Shared challenges, transformative actions

OECD Science and Technology Policy Ministerial

23-24 April 2024, OECD, Paris

Issues Notes

BETTER POLICIES FOR BETTER LIVES

Plenary 4: International action for global challenges: making Open Science a reality

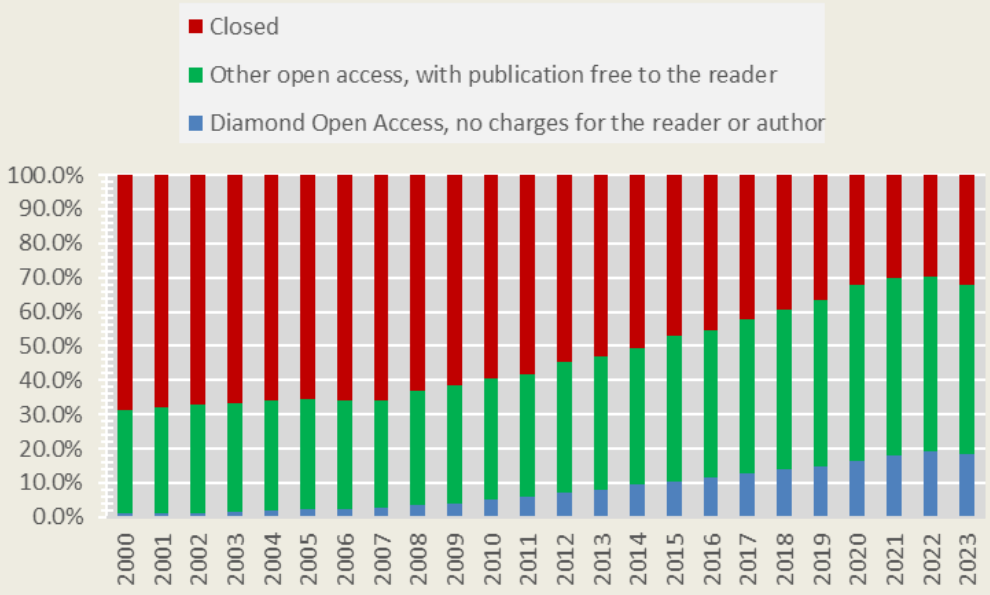
24 April 2024, 15:00-16:30 Paris time, CC15, OECD Conference Centre, 2 Rue André Pascal, Paris, France

Chaired by: Ms Martina Hirayama, State Secretary for Education, Research and Innovation, Federal Department of Economic Affairs, Education and Research, Switzerland

Key issues

- 'Open Science' combines principles and practices to make scientific knowledge openly available, accessible, and reusable for everyone. Many benefits can stem from such openness, including greater efficiency in science, increased knowledge spillovers, higher social returns on public investments in science, and more innovation across firms, civil society, and government. To achieve these benefits, which will also support the transition to a greener economy, Open Science needs to be adopted globally in a way that is trusted, inclusive and equitable.
- The OECD, along with other international organizations such as the European Commission (EC) and UNESCO, has led the shaping of policy for Open Science. Many countries have made significant efforts to promote Open Science, and several are developing monitoring systems to track the openness of scientific information, data, and software. Some organisations are also exploring how the engagement of different societal actors with science can be measured. A global consensus exists on fundamental principles. An illustration of progress is the fact that half of the articles published in 2020 were in some type of open access format, up from 24% of those published in the period 2002-2011 (Figure 1).

Figure 1. Share of scientific publications by access type in their year of publication, 2000–2023



Source: UNESCO (2023), UNESCO Open Science Outlook 1 updated with Curtis Open Knowledge Initiative (COKI) from a dataset which combines OpenAlex, Unpaywall, the Research Organisations Registry and Crossre for the period 2020 to 2023

Note: Several categories exist to describe types of 'open access' to scientific journals. Some authors use multiple strategies to share their work. For the bibliometric analyses presented here, the following categories are used : Diamond: articles published in an open access (only) journal without an article processing charge; in other words, the publication is immediately available free of charge for the author(s) and for the reader(s); Publication that are accessible for free to the reader which include : Green only, Gold , Hybrid and Bronze categories from the UNESCO categorization and finally Closed publications. The data set covers publications from 180 countries, including the 38 OECD member states.

