

Impact of the expert workshop

The SAPEA draft report was revised to take account of the expert feedback and sent for formal peer review in March. The final version of the report was published in July (SAPEA, 2019), and the Scientific Opinion in September 2019 (European Commission Group of Chief Scientific Advisors, 2019). This report of the expert workshop is submitted as a Deliverable to the European Commission, under the SAPEA Grant Agreement.

Report of the workshop

Opening remarks

Chair: Professor Ole Petersen, Vice-President Academia Europaea

Professor Petersen addressed the so-called 'reproducibility crisis' in science. His recent editorial article in the *Journal of Physiology* (Petersen, 2019) concluded that erroneous information had only been found within a fraction of the work in which he had been involved. Articles by Fanelli (2018) and an interview with Iain Mattaj (Gristwood & Breithaupt, 2019) also counter the view that there is a reproducibility crisis.

Session 1: Introduction to the SAPEA Evidence Review Report

Lead: Professor Ortwin Renn, Chair of the SAPEA Working Group

Producing an *evidence* report presents its own set of challenges in making sense of science for policy. Firstly, we encounter distinct and diverse communities of academic thinking on the nature of science and evidence. Secondly, science advice is not simply about providing facts and data to policymakers; *interpretation* also plays a vital role.

The SAPEA Working Group set out to focus on the *making of meaning*, embracing both science *and* the humanities. The Group was conscious to avoid placing itself at either end of the two extremes of academic thinking – the traditional positivist and the more recent relativist schools. Instead, the Group sought to be *pragmatic* in its examination of the role of science in advisory mechanisms. This may lead to the view that the report is either not deep enough or, conversely, that it is too philosophical. Furthermore, there is a lot of literature published on the topic and the Group could not be exhaustive.

Quality criteria in science vary between disciplines and fields of study. In defining *good* science, the Group included quality criteria for science *advice*, not for science itself.

The Working Group took the nine scoping questions and highlighted how they have been addressed and why, in some cases, it opted to apply a different framing to the question.

The draft Evidence Review Report is structured as follows:

- Chapter 1 is an introduction;
- Chapter 2 sets out the main terms;
- Chapter 3 focuses on the nature of science;
- Chapter 4 focuses on the needs of policymaking;

• Chapter 5 brings science and policy together; and

•Chapter 6 provides a set of conclusions.

Session 2: Overview of the SAPEA Evidence Review Report

Introduction

In this session, an invited keynote speaker presented an overview of the main points conveyed in the report, followed by his initial observations on strengths, possible limitations and gaps.

Summary of the keynote presentation

Over the decades, a lot of scholarly work has been dedicated to the topic of what science can offer to political decision-makers. Two dominant schools of thinking have developed, the 'realist' and 'constructivist' traditions. In the report, these traditions are not neglected, but neither does it lean to one side or the other. The report is a serious endeavour to give a broad account of the relevant debates and insights. This balanced epistemic perspective is surprising, as is the prudence of the evaluation done by the Working Group, as much published literature takes a position. It is notable that the report has several areas of agreement:

1. A broad, shared understanding of science, closer to the German term *Wissenschaft*;

2. A view that science is a vitally important component of policymaking, even if it does not have the ultimate authority in speaking 'truth to power';

3. Strong advocacy of 'evidence-informed' policymaking;

4. Conviction that the main contribution of science is to improve decision-making in complex environments;

5. Awareness of the many and diverse policy-science interfaces in existence.

The report takes the following structure:

• Chapter 2 looks at science as a *source of advice* for policymaking. The report states that science advice has become increasingly prominent within society. At the same time, policymakers often have unrealistic assumptions about science advice and the nature of evidence. The report highlights three conditions of scientific knowledge for policy – complexity, uncertainty and ambiguity – which are elaborated further in the report.

• Chapter 3 examines what science can *offer to policymaking*. It discusses science as one form of knowledge, amongst others. It asserts that scientists, as well as policymakers, are guided by values and interests. It describes the growing interest of civil society in science advice.

• Chapter 4 deals with the *use of science advice* in policymaking contexts. It puts forward two process models – the linear-rational and strategic. The varying roles of science for policymaking are described. The vital role of heuristics and modes of framing are also addressed.

• Chapter 5 looks at the potential for improving the use of science advice for policymaking. The complexities of translating scientific evidence into policy-relevant advice are described. A set of design principles for a working interface between policy and science is provided.

• Chapter 6 presents 13 basic insights from the report, all of which are convincing and relevant.

Possible limitations and gaps in the report include the following:

• The main *audience* for the report is not obvious.

• There is some *overlap and repetition* throughout the report.

• It could be useful to refer more explicitly to the institutional landscapes of science-based policy advice, and the limitations of each. For example, regulatory science operates under different constraints from academic science.

• The 'science advisory ecosystem' is not explained fully as a concept. There are numerous knowledge organisations operating at the interface of science and policymaking (these include, for example, applied research institutes, government labs, think-tanks, research-based consultancies etc).

• The role of knowledge and scientific expertise for policymaking in the context of ill-defined and contested 'Grand Challenges' should be given more attention. Policymaking in these contexts needs to be explorative and to work with experimentation, trying new models of strategic intelligence and governance.

