Discussion Paper: Researchers and Open Science

Author: Mafalda Picarra, Jisc

Reviewers: Alma Swan, EOS and Marina Angelaki, EKT

April 2016

Introduction

This paper introduces the concept of Open Science to policymakers and discusses how Open Science is fomenting change in the way scientific research is conducted, communicated, accessed and shared. The paper starts, firstly, by defining Open Science, identifying its pillars and describing its overall benefits. Secondly, it situates Open Science within the European Commission's agenda for transforming science and democratising research[1]. Thirdly, it highlights the benefits and implications of Open Science for researchers – who are being increasingly encouraged to share research more widely and openly – and for policymakers, who have been adopting strategies and policies that encourage Open Science and open research. Importantly, this discussion paper intends to raise policymakers' awareness to some of the reasons why researchers may or may not be supportive about Open Science. Finally, after highlighting the implications of Open Science for researchers, a reflection is made on how policymakers can implement cohesive and consistent policies and strategies that advance an Open Science agenda at the institutional, funder or national level(s).

I. What is Open Science?

The term Open Science relates to the principle that scientific research is meant to be communicated and shared throughout the research lifecycle – from the idea generation phase, through the data collection, testing and experimenting phases, to the publishing and dissemination phases. Traditionally, scientific knowledge has been disseminated through the scientific publishing system which means that research findings are published in scientific journals. This process of scientific knowledge dissemination has prevailed since the seventeenth century[2]. However, the emergence of the World Wide Web has had an impact on the way knowledge can be created and disseminated. Ideas and research findings can be discussed in real time between researchers from distant countries. Publications and data can be made freely accessible on the web. Scientific articles can be reviewed online in an open and transparent way and can be modified, developed and enhanced as time goes on ('liquid publications'). Access to education and to educational resources can be granted remotely and cost free.

Open Science embraces the opportunities offered by the Web and encompasses a multitude of practices in which scientific knowledge can be accessed and shared among researchers and with society in general. It relates to the 'opening up [of] the research process by making all of its outcomes, and the way in which these outcomes were achieved, publicly available on the World Wide Web'[3]. It also proposes that scientific research outcomes are shared 'as early as is practical in the discovery

1 Open Science, https://ec.europa.eu/digital-agenda/en/open-science
2 Bartling, S. and Friesike, S. 2014. 'Towards Another Scientific Revolution - Opening Science'. DOI: 10.1007/978-3-319-00026-8
3 The case for an open science in technology enhanced learning. p. 645. http://goo.gl/RZkquh

process'[4]. This allows researchers and society 'to follow the [research] process and collaborate'[5]. Open Science also contributes to 'mak[ing] science more transparent and accessible during the research process'[6]. Fecher and Friesike (2014), for example, emphasise that the Open Science movement encompasses various strands, 'ranging from the democratic right to access publicly funded knowledge (e.g. Open Access to publications), the demand for a better bridging of the divide between research and society (e.g. citizen science), to the development of freely available tools for collaboration (e.g. social media platforms for scientists)'[7].

Research funders and international organisations such as the European Commission (EC) and the Organization for Economic Cooperation and Development (OECD) have also proposed definitions for the term Open Science. The EC defines Open Science as 'the way research is carried out, disseminated, deployed and transformed by digital tools, networks and media'[8]. The OECD determines Open Science as the 'effort [undertaken] by researchers, governments, research funding agencies or the scientific community itself to make the primary outputs of publicly funded research results […] publicly accessible in digital format with no or minimal restriction as a means for accelerating research; these efforts are in the interest of enhancing transparency and collaboration, and fostering innovation'[9].

By and large, Open Science encloses a combination of concepts, tools, platforms and media that promote the creation and dissemination of knowledge in a free, open and more inclusive way and that enable the reaping of wider benefits from research (Figure 1).

