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Of Styles and Methods

A quest for JRC's identity at times of change

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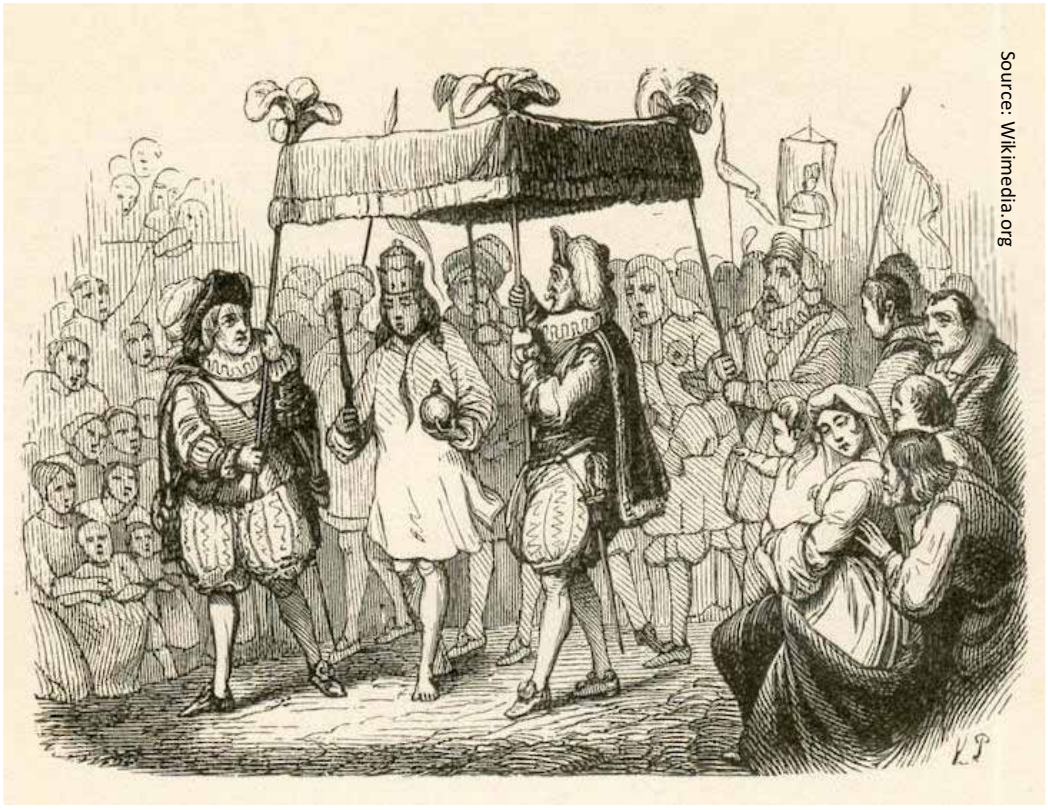

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Of styles and methods

A quest for JRC's identity at times of change

Ângela Guimarães Pereira and Andrea Saltelli*

*The opinions expressed in the present work are those of the authors and do not represent the view of the Joint Research Centre of the European Commission

Abstract

Some reflections are offered on challenges and opportunities for the JRC as a 'boundary organisation' between science and policy, at a time of increased complexity and polarisation and decreased trust in scientific enterprise. Some specific threats are identified in relation to the key role played by the JRC in the practice of front-line policy support. JRC is identified as a potentially relevant player to improve the quality of evidence feeding into the policy process. To achieve this potential, the JRC must develop in-house cultures and styles of reflexivity and humility, adopt more participatory styles of science co-production, and become confident enough of its role that it can dare to say 'the emperor is naked' whenever EU institutions appear to be in need of such a call.

Executive Summary

As the European Commission's (EC) in-house science service, the Joint Research Centre (JRC) has important roles and stakes to play in the complex landscape between science and policy.

The JRC performs anticipatory research as well as evidence production, validation and critical appraisal for the Commission services. In recent years the JRC contributed to more than thirty-five impact assessments on various subjects, ranging from climate change to financial economics issues.

The JRC also provides a critical role as a hinge between applied science and academia, and bridges academia with the other services of the European Commission. Less often JRC fosters linkages between universities and businesses through innovation and technology transfer. Technologies developed or mastered by the JRC are at times deployed in support of EC direct intervention, e.g. in cases of natural disasters or human accidents. All of these features are a result of JRC history and make JRC's position unique, with distinct differences from mission-oriented national or international laboratories and organisations.

In this multiple role, the JRC often finds itself at the centre of controversy, given that controversy currently surrounds several issues where science is called on to play a role: from GMO to climate, from bees and pesticides to shale gas fracking. Some issues, for which once upon a time a linear model of input from science to policy seemed possible, have even become 'wicked', meaning that they are deeply entangled in a web of hardly separable facts, interests and values. The present day sees media openly challenging trust in science, while norms associated with the scientific enterprise are under concerned scrutiny. A non-reproducibility tsunami is hitting medical research, organic chemistry syntheses work, social sciences, and many other research fields, and some historians link this to a collapse of norms due to the commoditisation of research.

Several challenges face the JRC:

- 'Policy-based evidence' can hardly be separated from 'evidence-based policy' when the dense agenda and strict deadlines of the policy cycle rush our scientists to support colleagues in the policy branches of the European Commission. The former though should not obliterate the latter. In these circumstances, transparency and humility become the JRC's best line of defence to uphold quality throughout the process of scientific advice to policy.
- Linked to the above is the issue of "stealth advocacy", where scientists claim to be focusing on science but are really seeking to advance a political agenda or, even unwittingly, a normative stance. As an example, in the field of economic policy the JRC may lack the

breadth of perspectives which one would expect from a mature research organisation.

- The JRC may become hostage to one party in a dispute in which different branches of the European Commission hold divergent views.
- The JRC may be tempted to copy the styles of policy EC services, e.g. in trying to provide 'unified' or 'consensus' views respecting given sectorial policy lines, or to attempt an in-house compression of the plurality of views emerging from the JRC's own multidisciplinarity. This may lead to unwarranted simplifications of complexity and deprive the users of JRC work of the necessary breadth and spectrum of advice.
- The JRC is apparently incapable of offering itself moments of true reflections on contested issues.
- Last but not least, a dangerous mind set in science advice to policy is adherence to the so called 'deficit model', according to which an issue becomes 'wicked', and public *perception*, acceptance and trust of science deteriorate simply because the public, the policy makers, and other *lay* actors all lack the scientific expertise which would allow them to understand the technical argument. Along the same lines, JRC researchers can take for granted science's impartiality and neutrality.

Two central features of the JRC are that it is part of the policy cycle on the one hand but is naturally close to academia on the other. JRC has developed a considerable experience with dealing with wicked issues. In this process JRC is learning that a wide range of epistemic positions and worldviews must be considered and brought to bear in the policy process. It does not befit JRC – if it ever befitted the European Commission – to adhere to a *pensée unique*. Dogmas tend to be contested in stakeholder consultations, in parliaments' hearings and on the media, and this has to be factored in by the JRC already at the stage of ex ante policy appraisal and notably in impact assessment studies.

The JRC already is and can increasingly position itself as a 'boundary organisation', defined as a type of organisation delegated to tackle issues at the interface between science and society. More than to the current extent, JRC should especially engage in participatory science and spearhead examples of knowledge co-production, responding to actual citizens' concerns.

The JRC could support the EU policies with evidence, while at the same time providing the institutions acting those policies with epistemic legitimacy. Evidence provided by the JRC and deployed by the EC could be of a certified nature, where certification would be ensured by the pluralistic nature of the process generating the evidence, tested over different disciplines and normative stances.

The present *straw man* has been prepared for consideration by the JRC in order for the organisation profile itself in the field of science and policy. To this effect the brief concludes with a 'to do' list and timetable which includes:

(i) communication to the media of JRC's approach by the senior management,
(ii) launch of a series of seminars and trainings on science and technology studies (STS),
(iii) introspective analysis of JRC worked examples and studies, with interview of relevant staff or ex-staff,
(iv) preparation of a JRC green paper on science and policy (of which the present *straw man* is the inception),
(v) presentation to the commission services via all relevant channels of JRC progresses.

Table of Contents

PREAMBLE

Here we make two assumptions: (1) that the Joint Research Centre is a boundary institution[1] at the crossroads of the scientific and policy spheres and as such is endowed with a unique role within the European Commission itself, and (2) that its current role is facing critical challenges which are specific and different from the important challenges facing EU institutions, specifically the European Commission.

Wanted or unwanted hybridisations[2] of role, authority, and competence are a pervasive reality among different types of organisations and the political and social context in which they are embedded. The JRC must come to terms with the intertwining of political, societal and business spheres, above all because it can no longer guarantee the original meanings of its assigned mandates and authority. This situation warrants a debate on how to approach these challenges, in order to transform these challenges into an opportunity for the JRC to reposition itself.

Through a brief account of the history of the JRC, we will try to understand to what models of science and policy the JRC has been subscribing; next, in order to highlight JRC's specificity, we shall compare it with other two emblematic institutions that are akin to the JRC. We proceed next to identify recent pivotal changes, on-going tensions, and public debates affecting the scientific endeavour, science governance and science-based policy advice to which the JRC is not immune. Finally, we suggest a roadmap for a reflexive and negotiated repositioning of the JRC, which makes justice of its uniqueness within the European Commission but also within the EU.

[1] Here we adopt a definition of boundary organisation by D. Guston (2001); see later in this document.
[2] Or if one prefers 'blurring', 'democratisation' or other euphemisms.

1. What the history of the JRC can tell us about science advice to policy

History and historical accounts are essential tools in the field of social studies of science and technology, commonly known as Science and Technology Studies (STS). The study of history can contribute to understanding the place and nature of science in various ways: for example, STS may bring to the surface historical myths, assumptions, knowledge claims, cultural roots and analogies that frequently find their way into the imaginaries that underlie policy initiatives and discourses. An example of this approach as applied to the concept of a European Research Area in in Rommetveit et al. (2013). In addition, this hindsight enriches foresight and anticipation activities (Higgit & Wilsdom 2013).

If one wants to contribute reflexively to a vision for the role of JRC in policy-relevant scientific research and to a political desire of evidence-based policy making, one inevitably needs to look briefly at the history[3] of the organisation in these specific contexts. Here we look briefly at the JRC's origins and original mandate, including its place within other European Institutions, exploring to what extent the JRC has responded to models of science and policy in the last 20 years.

The JRC is today a Directorate-General of the European Commission, and strives to act as a reference centre for research-based policy support in the EU. Historically, the JRC developed first as a 'joint nuclear centre', following the signature in 1957 of the European Atomic Energy Community (EURATOM) treaty by six European countries. In fact, as "*the nuclear industry started to expand at an unprecedented rate, national authorities in many European countries considered it critical to be able to further develop nuclear knowledge: for example, neutron data were urgently needed for reactor design, waste management and reactor safety calculations*" (European Commission 2009). Hence, in 1959 the Ispra site of the JRC was inaugurated, with the Ispra-1 nuclear reactor being completed within a year from its start; this site became part of the then 'European Community' in 1961. Throughout the 1970s the scope of the JRC was diversified in response to the reduced urgency for nuclear research, the emergence of new themes worthy of European research, and the need for collaboration and coordination. This led to programmes on renewable energy, informatics and materials research, which were eventually formalised in 1973 through the starting of a multi-annual research work programme overseen by a committee of experts from the Member States (MS). These experts provided guidance for the research and ensured the transfer of research results to the relevant communities in the MS; this was the beginning of the successive establishment of the JRC's Board of Governors in 2007.