• Science diplomacy, a set of practices at the intersection of science, technology and foreign policy, is a growing discourse and should be mentioned.

Discussion and Working Group response

One expert participant emphasised that although the report is aimed primarily at the European Commission, it could be equally useful to national policymakers. Another expert cautioned that many of the points in the report had been made before but had not led to action. The key is to address institutional barriers to change.

The recommendations were mostly supported by the Lead. He underlined that the report

summarises the available evidence, rather than putting forward recommendations for policy change. A separate paper directed at policymakers will be produced.

Summary of recommendations

1. Clarify the target audience for the report. Reflect this through appropriate use of language, style and tone.

2. Condense the report by addressing areas of repetition and overlap. Establish linkages between sections of the report by appropriate cross-referencing.

3. The term 'science advisory ecosystem' should be explained more fully.

4. The report should refer more explicitly to the institutional landscape and the strengths/ limitations of each form of science advice e.g. regulatory science, academic research.

5. The role of science in ill-defined *Grand Challenges* should receive more attention. There are new actors in the policy arena, each with competing knowledge claims. In this situation, policymaking needs experimentation, new models of strategic intelligence and tentative governance arrangements.

6. Science diplomacy deserves greater coverage in the report.

7. The report is not only relevant to the European Commission but is also invaluable as input to shaping other advisory mechanisms, for example, at national level.

Session 3: Science as a source of advice for policymaking

Introduction

Lead: Professor Ortwin Renn

Chapter 2 of the report introduces the reader to the terms used throughout.

Summary of the discussant's presentation

This is a comprehensive report and overview of the literature. However, it is easy to get lost in the sheer volume of information and more structure is required. The report needs an overarching narrative.

The focus of the report is on the epistemic perspective but the 'soft power' of science should not be ignored. It would be helpful to elaborate on how forms of expertise are constructed and challenged, and what is needed to lay the ground for sound policy-relevant expertise. As mentioned by the keynote speaker, more focus on the ecosystem of science advice may be required. One function of science advice should be to increase the resilience of democratic societies, by enhancing the capabilities of policymakers and developing policy options that are

robust when facing uncertainty, complexity, dynamic change and ambiguity. The discussion around the 'illusions' of both policymakers and experts towards science advice is helpful. This section also mentions the potential challenge of expert overconfidence, as well as describing the dynamics between science and policymakers.

At the same time, there appears to be an assumption that science itself does not face problems. This could be challenged; maintaining trust in scientific institutions is an issue and there is a risk of scientific 'disintegration'. Quality control of *expertise* is different from quality control of *science* itself. It might be said that scientific peer review is not well suited to preventing fraud or mitigating bias.

Discussion and Working Group response

One expert participant agreed that a discussion of terms was important, given the diverse audience for the report. For example, 'evidence' may have several meanings. There is also a difference between 'science' and 'expertise', and they should not be used interchangeably. Although the main addressee of the report is the European Commission, a community of different cultures, the report is written in English and is characteristic of English framing.

Another expert participant cautioned that it is not easy to address the issue of so-called scientific 'disintegration' and it requires a balanced stance. There are institutional changes to how science is rewarded within the system (for example, the growth of metrics such as citation-counting), which could increase further the pressures on quality.

Another expert participant warned that care should be taken to avoid the extrapolation of results beyond their original field of applicability. This is not about 'disintegration', but rather about paying attention to the way that science is used.

Lastly, an expert pointed out that the report highlights the importance of trans-disciplinary approaches to science advice, in the sense of incorporating different stakeholders and parties in the process. This can serve as a useful quality control tool.

Summary of recommendations

1. Further strengthen the structure of the report and ensure a consistent narrative throughout.

2. Take a balanced approach to the possible perceived crisis of quality within scientific output, ensuring that science is always used appropriately and carefully within policymaking.

Session 4: What can science offer to policymaking? The potential contribution of science, evidence and knowledge

Introduction

Lead: Professor Alan Irwin

Chapter 3 is the result of collective endeavour by several members of the Working Group.

Robust evidence is vital, but it cannot always fulfil its intended role in policymaking. There are challenges to science as a form of knowledge and limits to its validity. Science cannot *decide* policy. The report therefore uses the term 'evidence-informed', rather than 'evidence-based'. The chapter also deals with styles of reasoning, normative issues and assumptions, ethics, and mechanisms of quality control.

Summary of discussant presentation (1)

The assertion that social phenomena are uniquely 'complex' or intricate in character has a long, venerable and virtually uncontested tradition in social science. Classical theorist social scientists refer repeatedly and prominently to this assertion and the degree to which it complicates the development of sociological knowledge. More specifically, it is widely argued that the complexity of social reality has an inhibiting effect on the production of powerful *practical* social science knowledge. The claim that social phenomena are complex is designed to sensitise social scientists to the kind of explanatory and methodological devices that are equal to the task of adequately capturing social reality. This sensitivity is intended in both an epistemological and methodological sense, and in a more mundane sense, when it comes to how social scientists practise their craft.

