2nd Open Science Conference

Open Science for Climate Action

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Introduction

INTRODUCTION

Melissa Fleming

UNDER-SECRETARY-GENERAL FOR GLOBAL COMMUNICATIONS, UNITED NATIONS

Amid increasing attacks on science fueled by the rise of misinformation and disinformation, the sharing of scientific information and data during the global COVID-19 crisis has been unprecedented – giving new momentum to the Open Science movement. The value of access to scientific knowledge as the basis for actions and policies that affect our lives was made clear at the Second Open Science Conference organized by the Dag Hammarskjöld Library of the UN Department of Global Communications and the Division for Sustainable Development Goals of the UN Department of Economic and Social Affairs.

While the world was battling the health crisis, the sequencing of the COVID-19 genome was swiftly achieved, and the greatest achievement of all was the creation of safe vaccines to protect humanity. Yet, the inequality in the global distribution of these vaccines was also apparent to all – inequality not only among countries but also within nations.

During the pandemic, mistrust in science resulting from public rhetoric fed by misinformation and disinformation saw an increase and spread online quickly. The consequences were a matter of life and death. What have we learned from addressing this crisis? Can these lessons learned help devise more effective solutions to address climate change, an existential threat our planet and society are facing?

The Conference organizers requested speakers to submit a written contribution with lessons learned on Open Science from tackling the pandemic, which can be employed in climate action. Over 80% of Conference speakers submitted their views. They stressed the need for a global interoperable Open Science infrastructure of content, tools, services, hardware and software incorporating or embodying the principles of reciprocity, inclusion and diversity.

An infrastructure in service of the Sustainable Development Goals, and particularly climate action, will support and promote the global normalization of opening scientific outputs and processes, and the re-evaluation of research assessments and the rewards culture. Such an infrastructure would be an essential contribution to global crisis management.

The speakers highlighted that only a fragment of scientific studies and data about climate change is open access compared to studies and data about the pandemic; the rest remains behind paywalls, inaccessible to millions of people.

How can we lead to direct climate action without proper scientific information and data? Only with unrestricted access to climate change studies and data can we position data and facts against the plague of misinformation, defending a common, empirically backed consensus around facts, science and knowledge. Scientists, academia, institutions, librarians, research funding agencies and publishers have a crucial role to play in securing a scientific digital commons and ending the “war on science”.

We also need a greater focus on the communication of science to ensure trust in science is addressed more systematically. Dynamic and agile publishing systems; research assessment behavior change; platform independence; and Open Science metrics are all suggestions to advance the Open Science movement.

Everyone has a right to scientific advances and benefits. Now is the time to accelerate the opening of the scientific process. Let’s not lose this momentum. 

Keynote Speakers

KEYNOTE SPEAKER

Shamila Nair-Bedouelle

ASSISTANT DIRECTOR-GENERAL, UNESCO

The COVID-19 pandemic has proven worldwide the urgent need for universal and equitable access to scientific knowledge, data and information. The unanimous plea of countries for international scientific collaboration and the unique mobilization of the scientific community, civil society, innovators and the private sector in these unprecedented times reaffirmed the importance of science as a global public good and the need to fulfill the human right to benefit from the scientific progress and its applications.

Building back better after the COVID-19 pandemic will only be possible if open science becomes the new normal for practicing science, disseminating its results and enjoying the benefits of its progress.

By encouraging more transparent, inclusive and equitable science for all and by encouraging stronger connections between science and society, open science can be a true game changer for addressing global challenges and reducing the persistent knowledge gaps between and within countries.

Open science fosters open access to scientific knowledge, including publications and data, in view of expanding their use, but also improving their quality and reproducibility. More accessible and verifiable scientific knowledge also leads to increased reliability of the evidence needed for robust decision- and policy-making.

However, open science is not just about access to publications. Open science means making the entire scientific process more accessible and participatory, by sharing data, protocols, software and infrastructure. It means active engagement with communities, citizens, and science volunteers as well as fostering an open dialogue with indigenous peoples and local communities to harness the potential of traditional and indigenous knowledge systems. Open science also means taking science outside the scientific community, by developing open educational resources and investing in science communication to ensure that it responds to the needs of contemporary society.

There are barriers that will still need to be removed, if we are to operationalize the concept of open science to its full potential.

The open science movement is on the rise across the world. However, a global understanding of the meaning, opportunities and challenges of open science is still missing. The lack of common understanding of the elements and practices of open science is indeed an important barrier which must be removed to ensuring that open science meets it game-changing potential particularly for the poorest, the most vulnerable and the marginalized. It is vital to deal with the current inequalities associated with connectivity, capacities and resources which may deepen the North-South digital and scientific divide.

There are also questions of the cost of open science, possible misuse of open data and information, the right balance between openness and IPR protection, the low quality of some open access scientific outputs and the predatory behaviour of certain open access journals.

In addition, a systematic revision of the current science evaluation and reward system is urgently needed in order to encourage the transition to open science, in particular for young scientists.

Finally, the fragmented scientific and policy environment of open science needs to be addressed. The absence of a global policy framework for open science and harmonized legal and technical frameworks for sharing information and data already pose challenges for international scientific co-operation in an open context. International norms and standards are urgently needed.

The global community urgently needs to ensure that open science does not replicate the failures of conventional science systems.

Today, the global community urgently needs to ensure that open science does not replicate the failures of traditional closed science systems. It is these failures that have led to high levels of mistrust in science, the disconnect between science and society, and the widening of science, technology and innovation gaps between and within countries.