- However, challenges still exist in advancing Open Science. For example:
    - Trust and reciprocity in scientific collaboration is under increasing scrutiny in the aftermath of COVID and because of heightened geopolitical tensions. Concerns exist in some countries that sharing scientific knowledge might erode competitive advantages or pose security risks, especially with respect to dual-use research.
    - A large share of published research is still only available to readers via subscription or payment of fees. And many small and medium-sized enterprises (SMEs) face difficulties accessing publications and data necessary to their internal R&D.
    - The benefits of Open Science are not automatically shared evenly. Depending on the business model, open access to publications may entail significant charges for would-be authors, with disadvantages for less-resourced individuals, institutions, and countries.
    - The ease of on-line publishing has led to growth in predatory publications that have no quality controls.
    - While all public sector researchers have an interest in sharing published research articles, the same is not true for research data sets. In addition, data cleaning and curation is time-consuming and rarely acknowledged in evaluations or grant allocation procedures. The sustainable management of open software can be even more challenging.
    - Most evaluations of universities and researchers are based almost entirely on teaching and bibliometric indicators, with little value given to making data (and software) Findable, Accessible, Interoperable and Reusable (FAIR).
    - There are legitimate reasons why some sensitive or legally protected scientific information, tools and data should not be made fully open. Policy makers therefore face a challenge in finding the right balance between the free flow of scientific knowledge and other considerations.
    - Monitoring frameworks for implementation of the different aspects of Open Science need to be agreed and adopted universally.

Agenda

Intervention	Duration
Opening remarks by Ms Martina Hirayama, State Secretary for Education, Research and Innovation, Federal Department of Economic Affairs, Education and Research, Switzerland	5’
Scheduled interventions by Heads of Delegation following the French alphabetical order – speaking priority given to Ministers	2’ per Delegation
Open floor for further non-scheduled interventions or responses by raising of flag (speaking priority given to Ministers)	1’ per Delegation
Closing remarks from the Chair	3’

Key directions for policy

The OECD's work has identified several policy measures that could advance Open Science. These include steps to:

- Explore new business models, publication processes and incentives that will enhanceaccess to rigorous scientific information, whilst ensuring that costs to authors do not become a disincentive to publish.
- Expand policy action in the seven key areas identified by the Recommendation of the OECD Council concerning Access to Research Data from Public Funding.
- Address challenges faced by many research institutions and small and medium-sized enterprises (SMEs) in accessing scientific information due to high journal subscription costs.
- Promote Open Science Partnerships and novel mechanisms for sharing information, data, and expertise across public and private sectors.
- Promote the application of Open Science principles and practices to research software and algorithms.
- Develop a deeper understanding of Open Science practices and policies through monitoring of policy initiatives and their impacts globally.
- Reflect on and improve evaluation methods for assessing the implementation and impact of Open Science.
- Encourage the convergence of Open Science policy and implementation monitoring initiatives, adopting best practices while recognising diversity in policy priorities.

Key questions for discussion

1. Open science and inclusive access to scientific information, data, software and materials, is a critical foundation for a global research system and for cooperation within that system. What needs to be done to implement the various aspects of Open Science?

2. Openness and Cooperation in science can sometimes appear to conflict with other policy objectives, e.g. economic and national security, and with a shifting geopolitical landscape. How can we align these different objectives so that they are mutually reinforcing?

3. Not all countries have the same capacity to participate in science and exploit the potential of open science. How can we embed equity and inclusion into open science practices and ensure that they do not accentuate existing divides?

4. What role should the OECD, international partners and countries play in building the evidence base, convening dialogue, and consolidating best practices, providing policy guidance, and setting standards?

Background

Open science as a catalyst for research

"Open Science" combines principles and practices aiming to make scientific knowledge openly available, accessible, and reusable for everyone, to increase scientific collaboration and sharing of information for the benefit of science and society, and to open scientific knowledge creation, evaluation, and communication to actors beyond the traditional scientific community (OECD, 2015[1]), (UNESCO, 2022[2])).

With the 2006 Council Recommendation on "Access to Research Data from Public Funding", the OECD positioned itself at the forefront of policy discussions on Open Science (OECD, 2006[3]). In 2015 the OECD published "Making Open Science a Reality" and has subsequently produced reports on several key aspects of the topic, from research repositories (OECD, 2017[4]) and international networks (OECD, 2017[5]), to agenda setting (OECD, 2017[6]) and digital skills (OECD, 2020[7]).