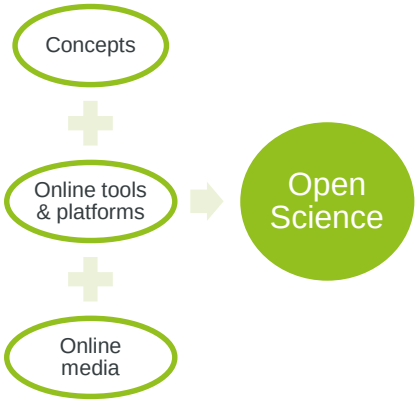

Figure 1: Concepts, tools and media that enable Open Science

4 ERA Portal Austria: Policy Brief: Open Science, https://era.gv.at/object/document/2279
5 What is Open Science? http://blog.f1000research.com/2014/11/11/what-is-open-science/
6 What is Open Science?, Eva Amsen, 11 November 2014, http://blog.f1000research.com/2014/11/11/what-is-open-science/
7 Fecher, B. and Friesike, S. 2014. 'Open Science: One Term, Five Schools of Thought'. p. 17-18. DOI: 10.1007/978-3-319-00026-8
8 See footnote 1.
9 Making Open Science a Reality, http://dx.doi.org/10.1787/5jrs2f963zs1-en

More specifically, Open Science encompasses:

- Concepts such as open access, open research data, open methodology, open education, open evaluation, altmetrics, citizen science, open source (see Table 1);
- Tools such as open source software, reference management software, open notebooks, open annotation, open bibliographies;
- Platforms dedicated to crowdsourcing[10], research collaboration[11], sharing research[12] and promoting engagement between scientists and society[13];
- Online media such as blogs, twitter, facebook and linkedin are free communication and networking websites that researchers use to share and discuss their research with broader audiences.

Concepts	Definition	Examples
Open Access	Open Access[14] designates the strategies and policies adopted by governments, research funders and institutions to promote free access to peer-reviewed articles and, in some cases also to conference proceedings, monographs and grey literature (e.g. reports, working papers, technical standards, theses, policy documents, government publications, etc.).	• European Commission Open Access policy (link) • Higher Education Funding Council for England Open Access policy (link) • University of Minho Open Access policy (link)
Open Research Data	Open Research Data[15] indicates the process of making the data produced as part of scientific research openly available without restrictions on the re-use and re-distribution of datasets. Data can be represented in a quantitative (e.g. statistics), qualitative (e.g. interview transcripts, field notes) or digital (images, videos) forms.	• European Commission Open Research Data pilot (link) • UK Engineering and Physical Sciences Research Council Research data policy (link) • University of Edinburgh Research Data Management Policy (link) • RECODE project (link)
Open Methodology	Open Methodology[16] designates the act of sharing methodologies that were developed or applied in research and that are required to replicate and achieve the same research results. In some life sciences research projects, lab notebooks are already being shared online in real time.	• Open Notebook Science Network (link) • OpenWetWare (link) • IPython Notebook (link)
Open Education	Open Education[17] promotes free online access to education. An increasing number of universities and organisations now provide free online access to their courses and educational resources (e.g. textbooks, teaching materials).	• Coursera (link) • MOOC (link) • FutureLearn (link) • OER Commons (link)

10 List of open innovation crowdsourcing examples, http://www.boardofinnovation.com/list-open-innovation-crowdsourcing-examples/
11 Collaborative Open Computer Science, http://gitxiv.com/
12 Academia, https://www.academia.edu/ ; ResearchGate, https://www.researchgate.net/
13 Digital4Science, https://ec.europa.eu/futurium/en/digital4science
14 PASTEUR4OA: Open Access, http://goo.gl/IpD9pG
PASTEUR4OA Briefing Paper, http://goo.gl/k9cWvX
15 Open Access to Research Data, http://goo.gl/4MtQnU
Digital Curation Centre Open Research Data Policy Resources, http://www.dcc.ac.uk/resources/policy-and-legal
16 The case for an open science in technology enhanced learning. p. 647, http://goo.gl/RZkquh
17 What is Open Education? https://opensource.com/resources/what-open-education
Open Education Consortium, http://www.oeconsortium.org/