The global transition to open science needs to take into account the needs of the Global South and consider the rhythm of development of the low-income countries, to avoid repeating the mistakes of traditional scientific practices.

To address these issues, UNESCO has been tasked by its Member States to develop an international standard-setting instrument on open science in the form of a UNESCO Recommendation on Open Science. The current draft text, to be adopted by the UNESCO General Conference in November 2021, includes a commonly agreed definition of open science, a shared set of overarching values and principles and a proposed set of actions addressed not only to governments, but to all actors of open science.

We are hopeful that this Global Recommendation on Open Science will provide the necessary framework for actors across the world to ensure that science truly responds to the most pressing needs of people and the planet, including tackling the social, economic and environmental impacts of climate change.

KEYNOTE SPEAKER

Geoffrey Boulton

BOARD MEMBER, INTERNATIONAL SCIENCE COUNCIL

REGIUS PROFESSOR OF GEOLOGY EMERITUS, UNIVERSITY OF EDINBURGH

The pandemic may well have proved timely as a lesson in facing the other looming, larger and more fundamental global crisis of climate change. Let's make sure we don't learn the wrong lessons.

LESSON 1: We're all in it together.

COVID is not just a public health emergency. It's something bigger. We are in the midst of one of the biggest global wake-up calls in history, threatening both individual lives and entire economic and social systems. It's nature telling us that the new global ecology that we have created through our ravaging of Earth's resources holds great risks for humanity. It's telling us that local impacts of our actions are transmitted through the global ocean, the global atmosphere and through global cultural, economic, trade and travel networks to become global impacts. The local infects the global and the global determines the local. It's telling us that national solutions alone are quite inadequate, that we must resolve the underlying causes of our vulnerability through global collaboration, revitalised global institutions and by investment in global public goods. It's telling us just how big the externalities are that conventional markets cannot resolve.

COVID has been a Stress Test for global governance, which has, so far, failed the test. Some countries had learned from SARS in 2003 and were ready. Some had it high on their national risk registers, they knew it would happen, but still weren't ready. Globally, we did not lack knowledge, we just didn't apply it. The editor of The Lancet journal commented "the human family seems to care so little for itself that we were unable to pool our experience, our understanding, and our knowledge to forge a common and coordinated response".

LESSON 2: "Reality must take precedence over public relations. Nature cannot be fooled."[1] No amount of self-delusion, political spin or fake news can ultimately protect us from reality.

For COVID, the grim consequences of missing the early warning calls for action have been exposed in several deadly waves of explosive, exponential

1 Richard Feynmann.

growth. Climate change has a slower and more complex tempo. Its long-term forecasts, derived from mathematical models, are hard for the public and policymakers to grasp as they challenge intuition and short-term thinking. We live in a world where we are used to the helter-skelter pace of technological change but we are mostly oblivious to the slower, ultimately more powerful stirrings of angry nature, and to the remorseless onset of major climate changes such as the planet has not known for 10,000 years.

Ignoring scientific calls for early action ends up being costlier in the long run, even if such measures appear initially punitive. Just as for COVID, control becomes difficult when the virus has reached a certain level in the population, so for climate, that has the potential for rapid, irreversible and unforeseeable change as the globe warms beyond critical thresholds.

LESSON 3: Open science is not a luxury, it's a necessity. Knowledge is part of the patrimony of humanity, it must not be locked up in national or anyone else's vault, or in the heads of scientists.

The potential of open science has been exemplified during the COVID-19 pandemic by the enormous range of scientific knowledge that has been spontaneously and rapidly mobilized to cope with its diverse aspects. It has been underpinned by unprecedented sharing of ideas and data within and beyond the scientific community and across the public-private interface. A "new normal" for science must absorb its lessons, particularly in two core components of the scientific enterprise and its application:

3A DATA: Data must not be locked behind paywalls. If the complexities of pandemic, sustainability and climate are to be addressed and managed, data need to be open and FAIR (findable/accessible/interoperable/re-useable), all along the data value chain from collection to impact. Data systems need to be dis-aggregated to expose essential factors across society; effectively funded in national and internationally distributed bodies; functionally adapted to anticipated circumstances; federally coordinated with high standards of interoperability; sensitively balanced between privacy and access; with national statistical offices and global scientific data bodies playing key roles.

3B COMMUNICATION: Without effective communication, the public good potential of science is diminished. Key COVID lessons have been:

- that the greatest public good is derived when ideas, evidence and data circulate freely, quickly and efficiently, and are openly available for sceptical scrutiny, application, interest & re-use by all;
- that open, clear and comprehensible articulation of issues by experts on public media stimulates public trust and is a powerful antidote for misinformation and fake news;
- that much of the commercial publishing model is dysfunctional, ponderous and anachronistic, falling far short of its technological potential for *"completely free and unrestricted access to it by all* scientists, scholars, teachers, students and other curious minds."[2]

LESSON 4: Don't put all your eggs in one basket.

Much of the science of COVID comes from public investment over many decades, where the university tradition of academic freedom has made a unique contribution. Academic researchers are given license to pursue their own inspiration, thus

2 Budapest declaration.

maintaining diversity of inquiry even when there are strong funding signals for particular national priorities. Notwithstanding the growth of private sector research in recent decades, publicly funded, university-based research has remained the mainstay of broad-spectrum, innovative research that represents a cumulative resource for unknown future needs. Most scientific understanding of climate change comes from this source.