2021 saw an important revision to the OECD recommendation on Access to Research Data from Public Funding, extending its scope to include research software (OECD, 2021[8]). Several other international organisations have been actively promoting Open Science, including the European Commission, sponsoring a major initiative to develop an Open Science Cloud, as well as UNESCO (Box1). However, despite the emerging global consensus on principles for Open Science, effective implementation remains challenging.

Open Science can improve the rigour and efficiency of research. Access to scientific publications is essential for any researcher because almost all research depends on previous observations and results. Paywalls are a barrier to access, particularly for persons and institutions with limited resources. At the same time, scientific publishing has costs, even in the digital world. For several decades commercial publishers have been entrusted with assuring the quality of scientific publications and the sustainability of the scientific record. In return, many publishers have made a healthy profit. The demand for wide access to publications necessitates a change in publishing business models. New business models have emerged with different degrees of openness and differing Article Publication Charges (APCs) to be paid by authors. At the same time, in research assessment processes, the continuing use of bibliometric indicators, such as journal impact factors, acts as a disincentive to change. In addition, the ease of on-line publishing has led to a growth in so-called "predatory publications" that have no quality controls.

Box 1. The international consensus in favour of Open Science

Introduction of the FAIR Data Principles in 2016 (al., 2016[9]), established the reference principles of findability, accessibility, interoperability, and reusability of data, has been instrumental in steering global research towards more open and transparent practices. In 2018, the revision of the European Commission's recommendation (EC, 2018[10]) underscored the importance of preserving scientific information in the digital era, while the establishment of the European Open Science Cloud signified a major step in fostering collaborative and interdisciplinary research environments. At the same time, societal engagement and citizen science became more strongly embedded in the framing of Open Science.

The evolution of open science since 2004 reflects a concerted international effort to enhance publication and data accessibility in research. The OECD's 2004 Ministerial Declaration on Access to Research Data from Public Funding (OECD, 2004[11]) marked the first step in that direction, advocating for access to publicly funded research data. This was further crystallized in the 2006 OECD Recommendation on "Access to Research Data from Public Funding" (OECD, 2006[3]), setting a precedent for globally agreed principles on data access. This served as inspiration for a host of multilateral and national policy instruments, including UNESCO's Policy Guidelines for the Development and Promotion of Open Access (UNESCO, 2012[12]) and the European Commission's Recommendation on access to and preservation of scientific information (EC, 2018[10]). These early initiatives sparked a series of influential measures, including the 2016 Amsterdam Call for Action (EU, 2016[13]) and the International Open Data Charter (ODC, 2016[14]), which collectively promoted open access to scientific publications and government data.

The OECD's 2021 revision of its Council Recommendation (OECD, 2021[8]) expanded its policy guidance to encompass not just research data but also related metadata, algorithms, and software, reflecting the evolving landscape of data-intensive science. The UNESCO Recommendation on Open Science (UNESCO, 2022[2]) further broadened the scope and made more explicit the inclusion of societal engagement as the critical third pillar – alongside access to scientific publications and data- for Open Science. International cooperation and equitable access to scientific knowledge are embedded in this recommendation that has been globally endorsed.

Over the past decade there has been a significant increase in so called 'open access' publications, although there are a variety of models with different degrees of openness and their adoption differs across countries (see earlier Fig 1). Journal-based OA (usually termed "gold" OA) is prevalent in Brazil other Latin American countries. Repository-based OA (also known as "green" OA) is more important for authors in some other countries, such as the United Kingdom. The OECD's first International Survey of Scientific Authors (ISSA1) showed that researchers had a positive willingness to pay to disseminate their papers, conditional on these being accepted (Galindo-Ruedai, 2016[16]). In 2019, About 5% of authors appeared to be paying a fee to make their papers publicly available in traditional subscription journals (also known as "gold hybrid" OA) (Galindo-Rueda, 2020[15]).

The availability of data and software is crucial for the reproducibility of scientific research. Sharing access to the data underpinning scientific publications allows peers to test and replicate scientific results. Research funders are increasingly requesting data management plans and mandating the deposition of research data in open repositories. However, data alone is often insufficient to ensure reproducibility; access to the code and software used to process and interpret the data is also necessary. An example is the discovery of the Higgs Boson at the European Centre for Nuclear Research, where datasets and analysis software were made open, helping to respond to the huge scientific (and public) interest in this long-awaited scientific breakthrough. The recent Amsterdam Declaration on Funding Research Software Sustainability highlights that beyond the availability of research software, attention must also be given to its stewardship over time (Research Software Alliance, 2023[17]) .