In 1985 The JRC and the DG for Research (then DG XII) are merged (COM decision 85/953/Euratom) but in 1996 the JRC and DG RTD were uncoupled.

During the 1980's, a major JRC focus has also been that of establishing research partnerships with industry. This is because "*there was widespread debate across the European Economic Community (EEC) on how research and technological development activities could strengthen industrial competitiveness in the community. This led to the*

[3] N.B. the only source we found to give this account is an institutional brochure from 2007 celebrating the 50 years of the JRC. "Highlights of the JRC: 50 years in Science". JRC publication number JRC37585. Ideally this work should be done with social research, interviewing those that have been in this house from the start and those who have accompanied the evolution of this institution in the last 25 years.

launch of industry-related programmes and improved collaboration between industry-related programmes and improved collaboration between industry and research" (European Commission 2009). In order to achieve better research results the JRC was increasingly involved in collaborative projects across the EU and encouraged to work more closely with national research bodies.

During the 1990's important research programmes focused on public health, safety and security. This move into entirely new fields reflected the challenges and developments of the time. At the end of the nineties, food scares such as BSE[4] and dioxin contamination led to the creation of the DG Health and Consumer protection (today's DG SANCO), separating the issue of food safety from that of industry and the environment; at the JRC the Institute for the Health and Consumer protection (IHCP) was created responding to a number of files which are emblematic still today. Another extension of the JRC was the establishment of the Institute for prospective Technological Studies (IPTS) responding to "*the need to address new policy challenges involving both socio-economic and a scientific or technological dimension*" (European Commission 2009). The JRC accompanied the burgeoning of restructurings around Europe, by merging institutes, renaming some (one institute refocused on security, for example), broadening the organisation's research portfolio. Throughout these developments the JRC continued to assert its mission to ***provide impartial technical advice*** on its relevant policy files (see Box 1.1).

Already in 1998 the JRC started activities on detection of GM in food by validation of analytical methodologies in the IHCP and production of certified reference materials in an Institute for Reference Materials and Measurements (IRMM). During the 2000s a number of what became known as "*community reference laboratories*" (CRLs) were established in various fields: feed additives, heavy metals, mycotoxins, polycyclic aromatic hydrocarbons, GM food and feed (in 2004), and food contact materials.

In the middle of the 2000s, a number of forward-thinking activities were put in place. Reflexive and anticipatory activities were given a more prominent place. The role of social sciences – though marginal – was promoted especially in the field of quantitative economic analysis and techno-economic foresight, with emphasis with impact assessment studies. Employment, education, taxation, single market and financial stability became part of the JRC's remit.

Box 1.1: Changing mission of the JRC over the last decade.

2002: The mission of the JRC is to provide **customer-driven scientific and technical support for the conception, development, implementation and monitoring of EU policies**. As a service of the European Commission, the JRC functions **as a reference centre** of science and technology for the Union. Close to the policy making process, **it serves the common interest of Member States**, while being **independent of social interests whether private or national**.	**2013:** As the Commission's in-house science service, the Joint Research Centre's mission is to provide **EU policies with independent, evidence-based scientific and technical support throughout the whole policy cycle. Working in close cooperation with policy Directorates-General, the JRC addresses key societal challenges** while stimulating **innovation** through developing new methods, tools and standards, and sharing its know-how with the Member States, the scientific community and international partners.

In Box 1.1 we compare 2 texts of the mission statement of the JRC at different times. Whilst the overall mission remains unchanged, and core values of independence are

[4] Bovine spongiform encephalopathy commonly designated as "mad cow disease".

maintained, one can see some interesting changes. For example, the "customer-driven" approach of the early 2000s is strongly substituted by a unique customer, the policy DGs of the EC. The closer collaborations with MS are substituted with closer collaborations with policy DGs. Another aspect that is certainly common to both is the framing of the mission on the narratives of authority. In the mission statement of 2002 the JRC is presented as an institutional reference *tout court*, which is somehow still visible through the sharing of its know-how with MS in the 2013 mission statement.

Overall, one can argue that while on the one hand the JRC has promptly addressed pressing societal and policy issues, on the other hand it has uncritically adopted the narratives of the time. These narratives included control, prediction, objectivity and neutrality of science and science-advice to policy, besides the recurrent quest for harmonisation across the EU.

The key question is now how can the JRC conjugate or temper the respect of the EC' accepted wisdoms, e.g. on innovation, growth, sustainability, and at the same time maintain a careful eye on the emerging or antagonist narratives on the very same subjects? In the economy of a complex organisation such as the European Commission, and of the necessary dialectic between 'preserving' and 'innovating', the JRC's role could perhaps hang on the latter, at times incisively so.

To make an example, classic positivistic narratives of prediction and control have been challenged in recent decades by more inquisitive questioning of the current state of science to policy advice, after the media exposed dysfunctional uses of scientific knowledge that ended in failure, untailored policy making, privilege of prevailing narratives of human development and normalisation of human action. At the same time, the prevailing market-based neoliberal philosophies - which naturally underpin the positivistic narratives - have been called into question following the onset of the present crisis (Mirowski 2013).

From the very beginning the JRC has engaged with research on the broader societal impacts of certain types of technology. It has also progressively applied itself to harmonisation and standardisation processes overcoming national specificities and cultures across the EU, and has enlarged and changed priorities in order to respond to pressing societal and political pressures of our times. The evolution of the texts of the JRC missions are also interesting to look at to the extent that they reflect not only the gradual self-attributed role of independent advice but also the drivers of consensus in multiple forms; from standards, exemplary re-usable reference methods and tools that are eagerly transferred to MS.

1.1 Rough Mapping of the history of the JRC onto models of Science and Policy

There are several ways (or conceptual models) to look at the relation between science and decision-making in policy processes. We will use models of the interfaces between science and policy developed at the JRC itself by Silvio Funtowicz[5] and his co-authors,

[5] Presently at the Centre for the Study of the Sciences and the Humanities (SVT) at the University of Bergen, Norway.

including the American-born Oxford scholar Jerome Ravetz, and many others in the course of the past three decades[6].

Starting from the "modern model" of perfection and perfectibility which represents a classic "technocratic" vision, where there are no limits to the progress of humans' control over their environment, and no limits to the material and moral progress of mankind, Funtowicz (2006) offers an evolutionary perspective of the governance of science in policy making through several stages and styles:

- *Precautionary model:* precaution is introduced as a normative element. The model focuses on uncertain and inconclusive information. It arises from discovering that the scientific facts are neither fully certain in themselves, nor conclusive for policy; therefore an extra, normative, element is introduced in policy decisions, precaution, which both protects and legitimises decisions.
- *Framing model:* stakeholders perspectives are introduced. The focus here is on the arbitrariness of choice and possible misuse. This model arises from the recognition that in the absence of conclusive facts, scientific information becomes one among many inputs to a policy process, functioning as evidence in the arguments. Stakeholders perspectives and values become relevant and even the choice of the scientific discipline to which the "problem" belongs becomes a prior policy decision, part of the debate among those affected by the relevant issue.
- *Demarcation model*: demarcations for protecting science from the political interference that would threaten its integrity. This model is especially concerned with the possibility of the abuse of science. It arises because the scientific information and advice that are used in the policy process is created by people working in institutions with their own agendas. It recognises that "scientific" information and advice cannot be guaranteed to be objective and neutral. In this sense, science can be abused when used as evidence in the policy process. A clear demarcation between the institutions (and individuals) who provide the science, and those where it is used, is advocated as a means of protecting science from the political interference that would threaten its integrity.
- *Extended participation:* The ideal of rigorous scientific demonstration is replaced by that of open public dialogue. The model acknowledges the difficulties of defending a monopoly of accredited expertise for the provision of scientific information and advice. "Science" (understood as the activity of technical experts) is included as one part of the 'relevant knowledge' which is brought in as evidence to a process. The ideal of rigorous scientific demonstration is replaced by that of open public dialogue. Citizens become both critics and creators in the knowledge production process as part of an extended peer community. It is argued that it is within the "extended participation" model of science and policy that new relations between science and the publics are usefully operated, underpinning upstream public engagement in knowledge production.

If one looks at the JRC history, including its mission statements, one can see that it has responded in some ways to the first three models, whilst remaining firmly attached to the core activity of the modern model, i.e. "the experts' *(desire for)* truth speaking to the politicians' *(need for)* power". It is clear however, that the JRC does not engage with the public in policy formulation. Neither its mission nor its operation implies dialogical

[6] For recent accounts see Carrozza, 2014; Hessels & van Lente, 2008.

engagement with the public in the process of knowledge production or assessment. At the European Commission it is often the case that some forms of public engagement are actually left to the policy DGs through mechanisms such as the portal 'Your Voice', the inclusion of civil society organisations in committees and task forces, and the standard of consultation which are part of the European Commission impact assessment practices and guidelines[7]. Although these activities have some value for the policy cycle, they remain confined in their actual function of consultation. Moreover, with regard to the JRC, they have very limited influence in the way science is conducted within the JRC and therefore on the advice provided.

1.2 Debate at the JRC

Let us assume for the sake of discussion that the model of *extended participation* is indeed desirable one for science advice to policy, as advocated by Funtowicz & Ravetz (1990), Jasanoff (2005), Gluckman (2014), Sarewitz (2013) and many others.

Could the JRC, given its institutional fabric and commitments, adopt such a model?

A way of answering the question is that whether we purposefully engage with the public or not is not an option but a necessity; the digital culture is changing knowledge governance, and what were once illuminated promises, such as quality assurance of policy-relevant science by extended peer review (Funtowicz & Ravetz 1985; 1990) and co-production of mutually supporting forms of knowledge (Jasanoff 1996), have today 'materialised' and have a societal place. Hence it could be argued – as we set up to demonstrate in the present analysis - that embracing a model of *extended participation* amounts to deepening the boundary work that is inherent to the JRC work. This would encompass the creation of 'safe spaces' that allow deeper involvement of the public in our supporting role to policy.

A relevant question is nevertheless the following: is the JRC ready to engage with the public beyond the reduced perspectives of just 'educating' it – e.g. via training the public on science, or 'studying' it, e.g. in the context of behavioural investigations? If so, what skills does the JRC need to acquire and what practices are we ready to embrace?

[7] The European Commission has 'Stakeholder consultation guidelines' in the context of impact assessment activities, under revision at the timing of the present work. For example, the Commission opens to consultation via the "Your Voice" portal some policy files. This portal is poorly accessed and disseminated. Moreover, it is not clear how the results of the consultations affect policy making. One of the conditions of institutional trust lies precisely in transparency, in this case and simply put, it is not obvious how the opinion of citizens who participate in these consultations influence the actual policy proposal.