'Complexity' means that particular social processes (for instance, exchange rates, unemployment, deviant behaviour) are set in motion, reproduced or changed by many interdependent factors. According to this conception, any empirically valid representation of a complex process - and therefore any effective and manageable control of such a process - requires a complete and faithful depiction of all the intricate factors involved and their interconnections. This implies that it is difficult to make detailed and precise forecasts about the outcomes of those processes (for instance, price changes, employment trajectories, crime rates) without such a depiction.

The Belgian astronomer, mathematician, statistician and sociologist Adolphe Quetelet (1796-1874) was the first to propose that social scientists should collect data in a big way, anticipating the current interest in *big data*. Quetelet was the originator of what he called 'social physics', a social science discipline devoted to collecting information about the 'average man', which required assembling a complete picture with as many observations as possible. This conception persists to this day.

The alternative to this position is to maintain that complexity is not an obstacle to practical knowledge. Max Weber and Karl R. Popper are among social scientists and philosophers of (social) science who seemed unimpressed with the common assertion about the intricate complexity of social phenomena. Popper ([1957] 1972) was convinced that the thesis actually constitutes a subtle form of prejudice which has two origins:

> 1. The thesis is a result of a meaningless and inaccurate comparison of circumstances; for example, comparing the controlled conditions found in a laboratory with real social situations.
>
> 2. The thesis is the result of the orthodox methodological conception that any adequate description of social phenomena requires a complete account of psychological and material circumstances of all actors. Since humans behave in most situations in a rational fashion, Popper maintains, it is possible to reconstruct social interaction with the aid of relatively simple models which assume such rational conduct among the participants.

Max Weber ([1904] 1949), in his essay 'Objectivity' in social science and social policy, emphasises that social science can only portray a fraction of the complexity of social reality and therefore can never grasp it fully in all its details:

> "All the analysis of infinite reality which the finite human mind can conduct rests on the tacit assumption that only a finite portion of this reality constitutes the object of investigation, and that only it is 'important' in the sense of being 'worthy of being known'."

The view that powerful practical knowledge requires complexity to be fully captured also relies on a couple more questionable premises (cf. Grundmann & Stehr, 2013). Complete intellectual control of the complex origins and process of social situations is not always necessary for 'mastery' over those situations, or to change them. Whatever control may be possible under given circumstances, such control likely is restricted to a few attributes of the context. Efforts to raise the theoretical complexity of social science knowledge may therefore have the unanticipated effect of even further reducing the possibility of social action.

The constituents of practical knowledge

It is not the 'scientificity' of social science knowledge (i.e. knowledge that captures the full complexity of social reality, conforms to specific methodological rules or is expressed in a quantitative language) that assures that such knowledge is practical. Rather, reflections about the conditions or constituents of practical knowledge have to start from the assumption that the adequacy (usefulness) of knowledge, produced in one context (of production) but employed in another context (of application) pertains to the relation between knowledge and the local conditions of action (Stehr, 1992). Within the context of application, constraints and

conditions of action are apprehended as either open or beyond the control of relevant actors. Practical knowledge pertains to open conditions of action, which means that theoretical knowledge must be reattached to the social context, and to those elements of the situation that are actionable, if it is to be effective in practice.

A brief example may serve as an illustration. A rather common knowledge claim (at least, a claim that appears to be central to a number of theoretical traditions within sociology) is that the degree of urbanisation is closely related to the birth rate or the divorce rate. But such a knowledge claim clearly does not pertain, in all likelihood, to conditions that are open to action. Even very powerful politicians in a centralised state, concerned about either a decline in the birth rate or an increase in the divorce rate and wanting to affect either of these, would consider such a claim to be highly irrelevant knowledge, since the degree of urbanisation is not a 'open' dimension within their context of action. But that is not to say that the same context of action is void of attributes and conditions which are, in some sense, open and may in fact influence the rates under discussion.

Conclusion

Yet there is another way in which social science knowledge becomes practical, namely as knowledge that represents the becoming of social worlds. That is, a powerful but largely invisible effect of social science, as Michel Foucault or Helmut Schelsky among others remind us, is the impact it has on interpretations of reality in everyday life and therefore the extent to which the self-understanding of actors and the media, in terms of which such convictions are expressed, are shaped by social scientific conceptions.

Whether one is prepared to describe this process as a 'social scientification' of collective and individual patterns of meaning may be left open. However, one might suggest that the many of the current problems faced by the social sciences in practice are related to the fact that the self-understanding of many groups and actors are affected, often in ways difficult to trace, by elements of social science knowledge. The empirical analysis of social problems by social science research then evolves into a form of self-reflection or doubling of social scientific conceptions.

Summary of discussant presentation (2)

Science provides a systematic method, based on rules of research, to produce and accumulate knowledge. In science advice, we should distinguish between fact, a narrative and semiotics.

Science is validated by a semiotic process, that is, of *making meaning*. Evidence taken outside its context is not necessarily valid. The selection of models, information and other forms of scientific 'evidence' is the result of the initial choice of problem definition. This definition then, in turn, determines the choice of scientific evidence used to address the policy concern. It

likewise defines the indicators selected to monitor success and implement the policy solution.