THE FINAL LESSON: What's the difference between COVID and climate?

There is no last-minute reprieve: no vaccine for the climate risk, unless we foolishly pin our hopes on the advent of some, as yet, non-existent and untried technology.

KEYNOTE SPEAKER

Jean-Claude Guédon

PROFESSOR OF COMPARATIVE LITERATURE (RETIRED), UNIVERSITY OF MONTRÉAL

Moving beyond journals: Designing platforms for the Great Conversation.

I. Background to present situation

- Commercial publishers have gradually (1950-1980) managed to design a market friendly to their objectives:
  - International (and based on a *lingua franca:* English)
  - Buyers are mostly libraries.
- The newly designed market rests on competition between journals, based on the impact factor.
- The competition between journals extends to individuals, teams/labs, institutions and countries.
- The market is sustained by hyper-competitive journal rankings that alter research communication.
- Conclusion: journals as presently configured are at the root of the problem.

II. The road forward: replacing journals by platforms, and exploring platform power

- Moving beyond journals to platforms rests on decoupling scientific evaluation from the assessment of journals.
- Portals and databases designed by libraries are a useful foundation to the design of platforms.

III. Platforms need to be properly designed: the urgent task of the next five years

- Platforms can reflect an institution, a region, a country, or a group of countries.
- Platforms shape, influence, dynamize, affect groups in all kinds of ways (platform power).
  - **Platform power** lies in its ability to relate documents to documents in a variety of ways (citations, quotations, links, algorithms relating data to results, software, translations, etc.).
  - **Platform power** lies in its ability to relate documents to people (visibility, retrieval, usability, relationship between various forms of knowledge, etc.), and people to documents (production, correction, comments, additions, analyses, processing, replicating, negative results, ambiguous outcomes, etc.).
  - **Platform power** lies in its ability to relate people to people (creation of speciality clusters or communities, schools, methods, instruments, mathematical and other intellectual tools, etc.),

but also context of relationships (competition, cooperation, innovation, critical revisiting, communication to various audiences).

  - **Platform power**, unlike journals, does not rest on owning documents. And, through the use of appropriate CC licenses, platforms prevent research-related documents entrusted to them from being owned by someone else.

  - **Platform power** is enhanced by effective networking, as is the case for the Internet: each network (or platform) exists for specific reasons, but all networks (or platforms) can cooperate to transmit packets (knowledge) from one actor to another, whatever their respective "position" in the networks of networks.

- Designing a platform is like designing the space, and it provides tools to develop science policies and research programs.

IV. The Actors: who designs the platform?

The researchers

- Researchers (especially young researchers) are prisoners of rankings and have little leeway to design research platforms.

- Researchers are presently divided between those who act as gatekeepers, and those who do not. Platforms can disrupt the power of gatekeepers (editors in particular). Some (powerful) researchers will push back as a result.

- Thanks to the tools available on the platform, researchers will form communities with greater ease. They can also participate in the design and construction of communication tools appropriate for these communities.

  - They can choose to deal with problems of great importance locally (e.g. agriculture), regionally (e.g. malaria), or globally (e.g. climate change) without worrying about chasing citations.

  - They can address problems selected by research funders (research programmes, related to science policy) – presumably a subset of the previous set of problems – without tweaking their research to respond to the desires of "prestigious" journals.

  - They can also deal with problems driven by individual curiosity (intellectual freedom).

The research funders

- Research funders are the natural candidates to design the new platforms that will reform scholarly communication.

  - They have significant funds at their disposal.

  - They generally place the common good at the centre of their objectives.

  - They have largely escaped the yoke of rankings, with a corresponding degree of autonomy.

- Research funders use research programmes that reflect science policies enunciated at the political level. But their evaluation systems, because it rests on the prestige of journals, diverges from their stated objectives.

The research managers

- The university senior administration

  - Often obsessed by rankings: research universities tie rankings to their ability to attract the "best" students and post-docs.

- The leader of a research team or a laboratory

  - Equally obsessed by rankings as they are crucial for getting research grants.

- Both senior administrators and laboratory directors can help populate a platform with meaningful communities and suggest tools to help researchers.

The libraries

- Libraries do not occupy a dominant position in their institution, which places them at a disadvantage when negotiating the

acquisition of scientific information.

- Libraries are in a particularly advantageous position to become "inside-out" libraries, i.e. libraries that harvest the intellectual production of their institution in order to expose it to the rest of the world, rather than acquire publications of the rest of the world to offer it to the local researchers.
- Libraries, because of their relations with local university presses, can support a variety of publication steps.
- Libraries have experience with portals and databases, which can be considered as first steps in the design of a platform.
- Libraries can help communicate scientific knowledge to wider audiences.

The publishers

- In the print world, the publishing functions (registration, certification, dissemination, preservation) coincided with a publisher. In the digital world, the publishing functions can be reallocated to various player. As a result, publishing remains essential, but not publishers.
- Publishers have approached the digital world gingerly. Their concern is to ensure that their economic position is not threatened by the new technologies.
- Platforms also have the power to shape markets by manipulating the rules of "engagement" (as does Facebook). Publishers design their platforms to monitor readers. Unlike public platforms, they will not seek transparency.
- Commercial platforms compete with each other and cooperation is difficult. The competition between commercial platforms will eventually be their Achilles heel.