2. The JRC in the context of other International organisations

Here we look at two different types of organisation that are akin with the stated JRC mission but have a different place in the policy and societal context; those differences resonate across their stated mission, function, operation and styles of knowledge governance. We have chosen an international institution, the Organisation for Economic Co-operation and Development (OECD)[8] – see Box 2.1 – and a member state research institute with strong international projection, the Fraunhofer-Gesellschaft - Europe's largest application-oriented research organisation – see Box 2.2. It is obvious that a straightforward comparison cannot be done because the three institutions are inherently different, but they have many mutual axes. The purpose here is rather to reflect on the uniqueness of the JRC within the existing institutional context and to understand what evolution can be expected for our institution.

Box 2.1 The mission of the ***Organisation for Economic Co-operation and Development (OECD)*** is "**to promote policies** that will improve the economic and social well-being of people around the world". The OECD provides a forum in which governments can work together to share experiences and seek solutions to common problems. The OECD works with governments to understand what drives economic, social and environmental change. It measures, analyses and compares productivity and global flows of trade and investment in order to "**predict future trends**". The OECD is also engaged in setting international **standards** on a wide range of issues. The OECD also claims that "**drawing on facts and real-life experience**, [it] recommends policies designed to improve the quality of people's lives", working with a large range of stakeholders from business, labour and civil society organisations. The discourse of the OECD is firmly aligned with imaginaries of innovation and growth as main pillars of their action with worldwide governments. Their core values are stated as:

- "**Objective:** Our analyses and recommendations are independent and evidence-based.
- **Open:** We encourage debate and a shared understanding of critical global issues.
- **Bold**: We dare to challenge conventional wisdom starting with our own.
- **Pioneering:** We identify and address emerging and long term challenges.
- **Ethical:** Our credibility is built on trust, integrity and transparency"

On their 50th anniversary, the OECD Members reaffirmed OECD's founding goals and set out a vision for the OECD's evolution to ensure its effective and influential role in a rapidly changing world so as to promote the well-being of citizens: "We are determined that the OECD **will continue to help countries develop policies** together to promote economic growth and healthy labour markets, boost investment and trade, support sustainable development, raise living standards, and improve the functioning of markets. This vision also underscores our resolve to make the OECD a more effective and inclusive global policy network."

Whilst, through its core values and vision, the OECD seems to have embedded qualities of anticipation, dialogical practices and a much needed capacity to reflexively challenge received views, we also see that the OECD's narratives for human betterment are based on market-driven imaginaries of growth. To our knowledge, the OECD is rather cautious in moving away from this paradigm and to follow the critiques of the neoliberal model which have received impetus from the present crisis. A study produced in house by the JRC has recently argued, for example, that the International Monetary fund (IMF) is more

[8] http://www.OECD.org/about/

reflexive than both the OECD and the EC when it comes to the relative virtues of different economic models (Saltelli & Dragomirescu Gaina 2014).
The point here is not that we face an 'All-Yin-and-no-Yang' organisation but that the Yin – perceived as a fundamental adherence to the economisation of everything – is in the driving seat, while the organisation's Yang – with its concern for increasing inequality and unfairness of the present arrangements, sits in the back. When the concerns of the environment are factored in, this is as much as possible framed in the context of the prevailing wisdom, such as witnessed e.g. in the support for the monetary evaluation of environmental goods (cost benefit analysis of everything – see Renda *et al.* 2013) or the implausible recipes to 'circularise' the economy in the context of a high throughput, ever more competitive society.

Box 2.2. The Fraunhofer-Gesellschaft Institute **conducts applied research for both private and public enterprises**, as well as for the general benefit of the public. The institution takes its name from Joseph von Fraunhofer (1787-1826), the illustrious Bavarian researcher, inventor and entrepreneur. The Fraunhofer-Gesellschaft **conducts research under contract for industry, the service sector and public administration offering information and services**. Fraunhofer claims that its "research efforts are geared entirely to people's needs: health, security, communication, energy and the environment", which, Fraunhofer claims, has therefore significant impact on people's lives. Fraunhofer is strongly oriented to technology development: it "designs products"; its researchers "are creative"; they "shape technology"; they improve methods and techniques" and they "open up new vistas". In short, Fraunhofer "forges the future". The Mission Statement of this institution outlines the character of "custom-driven" research activities and their strong business orientation:

- "The Fraunhofer-Gesellschaft promotes and conducts applied research in an international context to benefit private and public enterprise and is an asset to society as a whole.
- By developing technological innovations and novel systems solutions for their customers, the Fraunhofer Institutes **help to reinforce the competitive strength of the economy in their region, throughout Germany and in Europe**. [Their] research activities are aimed at promoting the economic **development of our industrial society**, with particular regard for social welfare and environmental compatibility."

Both the OECD and the Fraunhofer-Gesellschaft Institute, taken as stone of comparison for the JRC, influence the future through their research and technology development. They are aligned to current narratives of human betterment based on innovation, competitiveness and growth. The JRC on the other hand does not focus on "applied research", and even less for private enterprises since the JRC's main clients at present are the policy DGs or institutions in MS. The JRC has a different profile.

2.1 The uniqueness of the JRC

The JRC is not an institution that *promotes* policies as does the OECD; it is not a research and educational institution as a University or an institution that conducts research "to benefit private and public enterprise" as are the Fraunhofer Institutes. The JRC is a Directorate-General of the European Commission, but contrary to other DGs it resonates with what can be called a boundary organisation (Guston 2001). These types of organisations meet "*three criteria: first, they provide the opportunity and sometimes the incentives for the creation and use of boundary objects*[9] *and standardised packages;*

[9] I.e. information or knowledge that is used in different ways by different communities and networks. This concept was introduced by Star and Griesemer (1989).

second, they involve the participation of actors from both sides of the boundary, as well as professionals who serve a mediating role; third, they exist at the frontier of the two relatively different social worlds of politics and science, but they have distinct lines of accountability to each" (Guston *op. cit.*).

The JRC performs anticipatory research as well as scientific evidence production, validation and critical appraisal for different Commission services. For example, in recent years the JRC contributed to more than thirty-five impact assessments on various subjects, ranging from climate change to financial and economic issues.

The JRC acts as a hinge between science and academia, populates the different corners of the research, education and innovation triangle[10], bridges academia with the other services of the European Commission, and fosters linkages between universities and businesses through innovation and technology transfer. The JRC recently set up a network of technology transfer offices belonging to Europe's large public research organisations to test new methods of cooperation and an Innovation Observatory to collect relevant statistics at the service of the Innovation Union agenda. Thanks to its enlarged portfolio of competences JRC has a role to play in the monitoring of the achievement of the EU 2020 objectives as well as fostering optimal use of cohesion funds through its smart specialisation platform.

2.2 Debate at the JRC

Unlike other services of the European Commission and other analogous institutions, the JRC has an in-house and inbuilt capacity for reflexivity, through its multidisciplinary characteristics that critically support science advice to policy. It is not infrequent for the JRC to speak with 'more than one voice' in relation to important policy files. Yet, this is most often perceived by the organisation as a shortcoming rather than as an asset, also due to the presumed political constraints of the JRC, and the fact that the European Commission is perhaps not mature enough to use the JRC as a boundary organisation. We would argue that there is perhaps a crucial missing link in the JRC's structure which prevents it from truly critically assuring robustness of evidence over a broader spectrum of social norms and values.

As Pielke (2007) and others pointed out, most thoughtful advisers can help define plausible strategic choices in the light of disagreement and controversy in the assessment of uncertain evidence. This requires a great amount of individual introspection and institutional courage. Looking critically at current narratives of innovation should not be seen as a disservice to EU citizens; responsible scrutiny of dissent about main narratives by which we are living today should help policy to find alternative paths of societal development, knowledge production and betterment of the human condition.

In conclusion, through the previous and this section we have seen how the JRC is far from embracing an extended participation model of science and policy and how instead because of its boundary stand that model would seem to be the most natural one to follow. Is the JRC ready to consider adding to its mission statement the deepening of boundary work?

[10] "*Research, education and innovation are three central and strongly interdependent drivers of the knowledge-based society. Together they are referred to as the "knowledge triangle". To realise ERA* [European Research Area*], research needs to develop strong links with education and innovation*." Source: http://ec.europa.eu/education/policy/higher-education/knowledge-innovation-triangle_en.htm

3. Current Challenges for Science Advice to Policy that affect the JRC

> *"Science and technology are present in all of the narratives that modern societies weave about the world, as essential threads in the tapestry of social reality." Jasanoff 2005*

With the Modern State starting with the XVII century, science has become the legitimate and rational source for decisions and action. As many philosophers have argued, science has enjoyed a privileged place in the knowledge production endeavour, one that defines modernity and which has been labelled as a "great intellectual adventure" (Ravetz 2006). This state of affairs has been the subject of considerable debate and critique in the XX century, after thinkers such as Husserl, Toulmin, Lyotard, Shapin & Schaffer, Feyerabend, Lakatos and many others questioned the universal role of science in generating truth and adjudicating disputes.

As a result, the scientific enterprise has been changing for a long time; as a co-production within the societal and political contexts in which it develops (Jasanoff 1996), for science it is both the best and worst of times (Le Fanu 2010): research institutions and funding have never been so impressive, explosively productive publication-wise but, Le Fanu, argues, with little advances compared with times where the funding was scarce. Yet, science is seen as an instrument of profit, power and privilege (Lyotard 1979; Mirowski 2011; Ravetz 2006), and we may have entered what has been described as the period of "Post-Normal Science". Post-Normal Science is a concept developed by Silvio Funtowicz and Jerome Ravetz, attempting to characterise a methodology of inquiry that is appropriate for cases where "facts are uncertain, values in dispute, stakes high and decisions urgent" (Funtowicz & Ravetz 1991; 1992; 1993. Earlier work was in Ravetz 1971; 1985; 1990)[11].

While we cannot summarise here a century of intellectual disputes in the field of epistemology[12], we will outline current challenges that affect science and technology developments, and therefore also scientific advice to public policies, and the way both science and policy are mutually affected.

It should be noted that the public sphere displays these tensions in disputes on technology, climate, health, and the environment. Different styles of science advice coexist ranging from the positivistic to the post-modern and are at times instrumentally invoked by the contending parties. These disputes intermingle with those affecting the definitions of development, sustainability, and progress, the choice of economic model, and the role of Economics in adjudicating facts relevant to the common good.

An example of this state of affairs is the survival in science of the so-called *Deficit Model*. According to this model an issue becomes 'wicked', and public *perception*, acceptance and trust in Science is problematic simply because different actors lack the scientific expertise which would allow them to understand the technical argument. Thus if we could train, e.g. policy makers or stakeholders, including the publics, at large in maths and biology, then genuine progress would be achieved. 'If only they knew!' is a scientist's

[11] Other knowledge production model worth mentioning is Mode 2 Science was coined in 1994 by Gibbons, Limoge, Nowotny *et al.*

[12] There were 'science wars' in the eighties opposing natural and social sciences, and when 'social constructivism', e.g. the exercise to contextualise the generation of 'facts', was considered an assault on science. A readable short account is http://en.wikipedia.org/wiki/Science_wars.

typical refrain associated to this view. The deficit model has its advocates (Dickson 2005), but we would instead favour a culture of humility of science's input to policy, which especially rejects the deficit model. We do not reject this model for purely ethical reasons, though there would be a few. We reject it because of its limited usefulness. Most often the problem is not a lack of Science but of its abundance. Daniel Sarewitz, an American scholar, talks about the "excess of objectivity" claimed by science, so that "*Rather than resolving political debate, science often becomes ammunition in partisan squabbling, mobilized selectively by contending sides to bolster their positions.*" A cynical conclusion is that "*entrenched interests need not produce 'junk science' when they have a wide selection of credentialed scientists to choose from in support of their positions*" (Pielke 2007, p. 62).