The semiotic process is therefore about who decides the truth and how. It is critical to consider who are the winners/losers of a particular policy; this is not routinely posed within science for policy.

In today's society, all 'epistemic eggs are in the *economics* basket' i.e. seen from an economics perspective, which could have negative implications for the long-term future.

Discussion and Working Group response

The Lead agreed that simplicity is a wonderful aspiration, but the challenge is how to operationalise it, whilst remaining open to a range of perspectives. The aim is to simplify, whilst also remaining open to question and be clear about uncertainties. Advisers should be cognisant of the actions *actually* open to the institution asking for the advice, taking into account its ability to act. Sometimes, a problem has to be tackled *indirectly* as, for example, climate change.

Problem framing is essential, and this is made clear in the report. It needs humility and a way of understanding the issue at stake.

One expert participant suggested that literature be sought on the emergence of problems as a *social process*. It takes a long time for an issue to be recognised as a challenge; this concerns the *governance* of problems.

A Working Group member emphasised that narratives are built on values. Values matter, and a transparent approach to them is essential. The question is whether science advisers should keep their advice very theoretical ('*clean hands*') or get involved in giving 'real' advice and risk being criticised for it.

Another expert participant criticised the characterisation of the natural sciences in the report; some areas of the natural sciences rely on observation of single events. He recommended the work of Nancy Cartwright and others on natural phenomena.

Finally, it was pointed out that there is a power relationship inside the community of science, as well as fashions in science.

Summary of recommendations

1. Simplicity of approach to science advice is a laudable aim. However, the adviser must remain open to a range of perspectives and be aware of the capacity of the receiver of the advice to act.

2. The framing of a policy problem and understanding fully the issue at stake are critical. Examine the literature on the emergence of problems as a social process.

3. Values matter, and they impact on the approach taken to science advice.

4. Power relationships within the science community, as well as fashions in science, should be taken into account.

Session 5: Using scientific evidence in policymaking contexts

Introduction

Lead: Professor Ortwin Renn

The design of science advice must be useful to policymaking. The chapter starts with the contrast between two models – the linear ('truth speaks to power') and the strategic (the use of science for legitimisation of policy). Neither represents what happens in the real world.

The chapter looks at five functions of science for policy. The first is *enlightenment* i.e. a policymaker needs to understand a situation or system. The second is *orientation*; the purpose of the advice. Thirdly, strategy is about *goals*. What is the goal and what are the potential side-effects of certain strategies? This is a common use of science (such as regulatory science) i.e. what is the best strategy to protect health, the environment etc? Fourthly, science can be used for *integration*. This involves the integration of differing knowledge sources and disciplines, making sense of plurality. Lastly, *co-creation* is fashionable; the co-creation of knowledge and solutions with policymakers and stakeholders.

The chapter also deals with bias and includes a section on heuristics. Finally, there is the issue of uncertainty and how to communicate it. There is a lot of published material on communicating to the lay public, but the report may need more on communicating science to policymakers.

Summary of discussant presentation (1)

This is an unusual type of evidence report, as it is not looking only at facts but trying to establish a consensus around a topic. A useful approach might be to establish a schema on a particular issue and then say what other views/opinions there are. Quite a few points rely on secondary sources that are citing authors who may misinterpret some of the primary literature; for example, overconfidence is *not* a heuristic. Think about tone in this part of the report; sometimes it is overly negative and gives the impression that "people are idiots". The problem is not with the *audience*. Some of the studies are presented as universal patterns of behaviour, when they are not. This is undemocratic and disempowering. Instead, give examples that seem to work then relate these more broadly. With each example, set out its pros and cons. People learn from examples and models, not abstract principles.

A short consensus report addressed to a specific audience is a good idea. For example, two published reports on science communication deserve attention – *Improving Risk Communication*

(National Research Council, 1989) and *Communicating Science Effectively* (National Academies of Sciences, Engineering, and Medicine, 2017). Procedures are more useful than principles. For example, a set of auditing steps is a good idea. A diverse set of communication skills is essential to ensure advice is comprehensible. Who controls the discourse? Has the science been vetted? Some areas of science are weaker than others in this. The paper of Shanks et al. (2015) is an expose of celebrity in science through a systematic review of the existing literature base. Three special issues of the *PNAS (Proceedings of the National Academies of the United States of America)* seeks to broaden the science communicators' community of expertise.

Are experts talking to each other across disciplines? Are we talking to stakeholders? Have the messages been tested? Scientists communicate poorly and then blame their audience. Standards for communication are needed (Fischhoff, Brewer & Downs, 2011). In the US, the Common Rule (US Department of Health & Human Services, n.d.) has just been revised to incorporate these new standards.

European academies have the opportunity to establish how to assemble expertise, gather information, evaluate drafts and 'pool' what has already been done, so that we do not have to start from scratch. This is about *economies of scope*. There is the example of how the FDA communicates evidence (Food and Drug Administration, 2013) which is used in training and other work. These might be useful resources for an organisational audit by SAPEA.

Summary of discussant presentation (2)

The importance of framing the 'right' problem and indicating the possible pathways forward should come earlier in the report. 'Wicked' problems should also be covered earlier on, as most problems on which scientists are consulted are 'wicked'.