When scientific datasets are openly available, they can also be repurposed and combined with new data, generating new insights and making the use of limited resources more valuable. Open data, e.g. from clinical trials, can enable meta-analyses that improve the rigour and generalisability of the findings from individual studies. However, in a 2017 OECD survey of scientific authors, less than half of respondents in all fields of science delivered data or code to a journal or publisher to support their papers.

Open science as a catalyst for innovation

Firms, particularly small and medium enterprises (SMEs), can face difficulty in accessing the publications and data necessary for their internal R&D. A survey in 2011, at the start of the major policy shift towards Open Science, found that 48% of SMEs consider research outcomes very important for their business activities, although more than two-thirds had difficulties in accessing research material (Houghton, 2011[19]). A more recent study of patent citations in the pharmaceutical industry reveals a high reliance on 'Open Access' publications for smaller companies (ElHassan ElSabry, 2020[20]).

Open Science can also catalyse innovation by facilitating collaboration between public research and the private sector. The business community is a critical stakeholder in Open Science, as firms benefit from open access publications and data to develop new products and services. They also possess huge amounts of information and data, which can, under appropriate conditions, be used to advance scientific discovery in academia.

The intersection between Open Science and public-private partnerships has become increasingly important for addressing global challenges, such as anti-microbial resistance. . Novel Open Science partnerships (OSPs) can be considered an advance on more traditional open innovation models, in that they support a broader, more inclusive form of collaboration between multiple actors working together in consortia. OSPs embrace open access to, data and sharing of tools and expertise thereby reducing transaction costs for individual partners While benefiting from shared explicit knowledge, firms in OSPs also gain access to tacit knowledge, enhanced reputation, and reduced development risks (Gold, 2021[21]) (Box.2).

The COVID-19 pandemic highlighted the importance of inclusive inter-sectoral collaboration that is both facilitated by Open Science and acts as a facilitator of Open Science to address urgent societal challenges. For instance, in several regions and/or countries, High Performance Computing Consortia have brought together industry, academia, and government to provide researchers worldwide with access to the world's most powerful high-performance computing resources.

Box 2. The Viral Interruption Medicines Initiative: An Example of an Open Science Partnership (OSP)

The Viral Interruption Medicines Initiative (VIMI) is an OSP that merges academic, philanthropic, governmental, and private sector resources. This collaborative model accelerates the development of crucial medical interventions and serves as a blueprint for addressing market failures in pandemic drug discovery. By adhering to Open Science principles, VIMI has established a framework that can enable rapid and innovative responses to future health crises.

At the core of VIMI's operational model lies the strategic collaboration between academic institutions, firms, and a variety of non-profit initiatives. This approach facilitates the co-funding of drug development projects, integrating the expertise and resources of different partners. This strategy not only speeds up the overall process of bringing essential drugs to market. It relies in part on regulatory exclusivity for incentivising business engagement.

VIMI's model is an embodiment of how open science can transcend traditional research boundaries, bringing together diverse stakeholders in a common pursuit of scientific advancement and public good. (E. Richard Gold, 2022[22])

Navigating the intersection of Open Science, security, equity, and trust

Despite the enormous potential of Open Science, there are legitimate reasons why some scientific information, tools and data should not be made fully open. It is imperative for policy makers to maintain a balance between the free flow of scientific knowledge and other considerations. This includes protection of sensitive data and respect for IPRs, as well as security concerns, in a context of increasing geopolitical tensions.

The global research landscape is increasingly influenced by geopolitical, security and economic considerations as well as heightened concern about ensuring trust in scientific collaborations. Countries are becoming more cautious about openly sharing scientific knowledge, fearing it might compromise their competitive edge or pose security risks. Individual researchers and their institutions can be reluctant to share their scientific assets in the knowledge that they might be more effectively exploited by their rivals.