According to Sarewitz this may lead to scientists *de facto* cancelling each other out so that "*the more powerful political or economic interests prevail, as they would have without Science*" (Pielke 2007, p. 62). This is an outcome JRC fights to avoid, foremost by developing in house a culture of reflexivity, fostering "*an internalized, cross disciplinary capacity for self-reflection and self-criticism*" (Jasanoff 2009) which can then be brought to bear when JRC engages with Commission services and their stakeholders.

The fact that scholars are critical of knowledge production modes and their governance trends, and the resulting tensions, are not unique to our times; those tensions arose under many forms at different times of human history and about different bodies of knowledge. For example, one can argue that through time some "institutions" of knowledge have established privileged relationships with the state but have systematically (and oftentimes intentionally) alienated from wider (lay) publics. Current challenges for the scientific endeavour, and in particular for science advice to policy, cannot be decoupled from the narratives that are used to respond to challenges to humans and the planet - including the definition of the challenges themselves and their plausibility. The debate is about the place of science and technology on addressing great societal challenges and the loci and bodies of knowledge to which we refer to tame those. The debate has been set from different perspectives of epistemic, anthropological, ontological, and ethical nature. Here we examine those current challenges which inevitably affect the JRC, and, we would argue, in quite important ways. Based on these observations, we submit that a reflexive journey is imperative for the JRC, especially when others start speculating about its role and place.

3.1 Challenges from *within*…

Here we allude to challenges as elements of what we (and others) describe as a crisis *within* the scientific endeavour that necessarily affects science advice to policy, its integrity, authority and legitimacy. For the sake of clarity we have divided these into 3 different groups but they are all strongly inter-linked: trust, quality, and legitimacy. We also believe that our current digital culture has aggravated and anticipated tensions that have been there for a long time.

3.1.1 Trust

A Rightful place for science

In his inaugural address, President Barack Obama promised to "restore science to its rightful place" in U.S. society. In an interdisciplinary workshop organised at Arizona State

University in 2010[13], a number of scholars and other societal actors set out on a reflection about the meaning of such a political "gift". Where is that place? – it was asked; and how do we find it in an ever more complex, uncertain, and politically, socially and culturally diverse world? And is the rightful place of science also the place that assures the best outcomes for all of us?

Relevant questions for JRC are hence not only "which is our rightful place or places" but also "how do we take that place and what do we fill it with".

Truth about the truth

The privileged role of scientific knowledge in legitimating a common authority in pluralist societies, has been challenged for quite some time. '*Solutions to the problem of knowledge are solutions to the problem of social order*', state Shapin and Schaffer (2011), a point also admirably made by Lyotard (1979). Through a number of case studies Braun and Koop (2014) observed that, "The expectation that scientific expertise will provide reliable, objective, true knowledge and thereby close down policy controversies is gone". The debunking of myths about unrealistic capabilities attributed to science and scientists has been taken care of by philosophers, from Husserl to Lyotard, and recently by thinkers such as Ravetz, Wynne, Jasanoff, Sarewitz, Latour, and many others - coming from the field of social studies of science and technology but also from the realm of practice itself. In fact, the quick framing of issues in scientific terms can amount to what is described as "Type 3 error" - i.e. the error of answering the wrong question. The same principle exists in applied econometrics[14]. If the question is wrong the supporting evidence is irrelevant. An issue may be framed as one of 'risk' of a technology when the concern of the citizens is about whose technology is adopted and why and who controls it. Thus, scientific framings do not necessarily resolve socio-political controversies with scientific underpinnings.

Through a number of examples from climate change, genetically modified foods and nuclear waste disposal, Sarewitz (2004) describes the exacerbation of controversy through scientised framings that misrepresent the actual issues. Another example, reinforced with headlines, is what Bittman (2013) described as an exercise of misdirection on organic foods. The study (see Smith-Sprangler et al. 2012) focuses on a trivial aspect of the organic versus conventional comparison, i.e. the poorly defined "nutritious" aspects of organic food, whilst that is not the primary reason why people acquire organic food. We shall revisit this topic later in the present work.

In its multiple role, the JRC often finds itself at the centre of controversy, as controversy surrounds today several issues where science is called in to play a role: from GMO to climate, from bees and pesticides to shale gas *fracking*. The plain appeal of *Science speaking truth to policy* must be considered critically. Even issues where once upon a time a linear model of input from science to policy seemed possible have become today 'wicked' (Rittel & Webber 1973), implying that they are deeply entangled in a web of hardly separable facts, interests and values.

Adding to this, we live in times where the media openly challenge trust in science (Mombiot 2013), norms associated to the scientific endeavour are under concerned scrutiny (Jasanoff 2013), laboratory experiments cannot be trusted without verification (Sanderson 2013) and rules are on offer to spot "*suspected work […in] the majority of preclinical cancer papers in top tier journals*" (Begley 2013).

[13] See http://cspo.events.asu.edu/

[14] Peter Kennedy's second commandment of applied econometrics reads: 'Thou shall answer the right question', Kennedy (2007).

Even the Economist, a usually conservative and positivist magazine, enters this debate commenting on the poor state of current scientific practices devoting his cover to "How Science goes wrong". Its first editorial reads:

> *"Science still commands enormous—if sometimes bemused—respect. But its privileged status is founded on the capacity to be right most of the time and to correct its mistakes when it gets things wrong. […] The false trails laid down by shoddy research are an unforgivable barrier to understanding. "* (*The Economist* 19 October 2013, p. 11)

Faithful to its positivistic imprint, *The Economist* (19 October 2013, p. 21-24) argues that technical shortcomings are among the main causes of trouble with scientific practice, including scientists' incapacity to balance false positive and false negative (a statistical issue) and poor refereeing. The truth is perhaps more worrisome, as revealed by one of the sources quoted by the same magazine, Ioannides (2005), according to whom:

> *"In this framework, a research finding is less likely to be true when […a list of statistical limitations]; when there is greater financial and other interest and prejudice; and when more teams are involved in a scientific field in chase of statistical significance."* (Ionannides *Op. cit.*)

In other words Ioannides hints at normative issues associated with scientific practice. We shall discuss this later in relation to the privatisation of science. Note among the reactions to this worrying trend the creation of the Meta-Research Innovation Centre launched at Stanford (METRICS), involving the John Ioannidis (*Op. cit.*), to combat 'bad science' (*The Economist* 15 March 2014).

Language, manners and ethos

One consequence of the new climate of scepticism and confrontation surrounding science's input to policy is that its language becomes decidedly unceremonious, miles away from the aseptic tone met in scientific papers.

Box 3.1 - On Models: Overreliance on model-generated crisp numbers and targets recently hit the headlines again in the relation to the 90% ratio of public debt to gross domestic product stipulated by Harvard professors Kenneth Rogoff and Carmen Reinhart. Debt ratios above the threshold were considered by these authors as unsafe for a country, but a later reanalysis by researchers from the University of Massachusetts at Amherst disproved this finding by tracing it to a coding error in the authors' original work. This particular instance of error became subject to self-correction, but most aspects of most models will not be subject to such close scrutiny. Critically, the error was corrected too late and much of the damage could not be undone, as the original model results kept austerity-minded economists trading blows with their anti-austerity counterparts on the merits and demerits of balanced budgets and austerity policies, a battle that dominated the financial press for months, was in no way defused by the repudiation of the Rogoff-Reihnart results. (in Saltelli *et al.*, 2013, Saltelli & Funtowicz, 2014)

A couple of examples will illustrate this trend – see also Box 3.1. "*Beware the rise of the government scientists turned lobbyists*", was the headline of an article by British journalist George Mombiot in the left-leaning newspaper *The Guardian* (29 April 2013), adding that "*From badgers to bees, government science advisers are routinely misleading us to support the politicians' agendas.*" The article criticised the current chief scientist at the UK's environment department for his assessment of the desirability of culling badgers, and the British government's new chief scientist for his opposition to the European ban on the pesticides blamed for killing bees and other pollinators. From the other side of the ocean and the political spectrum, Rep. Chris Stewart (R-UT) asked

(rhetorically) during a U.S. congressional hearing in July 2013 whether the federal Environmental Protection Agency's study of shale-gas fracking "is a genuine, fact-finding, scientific exercise, or a witch-hunt to find a pretext to regulate[15]."

Wherever one stands on these specific issues, scepticism seems on the rise, and increasingly independent of ideological positions. Science is facing a question: does the tone of these sorts of attacks reflect a collapse of trust in the scientific enterprise and in its social and institutional role? Scientific leaders have long portrayed their enterprise as a self-regulating community bound to a higher ethical commitment to truth-telling than society as a whole. Yet the tone and intractability of controversies suggests that society may be less willing to accept such claims than in the past. Seen in a JRC context these developments imply that the role of the JRC could easily come to the forefront of public debate, and find itself at the heart of hot disputes.

Something worth recalling is that ethos is fundamental to the scientific enterprise. In the words of Jerome R. Ravetz (writing in 1971!), and which complements what just said on the privatisation of science.

> *"Two separate factors are necessary for the achievement of worthwhile scientific results: a community of scholars with shared knowledge of the standards of quality appropriate for their work and a shared commitment to enforce those standards by the informal sanctions the community possesses; and individuals whose personal integrity sets standards at least high as those required by their community. If either of these conditions is lacking – if there is a field which is either too disorganized or too demoralized to enforce the appropriate standards, or a group of scientists nominally within the field who are content to publish substandard work in substandard journals – then bad work will be produced. This is but one of the ways in which "morale" is an important component of scientific activity; and any view of science which fails to recognize the special conditions necessary for the maintenance of morale in science is bound to make disastrous blunders in the planning of science. There is then a danger that a firm (or more commonly a government) will try to redress an error by making it bigger, and all considerations of what is economically viable (not to say socially desirable) will be cast aside. Supersonic airliners are a case in point. Hence scientific technology, as much as industrialized science, can suffer from a new and dangerous form of corruption."*

Consensus is not the same as authority

Many scholars have asserted that the authority of science resides above all on the accommodation of dissent and the welcoming of critics. D. Sarewitz (2011), for example, has argued that, "[s]cience would provide better value to politics if it articulated the broadest set of plausible interpretations, options and perspectives, imagined by the best experts, rather than forcing convergence to an allegedly unified voice." Taking the IPCC example, M. Hulme (2013) challenges the assumption that consensus in science is an end to argument or even embedding any kind of authoritative stand.