Open Evaluation	Open Evaluation refers to the use of open methods such as open annotation and open peer review to comment on and / or evaluate research.	• Open Scholar (link) • Media Commons Press (link) • Digital Pedagogy in the Humanities (link)
Altmetrics	Altmetrics[18] refers to the use of alternative methods to measure research impact. These methods go beyond the traditional peer-review and citation-based bibliometric indicators.	• Mendeley (link) • CiteULike (link) • Social media: Twitter, LinkedIn, Facebook
Citizen Science	Citizen Science[19] concerns citizens' engagement with research through their contribution to the processes of collection and analysis of scientific data. It also encompasses citizens' contribution in research dissemination and exploitation activities.	• Citizen science projects (link) • National Geographic (link)
Open Source	Open Source[20] refers to the software that are 'made available under a licence that permits anyone to use, change, improve, or derive from existing source code, and sometimes even to distribute the software'[21].	• SourceForge (link) • GitHub (link) • OpenScience project (link)

Table 1: Open Science concepts

The advances made in Open Science have been promoted by institutions, funders and international organisations. This is visible, for example, by the number of policies being implemented that promote free online access to peer-reviewed articles and research data. Notwithstanding, academic, economic, social and political factors have also been contributing to drive the agenda for Open Science.

At the ***academic level***, there has been a significant increase in the global scientific community and as a result there has been an increase in the research being done across all academic disciplines[22]. There has also been an increase in multi-institutional collaborative research projects which stimulate the sharing of ideas and the transfer of knowledge[23]. The widespread access to digital technology has also led researchers and society to explore new ways of producing, transmitting and disseminating scientific knowledge[24].

At the ***economic level***, access to information, knowledge and technology is vital to drive productivity and growth. Western societies live in knowledge-based economies – 'economies which are directly based on the production, distribution and use of knowledge and information'[25] – where the knowledge generated in academic institutions is crucial to develop new or improve existing products, processes and services. Scientific research also contributes to the development of new applications, reduces product development cycles, and informs the formulation and implementation of new economic, research & development, and business policies[26].

At the ***social level***, the agenda for Open Science is driven by the vision that free access to scientific research makes significant contributions to address key societal challenges[27] and to improve social well-being. The internet has also made it

18 Research Impact Measurement in Higher Education, http://goo.gl/ZW2FUQ
Better ways to evaluate research and researchers, http://goo.gl/DQYFLs
Fenner, M. 2014. 'Almetrics and Other Novel Measures for Scientific Impact'. DOI: 10.1007/978-3-319-00026-8
19 White Paper on Citizen Science, https://ec.europa.eu/futurium/en/content/white-paper-citizen-science
Citizen Science, http://ec.europa.eu/digital-agenda/en/citizen-science
Crowd Science: The Organization of Scientific Research in Open Collaborative Projects, http://goo.gl/tpdNzU
20 Open Source Initiative, https://opensource.org/osd-annotated
21 The case for an open science in technology enhanced learning. p. 646, http://goo.gl/RZkquh
Pampel, H. and Dallmeier-Tiessen, S. 2014. 'Open Research Data: From Vision to Practice'. DOI: 10.1007/978-3-319-00026-8
22 Background Paper: Public Consultation 'Science 2.0': Science in Transition, https://goo.gl/SZNdI9
23 Study on Open Science: Impact, Implications and Policy Options, https://goo.gl/ZLR1nm
24 How the Internet Changed Science Research and Academic Publishing, http://goo.gl/PbUWlp
25 The Knowledge-Based Economy, p. 7, http://www.oecd.org/sti/sci-tech/1913021.pdf
26 The Knowledge-Based Economy, http://www.oecd.org/sti/sci-tech/1913021.pdf
Open Access to scientific information: facilitating knowledge transfer from the academic to the private sector, http://goo.gl/Ozx8RV
27 Europe's Societal Challenges: An analysis of global societal trends to 2030 and their impact on the EU, http://goo.gl/7gezyK

possible for citizens to become more involved with and contribute to scientific research (i.e. citizen science). At the ***political level***, governments in OECD countries, research funders such as the European Commission, and international organisations such as UNESCO have been increasingly engaged in driving the agenda for Open Science[28].