The wider audiences

The communication of knowledge to wider audiences is crucial, but it must not fall into a patronizing mode. Two-way communication should be emphasized in such efforts.

Policy designers

- Ensuring good information is crucial for the political class, as the recent debates around COVID-19 and climate change have amply illustrated. Scientific knowledge, however, is a provisional form of knowledge while people want certainty. Educating people, particularly young people, about the reach and limits of scientific knowledge is essential.

  If science is presented as absolute knowledge, rather than the best form of knowledge we presently have, confusion between knowledge and belief will ensue. Distinguishing between denialism and refutation, as is regularly demonstrated in climate change and COVID-19 debates, will also prove difficult.

Teachers

- The pay-walled nature of much scientific publishing has largely contributed to cutting the teaching profession in primary and secondary schools from the current advances of science. The existence of Open Science platforms will allow each and every teacher to advance as much as he/she wants (and can).

Students

- Students are very much in the same position as teachers, only more vulnerable. They also have a greater need for information in their native tongue.

Citizens

- All the issues raised in the points immediately above apply here with greater or lesser importance. Moreover, as observers, measurers, etc., citizens can take on a number of tasks outsourced to the entire population as a way to engage that

population in the process of creating knowledge, and in the understanding of its constraints. Citizen science may be the best way to further the scientific education of entire populations.

IV. Conclusion

The channeling of scientific knowledge through vehicles called "journals" set up in a competitive market of journal titles has led to a great many problems that have been richly discussed in the course of the 2nd UN Open Science Conference. In particular, assessing the quality of scientific knowledge through indicators that really point to the commercial status of journals strongly distorts the production of scientific knowledge. Various forms of inequality and inequity ensue from this situation. However, given the hold of journals on the collective vision of scientific knowledge among all the actors, they will not be easily replaced, and it is important to have a well-defined and well-tested alternative available.

The notion of platform as a substitute for journals has been introduced. It also acts as a policy tool for public and non-profit research funders. The most urgent task for research funders, research managers, researchers and librarians is to begin designing and testing platforms that can reflect local issues of concern while contributing to the global construction of human knowledge. Platform power is of the essence. And, phoenix-like, journals can then reappear: as embodiments of communities linked by common problems, they revert to their position and roles when they reflected communities and their concerns, and gave them a voice among other similar communities.

Appendix

I. Some vocabulary-based caveats

- Sustainable: The term comes from environment science and refers to the ongoing stability of a complex system undergoing various dynamic processes. In the contemporary jargon of private companies, it has come to mean an environment suitably designed to ensure a revenue stream that will reassure investors of all types. The sustainability of a library bears little resemblance to that of a large publishing corporation.
- Public-ation: In the print world, publishing was largely structured around processes determined by the requirement of the printing process. As a result, the basic functions of publishing (registration, certification, dissemination and preservation) have come to be seen as depending upon the continued existence of a specific kind of entity: the publisher. However, in the digital world, publishing can be disaggregated and its parts reallocated to various, independent actors. Scientific knowledge absolutely needs to go public – hence to be submitted to public-ation – but its reliance on publishers is far less obvious.
- Journals: In the print world, the invention of gazettes, transferred as it was to the world of science, has led to the creation of scientific journals. These journals have evolved with time, most notably after WWII, when the commercial sector found a way to create a competitive market of scientific journals that allowed them to garner great profits. The competition of scientific journals, based on the impact factor, negatively affects the nature and the integrity of scientific knowledge. Going beyond this particular kind of journal has, therefore, become a call often heard in the last few years, and particularly during the recent UN Conference on Open Science. However, this does not mean that journals should be entirely banned from scientific knowledge production. Correctly reconfigured and well located on suitable public platforms, they could become good instruments to serve research clusters and communities. To play this role, ownership is to be avoided; their role in identifying provenance, on the

other hand, could contribute to the registration and certification functions of publishing.

- Excellence/quality: The term excellence behaves like the word "horizon": one may seek to reach the horizon, but one never does. Excellence exists only through comparisons to others, often effected through a competition. Indeed, excellence is often a coded expression for competition. Scientific knowledge does include, and can benefit from competition, but it does not depend only on competition. Too much competition can hurt rather than abet knowledge production.

  Quality, by contrast, often involves thresholds: knowing how to handle a degree of difficulty in knowledge production – a level of mathematics, the mastery of a complex instrument, etc. – refers to a particular level of quality (or of competence). Quality does not entertain an intense and necessary connection with competition.

- Portals, databases:
  In the early years of digitization (e.g., 1970-2000), most of the attention of libraries and publishers was focused on databases (indexing) and portals (virtual bookshelves of journals). Institutional repositories were also and largely conceived along those lines. This store of experience should not be neglected.

- Platforms:
  Platforms build on portals and databases, but they have evolved into forms of social, communicational, and documentary "space": a triple layer of sociological relations can be distinguished and worked upon: relations between documents, relation from people to documents and from documents to people, relations between people. Designing a platform is to design a whole environment, in this case a research and knowledge-producing environment. Ever since the invention of writing, humanity has been designing all kinds of platforms.