Ethics

Ethics as applied to science and technology policy is in a perpetual flux. Whilst the application of ethics in science and technology realms has largely been in the hands of

[15] See http://stewart.house.gov/media-center/press-releases/stewart-questions-scientific-integrity-of-epa-hydraulic-fracturing

professional communities, the failures of the scientific community's *ethos* in respecting individuals in research during World War II, and before that the role of statistical science in upholding eugenics (Hacking 1990), gave ethics a definitive part for addressing values challenges arising from techno-science developments. During the 1990s ethics was established as institutional practice through various forms, with the establishment of ethics committees producing official (though usually non-binding) opinions on ethical, legal, and social aspects; the creation of expert ethics committees, of ethics as expert knowledge, and of mandatory ethical checklists to comply with (Tallacchini 2009). Whilst ethics inherently bounds regulatory frameworks including science and technology innovation policies, the pace at which techno-science is developing is making it untreatable with the current institutional arrangements.

Moreover, in certain domains of science and technology research has been further fragmented, including along private and public dimensions arising from privatisation of the scientific enterprise, collaborative and competitive enterprises, developing within institutional and informal spaces [the "garage" and "do it yourself" movements; the "Open everything" paradigm] giving rise to different ethics "strategies". With an enlarged set of actors participating in the techno-scientific knowledge production with their norms and values, not only the loci of ethics have been distributed and extended (Lifson 1997; Tallacchini 2013) but also systematically interrogated, including by citizens, as well as by old and new media. The digital culture has accelerated this process by providing it with both ever larger audiences and ever more powerful tools.

3.1.2 Quality

Uncertainty fabrication

Uncertainty amplification or minimisation are standard practices operated by stakeholders to either support (minimising uncertainties) or deter (maximising them) the adoption of a policy. Famous cases of uncertainty fabrication see tobacco companies fighting to deny the health effect of smoking (Oreskes & Conway, 2010), and the battles between industry and regulators over the USA's data quality act, where industry fought hard to amplify uncertainty in order to prevent regulators from imposing more stringent standards (Michaels 2005).

It has also been argued that the greatest threat in science advice is not partiality (impartiality being an ideal rather than a practical attribute of the involved scientists) but rather purported impartiality, also known as stealth advocacy (Pielke 2007). As already discussed scientists may encumber the public debate with an extra dose of conflict and animosity, making controversies less amenable to a solution (Sarewitz 2004).

Frauds and "alikes"; "Another busy week at Retraction Watch"[16]

In 2011, Nature published an article on the rise of retractions of scientific papers (Van Noorden 2011); almost all of the retractions that hit the headlines are dramatic examples of misconduct, but they can also be due to honest errors, Van Noorden argued. This situation, in combination with situations of un-verifiability of experiments and data, poses challenges to the maintenance of quality of scientific publications, which becomes even more problematic for policy relevant science[17].

[16] http://retractionwatch.com, (last accessed 29th June 2014)

[17] See for example, the recent proposed legislation in the USA to cover for the alleged accusation that EPA had relied on undisclosed and unverifiable data upon which to base its regulations; hence the proposed legislation seeks: *To prohibit the Environmental Protection Agency from proposing, finalising, or*

Peer review extended

In a workshop organised by the JRC in 2011[18], Ehsam Massod observed, "Scientists, policymakers and publishers regard peer review as the gold standard in science. But how true is this in a world where the very idea of expertise and authority is open to question? Does conventional peer review make sense in a world in which anyone with a cellphone, a WiFi connection and a Twitter account is both reader and reviewer?"[19] The rise of digital publications needs to be accompanied with collectively agreed ways of quality assurance. However, this is not just about the publications. This is about research framings, agendas, questions, assumptions, choices and ultimately about the choice of knowledge input into addressing societal matters. One can argue that current digital culture has at last been implementing the concept of "extended peer review" and extended quality assurance (Funtowicz & Ravetz 1990). The "extended peer review" model suggests that such quality assurance is done based on different types of knowledge and involving an extended community of social actors. In the end of the day, as Jasanoff (2013) suggests "[…]*a prime casualty in the age of information and informatics appears to be public confidence in the power of reason*"; trust and quality go toghether.

Knowledge governance

The digital culture and phenomena like Citizen Science and the "Open Everything" paradigm (Steele 2014), where the number of actors that produce and preserve knowledge is broadened, certainly has effects on scientific institutions' memories, on their practice and on their governance. Therefore, the processes for selecting, preserving and disseminating knowledge, digital or not, need interrogation.

3.1.3 Legitimacy and Democracy

Science - Society Interfaces

In Europe, the UK BSE "scandal" of the mid-1980s to mid-1990s is often cited as pivotal in the change of direction in the relations between science and policy making. A key moment was the publication of the 2000 House of Lords report on *Science and Society* followed a year later by the European Commission's *Science and Society Action Plan* (European Commission 2002), as well as the EU 5th Framework research programme's "Raising Awareness of Science and Technology" activity of the late 1990s.

In the eyes of the British public the BSE episode was epitomised by the then-Minister of Agriculture, John Gummer, trying to feed a beef burger to his four-year-old daughter, Cordelia, before media and cameras.

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disseminating regulations or assessments based upon science that is not transparent or reproducible. See https://beta.congress.gov/bill/113th-congress/house-bill/4012

[18] Science in a Digital Society. 17-19 May 2011. Calouste Gulbenkian Foundation, Lisbon. See report, Pubsy nr. JRC68607, EUR 25201 EN.

[19] The history of quality assurance of Open source software development (and shareware, freeware, for that matter) is relevant for the world of extended peer review. Over the years the "open source communities" have been following the Open Source Software Development (OSSD), an agreed quality process by which open source software is developed in agreement with software engineering life-cycle methods. It is based on usage, and depends largely on the size of the community of users and developers – see e.g. Khanjani and Sulaiman 2011.

Box 3.2: "The GM Nation?" is often seen as an example of response to face the BSE crisis. The UK government sponsored a debate on genetically modified crops with the intention of having a wide-ranging and effective public debate, going beyond the "often polarised views in order to find out what people really think about GM" (Gaskel et *al.* 2003). It is important to note that this debate springs from a recommendation of the *Agricultural and Environment Biotechnology Commission*, which is an independent body that advises the UK government on biotechnology issues and their impacts on agriculture and the environment. This debate should "establish the full spectrum of the public's views on GM and possible commercialisation of GM crops, and any conditions it might want to impose on this" (Agriculture and Environment Biotechnology Commission 2003). It is remarkable that the GM Nation was a governmental operation since, as Jasanoff (2005) notes, in biotech times, upstream efforts to identify risks and explore ethical dilemmas were led by the science community itself.

Partly as a result of the failings of the deficit model (also known as Public Understanding of Science - "PUS"), public views of science worsened throughout the 1990s, and a new language of "science & society" towards dialogue and engagement emerged – see Box 3.2. This phase corresponds to Callon *et al.*'s (2001) model of science and public relations as a "public dialogue and participation model" or the already mentioned "model of extended participation" – i.e. working deliberatively within imperfections (Funtowicz 2006). As Toulmin (1997) noted, it is also during the 1990's that ethics discussions of e.g. environment and medicine stepped out from the professional monopoly and reached wider publics. Indeed, many initiatives of public involvement in controversial issues depart from the academics or NGO's and fewer from governmental institutions. With Horizon 2020, the deepening of these interfaces is done by setting engagement and ethics as key pillars of the newer governance lemma of science and technology, i.e. "responsible research and innovation" (RRI)[20].

Extended Facts and Civic Epistemologies

In the concept of "post-normal science" described earlier,

> "*extended peer communities will not necessarily be passive recipients of the materials provided by experts. They will also possess, or create, their own 'extended facts'. These may include craft wisdom and community knowledge of places and their histories, as well as anecdotal evidence, neighbourhood surveys, investigative journalism and leaked documents. Such extended peer communities have achieved enormous new scope and power through the Internet. Activists scattered among large cities or rainforests can engage in mutual education and coordinated activity, providing themselves with the means of engagement with global vested interests on less unequal terms than previously. This activity is most important in the phases of policy-formation, and also in the implementation and monitoring of policies. Thus in addition to extending the traditional processes of quality assessment, participants can enhance the quality of the problem solving processes themselves.*" (Funtowicz & Ravetz 2003).

Ulrich Beck (1992) called "reflexive modernity" a state in which growing bodies of knowledge are accessible to growing number of individuals with added agency that enables them to intervene in the world. Can we argue that we are in such state?

[20] Looking at the semiotics of these developments at EU level we see through the preposition changes of the science - society research framework programs, that a deepening of such interfaces has been sought: first Science *and Society*, then Science *in Society*, then Science *with Society*, and in Horizon 2020 Science *in* and *with Society*.

Box 3.3: The phrase **civic epistemology** was first used by Sheila Jasanoff in a series of European lectures in the spring of 2002 and widely explored on her 2005 book (Jsanaoff, 2005). A useful definition provided in Miller (2005) is "civic epistemology as the broader array of activities, social processes, informal practices, and institutionalized procedures by which people collect, aggregate, validate, and wield claims to knowledge about nature and society in public and policy settings. This includes, in addition to science, accounting frameworks, styles of assessment, formal and informal policy analysis, local knowledge, the media, and public understanding."

The ideas of post-normal science, the "extended facts" and the "civic epistemologies" (Box 3.3) describe deeper involvement of non-experts in societal matters that are often dealt with in the scientific remit. These concepts explicitly exclude the "public understanding of science" model and the thesis of the public's inability to act on scientific issues, - the so-called deficit model already mentioned, supporting instead the launch of various efforts for democratising science. These deeper involvements of society in the scientific enterprise arise from individuals and communities, realms that we call "citizen science" or "do it yourself movements" which rely on voluntary and self- or community supported initiatives that are seeing, with different forms of philanthropy, including crowd-funding, a fresh start. It must be noted that such an extension of participation calls for a reflection about the nature of the knowledge, values and normativity produced and on what might be the criteria and processes for ensuring their quality and integrity.

Box 3.4 – Expressions of PNS: In Fukushima, radiation levels measured by non-experts were considerably high than those officially published; a biologist at Japan's Ryukyu University wrote papers suggesting that radioactivity at Fukushima has triggered inherited deformities in a species of butterfly, but his research is paid for through private donations, including crowd-funding[21].

In Aquila, six scientists were condemned because they mislead the public and public authorities about earthquake risks discrediting an amateur earthquake forecaster who had warned public authorities about the upcoming strong earthquake.

The Quantified Self movement is an international collaboration that encompasses users and makers of self-tracking tools. It describes the concept as "self knowledge through numbers". The areas of interest are mainly health and lifestyle related. The user community is organised by cities, and frequently organise meet-ups to share their knowledge. It is an example of what Benkler & Nissembaun (2006) called commons-based "peer production" of knowledge.

Civic epistemologies (see Box 3.3) in different settings and scales are technologies through which people are coproducing new ways of knowing and ordering the world at these scales (Miller 2005). We would argue that those civic epistemologies are a natural response to the critique of modern science meant to "speak truth to power" (Wildavsky 1979), and of the Cartesian dream of rational value-free answers to human "problems".. As Jasanoff (2005) argues, "*science, no less than politics, must conform to* […] *established ways of public knowing in order to gain broad-base support – especially when science helps underwrite significant collective choices*". The question, we would argue, is not so much to what extent can the scientific community accommodate extended facts but rather about what spaces need to be created in order for co-existence, collaborations and co-productions – see Box 3.4.

What quality assurance can be put in place in those existing or emerging realms? The actual issue here is to make (safe) space for these types of knowledge to acquire significance and be acted upon.