As a result, the benefits of Open Science traverse the academic, economic and social realms. Open Science enables scientific research to be shared openly and disseminated more speedily. It promotes greater transparency and accountability. It potentiates greater academic rigour and facilitates scientific collaborations. It increases the scope for research to be re-used and built upon. It promotes the use of open platforms and tools where 'experimental methods and results'[29] can be shared and discussed. It enhances the potential for new findings to be made more rapidly[30]. It fosters a culture where knowledge is transferred from the academic to the public, not-for-profit and private sectors. And it delivers increased returns on investment in publicly funded research. Ultimately, Open Science makes research visible and accessible to all, it promotes a more inclusive research process, and empowers citizens to participate in scientific research as well as re-use scientific information.

II. The European context

The European Commission (EC) has been taking an active role in endorsing Open Science. The EC's drive towards Open Science derives from programmes and policies that have been previously implemented with the aim of advancing economic progress and scientific research in the EU. In particular:

- Strategies to promote economic growth, job creation, transnational cooperation and optimal circulation, access to and transfer of scientific knowledge[31];
- Policies to promote Open Access to scientific publications and data[32];
- Recommendations for EU Members States to implement Open Access policies[33];
- Strategies to promote citizens' closer engagement with science in more transparent, accessible and inclusive ways[34].

To better understand what role and strategy towards Open Science it should take, the EC undertook a public consultation on 'Science 2.0: Science in Transition' in 2014. The consultation aimed to 'understand the full potential of 'Science 2.0' as well as the desirability of any possible policy action'[35]. The results from the public consultation showed that there is an overall positive attitude towards Open Science and that some of its benefits include the 'wider dissemination and sharing of research outputs […] as well as the ability to design accountable and collaborative research modes'[36]. Importantly, the EC was identified as a key player in advancing the Open Science agenda and 72% of respondents identified the 'need for policy intervention' in this area[37]. In the report, a series of policy recommendations were made by various stakeholders on issues related to awareness raising, infrastructure development, promotion of citizen science, and support for altmetrics, among others.

28 Making Open Science a Reality, http://goo.gl/8k98iC
29 Open Science at Web-Scale: Optimising Participation and Predictive Potential Consultative Report, p. 16, http://goo.gl/JmUtJQ
30 See footnote 23.
31 A Reinforced European Research Area Partnership for Excellence and Growth, http://goo.gl/UmmXMd
32 Open Access to scientific information, https://ec.europa.eu/digital-agenda/en/open-access-scientific-knowledge-0
33 Recommendation on access to and preservation of scientific information, http://ec.europa.eu/newsroom/dae/document.cfm?doc_id=2123
34 Citizen science, https://ec.europa.eu/digital-agenda/en/citizen-science
35 Science 2.0: Science in Transition, https://ec.europa.eu/research/consultations/science-2.0/background.pdf#view=fit&pagemode=none
36 Final report on the Public Consultation "Science 2.0: Science in transition", https://goo.gl/5gbyfC
37 See footnote 36.

In June 2015, the EC announced three strategic priorities for research, science and innovation which include Open Innovation, Open Science and Openness to the World[38]. Accordingly, the EC's strategy for Open Science is being undertaken in five key areas: Open Access, Citizen Science, Global Systems Science, ICT & Art, and Digital Science. The EC envisages that Open Science will enable a change in the way scientific research is conducted 'through ICT tools, networks and media'[39]. Moreover, it considers that Open Science will contribute to greater 'research integrity, openness, inclusiveness and networked collaboration'[40] and that it will impact on the 'quality of science, making science more efficient, reliable and responsive to the grand challenges of our times as well as foster co-creation and Open Innovation'[35].

Also in 2015, two studies were published by the EC that look at the 'Impact, Implications and Policy Options'[41] of Open Science and at 'How will change occur?'[42] in a Science Ecosystem 2.0. Whilst the former study focuses on new forms of learning, the impact of Open Science on research funding and assessment and on the role of Open Science in the wider society, the latter focuses on how Open Science will impact on distinct stakeholders (researchers, public sector, business sector, etc.) and on what the conditions for Open Science to succeed are. Both studies draw scenarios on the role and transition to Open Science and make a number of policy related recommendations.

The EC's Horizon 2020 Work Programme for 2016-2017 also addresses Open Science, with reference being made to the importance of 'a systematic opening up of the research process'[43] and to the role of Open Science in Responsible Research and Innovation (RRI) practices.