Speakers in alphabetical order

Juan Pablo Alperin

ASSISTANT PROFESSOR, PUBLISHING

ASSOCIATE DIRECTOR, PUBLIC KNOWLEDGE PROJECT

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For all the disruption, suffering and loss that the Covid-19 pandemic has brought, and continues to inflict, it has also led to some positive changes in how we carry out, communicate, and engage with science. Among the changes are:

A) a growing acceptance that sharing research publicly is a key aspect of advancing knowledge;

B) a rise in Open Science practices, especially the use of preprints (pre-peer review publications), open access (research that is freely available; OA), and, to some degree, the sharing of research data (for reproducibility);

C) a greater engagement in science communication by scholars, academic institutions, and journalists to satisfy the public demand; and

D) increased public engagement in science to levels beyond what even the most optimistic science communicators could have dreamed of.

When taken together, these changes in science and science communication practices have allowed us to better understand Open Science (OS) and Science Communication (SC), not as separate realms, but as two interconnected sets of activities, in which all scholars, policymakers, science communicators, journalists, and members of the public take up overlapping roles and influence each other. As we seek to keep the positive changes in science and science communication beyond the pandemic period, a first lesson is to value public engagement with science as a core aspect of OS, and not as a secondary goal, nor as a chore to be taken up after the science is complete.

While the scientific community, including scholars, institutions, and funders, has not historically valued such public engagement and has, instead, created and propagated academic reward systems that value citations and prestige, the pandemic has demonstrated that the public are more than willing to embrace the opportunity to engage with complex scientific topics, such as aerosol transmission and vaccine effectiveness, when given the opportunity. The observable interest in science and in the scientific process seen throughout the last 18 months has severely challenged, if not outright dismantled, many of the arguments against prioritizing direct public access to research, but these arguments may re-emerge as public interest in Covid-related research subsides. As such, a second lesson is to cement the public's expectation of access to scholarship and of opportunities for participation in science, in part by doubling down on OS practices and by

engaging the public in a broader set of issues, especially those as urgent as the climate crisis.

And yet, while it is true that the public has engaged with science at unprecedented rates around the world throughout this pandemic, it is equally true that the pandemic has served to highlight how, even in a global crisis, the conversation continues to be dominated by the experiences and voices of select groups from the wealthiest countries. These inequalities make themselves apparent in a global scientific system that undervalues and underrepresents the perspectives of a silenced majority of historically disadvantaged groups, particularly those from Global South. OS carries with it the promise of distributing power and opportunity, giving rise to many different conceptions about how to define and tackle our global challenges, but it will only do so if those who participate in science and science communication represent the diversity of society from all corners of the world. To achieve the full promise of OS, a third lesson is to prioritize approaches to OS that support diversity and inclusion and eschew those that serve short-term national or commercial interests at the expense of a truly global and inclusive system of science and scholarship.

The climate crisis shares many of the qualities that made Covid a compelling issue that dominated the global research and public agendas: it is urgent, it intersects with every aspect of our lives, and reaches every corner of the world. After seeing the public's willingness to engage so deeply with Covid, there is no reason to believe that researchers, policymakers, science communicators and journalists will not be able to maintain similar levels of engagement towards other topics, especially the climate crisis. Doing so will require that we understand public science communication and engagement with science as a core aspect of OS, that we actively promote and maintain an expectation that research and scholarship are public endeavours, and that we adopt approaches to doing so that are inclusive of all voices, especially those from the Global South and from all equity-seeking groups around the world.

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Bianca Amaro

COORDINATOR OF THE BRAZILIAN OPEN SCIENCES PROGRAM, BRAZILIAN INSTITUTE OF INFORMATION IN SCIENCE AND TECHNOLOGY (IBICT)

PRESIDENT, LA REFERENCIA

1 The commodification of scientific communication delays scientific developments – the proof is that in the pandemic the large commercial publishers opened their journals and data aware that the free circulation of knowledge is essential for a rapid scientific development. Editorial oligopolies charge high subscription or APC (Article Processing Charges) prices which means that not all researchers have access to the research results and research data of their peers, or publish their advances to the world scientific community.

2 Researchers and their institutions need to be evaluated positively for their efforts to widely disseminate their research data and research results. Thus, global problems would be treated equally throughout the world, and those who engage in research whose results will impact everyone would receive due recognition.

Dominique Babini & Laura Rovelli

LATIN AMERICAN COUNCIL OF SOCIAL SCIENCES (CLACSO)

Open Science needs to be the default with no paywalls for participants and no paywalls for beneficiaries – the case of open access

In the initial months of the COVID-19 public health emergency, a request from national science advisors from a dozen countries to scholarly publishers[1] resulted in publishers providing free access to coronavirus-related articles, but this exemption of payment to read COVID-19 research results in subscription journals will be limited to the duration of this crisis. And these exemptions of payments are not applicable for authors and institutions needing to publish their research and data on COVID-19 in open access journals charging article processing charges (APC).

Paywalls to read or to publish results of publicly funded research should not exist. Scholarly communications infrastructures can be owned and managed by the scholarly community providing non-profit services, as is the case of many open access publishing initiatives in universities and other research institutions worldwide.

This is the case in Latin America, which today is the most advanced region in the world as per percentage of scientific output in local and regional publications available in open access.[2] Journals in Latin America are published by universities and other scholarly institutions, and funded as part of the cost of research, with no charge to read and no charge to publish. In a study about the use of these open access contents[3], 75% of use comes from university students, professors and researchers, and to a lesser extent from practitioners and citizens looking for information in the Web.

Community-led open access and open science has better chances to be more inclusive, equitable and sustainable.