In this context, several national funding agencies have integrated risk assessment and management into their application and review processes and many universities are developing rules and guidelines to mitigate risks to research security and protect the integrity and freedom of scientific research. At the intergovernmental level, the OECD has published a report on integrity and security in the global research ecosystem (OECD, 2022[23]) and launched a web portal on policies for research security. G7 countries, for their part, have established a working group on the security and integrity of research (G7, 2022[24]). The EC is also working on guidance in this area with an EC Council recommendation planned for mid-2024 (EC, 2024[25]).

The intersection of Open Science and research security is particularly sensitive when considering the dual-use potential of research. The ethical and practical challenges of striking a balance between sharing scientific progress for the common good and safeguarding against the potential misuse of knowledge are significant. Fundamental research can inadvertently contribute to dual-use knowledge. For example, advances in artificial intelligence and quantum computing could have civilian and military applications and research on these topics is at the heart of economic competition globally.

Disparities in scientific capabilities and infrastructure across countries further complicate the international situation in relation to Open Science. Concerns exist about the uneven distribution of the benefits of open knowledge. These are linked to discussions on the exploitation of researchers and knowledge from low-income countries and the shortage of sustained efforts to build lasting research capacity in developing countries (Munung NS, 2017[26]).

The use of indigenous knowledge and resources is particularly sensitive. The “CARE Principles for Indigenous Data Governance” (Collective Benefit, Authority to Control, Responsibility, and Ethics), developed by the Research Data Alliance’s International Indigenous Data Sovereignty Interest Group in 2019, build on and codify earlier work (Carroll, 2020[27]). The principles have implications for governments, institutions, and researchers in the design of studies and the collection and stewardship of data. Their widespread application, serves to recognize and affirm the collective rights and interests of Indigenous Peoples in their data (OECD, 2023[28]).

Overall, the openness and integrity of research and international cooperation are at risk from both direct threats and the potential for over-reaction to these threats. Countries are faced with the delicate task of balancing openness and international collaboration with new security regulations that, while protective, could also be restrictive or discriminatory (for example, strengthened regulations on visas for scientists might be considered discriminatory if they are based on nationality, ethnicity, and race). Over-regulation may hinder scientific inquiry and exchange, whereas a lack of agreed and respected international norms can lead to misappropriation of research.

The concepts of reciprocity and equity are crucial for effective international cooperation. Respect for these concepts can help ensure that collaborations are mutually beneficial, even in the face of asymmetries in the capacity of research partners. Trust and transparency are essential for effective and sustainable international research cooperation. Openness, within necessary limits, is critical for maintaining trust and ensuring transparency.

A policy future for Open Science

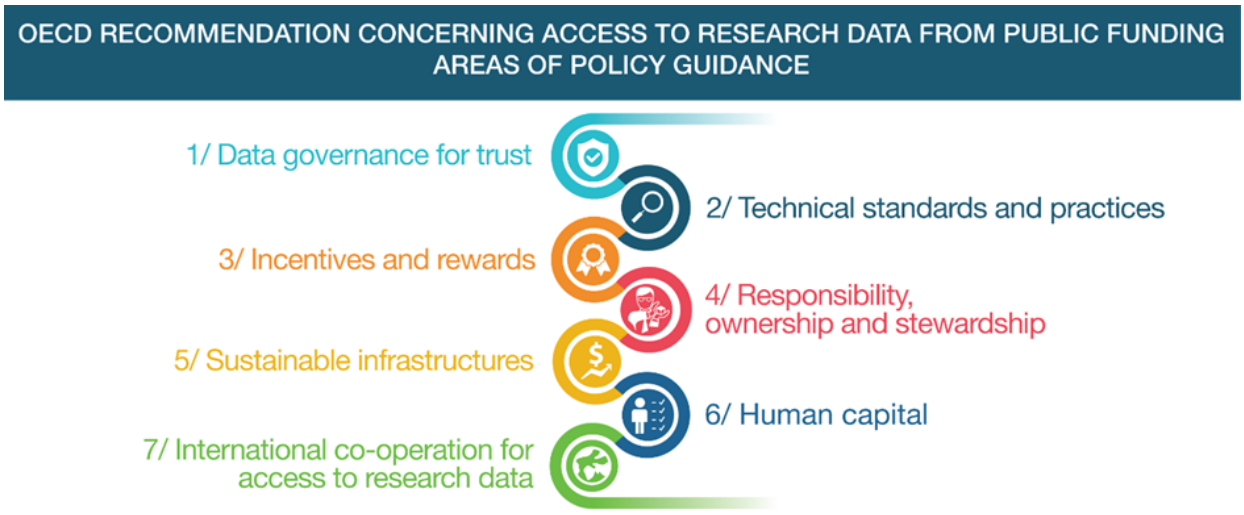
For scientific publications:

Many governments and/or funders are mandating that the results of publicly funded research should be made openly available. New business models are being developed and new publication processes are being experimented with. However, old incentives to publish in high impact journals, that are frequently have prohibitive subscription charges and/or article processing charges (APCs) are holding back a more rapid transition to wider access to scientific publications. Policies to address these issues need to be implemented and enforced if open access to scientific publications is to be made a reality.

Data, including software:

Much research data can be linked to publications to assist reproducibility, and a growing number of publishers and funders require the publication of supporting data. However, access to research data goes beyond that which can and should be linked to publications. The revised OECD recommendation on access to research data (OECD, 2021[8]) identified 7 key areas for policy action (Figure 3). These areas cover not only data but also software and other digital objects relevant to research. Many countries are taking action in each of these areas, and some research domains have fully embraced open data. Other fields need more support and encouragement to do so.

Figure 2. Policy topics under the OECD Recommendation Concerning Access to Research Data from Public Funding



For innovation:

Access to scientific information is a particular challenge for SMEs in research intensive areas, which cannot always pay expensive journal subscription charges. Open Science Partnerships and other novel mechanisms for openly pooling and sharing information, data, and expertise among many actors from both the public and private sector need to be encouraged and best practices identified and propagated.

Monitoring the Impact of Open Science:

Several countries are developing monitoring systems to track the openness of scientific information and data. Open Science monitoring systems are also emerging at the international level. The proportion of scientific publications that are 'open access' to varying degrees is being measured and, in different domains of science, much work is being done to enable and monitor the adoption of the FAIR data principles (Findability, Accessibility, Interoperability, and Reusability). Other aspects of Open Science, such as societal engagement, are increasingly being included in research assessment and evaluation processes. Open and trusted monitoring systems are essential for measuring the effectiveness and impacts of Open Science policies. They can also incentivise the adoption of Open Science practices. Different organisations and countries have different policy priorities for Open Science and different perspectives on what should be monitored and how. Benefits could come from encouraging the adoption of common principles and best monitoring practices, which in turn will require good cooperationbetween different Open Science monitoring initiatives.

References

Wilkinson, M. (2016), "The FAIR Guiding Principles for scientific data management and stewardship", *Scientific Data*, https://doi.org/10.1038/sdata.2016.18. [9]

Carroll, S. (2020), "The CARE Principles for Indigenous Data Governance.", *Data Science Journal*, Vol. 19/1, https://doi.org/10.5334/dsj-2020-043. [27]

E. Richard Gold, A. (2022), "Oveercoming market failure in pandemic drug discovery through Open Science : a Canadian solution", *Frontiers in Drug Discovery*, Vol. 2, https://doi.org/10.3389/fddsv.2022.898654. [22]

EC (2024), *Boosting research security in the EU (guidance)*, https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/14056-Boosting-research-security-in-the-EU-guidance-_en. [25]

EC (2018), *Recommendation on access to and preservation of Scientific Information*, https://digital-strategy.ec.europa.eu/en/library/recommendation-access-and-preservation-scientific-information. [10]

ElHassan ElSabry, K. (2020), "Does open access to academic research help small, science-based companies?", *Journal of Industry*, Vol. 2/3, https://doi.org/10.1108. [20]

EU (2016), *Amsterdam Call for Action*, https://www.openaccess.nl/sites/www.openaccess.nl/files/documenten/amsterdam-call-for-action-on-open-science.pdf. [13]

G7 (2022), *G7 Common Values and Principles on Research Security and Research Integrity*, https://www.bmbf.de/SharedDocs/Downloads/de/2022/220812-g7-sigre-paper.pdf?__blob=publicationFile&v=2. [24]

G7 OSWG (2023), *Annexe 1 to the G7 Sendai communique*, https://www8.cao.go.jp/cstp/kokusaiteki/g7_2023/annex1_os.pdf. [30]

Galindo-Rueda, F. (2020), *How are science, technology and innovation going digital? The statistical evidence*, OECD, https://www.oecd-ilibrary.org/sites/1cfd272a-en/index.html?itemId=/content/component/1cfd272a-en. [15]