In 2016, the EC's Open Science agenda is being extensively promoted and supported by the Netherlands Presidency of the European Union (January-June 2016). Open Science has been identified as one of the key priorities of the Dutch Presidency[44]. To reinforce the agenda for Open Science, the Dutch Presidency will host an Open Science Conference[45], launch an Open Science Policy Platform[46], and is involved in the foundation of a European Open Science Cloud[47]. The PASTEUR4OA project will also host the conference 'Green Light for Open Access: Aligning Europe's OA Policies'[48] which is an event officially associated with the Dutch Presidency. Importantly, the emphasis placed on Open Science is likely to lead to greater awareness about Open Science across Europe and to an increase in national policies and strategies that support these principles.

III. What are the implications of Open Science for researchers and for policymakers?

Emerging practices that seek to open the research process have raised awareness about the positive impact and some of the current challenges that researchers and policymakers face in the transition to an Open Science ecosystem. This section

38 Open Innovation, Open Science, Open to the World, http://europa.eu/rapid/press-release_SPEECH-15-5243_en.htm
39 See footnote 1.
40 Open Science, http://ec.europa.eu/research/openscience/index.cfm
41 See footnote 23.
42 Crouzier, T. 2015. 'Science Ecosystem 2.0: How will change occur?', https://goo.gl/Ok5CPR
43 Horizon 2020 Work Programme 2016 – 2017, http://goo.gl/bHjNr6
44 The Netherlands and the EU Presidency, http://english.eu2016.nl/eu-presidency/councils-and-themes/competitiveness
45 Open Science Conference, http://english.eu2016.nl/latest/events/2016/04/04/open-science-conference
46 New policy initiative: The establishment of an Open Science Policy Platform, http://goo.gl/w10cVy
47 European Open Science Cloud, https://ec.europa.eu/research/openscience/index.cfm?pg=open-science-cloud
48 Green Light for Open Access: Aligning Europe's OA Policies, http://www.pasteur4oa.eu/final-conference#.VwJRyPL2bIU

highlights some of the issues that are referred to in the advance of Open Science which include new publishing, outreach and research evaluation practices.

Considerations on researchers' involvement with Open Science:

The route to Open Science will lead to a significant change on the way in which research is conducted and disseminated. Open Science will also impact on how career progression is evaluated. In the last few years, researchers have been increasingly required to open their research and to share their research findings. This has been the result of policies adopted by institutions and funders that require researchers to make their research findings freely available online. Online media and online tools have also been acting as means to share information more openly. Nonetheless, in some cases Open Science principles are hindered by, among other things, researchers' concerns about the ways in which their research is disseminated in an open form (e.g. due to the reliability of new publishing systems, the lower prestige of open access journals, the inappropriate re-use of research findings and data, etc.) and the implications this will have for career evaluation and advancement.

The present academic evaluation and reward structure places a significant emphasis on academic publications, mainly on peer-reviewed articles but also on monographs (particularly for humanities and social sciences researchers). Academic publications are considered to be the most important factor in career evaluation and judgements on the quality of publications are largely based on the journals where researchers publish their findings (i.e. whether findings are published in top journals or in less prestigious journals), on the journals impact factors, and on bibliometric data (e.g. citation analysis). The publication of peer-reviewed articles in top journals can 'make it easier to publish further articles in [top] journals, to secure more research funds, [and] to conduct even more expensive experiments'[49]. However, the prevalent peer-review and metric system subjacent to academic publishing is filled with flaws (e.g. inefficient and non-transparent peer review models, unreproducible research findings, unreliable metrics such as journal impact factor and H-index)[50]. Thus, limiting the academic career evaluation process on the number of peer-reviewed articles published (preferably in highly ranked journals) and on the number of citations seems problematic.

Open Science, however, has the potential to impact on the research workflow (how researchers conduct their research), on networking (how they share and discuss research findings), on publishing practices (how they publish articles and monographs), on outreach activities (how research findings are disseminated to academics and civil society), and on research evaluation (how research findings are evaluated with new metrics that assess research impact in more complex and detailed ways). By promoting a wider access to research and research findings, the entire research process becomes more open and transparent and science becomes more accessible to all.