[21] http://www.nytimes.com/2014/03/17/world/asia/concerns-over-measurement-of-fukushima-fallout.html?_r=0

Citizen Science, Science 2.0, Science in Transition, Open Science, etc.

In February 2014, the University College of London organised the 3rd citizen cyberscience summit[22]. Deeper forms of public engagement in co-production, described as citizen science[23], science in transition, science 2.0, present themselves with different agency, gazes and guises – e.g. "Do it yourself", self- and sous-veillance, crowd-funded initiatives, hacker spaces, maker spaces, *fablabs*, and community ICT based research. The *phenomenon* is becoming stronger with the pervasiveness of our digital culture and the "open everything paradigm". In his recent book, "The Open- Source Everything Manifesto – transparency, truth and trust" the former CIA case officer Robert D. Steele, argues that the Open everything paradigm is the condition sine qua non for restoring trust from the "closed world corruption and secrecy that has enabled massive fraud within governments, banks, corporations, [etc.]" advocating for "a world of bottom-up, consensual, collective decision-making as a means to solve the major crises facing our world today", Steele (2014)[24]. At the JRC a few groups are already looking at these new styles in the ICT, environment and health fields.

Privatisation of Science

According to historian Philip Mirowski (1991; 2013), one of the consequences of having adopted neoliberal policies and a neoclassic stance in economics since the eighties has been a massive privatisation of research. This would have led to a corruption of the self-governance method of science, and would be now jeopardising the very mechanism of science driven innovation. His 2011 book 'Science-Mart: Privatizing American Science' he argues *inter alia* that commoditised science loses quality, given that since the 1980s research moves away from government laboratories and large research laboratories of major corporations and universities into contract research organisation (CRO) acting under budget pressure and short time horizons. It is not difficult to see a link between commoditised research and the reproducibility debacle described above (*The Economist*, 19 October 2013; *The Economist* 15 March 2014; Ioannides 2005).

3.2 Co-production. Examining the context of science advice to policy

> "*A full-blown political analysis of science and technology seeks to illuminate the 'co-production' of scientific and social order -that is, the production of mutually supporting forms of knowledge and forms of life - with all the detail and specificity that such a project entails*" (Jasanoff 1996).

Figure 1 Drawing Hands by M.C. Escher. 1948

Source: WikiArt. © MC Escher Company, B.V.

The crisis arising within the scientific endeavour that we have described as crisis of quality, trust and legitimacy brings to mind Escher's Drawing Hands – i.e. one hand writes

[22] See http://cybersciencesummit.org/

[23] ExCiteS is commonly referred to as a citizen science project and an example of empowerment of communities that traditionally would not participate in research projects, collecting and contributing their own data. But other forms of "citizen science" are more empowering of the participants such as those arising from the health sector, in which many people use wearable sensors to monitor their health and organise themselves into specific movements – se for example, the quantified self: http://quantifiedself.com/

[24] See also the article in The Guardian published in June 2014 regarding this book, available at: http://www.theguardian.com/environment/earth-insight/2014/jun/19/open-source-revolution-conquer-one-percent-cia-spy

the other. The elements of the crisis arise from the scientific practices – in turn deeply affected by the neoliberal zeitgeist as discussed above. Science advice is dependent upon the context in which techno-science develops. In other words, science and advice based on it are co-produced and interwoven in the narratives we live by and sustain.

3.2.1 Narratives we live by

In this section we allude to some of the narratives we live by and sustain, a sort of new credo that affects not only the scientific endeavour, but also science policy and scientific advice to policy.

Growth

In the EU "growth" and "jobs" are the credo at the heart of any justification for political action. This is also true across research policies, priorities and funding. But what if the concept of *growth* – intended as growth of GDP per capita (by definition a mean over a population) – is devoid of salience, as three decades of increasing inequality have made the mean inadequate to describe living standards, so that other measures such as the median should be used, as recommended by the Stiglitz report (Commission on the Measurement of Economic Performance and Social Progress 2009)[25] ? Or, what if Philip Mirowski[26] (2011) is right, and the economic profession is still committed in its majority to a neoliberal creed and neoclassic economic stance, which has been largely falsified by current events[27]. What if this is one of the root causes of the financial and economic crisis? We have already discussed the link between an economic stance that privileges the market as a solution to problems – and hence the market-place of ideas concept – and the resulting privatisation / commoditisation of science. Note that in the European discourse growth is systematically qualified by a set of adjectives, such as sustainable, smart, inclusive, which are among themselves the subject of formidable trade offs, typically the one between competitiveness – associated to higher productivity – and employment (Saltelli & Dragomirescu Gaina 2014).

Innovation

Innovation is one of the pillars on which the EU relies to counteract a low pace of growth in Europe. The ways in which the quest for "innovation" (i.e. the driver and engine of economic, social and environmental wealth) is heralded today in the EU is rather political. The word is used as a noun (substantive), e.g. "responsible innovation", or as a qualifier, e.g. "Innovation Union" and "innovation policy". This pervasive appeal acts as a normative driver of activities in the EU that seek to resolve (rescue) societal issues.

The European Commission in particular presents "innovation" in a salvific role, used to justify and defend technology. The abusive usage of this concept in policy realms has also been object of criticism. For example, Van den Hove *et al.* (2011) reflected on the narrow focus of "innovation" as an "end in itself" in the form of products instead of a means to

[25] Recommendation 4: Give more prominence to the distribution of income, consumption and wealth: '*Average income, consumption and wealth are meaningful statistics, but they do not tell the whole story about living standards. For example, a rise in average income could be unequally shared across groups, leaving some households relatively worse-off than others. Thus, average measures of income, consumption and wealth should be accompanied by indicators that reflect their distribution. Median consumption (income, wealth) provides a better measure of what is happening to the "typical" individual or household than average consumption (income or wealth)'.* (Commission on the Measurement of Economic Performance and Social Progress 2009). With increasing inequality it is not unusual for the mean to increase (driven by the high end tail of the distribution) while the median recedes. The same point is made by the OECD (2011).

[26] See Mirowski (2011) and references therein.

[27] See Mirowski (1991) and Mirowski (2013).

achieve socially meaningful and responsible paths of human development taking into account different ideas of sustainability. Another critique saw that this political imperative should recognise better more socially distributed, autonomous and diverse collective forms of enterprise (European Commission 2007) as well as normativity. Partly to meet these criticism the EC has introduced in its research work programme a line of "Responsible Research and Innovation" in its Horizon 2020 programme. Perhaps unintentionally this recalls the movement for *Appropriate Technology* in the seventies, rightly seen with suspicion by ecologists as a fad to fix the most obvious downside of blind adoption of technology, any technology. The story is told in a chapter aptly titled 'Building the better mousetrap' of a famous book from Longdon Winner (1986).

Benessia and Funtowicz (2014) talk about the visions and promises of "innovation" and the techno-scientific imaginaries the term projects: wonder, power, control, and urgency (Benessia 2013). These imaginaries are cultural and socially implicit constructs that reinforce the modern ideals of science as a privileged knowledge system and technology as key instrument for action (Benessia & Funtowicz 2013; 2014). The problem, as the authors state, is that technoscientific enterprises often do not start with a question, but rather with an answer framed on arguments of optimisation, substitution or defeat, a set of silver bullets heralded in the name of sustainability, and security.

This is not a new story, and one that was the subject of deep analysis in the historic ecological movement. According to Lewis Mumford this is a salient consequence of the tight relationship between technique and capital (Mumford 1934, p. 26-27).

> "*Whether machines would have been invented so rapidly and pushed so zealously without the extra incentive of commercial profit is extremely doubtful: for all the more skilled handicraft occupations were deeply entrenched, and the introduction of printing, for example, was delayed as much as twenty years in Paris by the bitter opposition of the guild of scribes and copyists. But while technics undoubtedly owes an honest debt to capitalism, as it does likewise to war, it was nevertheless unfortunate that the machine was conditioned, at the outset, by these foreign institutions and took on characteristics that had nothing essentially to do with the technical processes or the forms of work. Capitalism utilized the machine, not to further social welfare, but to increase private profit: mechanical instruments were used for the aggrandizement of the ruling classes. It was because of capitalism that the handicraft industries in both Europe and other parts of the world were recklessly destroyed by machine products, even when the latter were inferior to the thing they replaced: for the prestige of improvement and success and power was with the machine, even when it improved nothing, even when technically speaking it was a failure. It was because of the possibilities of profit that the place of the machine was overemphasized and the degree of regimentation pushed beyond what was necessary to harmony or efficiency. It was because of certain traits in private capitalism that the machine - which was a neutral agent - has often seemed, and in fact has sometimes been, a malicious element in society, careless of human life, indifferent to human interests. The machine has suffered for the sins of capitalism; contrariwise, capitalism has often taken credit for the virtues of the machine.*"

Besides, different cultures of innovation exist arising from different cultures of technology (ed. Nowotny 2006), while the call for innovation of the present European discourse is presented to us hegemonically.

Evidence based policy to policy based evidence?

"Evidence based policy" is another narrative by which we live and which is high on the European Commission's agenda, the latest slogan being a quest for a centralised "evidence service" in the words of A. Glover, the Chief Science Adviser of President J. Barroso (see Wildson 2014); she suggested that "*the incoming commission must find better ways of separating evidence-gathering processes from the 'political imperative'*".

This suggestion is problematic; on one hand it rejects the inevitability of co-production of scientific and social order (Jasanoff 1996); on the other hand it does not recognise that evidence gathering is also a matter of choice of the questions to be asked and researched; of the framings in which questions are tackled; governance of uncertainty and unknown; science therefore is not apolitical and sides are mostly taken in the pre-analytical phase of a study, when the question to be addressed, as well as the chosen methods to tackle it, are framed.

It is interesting to note that the newly-elected President of the European Commission, Jean Claude Juncker, recognises this issue. In his speech of the 15th July 2014:

> "*I also intend to review the legislation applicable to the authorisation of Genetically Modified Organisms. To me, it is simply not right that under the current rules, the Commission is legally forced to authorise new organisms for import and processing even though a clear majority of Member States is against. The Commission should be in a position to give the majority view of democratically elected governments at least the same weight as scientific advice, notably when it comes to the safety of the food we eat and the environment in which we live.*" [28]

Stilgoe (2013) makes the point that the assumption behind *evidence-based policy* is that there are *hard facts* and *soft values*, while there are plenty of examples that show how much they are intertwined.

But there is an even more problematic issue with this narrative; the danger of *evidence-based policy* being turned into *policy-based evidence*, not necessarily because of lobbyists' pressure or because of some wicked characteristics of the responsible policy makers, but simply because of the frantic pace of the policy cycles internal to the European Institutions, whereby by the time the bell for evidence rings in the office of the tasked officer the policy options have already been taken. It is in these settings that the standard for quality must be set high both for the internal institutional peer review process as well as for the consultation of stakeholders. This has implications for the JRC as we shall discuss next.

Consequentialist culture versus an anticipatory culture

We do not intend here to review the critique to the culture of cost benefit analyses and risk assessment[29] as a basis for consequentialist governance that has been underpinning a great deal of research on impacts of science and technology and political action.