1 https://wellcome.org/sites/default/files/covid19-open-access-letter.pdf

2 http://www.unesco.org/new/en/communication-and-information/portals-and-platforms/goap/access-by-region/latin-america-and-the-caribbean/

3 https://figshare.com/articles/presentation/Research_is_also_for_non_scholars_Lessons_from_Latin_America/3187551

Assessment of scholarly publishing based on traditional indicators (e.g. impact factor of journals) does not contribute to incentivize inclusive and participatory open science practices using bibliodiverse and multilingual local as well as international open access venues for publishing

The dominant use of the impact factor (IF) to assess research being published – an indicator based on collections of journals with very poor presence of quality journals from developing regions in languages other than English – is a practice that does not incentivize open science.

Putting all quality-controlled collections available in a diversity of open publishing venues – publishing platforms, preprint and data archives, and institutional and subject repositories – on the same footing during research assessment practices, could remove some of the pressure to publish in prestige journals with high IF. And it will make the DORA and Leiden recommendations easier to implement.

Mission-oriented research assessment requires contextualizing frameworks and situated methodologies, particular or extended evaluation criteria, and reviewers with wider backgrounds and expertise and the participation of social movements and/or local communities

Lessons learned from the COVID-19 pandemic and of interest for climate change emergencies make emphasis on the trend towards high-quality mission-oriented research to improve policy efforts for global sustainability, its contribution to solving social and environmental issues and increase public engagement.

On the road of an increasing demand for new indicators to capture the contribution of research to society, particularly those aligned with The United Nations Sustainable Development Goals (SDGs) – established as part of the UN's Agenda 2030 –, there is a need to compare various methodologies, each of them with a particular understanding of the SDGs, and evaluate their use for specific contexts and purposes in Latin America and the Caribbean[4]. Mission-oriented research assessment might require referencing frameworks and situated methodologies, particular or extended evaluation criteria, and reviewers with wider backgrounds and expertise, practitioners, or non-academic stakeholders and the participation of social movements and/or local communities[5].

From our experience and perspective, as a network of more than 800 research institutions in 55 countries, there is a unique opportunity to address those concerns by reviewing evaluation procedures and making a transition to open science practices (UNESCO, 2021) and producing new data and analysis that can contribute to strengthen the interactions between science systems and society.

4 See Ráfols, Ismael (2021). Consensus and dissensus in 'mappings' of science for Sustainable Development Goals (SDGs). http://strings.org.uk/consensus-and-dissensus-in-mappings-of-science-for-sustainable-development-goals-sdgs/

5 Science Europe (2020). Science Europe Study on Research Assessment Practices. Technopolis Groups. Final Report: https://www.scienceeurope.org/media/fmdihoqy/se-study-on-research-assessment-practices-report.pdf

Ginny Barbour

DIRECTOR, OPEN ACCESS AUSTRALASIA

To address the pandemic, open science practices were essential across the research lifecycle, but these practices were not systematically planned or implemented.

Open science has been subject of increasing discussion and investment over the past 20 years. Though initially the focus was open access to research publications, there is now an increasing understanding of the need for open research practices across the research lifecycle which includes sharing of data, software and publications and the infrastructure to support these practices.

- As articulated in the draft UNESCO Open Science Recommendation, these practices require a whole of system approach from top to bottom: an international and national policy framework, investment in systems and infrastructure, investment and training in people; incentives that support open research practices, and an appetite to support experimentation.
- The limitations of many systems of sharing research became apparent, for example, there was a serious bottleneck caused by publication of research through traditional journals, which could not keep up with the demand. Preprints, especially medRxiv, a then relatively untested model of sharing in medical research, became an essential route.
- Even commercial providers of publishing services, who have often resisted a change in their business model from closed to open publishing practices, were persuaded that open access to publications was essential in addressing the pandemic. However, it took calls from international policy makers in order for the majority of commercial providers to collaborate with open initiatives such as the CORD-19 publication dataset. Despite these calls, some publishers still resisted, and others placed conditions on their collaboration. It was notable that there is even less willingness to collaborate on open science practices in relation to the sharing of intellectual property for patents, especially as the holders of the intellectual property looked beyond the pandemic. This unwillingness is despite high level international political support, led by the US Government. A key lesson therefore is that it cannot be assumed that commercial providers will act in a way that does not support their own interests.

International, regional, and national collaboration is essential to address complex scientific challenges.

The fast moving and global nature of the pandemic highlighted problems caused by a lack of internationally agreed standards and processes for performing and sharing of research. In the absence of standards or agreements, data sharing often happened through ad hoc means, rather than by coordinated, proactive approaches.

- Not one research group, university or country had all the resources needed to address the diverse needs that arose in the pandemic.
- Concerted international political will was needed to agree that collaboration and open science was needed. Despite this will being expressed, it is not clear that the open science that was supported during the pandemic will endure long term.
- Because of unequal access to resources globally, research and its open dissemination was dominated by high income countries. It's therefore likely we have only a partial understanding of the effect on the pandemic in low- and middle-income countries.
- In order to facilitate collaboration core infrastructure is needed, such as agreed metadata standards. However, more than 18 months after the pandemic we still lack full agreement on the minimal requirements and standards that should be required for the sharing of data associated with publications of research in the pandemic.

We need a fundamental shift in thinking to ensure that openness is integral to how science is done in future: this shift requires high-level political will.

The pandemic has proved to be a real-time lesson in demonstrating not only the need for open science, but also what is needed for open science to function well. It is essential now to assess how the entire research ecosystem functioned throughout the pandemic in order to understand what worked well and what did not and to direct resources and processes to strengthen and future-proof the open science ecosystem for times of crisis, for long-term threats such as those posed by climate change, and even for more stable times.