To address researchers' concerns, some institutions and funders are taking the first steps into re-defining research evaluation processes and implementing policies that align on Open Science principles[51]. Institutions and funders play a key role in supporting researchers in the transition to an open and collaborative research environment. For example, researchers are increasingly being required to grant free online access to publications and to the research data required to validate

49 Binswanger, M. 2014. 'Excellence by Nonsense: The Competition for Publications in Modern Science', http://goo.gl/GZbKn3
50 SPARC Europe Briefing Paper: Better ways to evaluate research and researchers, http://sparceurope.org/wp-content/uploads/2015/12/Evaluate-SEBriefingPaper-1215.pdf
51 See footnote 9, pp. 73-75.

publications findings and some are voluntarily using open methods (scientific blogs, lab notebooks), open peer review and open source software as means to share their research findings more widely[52] (Figure 2).

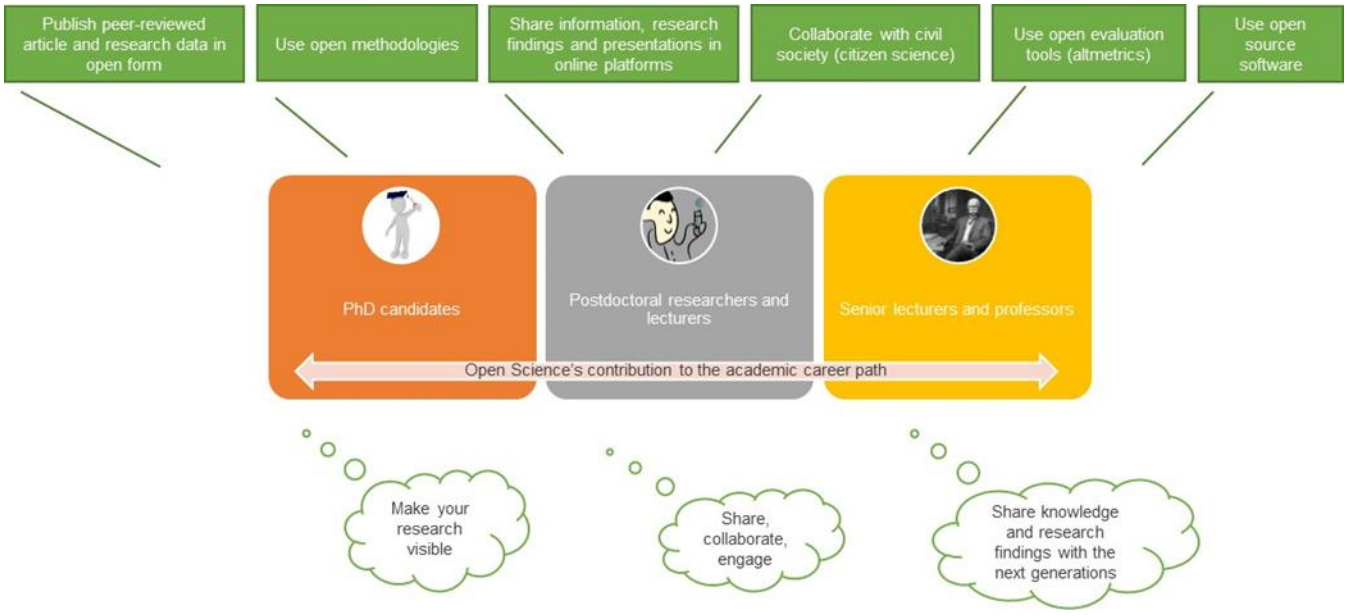

Figure 2: How Open Science can contribute to the academic career path

As the agenda for Open Science moves forward, more institutions and funders will determine alternative methods that will become an inclusive part of the career progression and evaluation process[53]. Institutions and funders can play a key advocacy role and build on the examples where researchers use Open Science concepts, tools and media to demonstrate the practical contributions that such a move makes in advancing research, in sharing information and resources, and in making new discoveries. Researchers from academic disciplines such as medical sciences[54], natural sciences[55], technology[56] and social sciences[57] have already demonstrated how they share their research in an open form.