Suffice say here that there are indeed cases where cost benefit analysis are pushed too far, quantifying the unquantifiable, or where a problem of acceptability of a new technology is arbitrarily reframed as an issue of risk. In this respect we turn again for example to Langdon Winner (1989) for the core of the argument:

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[28] Available at: http://ec.europa.eu/about/juncker-commission/docs/pg_en.pdf

[29] This is a field on its own right. We can suggest classic reading like Krimsky and Golding 1992; Perrow 1984; Funtowicz & Ravetz 1990; Jasanoff 2010; but so many others such as Taleb (2007; 2012), and European Commission (2007).

> "[T]*he risk debate is one that certain kinds of social interests can expect to lose by the very act of entering. In our times, under most circumstances in which the matter is likely to come up, deliberations about risk are bound to have a strongly conservative drift. The conservatism to which I refer is one that upholds the status quo of production and consumption in our industrial, market oriented society, a status quo supported by a long history of economic development in which countless new technological applications were introduced with scant regard to the possibility that they might cause harm (…) Fortunately, many issues talked about as risks can be legitimately described in other ways. Confronted with any cases of past, present, or obvious future harm, it is possible to discuss that harm directly without pretending that you are playing craps. A toxic waste disposal site placed in your neighborhood need not be defined as a risk; it might appropriately be defined as a problem of toxic waste. Air polluted by automobiles and industrial smokestacks need not be defined as a 'risk'; it might still be called by the old-fashioned name, 'pollution'. New Englanders who find acid rain falling on them are under no obligation to begin analyzing the 'risks of acid rain'; they might retain some Yankee stubbornness and confound the experts by talking about 'that destructive acid rain' and what's to be done about it. A treasured natural environment endangered by industrial activity need not be regarded as something at 'risk'; one might regard it more positively as an entity that ought to be preserved in its own right*".

As a viable alternative to risk we would like to allude here to another trend that focuses on anticipation and anticipatory governance. Anticipation denotes "building the capacity to respond to unpredicted and unpredictable risks" (Guston 2008). Anticipatory governance requires the development of a foresight capacity that includes not only formal methodologies but also informal ones that extend the imagination and their assessment to the public; anticipatory governance implies reflexivity based on both analytical capacities and on relevant empirical knowledge. Moreover, "[A]nticipation implies an awareness of the co-production of sociotechnical knowledge and the importance of richly imagining sociotechnical alternatives that might inspire its use" (Barben *et al.* 2008, p. 992). Such a culture of anticipation needs to be further reinforced at the JRC. Note also the renewed societal attention on the topic driven *inter alia* by the successful book of Nassim N. Taleb on anti-fragility (2012).

The purpose of this section on narratives, where we focus on growth, innovation and evidence-based policy, was to make the point that narratives need not to be taken for granted, need not to be panaceas, need not to be inevitable, cannot be narratives by which we live if appropriate space is not given to interrogate them. We believe that the JRC should secure this space.

3.2.3 Cultures of Advice

Heroes and Boards

Here we examine a few relevant discussions of science advice to policy.[30]

There are (inevitably) different cultures of science advice in Europe[31], from the "heroic model" (Pielke 2013; Doubleday & Wilsdon 2013) of scientific advice impersonated by

[30] In an edited volume Guimarães Pereira and Funtowicz (2009) have collected several cases that illustrate the ongoing challenging role of science in policy making, sustaining that the challenge is to develop new decision-making styles in order to cope with deep uncertainty, even ignorance, about facts, and in a plurality of value systems.

[31] As there are different cultures of scientific production, communication and publication.

Chief Scientific Advisors (CSAs) as in the UK and few other countries, to other models that rely on broader consultations with civil society, such as the Danish Board of Technology.

We will briefly look at those two models and highlight some of the ongoing challenges.

Box 3.5: Doubleday and Wilsdon (2013) organised a series of small essays about the future of science advice in the UK. They conclude with ideas that could be helpful for a debate at the JRC: collegial work modes across all departments of the UK government; promotion of interdisciplinary approaches blending natural and social sciences; championing of the full breath of scientific expertise; strengthen foresight; and action with humility.

We start with New Zealand's chief science adviser Peter Gluckman. In a note recently published in Nature (2014) he finds science advice challenging in issues that he suggests have "the hallmarks of what has been called post-normal science" (PNS - Funtowicz & Ravetz 1993, p. 744).

As discussed above, the post-normal science situations lead necessarily to changes in the science-policy model, both in terms of the ways in which science underpins policy and the ways in which the policy process informs science.

Using again the words of CSA Peter Gluckman, PNS issues are those that "are urgent and of high public and political concern; the people involved hold strong positions based on their values, and the science is complex, incomplete and uncertain." He offers ten principles for policy advice to governments that he describes as an activity to "elucidating the evidence-informed options, rather than simply advocating a course of action"[32], from which we highlight two, that we see as relevant for the JRC:

- the expectation of the CSA should be to inform policy, not make it, while recognising the limits of science and of the advice;
- the CSA should engage with wider members of the scientific community, as well as with the policy community.

As Pielke (2013) noted in his address to the UK chief scientific adviser, "science advice" is a misnomer as it implies a deficit model, where the "advice" is artificially decontextualised from the political situation. Hence he further notes that science advisers are not "superheroes", in the sense that they cannot "carry the authority of science as a counterbalance to the messiness of politics". Pielke (2014) argues that "improving science advice in Europe will depend on improving advisory processes, not scrapping them". In what balanced form, if that is possible, should an individual advisor act as "spokesperson" of a multi-disciplinary community of scientists and researchers in a specific field? It is interesting to note that many prestigious newspapers offer advice (checklists of dos and don'ts and principles) on how scientific advice and in particular CSA should do their job. This debate is relevant for the JRC.

We now move to other models of science advice which do not impersonate such activity. An example is the extinct and now refurbished Danish Board of Technology[33].

The DBT describes itself as working at the interface between "public challenges, technology, knowledge, values and actions to be taken. The DBT [counsel] decision-makers about possibilities and consequences for citizens, environment and society and create platforms for participants to pool their knowledge, finding sustainable and

[32] The 10 principles are: 1) Maintain the trust of many; 2) Protect the independence of advice; 3) Report to the top; 4) Distinguish science for policy from policy for science; 5) Expect to inform policy, not make it; 6) Give science privilege as an input into policy; 7) Recognising the limits of science; 8) Act as a broker not an advocate; 9) Engage the scientific community; 10) Engage the policy community

[33] See http://www.tekno.dk/subpage.php3?page=forside.php3&language=uk.

interdisciplinary solutions. The DBT works with developing dialogue based and involving working methods at a local, national and global level. The DBT furthermore implements projects at a national and an international level for the EU and globally in collaboration with the United Nations". The activities of the DBT spans from technologies (e.g. biotechnology and ICT) through economic sectors developments (e.g. transports and agriculture. DBT Methods are participatory in nature: World Wide Views (WWViews); Inter-disciplinary Work Groups; Interview Meeting; Cafe Seminar; Citizens' Summit; Citizens' Jury; Citizens Hearing; Future Panel; Hearings for Parliament; The Voting Conference; The Consensus Conference; Workshop Methods (Future workshops, Perspective workshops, Scenario workshops, Future search conferences); Danish participatory models.

Extended scientific advice to policy

Petersen, Heinrichs and Peters (2010) investigated transformations of scientific policy advice in relation to mass media, arguing that the increasing mediatisation of science deeply affects the ways in which policy-makers refer to scientific expertise. For example, policy makers cannot afford to ignore scientific knowledge and controversies once these are published in the media, especially since the protagonists are scientists known or respected by the public. In one way or the other, we are witnessing a process of mass media expertise which, the authors argue, has altered the relationships between advisors and policy makers.

It is interesting also to see how the science of policy advice has stepped out from academic circles and practitioners' spheres and is now followed by the media. For example, the British newspaper "The Guardian" has for the past months maintaining a series of informed commentary about science advice to policy[34].

Scientific advice - a reflexive enterprise?

Pielke (2007) offers a reflection on how the policy-relevant scientific endeavour is strongly framed by styles of advice and science policies. This issue is particularly important for the JRC. The research effort at the JRC is often conditioned by the questions of those who order the studies and activities – often other departments of the European Commission. What if those questions are incomplete and even irrelevant? Isn't the JRC embracing a trap that compromises its researchers' integrity?

Jasanoff (2013) notes that scientific advisers are bound by the same principles and discipline of science practices (i.e. "*known facts, reliable methods, responsible professional codes, and the ultimate test of peer review*"). For this reason "*science advisers are not inclined to introspection in situations where their work fails to persuade*". Instead, she argues, it is often the case that such failures are attributed to factors that are external to the scientific endeavour, such as an ignorant and misbehaved public, or perverse media and corrupting "powerful corporate funders or other large interest groups". Indeed, we note that it is a practice inside the European Commission to seek (through at times paternalistic approaches) a model – be it behavioural, psychological or cultural - to explain why is that the public dissent (Winner 1989; Wynne 1993). This can also lead to overt attempts to manipulate public and media opinion to counteract dissent and disengagement. We have witnessed several times that when strong dissent exists, but stakes are high, not all perspectives have the same legitimate voice (e.g. on GMOs, and on the Internet of things). As an example of different perspectives on GMO see Box 3.6.

[34] see http://www.theguardian.com/science/science-policy

Box 3.6 - Inconvenient truths of GMOs – an STS perspective:
Proponents of GMOs observe that citizens' hostility to GMOs is at odds with the evidence that GMOs do not have negative health effects. According to the results of an EU-funded study (Marris *et al.* 2001), food safety is not prominent in the list of citizens' concerns on GMOs. A list of concerns registered by Marris *et al.* includes:

"1. Why do we need GMOs? What are the benefits? *2. Who will benefit from their use?* *3. Who decided that they should be developed and how?* *4. Why were we not better informed about their use in our food, before their arrival on the market?*	*5. Why are we not given an effective choice about whether or not to buy and consume these products?* *6. Do regulatory authorities have sufficient powers and resources to effectively counter-balance large companies who wish to develop these products? "*

Instead, GMO concerns are almost universally framed as food safety scares including. A somewhat abusive example is from the Economist, discussing the introduction of a GMO labelling scheme in Vermont (US):

> *Montpelier is America's only McDonald's-free state capital. A fitting place, then, for a law designed to satisfy the unfounded fears of foodies*. (*The Economist* 10 May 2014).
> *Just ask about genetically modified crops, declared safe by the scientific establishment, but reviled as Frankenfoods by the Subarus-and-sandals set*. (*The Economist* 10 May 2014).

This is an example of a more general class of problem, where cost-benefit analysis or risk analysis is performed to demonstrate the safety of a new technology after the technology has been introduced. As cogently noted by Langdon Winner (1989 p. 138-163), ecologists should not be led into the trap to argue about the 'safety' of a technology after the technology has been introduced. They should instead question the broader power, policy and profit implications of that introduction.
(Source: Saltelli & Funtowicz 2015).

According to Jasanoff (2013):

> *"It is well recognised that in thorny areas of public policy, where certain knowledge is difficult to come by, science advisers can offer at best educated guesses and reasoned judgments, not unvarnished truth. They can help define plausible strategic choices in the light of realistic assessments of evidence; rarely can they decree the precise paths that society should follow."*

Trust is a condition *sine qua non* for the recognition of the role of science advisory systems; such systems and institutions need scrutiny, as any other democratic institutions. "If judges may not presume to stand above the law, still less should science advisers seek to insulate themselves from the critical gaze of the sciences of science advice" (Jasanoff 2013, p. 67).