Are there only five functions of science advice for policy, or are there more? For example, could we add '*balancing the books*'? There are already internal science advice mechanisms in government, which are often incomplete and one-sided. External advisers often have to complete the evidence and provide a balance of perspectives.

Advising on values and ethics is important. Indeed, ethical issues can also be the subject of science advice in themselves. Science is not always prepared for this type of advice, as it can concern subjective viewpoints and qualitative studies. Insights may come from philosophy, or other fields.

Legitimising a policy – 'give us good reasons for what we already know' – is an important area. Is it possible for governments to 'buy' the results they want?' In a Norwegian study (Norwegian National Committees for Research Ethics, 2003), initiated in the Norwegian Parliament and ordered by government, the initial assumption was that industry would be the main 'culprit' (this was true of the pharmaceutical industry) but, in reality the results showed the major offenders

were the public administration, ministries and agencies, some of which were ordering reports and then censoring or influencing them.

The treatment and communication of uncertainty, complexity and ambiguity need to be rearranged in the report. There is a large focus on EFSA's procedures (2019), combined with Codex (Food and Agriculture Organization of the United Nations & World Health Organization, 2018, originally published in 2003). The EFSA procedures are quite new. We do not know that much about them and consequently they are over-exposed in the report. In the discussant's experience, there is often either an absence of uncertainty communications or unfounded quantitative probability assessments. Dividing complex issues into parts and then integrating the results to assess overall uncertainty is 'Russian roulette' and misleading. There is also an over-exposure of Bayesianism and the quantification of risks and uncertainty in the report.

Discussion and Working Group response

The Lead agreed that there were different terminologies in the literature and accepted that some are missing in the report. He took very seriously the matter of 'don't blame the audience'. A question was asked about communicating uncertainty. Do we need more approaches to communicating uncertainty, such as emotions, stories, narratives, concrete examples etc? The Lead acknowledged the point. There appears to be a dearth of literature on specific communications between scientists and decision-makers. Communicating to the public is not specifically part of the report.

The Lead agreed that the balancing and monitoring function is important. Indeed, many advisory committees do what internal bodies are or should be doing. Ethics as a subject is certainly important. Framing should come earlier in the report. The discussant's characterisation of uncertainty is valid for many cases but not all. He did not agree that most problems are 'wicked'. Many questions that are handed over to expert committees are complex, but they are not contested or highly uncertain.

The Working Group contributor on risk acknowledged that the emphasis on the Codex was accurate. However, the EFSA guidance has been developed since 2005 and has been a gradual process; it is used routinely by one of its panels. The first part of the Codex had been published in 2003 and not implemented, due to factors like institutional inertia and science behaviour. EFSA is trying to push the matter forward and give substance to what Codex has been saying. The IPCC have been doing it since early 2000s, issuing revised guidance once (Mastrandrea et al., 2010). The section was written to complement the description of another tool, NUSAP (around since the 1990s as a diagnostic and analytic tool of uncertainty in science and policy), which is used in particular domains and not universally. The Bayesian approach is well-established and commonly used for uncertainty. The approach in this chapter should be linked to text in the following chapter, as it is complementary. In this chapter, the Working

Group is looking at how to characterise uncertainty in scientific advice, not how to frame problems. Problems are already framed by others, such as the European Commission or other policy actors. The approach covers uncertainties for each element of an issue being addressed, not for wider issues of complexity.

Summary of recommendations

- Make more use of examples and models, rather than abstract principles.
- Establish and apply standards for science communication.
- Look for further literature about science communication to policymakers
- Key issues like problem framing and the challenges of 'wicked problems' must come earlier in the report.
- Focus further on ethical aspects and issues.
- Sections on risk and uncertainty across the report should be linked and cross-referenced.

Session 6: Translating scientific evidence into policy-relevant science advice

Introduction

Lead: Professor Jeroen van der Sluijs

The chapter covers the translation of scientific evidence to policy-relevant science advice.

There is a wide range of bodies providing some form of science advice. The chapter deals with the need to reduce complexity from practical problems into technical issues, and what is lost in translation. It deals with 'wicked' problems and post-normal science. It suggests new approaches to the management of uncertainty and quality control of science. The chapter puts forward specific guidelines and good practices in science advice. It deals with ways of integrating different types of knowledge. It covers good practices for integrating values into decision-making. Transdisciplinary approaches to designing a working interface between expertise and policies are described. Lastly, it finishes with possibilities for enhancing the European landscape, for example, linking evidence providers such as the Joint Research Centre, SAPEA and other bodies.

Summary of discussant presentation (1)

Science advice cannot be separated from wider society, science and democracy. The politics of science advice cannot be ignored; there is growing tension between science and democracy.

There has been recent criticism of the concept of 'wicked problems' (Turnbull & Hoppe, 2019). Recent papers talk about 'tribes' around science advice; a comprehensive survey was done of the literature around science advice (French, 2019).

It is always important to be aware of the dialectics between simplicity and reductionist or 'magic' solutions. A diagram in the chapter shows an example of simple communication, how to translate a practical political problem into a scientific exercise. However, 'techno-science' can encroach on the reality of politics and policy. A practical political problem can be translated into many different types of technical problem and has many ways of being expressed. It is a question of choice.