Considerations for policymakers' on strategies and policies for Open Science:

There are key issues that policymakers at the national, institutional and funder levels must be aware in order to promote the transition to Open Science. Firstly, policymakers must be aware of the developments taking place at the national and

52 Crouzier, T. 2015. 'Science Ecosystem 2.0: How will change occur?', pp. 13-15, https://goo.gl/Ok5CPR
53 See footnote 49.
54 Curing TB with Open Science, https://goo.gl/CvWpuY
Open source clinical science for emerging infections, http://goo.gl/dkJqji
Moving Forward from rhBMP-2: Open Science and Data Sharing, http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3981828/
The Importance of Clinical Trial Data Sharing Toward More Open Science, http://circoutcomes.ahajournals.org/content/5/2/238.full
The Human Genome Project, http://www.genome.gov/10001772
55 The open data debate: a need for accessible and shared data in forest science, http://goo.gl/CqDNnj
Building a multi-scaled geospatial temporal ecology database from disparate data sources, http://goo.gl/cZwo1X
Data visualization: Science on the map, http://goo.gl/7he3e2
56 The case for an open science in technology enhanced learning
Open-Access Databases as Unprecedented Resources and Drivers of Cultural Change in Fisheries Science, http://goo.gl/izjAt7
Do-it-yourself biology: challenges and promises for an open science and technology movement, http://goo.gl/mWL0lA
Open Design: Non-professional User-Designers Creating Products for Citizen Science: A Case Study of Beekeepers, http://goo.gl/u66bLu
57 When publications lead to products: The open science conundrum in new product development, http://goo.gl/ThXSn4
Opening up Science: Towards an Agenda of Open Science in Industry and Academia, http://goo.gl/U7BQ1a
Toward Open Behavioral Science, https://goo.gl/b4SHNB
Open educational resources in support of science learning: tools for inquiry and observation, http://goo.gl/8IqQxv

international levels on Open Science in order to make informed decisions on the strategies to be followed and the policies to be implemented within their organisations. Secondly, they must be aware of the implications of Open Science in changing researchers work culture. They must be aware of the reasons why researchers do not want to share their research (e.g. evaluation system, intellectual property rights, quality assurance, prestige) and find solutions to address those issues. To address these issues, policymakers can build on success stories and demonstrate the benefits of Open Science. They can use examples where researchers have shared their research openly, demonstrate how they have done it and illustrate what have been the advantages of doing so[58].

To ensure that their policies and strategies are effective, policymakers should develop them in consultation with academics and researchers. Institutions and funders should develop aligned strategies to raise researchers' awareness about Open Science and promote joint activities, training and support for researchers. They should also implement consistent reward schemes and incentives to promote Open Science, consider which methodologies can be implemented to evaluate research and research impact (i.e. alternative metrics), and identify mechanisms that ensure the scientific quality of the new methods used (e.g. publication in open access journals, open peer review).

IV. The way forward

By explaining what Open Science is, what concepts, tools and online media are available for researchers, which stakeholders are implementing strategies for Open Science, and what concerns researchers have in relation to Open Science, this discussion paper has sought to inform policymakers at the institutional and funders levels about some of the key issues they must consider in the transition to an Open Science landscape. The checklist below intends to highlight some the issues that institutions and funders should address when developing strategies for Open Science:

- ✓ Which Open Science concepts, tools and media will become an inclusive part of institutions and funders strategies, and which will be left out and for what reasons;
- ✓ What policies will need to be implemented to support the transition to Open Science (e.g. open access policy, open research data policy, blogging policy, social media policy) and what resources will be required to implement such policies;
- ✓ What internal structures and processes will need to be in place to support the effective implementation of Open Science strategies and policies;
- ✓ What advocacy strategies will be implemented to raise academics and researchers awareness about Open Science;
- ✓ What will be the implications of the strategies and policies adopted for researchers in different academic disciplines;
- ✓ What mechanisms will be implemented to support the transition to Open Science and to address challenges researchers will face;
- ✓ What incentives will be provided to researchers that make research openly available;
- ✓ What metrics will be used and evaluation criteria adopted that fit with the vision for Open Science.

58 See case study 'Arctic scientist engages through tweets, blogs and podcasts', http://www.rcuk.ac.uk/media/brief/impactcase/pe/Lewis/