- There are a number of systems of oversight and management of research that did not function as needed in the pandemic and which showed up a range of gaps. These gaps included: how to strategically decide what research is needed; how pandemic research is funded; how standards are set in research to ensure it is of a high quality; and who has responsibility for sharing that research.

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The importance of open science within the global health crisis we are all facing today comes from the fact that COVID-19 proved worldwide the urgency of boosting scientific progress as a human right and the need to enhance scientific collaboration to respond to global emergencies, increasing the resilience of societies.

However, to adhere to these goals is not enough. The main challenge of the transition to open science is to surpass the diverse inequalities that affect the universal access to the benefits of science and the infrastructure that is needed for opening data and making citizen science truly possible.

In a socially unequal region such as Latin America, science is mainly supported by national governments. Information systems and open access to scientific publications were developed since the 1960s, also fostered by public universities that created regional repositories and thousands of indexed scientific journals in diamond route. With the launch of the open access journals databases such as Latindex (1995), SciELO (1998) and Redalyc (2005), the digitisation of scientific journals was given a boost and a quality seal was granted to published research. With a strong public imprint, these repositories acted as a springboard for the development of non-commercial open access environment that is today the hallmark of the region. More recently in 2012, LA Referencia was created, a federation of repositories from 10 countries, harvesting 790 institutions and open access journals, making available 3.115.141 documents, 1.927.514 articles, 355.306 doctoral dissertations and 686.521 master degree dissertations.

Latin America has indeed optimal conditions to create an open science infrastructure that capitalises on these previous efforts. The development of national information systems (CRIS) aiming to integrate existing databases for people, projects and production stand out. Brazil's BrCris was developed by the Instituto Brasileiro de Informação em Ciência e Tecnologia alongside major national public agencies. Brazil is an immense country, with a professionalized scientific and technological system that has produced many databases on a national scale, making integration a huge challenge. Examples include the Open Data Portal, the CV system Plataforma Lattes and the directory of research groups known

as CNPQ. The BrCris architecture foresees not only integrating these large existing databases, but also ensuring an open science infrastructure compatible with LA Referencia. BrCris also aims to repatriate Brazilian data from around the world.

The second case is that of the PerúCRIS platform. It was first devised when Peru approved its Open Access Law in 2013. The need then arose to integrate three scientific information platforms: the directory of researchers, the national directory of institutions and the national network of repositories. The new platform also includes all undergraduate and graduate theses. Today, PerúCRIS includes five directories – human talent, scientific production, projects, institutions and infrastructure – and is designed not only for the scientific community but for society as a whole. It allows the public to discover new technologies, to participate in citizen science or to find creative ideas to generate opportunities for investment. The fact that Latin American pilot CRIS projects are national rather than institutional, as in Europe, is due to the way research is funded. Most of the universities that contribute to scientific and technological research in the region are public and participate in national information systems. Given their reliance on public funds, most of these institutions do not have the resources to finance an institutional CRIS system, much less to purchase it as a package from large companies that offer these services.

The cases of Brazil and Peru show that a national-level CRIS can promote true integration of all existing scientific platforms and organisations in a country or even a region. These platforms can then be used for research assessment because they have a complete registry of people, institutions, productions, and projects in each country. Latin American CRIS databases will give visibility to different styles of publication and diverse researcher profiles, while enhancing new forms of scientific collaboration – especially those devalued by the dominant trends in academic evaluation. This approach opens the way to adequately value bibliodiversity and multilingualism moving towards increasingly inclusive and socially relevant science, while participating actively in the conversation of open science with the rest of the world. To achieve these regional and national infrastructures is not an easy task and involves increasing public funds that are scarce and disputed by other urgent needs of the society. This is why digital and technological inequalities must be addressed as a global problem.

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Natalia Carfi

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The Open Data Charter is a collaboration between over 150 governments and organisations working to open up data based on a shared set of principles. We promote policies and practices that enable governments and CSOs to collect, share, and use well-governed data, to respond effectively and accountably to our focus areas.

UNESCO's idea of Open Science is ***"to allow scientific information, data and outputs to be more widely accessible"***. This leads us to the term "Open Access" and with more data reliably harnessed, what we have is Open Data. The open data we at the Open Data Charter speak about and advocate for, is a part of the broader open data governance and policy community, which I have been a part of for over ten years now. I have heard a lot of recommendations and lessons learnt from collaborations continue to emphasize that data openness is the only way forward.

Open data is data that is freely available in open formats and with open licences for anybody to use. That would be the minimal definition of it. Open government data is that but created within government, and every civil servant is in fact the creator of data that should be open data. Of course there are limitations to openness as data is seen in a spectrum[1] and personal and national security data for example should not be open. Taking those exceptions aside, shared platforms and standards to open up data actually unlock the public value that open governmental data holds as the possible re-uses are unimaginable. The use of that data for scientific purposes is one of those possible and important reuse cases.