There is also politicisation of uncertainty. Uncertainty can be created when there is little or no knowledge. There can be fabrication of uncertainty, creating the emergence of doubt in certain sectors (such as tobacco and petroleum). Everyone can play the 'uncertainty game' to interfere in the political process. Society has become ever more sophisticated and increasingly fragmenting into constituencies, a process exacerbated by social media. Uncertainty is ever more important in the 'post-truth society'. Scientists have ways of coping with it and it is part of the research process. We should not confuse scientific uncertainty with uncertainty in the policy process. It is about how much uncertainty communities can tolerate.

Summary of discussant presentation (2)

There is potential for improving science advice and the report is light on evidence of what needs to be improved. What evidence is there that specific scientific advice mechanisms work or not? Are the principles of good practice, set out in the chapter, already adopted? If so, are they effective? If recommendations for action have already been made ten or twenty years ago, why is a new report needed now? The SAM should know what the need for evidence is and the chapter did not convey this sufficiently. The reference in the chapter to Type III errors seems appropriate, given that effective advice relies on the 'right' question being asked. There are barriers and challenges to science advice for policy, for example, time constraints, training and communications. Why do so few scientists participate in science advice? Lastly, what about open science as an aid to quality assurance?

Discussion and Working Group response

The Lead responded that the growing tension between science and democracy could be addressed. The criticism of 'wicked problems' would be added. More emphasis could be given to the many ways that practical problems can be turned into technical problems. The manufacturing of uncertainty could be added, along with uncertainty in the policy process.

There is not much published evidence on whether the examples in the chapter are effective. Type III errors are the most common sort in public policymaking. Barriers and challenges

should be covered.

Lastly, one expert respondent suggested that a few rich examples be given to illustrate points being made in the chapter, and that graphical devices like boxes be used to highlight cases.

Summary of recommendations

- Address the politicisation of science advice and the potential conflict between science and democracy.
- Pay attention to the many ways in which practical problems can be translated into technical issues.
- Address the 'manufacturing' of uncertainty to suit particular ends.
- Barriers and challenges to science advice could be covered in more depth.
- Make greater use of graphics and boxes to present information, rather than long, text-based lists.

Session 7: Lessons learned

Introduction

Lead: Professor Ortwin Renn

The report is not intended to give recommendations, but this chapter is a way of providing orientation on how to improve science advice. Looking at the evidence, there is a real plurality of it, some of it contradictory. This concluding chapter is more condensed, reducing the 'big map' into something readable. The Working Group avoided the two extremes (relativist and constructivist) and instead proposed pragmatism. It focused on what seems to work and what kind of context is important to make science advice effective. The lessons learned are related strongly to processes. The Group recognised that there is less information on institutional requirements, and which of these works. The challenge is that there are many institutional structures in Europe. Some models work well in certain countries but are not recognised in others; for example, the model of a Chief Scientific Adviser is normal in the UK, but alien in Germany, where the preferred model is the science council. The choice of model is related to national culture, the nature of science and the type of issue being examined. Members of the Working Group found themselves in a difficult position to evaluate mechanisms at institutional level, but there is some reliable evidence to state what processes work.

Summary of discussant presentation (1)

The report tends to be text-heavy and under-referenced in certain places. Good examples would be helpful to underline the 'story'.

On methods, systematic review and systematic mapping in the social sciences, based on strict protocols, are spreading and are very helpful.

Most bias can be debiased but 'noise' not so readily. Look at ideas around '*noise audits*' (Kahneman, Rosenfield, Gandhi & Blaser, 2016).

Politics is strong on procedure and the report is robust here. Groups work in specific ways and there are procedures to avoid 'group-think'. Not all the groups have the best communication skills to achieve the best results. The examples given in the report are appropriate but there might be other practical models. The OECD, for example, has developed a basic standard operating procedure for all actors involved, covering the different stages of advice, what knowledge is needed, process and pitfalls (OECD, 2015). It would be useful to extend more on what literature is out there, as there could be other practical and helpful models. It would be useful to think also about deliberative processes. Present the pros and cons in a very transparent way, make clear where there is consensus, and where there is a 'red flag'. Give examples.

There should be transparency about the background of experts, including their incentives and goals (in the spirit of the 'honest broker'). There are increasing numbers of institutions that present themselves as 'scientific actors' but who are not so. Some of them are economically powerful and can influence the public discourse and have even effective ways to undermine experts' credibility and silence critical voices. Not everyone is aware of the background and covert interests of these actors; sometimes they come disguised as 'independent journalism' or as a foundation with a research interest. *De facto*, they serve commercial goals.

Finally, who protects the scientists giving advice? This problem is underestimated, and we should help scientists in contentious sectors like tobacco, gambling, advertising, sugar, climate change research etc.

Summary of discussant presentation (2)

The report is complete and well argued. There is indeed no simple concept of 'evidence' and the nuance between 'evidence-based' and 'evidence-informed' policy is well made. The relationship between science and ethics is helpful. It is indeed not possible for science to be fully impartial. The involvement of citizens and stakeholders is part of a transformation in how science is done, and the Internet is playing a crucial role in this.