Galindo-Ruedai, B. (2016), "Drivers and Implications of Scientific Open Access Publishing", *OECD Science, Technology and Industry Policy Papers*, https://doi.org/10.1787. [16]

Galindo-Rueda, M. (2020), "Charting the digital transformation of science, Findings from the 2018 OECD International Survey of Scientific Authors (ISSA2)", *OECD Science, Technology and Industry Working Papers*, https://doi.org/10.1787. [18]

Gold, E. (2021), "The Fall of the Innovation Empire and its Possible Rise Through Open Science", *Research Policy*, Vol. 50/5, https://ssrn.com/abstract=3813139. [21]

Houghton, J. (2011), *Access to research and technical information in Denmark*, http://eprints.soton.ac.uk/id/eprint/272603. [19]

Munung NS, M. (2017), "Equity in international health research collaborations in Africa: Perceptions and expectations of African researchers", *PLOS ONE*, Vol. 12/10, https://doi.org/10.1371/journal.pone.0186237. [26]

ODC (2016), *International Open Data Charter*, https://opendatacharter.org/wp-content/uploads/2023/12/opendatacharter-charter_F.pdf. [14]

OECD (2023), "COVID-19 and policy for science", *LOECD Science, Technology and Industry Policy Papers*, Vol. 152, https://www.oecd-ilibrary.org/docserver/8f86e60b-en.pdf?expires=1706712906&id=id&accname=ocid84004878&checksum=5A054FB3E8C5D1C350CA174314BBAA33. [28]

OECD (2022), "Integrity and security in the global research ecosystem", *OECD Science, Technology and Industry Policy Papers*, Vol. 130, https://doi.org/10.1787/1c416f43-en. [23]

OECD (2021), *Recommendation of the Council concerning Access to Research Data from Public Funding*, https://legalinstruments.oecd.org/en/instruments/OECD-LEGAL-0347. [8]

OECD (2020), "Building digital workforce capacity and skills for data-intensive science", *OECD Science, Technology and Industry Policy Papers*, No. 90, OECD Publishing, Paris, https://doi.org/10.1787/e08aa3bb-en. [7]

OECD (2020), "Why open science is critical to combatting COVID-19", *OECD Policy Responses to Coronavirus (COVID-19)*, https://www.oecd.org/coronavirus/policy-responses/why-open-science-is-critical-to-combatting-covid-19-cd6ab2f9/. [29]

OECD (2017), "Business models for sustainable research data repositories", *OECD Science, Technology and Industry Policy Papers*, No. 47, OECD Publishing, Paris, https://doi.org/10.1787/302b12bb-en. [4]

OECD (2017), "Co-ordination and support of international research data networks", *OECD Science, Technology and Industry Policy Papers*, Vol. 51, https://doi.org/OECD Science, Technology and Industry Policy Papers. [5]

OECD (2017), "Open research agenda setting", *OECD Science, Technology and Industry Policy Papers*, No. 50, OECD Publishing, Paris, https://doi.org/10.1787/74edb6a8-en. [6]

OECD (2015), "Making Open Science a Reality", *OECD Science, Technology and Industry Policy Papers*, No. 25, OECD Publishing, Paris, https://doi.org/10.1787/5jrs2f963zs1-en. [1]

OECD (2006), *Recommendation of the Council*, https://legalinstruments.oecd.org/api/download/?uri=/private/temp/1acfed4b-160c-44b2-94ca-8a0895f19bd7.pdf&name=OECD-LEGAL-0347%20(2006)-en.pdf. [3]

OECD (2004), *Declaration on Access to Research Data from Public Funding*, https://legalinstruments.oecd.org/en/instruments/OECD-LEGAL-0321. [11]

Research Software Alliance (2023), *Amsterdam Declaration on Funding Research Software Sustainability*, https://adore.software/declaration/. [17]

UNESCO (2023), *UNESCO Open Science Outlook 1*. [31]

UNESCO (2022), *UNESCO Recommendation on Open Science*, https://doi.org/10.54677/MNMH8546. [2]

UNESCO (2012), *Policy Guidelines for the Development and Promotion of Open Access*, https://en.unesco.org/open-access/sites/open-access/files/215863e.pdf. [12]