3.3 Debate at the JRC

We have highlighted several of the challenges for the scientific endeavour within and in its context. Many of those, if not all, need to be faced at the JRC. We highlight a few that require a debate with all at the JRC:

- 'Policy-based evidence' can hardly be separated from 'evidence-based policy' when the dense agenda and strict deadlines of the policy cycle rush our scientists to support colleagues in the policy branches of the European Commission. The

former though should not obliterate the latter. In these circumstances, transparency and humility become JRC's best line of defence to uphold quality throughout the process of scientific advice to policy.

- Linked to the above is the issue of "stealth advocacy", where scientists claim to be focusing on science but are really seeking to advance a political agenda or, even unwittingly, a normative stance.
- Organisations such as the JRC, embedded into the policy cycle, may become hostage to one of the parties in the dispute in cases where different branches of the European Commission may happen to hold divergent views.
- A dangerous mindset in science advice to policy is adherence to the so called 'deficit model'. In the Policy Paper by President Barroso's Science and Technology Advisory Council issued in August 2013 (Science and Technology Advisory Council 2013) it is suggested that "*More appropriate education programs, effective investments into initiatives for improving public understanding of the interplay between science, technology, institutional settings and patterns of behaviour, effective and targeted communication programs that are tailored towards different target groups in Europe, and last but not least a major drive for public participation are the main ingredients that can help Europe to live up to its claim of a knowledge-based continent with a broad future*." Whilst the document advocates the importance of trust in institutions and the need for a new science and society contract, it also sustains the 'deficit model', and the 'public understanding of science' approach, while being critical of "*post-modern thinking*", portrayed as a source of arbitrary or interested truth claims (p. 4).
- In the face of contradictory concepts of advice, what is the JRC positioning? In case the EC maintains a Chief Science Adviser, how should the JRC act on issues where both the JRC and the CSA are called to give an opinion? Can this opinion differ from that of the CSA?

The JRC should reflect that its own role is as a part of the European Commission, at a point in time where the European project is not at its healthiest, where the narrative of the European enterprise has to some extent gotten lost in the dramatic challenges of budget consolidation, increasing inequality, and imbalances between countries. That this happens when science simultaneously suffers a crisis of trust and credibility, should remind us all of how complex the context is for the suggested reconsideration of JRC's role in policy advice.

4. The JRC: an "Emperor is naked" model?

In the last sections we have tried to situate the JRC in the broad institutional international scene while reviewing the challenges of the Post-Cartesian momentum[35] and the zeitgeist change underway. We presented elements of an internal and external crisis to science and knowledge production that affect not only scientific practice but also scientific advice; we submit that the JRC is in a unique position to address those. Rather than trying to continue things according to received wisdom – what we designate elsewhere as Cartesian dream - we acknowledge that the JRC needs to operate within existing conditions, and we are convinced that this constitutes momentum for exploring a different understanding of knowledge production, power and societal organisation in order to respond to the crisis.

Hence, there are no panacean routes to engage with change; in fact we think that this **should be object of a collective reflection involving all JRC researchers**. Here we offer a model that tries to encompass key challenges of our current predicament, embracing the criticisms and exploring models of operation, taking stock and extending the two central features of the JRC: it being part of the policy cycle on the one hand and its natural closeness to academia on the other. We called it "the emperor is naked" model, after the story of Hans Christian Andersen, which emphasises 3 complementary cultures:

(1) Quality. Developing a culture of *extended peer review*: by embracing/ pursuing emerging epistemologies and by putting social sciences at the heart of JRC's operation. The quality model proposed here aims for social robustness of techno-science proposals, as advocated in PNS and Mode 2 science, acknowledging that emerging normativities and ontologies need to be accounted for.

(2) Reflexivity. Developing a culture of reflexivity: the JRC needs to train itself as a sceptic body of researchers inquisitive about policy agendas and political imaginaries through knowledge assessment. This reflexivity model aims at challenging narratives based on business as usual and at testing their relevance against social agendas and social value.

(3) Humility. Developing a culture of *engagement*: firmly rejecting the "public understanding of science" model and valuing dialogic governance on the acknowledgment that in the face of different types of uncertainties and unknowns, anticipation of impacts, determination of relevant facts and normativities, questions to be asked and methods of enquiry are collective tasks not to be relinquished to powerful elites.

This model explicitly recognises the JRC as a boundary institution, which needs to invest on better liaison with the public, creating safe spaces of interaction and engagement, and to reinforce its capacity in the field of science and technology studies (STS).

[35] In a forthcoming volume with Routledge edited by Guimarães Pereira and Funtowicz, a number of cases are included to illustrate this observation.

4.1 Quality

As discussed above the JRC must foremost strive to be non-dogmatic in the way it offers advice, even when the dogmatism descends from the recipient of the advice.

A central issue of today's scientific enterprise is the link between trust and quality. Standards for policy-relevant science and for the quality of the evidence are now insistently called upon, even from the columns of Nature[36] where Ian Boyd (2013), speaking in its capacity of science adviser to DEFRA, the UK government department for environment, food and rural affairs, laments about '*concern about unreliability in scientific literature*' and '*systematic bias in research*'. This is where the JRC's role is irreplaceable; the JRC can develop evaluation strategies and provide pedigrees for what is taken as evidence-based policy. Hence, the JRC has a role to play not only in producing facts and figures, not only in modelling, but also in the verification of the worldviews that sustain them, engaging all relevant social actors in that quality assurance process.

4.2 Reflexivity

Lack of institutional reflexivity seeks on and transfers to external factors, institutional failures. Science is seen as the epitome of self-reflexivity, but as Wynne (1993) noted, the prevalence of the PUS model - which sees the public as ignorant, risk-adverse, unreflexive and misbehaved – has made prominent instead that scientific institutions are poorly reflexive when it comes to their unstated presumed "models of the public that structure their scientific discourses" (Wynne 1993) So, reflexivity here is understood as not merely internal consistency, but rather as the continuous interrogation of the narratives that sustain institutions. Again, we see here a clear opportunity for the JRC, through knowledge assessment, to interrogate and not blindly sustain what is coming to be designated as "policy based evidence". This, we argue, needs a shift of culture, i.e. development and or strengthen of new meanings for policy support: anticipation, extended peer review, ethics, knowledge assessment, upstream engagement, etc.

4.3 Humility

Box 4.1. Technologies of Humility (Jasanoff 2003; 2007) These are methods, or better yet institutionalized habits of thought, that try to come to grips with the ragged fringes of human understanding – the unknown, the uncertain, the ambiguous, and the uncontrollable. Acknowledging the limits of prediction and control, technologies of humility confront 'head-on' the normative implications of our lack of perfect foresight. They call for different expert capabilities and different forms of engagement between experts, decision-makers, and the public than were considered needful in the governance structures of high modernity. They require not only the formal mechanisms of participation but also an intellectual environment in which citizens are encouraged to bring their knowledge and skills to bear on the resolution of common problems."

Our last pillar is Humility; humility in the face of what we don't know and what we cannot anticipate. Humility recognises the post-Cartesian momentum, i.e. the recognition that not only the human ability to anticipate is limited but also the recognition that the questions to be made about particular heralded routes of human betterment need to be done beyond the usual self-attributed privileged spaces of enquiry.
Jasanoff described 'technologies of humility' as the institutionalised and pragmatic tools that allow influential and genuine engagement of the public in matters that concern all –

[36] Ian Boyd calls for an auditing process to help policy-makers to navigate research bias

see box 4.1. This is in line with the model of "extended participation" (Funtowicz 2006), where citizens become both critics and creators in the knowledge production process. As a boundary institution, it would be a missed opportunity for the JRC to not further engage with European citizenry in the science and technology matters that concern them, and whose disengagement shapes science and technology anyway, often in painful ways for policy making.

4.4 A roadmap

In this section we propose a possible roadmap to implement what we called the 'emperor is naked' model at the JRC.

Setting the Scene

(1) An interview or a piece authored by the JRC's Director General on a well-read journal such as Science or Nature, to launch a serious reflexivity programme at the JRC on a modern vision of science advice . An example to take inspiration from on matters of style and content could be the piece on Nature of New Zealand's chief science adviser (Gluckman 2014)

(2) Establishment of a science and technologies (STS) group (a core team plus a group of young persons from all institutes) in charge of reinforcing social sciences at the JRC and implement the reflexivity program

(3) A set of ethnographic studies at the JRC to investigate practice (past and current) of boundary work (including policy advice, communication, engagement and dissemination)

(4) Anthropological studies of JRC's scientists-in-action (cooperation between STS team and teams from the institutes).

(5) Partnerships with key institutions that perform STS work.

Creating spaces

(6) Creation of a "Public Engagement Lab." that aims both to engage researchers with the public and to create the interdisciplinary space among researchers at the JRC (a physical as well as a virtual space).

(7) Demonstration cases of interdisciplinary work for three chosen cases per year with three different institutes.

Training

(8) Training on methods that span STS and other relevant social research methods.

(9) Invited seminars with STS scholars (max. four per year) – for two years.

Embedding

(10) Annual two-day meetings at the JRC with work from JRC researchers and invited STS scholars and practitioners. Putting the JRC in the forefront of a reflexivity culture and engagement with EU citizens.

(11) Handbook for JRC researchers – the "emperor is naked model": how to develop a sceptical culture.

4.5 A final thought

Science and technology have been the basis of progress and economic growth, and the instruments whereby humanity exercises its control, or in Descartes own words, "humans as masters and possessors of Nature". This worldview can be ascribed to the Cartesian dream and to the modern secular state, i.e. prediction and control over a disenchanted Nature through rational management and governance. Our approach, which responds to the several 'crises' described in the present brief, is to consider new ways in which science can sustain our planet and enrich our lives and to make such a body of knowledge

available to JRC collective intelligence. The key for science to remain a legitimate and trustworthy source of knowledge is that society will have to engage in the processes of knowledge co-production, which does not only include science, but also other *knowledge*. What place better than the JRC for this exercise of quality, reflexivity and engagement to take place?

5. Towards a new mission

As the Commission's in-house science service, the Joint Research Centre's mission is to provide EU policies with **reflexive,** independent, evidence-based scientific and technical support throughout the whole policy cycle. Working in close cooperation with policy Directorates-General **and EU citizens**, the JRC addresses key societal challenges arising **from the current innovation** agenda through **exploring and** developing new methods, tools and standards, and sharing its know-how with the Member States, the scientific community and international partners.

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Abstract

Some reflections are offered on challenges and opportunities for the JRC as a 'boundary organisation' between science and policy, at a time of increased complexity and polarisation and decreased trust in scientific enterprise. Some specific threats are identified in relation to the key role played by the JRC in the practice of front-line policy support. JRC is identified as a potentially relevant player to improve the quality of evidence feeding into the policy process. To achieve this potential, the JRC must develop in-house cultures and styles of reflexivity and humility, adopt more participatory styles of science co-production, and become confident enough of its role that it can dare to say 'the emperor is naked' whenever EU institutions appear to be in need of such a call.

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