Today, our destiny is in our own hands. Society must counter 'fake news'. The truth is often less popular than consensus, where people hit 'like' on social media. Agreed rules are needed on what is defined as *legitimate*, within a welter of insights and perspectives. Exact science has a foundation of incontrovertible facts; it forms the basic building block and scientists should act as its guardians. Scientists are also humans and there is no 'theocracy' of science. Trust is built

on agreed goals and working in a shared sense of direction. Citizens should be integrated into the process, but this does not make it easy to find consensus. High-quality public outreach is needed to counteract fake news, although some science is difficult to present to the public. The authoritativeness and dedication of scientists in serving the community and improving the quality of people's lives should be recognised. Trust between stakeholders, policymakers and scientists is needed.

Summary of discussant presentation (3)

The final discussant focused on the institutional aspect of science advice.

The demand side of science advice is hugely important. Politicians are elected and most are not scientists. Understanding how the policy process works is fundamental to the effectiveness of providing science advice and having it appreciated. In the UK, special advisers (a special type of civil servant) are the individuals that ministers trust and turn to for advice. Crucial to delivering science advice is also knowing how the system works. An elected minister and/or policymaker will typically have limited 'bandwidth' and limited manoeuvrability when having to make a decision. Moreover, as the policy cycle is generally short and the science available is generally incomplete, policymakers cannot be expected to act as scientific referees. Significantly, science advice is one only input of many that a minister has to consider, and rarely will it be the deciding factor.

The European Commission's Scientific Advice Mechanism is an experiment and an alternative system of approach to that in some countries. Most democratic societies have science built into their decision-making processes, and politicians are sensitive to what the public thinks. In a survey conducted in Ireland, 68% of the public considered scientific findings to be important to inform government and 97% of scientists thought the same (Science Foundation Ireland, 2017). Special advisers, being closest to politicians, are often those who are contacted for advice or to interpret science advice. The UK operates a heterogeneous model, comprising Chief Scientific Advisers but also various committees and national academies. Cultivating trust and managing ministerial expectations is hugely important. A survey on trust in Germany, Sweden and Switzerland revealed an ambiguous relationship between the high level of trust in the system (academic institutions etc) and the motives of scientists. In short, there was a less trust of scientists' motives, especially when they were involved in industry (EuroScientist, 2017). In the UK, *younger* people distrust government more, citing that the government does not deliver on its promises, and that it does not communicate honestly and is not transparent (Centre for Public Scrutiny, 2018). On the Veracity Index (Ipsos MORI, 2017), scientists are clearly still well trusted, whereas politicians remain at the bottom of the table and civil servants (including Chief Scientific Advisers) remain somewhere in-between. Those with less education were often the least distrusting of scientists.

The SAPEA report would be used widely, as there is little on this scale that has been done before. It has the right tone and balance. It is not arrogant, which is important. It has a huge amount of epistemic coverage and humility. In terms of presentation, who is it for? What should policymakers take away from it? The title is clearly important, but currently conveys a sense of ambiguity or quandary with science advice (i.e. making 'sense' of science). It might be worth revising it to something like '*optimising science advice for policy*'. Look at capability and capacity in science advice, and where there are gaps; the UK Chief Science Adviser conducted a survey of UK government departments, for example. Is it clear what the capability across Europe is to respond in a timely and independent way? In terms of cognitive bias, it is worth considering the report *Behavioural Government* (Hallsworth, Egan, Rutter & McCrae, 2018), which provides options to understand and mitigate several common areas of bias. Give examples of where science advice works.

What happens to science advice? It requires an evidence transparency framework. See the Institute of Governance's rapid assessment tool to rate the level of transparency in the *use of evidence* (Institute for Government, 2015). Science diplomacy is also hugely important because of the international nature of challenges. This is about 'soft power' and nations convey this through their institutions.

Discussion and Working Group response

The Lead agreed that systematic mapping is an interesting idea. 'Noise' should indeed be taken into account and requires references. In terms of scientists' background, transparency is important. Integrity is important, but not total independence. For example, connection with industry should not exclude a scientist, but it should be made clear that he/she is willing to work within the group's agreed methodology. Defence of the scientist and protecting the group is an interesting point. Social media is very powerful, and scientists need to be defended from unpopular views.

The Lead agreed that there are constraints on the demand side in terms of timing, framing etc. In terms of capability, a lot of European countries (e.g. Eastern Europe) need capacity. The management of trust, expectations and post-truth issues are an enormous topic. Policymakers mostly trust scientists and know what is fake and what is not. Sources such as academy reports are trusted over social media. The challenge is getting this into the policymaker's constituency. The situation may change with the emergence of populist politicians. Some politicians may like 'fake news' and uncertainty because it is their way of legitimising themselves or their policies. Generally, this is less prevalent in Europe than in other parts of the world.

Summary of recommendations

- Consider the role of systematic review within the social sciences and policy.

• Literature should be sought on the topic of 'noise' in the process.

• The background of experts should receive more attention.

• Reflect on whether scientists deserve greater protection when working in areas of contention.

• More respect should be given to the role played by scientists in serving their communities.

• Consider the capabilities and capacities of Member States to deliver science advice.

Session 8: Closing remarks

One expert participant suggested that the nature of European Commission funding calls had changed over the years, with science increasingly being used to confirm policy claims. If society uses science in this way, it raises quality concerns. The example of genetically modified babies in China shows how questions are reframed. At one point, the consensus of society was considered important but no longer.

Another expert participant pointed to recent Lord Martin Rees interviews (Dreifus, 2018; Fitch, 2019; Tucker, 2019). Lord Rees had suggested that society has been unsuccessful when certain problems were left to large global organisations. In the case of gene editing, Chinese scientists were blamed but many others were involved. It is a very serious matter that implicates the political agenda.

Another expert participant cited examples of where there had been enormous financial investment wasted, agreeing that there is a political agenda that creates problems for science advice. Scientists are paid by powerful institutions to say what they want to hear. It is a growing problem, for example, in certain fields like energy analysis.

As a solution, an expert suggested including a short paragraph cautioning about an overly 'heroic' view of science. Science is embedded in institutions that can be open to political influence. Some academic colleagues may be susceptible to it, as they are sometimes pressured by incentives and by superiors. This inevitably has consequences and it could be mentioned as a framing condition that should be reflected upon as part of an advisory mechanism. The independence of science must be assured. One Working Group member recommended looking at ALLEA's report on research integrity (ALLEA, 2017) and that its guidelines should be followed.

Appendices

Appendix 1: References

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Appendix 2: Workshop participants

Invited experts

Professor Sven Bestmann

Professor Baruch Fischhoff

Professor Silvio Funtowicz

Professor Mario Giampietro

Professor Peter Halligan

Professor Matthias Kaiser

Professor Stefan Kuhlmann

Dr Justus Lentsch

Professor Lucia Reisch

Professor Nico Stehr

Dr Filippo Zerbi

Working Group members and related attendees

Professor Andy Hart

Professor Alan Irwin

Professor Ortwin Renn

Professor Nils-Eric Sahlin

Professor Jeroen van der Sluijs

Dr Dorota Stasiak

SAM attendees

Professor Janusz Bujnicki

Louise Edwards

Dr Piotr Kwiecinski

Professor Ole Petersen

Apologies for absence

Professor Maria Baghramian

Appendix 3: Workshop programme

Making Sense of Science Expert Workshop

11th February 2019, Berlin

Final programme

Venue:

acatech (https://www.acatech.de/) offices at Pariser Platz 4a, Berlin.

Workshop programme

8:30	Coffee on arrival
9:00	Welcome and introductions *Professor Ole Petersen, Vice-President, Academia Europaea*
9:10	Overview of the Scientific Advice Mechanism, the Group of Chief Scientific Advisors and the Making Sense of Science Scientific Opinion *Professor Janusz Bujnicki, Group of Chief Scientific Advisors*
9:20	Overview of SAPEA and the Making Sense of Science evidence review *Professor Ole Petersen, Vice-President, Academia Europaea*
9:30	Introduction to the SAPEA Evidence Review Report, with very short Q&A's *Professor Ortwin Renn*
9:45	Opening: overview of the SAPEA Evidence Review Report, with observations on strengths, possible limitations and gaps, with short Q&A's
10:15	Chapter 2: Science as a source of advice for policymaking Overview of Chapter 2, *Professor Ortwin Renn* Response Discussion
10:50	Coffee break
11:00	Chapter 3: What can science offer to policymaking? The potential contribution of science, evidence and knowledge Overview of Chapter 3, *Professor Alan Irwin* Response Response Discussion
12:00	Chapter 4: Using scientific evidence in policymaking contexts Overview of Chapter 4, *Professor Ortwin Renn* Response Response Discussion

13:00	Lunch
13:30	Chapter 5: Translating scientific evidence into policy-relevant science advice Overview of Chapter 5, *Professor Jeroen van der Sluijs* Response Response Discussion
14:30	Coffee break
14:35	Chapter 6: Lessons learned Overview of Chapter 6, *Professor Ortwin Renn* Response Response Closing remarks
15:30	Summary of the day *Professor Ole Petersen* Next steps Any other business
15:35	Close

Appendix 4: List of abbreviations

EC	European Commission
GCSA	Group of Chief Scientific Advisors
SAM	European Scientific Advice Mechanism
SAPEA	Science Advice for Policy by European Academies

Appendix 5: Acknowledgements

We would like to thank acatech (German Academy of Science and Engineering) (Berlin office) for hosting the workshop.

Spanning the disciplines of engineering, humanities, medicine, natural sciences and social sciences, SAPEA brings together the outstanding knowledge and expertise from over 100 Academies, Young Academies and Learned Societies in over 40 countries across Europe.
SAPEA comprises the European Academy Networks: Academia Europaea, ALLEA, EASAC, Euro-CASE and FEAM.

SAPEA is part of the European Scientific Advice Mechanism (SAM) which provides independent, interdisciplinary and evidence-based scientific advice on policy issues to the European Commission.
SAPEA works closely with the SAM Group of Chief Scientific Advisors.

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