Data re-use is an important part of the data life cycle and its open publication is crucial as we have seen last year (and this year also) while we continue to grapple with the pandemic. Being a global civil society organisation (CSO) that gathers a broad community of governments, multilateral institutions and other CSOs, the Open Data Charter was in the perfect position to call for a collaborative approach to understand which

1 See Open Data Institute's Data Spectrum

were the key datasets that needed to be opened in order to understand the governmental response to the pandemic. We had a very simple document where we proposed a series of key datasets that were being demanded by citizens, researchers, journalists and CSOs from around the world, did some desk research on the existing standards and just called our community to freely comment on it. We received questions, comments and suggestions from all over the world, colleagues from the open data community, government officials and privacy experts helped us enhance that open document and move forward with deepening our understanding of the "high value datasets". We developed a Data Taxonomy for these datasets that are now being finalized after a global consultation process. The main lesson learnt was that collaboration is key to move fast and further in times of uncertainty like the one the pandemic means. Sharing the smallest draft of our document and asking experts and colleagues only enhanced the work and allowed us to leverage questions and resources that we might have not thought about in the first place.

COVID-19 was only part of our work last year. Since 2019, the Open Data Charter has been collaboratively working on open data for climate action. Together with the World Resources Institute, we developed a practical tool known as the Open Up Guide on Climate Action, a tool that investigates which datasets and standards can be used to publish climate data related to the Paris Agreement. This Agreement has called upon its signatories to be innovative in the way they report their obligations as well as enhanced Article 13 by calling for even greater transparency. And open data is the way to do just that. Governments spend a lot of time and resources on the creation and reporting to the UN around this Agreement but that data is not necessarily open. Once again, this critical data meant for openness, loses its public value. Promoting and advocating for open data for climate change is more crucial than ever. It is one of the collaborative ways we can tackle a global problem. And openness needs to be part of that equation.

From implementing the Open Up Guide on climate action in two countries and further research, we have found that data interoperability is not only important, but people interoperability is, too. Building trust bridges among the different stakeholders is critical for any open data policy. We now have the opportunity to embed open data as part of the follow up to Green Recovery Plans that governments are presenting. We need to be able to hold them accountable and understand the steps that are being taken. Let's not miss this opportunity.

Antoinette Foster

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Missing questions:

Concrete solutions must include essential questions oftentimes overlooked. Utilizing the power of open science to drive climate change solutions, we must ask:

- Are the values that shape open science and climate change solutions aligned with equity and community benefit?
- Who controls decision making processes for open science and solutions for climate change? Who is left out? Are we including and centering the voices of the most vulnerable who are historically disenfranchised by these decisions? What specific challenges arise in these communities? (For example, less green spaces means higher temperatures, lower wages means less resources to cool.)
- What would a radically different world look like if we empowered the most disenfranchised? Vulnerable communities know how to remain resilient through adversity, how to properly steward the land to conserve rather than destroy natural resources, and value the strength of interdependence. We must build genuine partnerships with these communities and in doing so, consider how our organizations change, how we personally change, and what happens if we don't.

Lessons from COVID:

These questions should be central to climate change solutions and any system of open science we create. Why? Within the US, the disproportionate impact of COVID is unsurprisingly predicted by race, class, and overall socioeconomic status[1]. Data show whites having lower infection, hospitalization, and mortality rates, greater ability to work from home, lower job loss, and greater access to health care, health insurance, food and housing securing. African American, Native American, and LatinX communities generally show the opposite trends. Even amongst whites within the US, the poor and working class are disproportionately negatively impacted by COVID. Globally, current vaccine distribution and access can be traced back to major colonial power, with North America and Europe having the highest vaccination rates because wealth, health, and survival during disaster can always be linked back to historical and current-day

1 Don Bambino Geno Tai, Aditya Shah, Chyke A Doubeni, Irene G Sia, Mark L Wieland, The Disproportionate Impact of COVID-19 on Racial and Ethnic Minorities in the United States, *Clinical Infectious Diseases*, Volume 72, Issue 4, 15 February 2021, Pages 703–706, https://doi.org/10.1093/cid/ciaa815

power. Each outcome reflects historical and current-day decisions deprioritizing time and money spent in vulnerable communities, deprioritizing building genuine relationships with these communities, and prioritizing profits over people. The fact that vaccine patents are not open source reflects this. We do not need to look at COVID specifically to predict these outcomes as they repeat within and outside of disasters. In a time of nothing being normal, these outcomes remain the same. However, our past does not need to predict our future. Equity is established when we prioritize equity-centered solutions. Equity is often tacked on to current solutions once indicators of these outcomes arise within a crisis, rather than central to the solutions we create. Without centering the needs of the most disenfranchised first and as the most important, any approach to open science or climate change will disproportionately ensure survival for those with access to wealth and power and vulnerable populations will continue to be disproportionately impacted. When our solutions genuinely center the needs of the most disenfranchised, we by default, help everyone.

Equity-centered solutions:

To create equity-centered solutions, we must first acknowledge and understand all inequities are rooted in specific and overlapping systems of oppression such as systemic racism, classism, white supremacy, colonialism, patriarchy, ableism and more. These fabricated constructs are intimately woven into our society manifesting via the cumulative effect of past and current policies, procedure, and culture (culture being collective values, attitudes, beliefs, and behaviors that maintain each system). With a widespread acknowledgement and understanding of how these systems of oppression historically and currently operate, we can begin to build equity-centered solutions. If we see open science as pivotal to our approach to climate change, we must understand how these systems of oppression operate not only within the current and predicted outcomes of climate change, but within open science itself. Moreover, open science operates within the larger context of science, so we must ask ourselves how scientific policies, procedures, and culture uphold these systems on micro and macro levels, and predict how this might impede our equity-centered solutions to climate change. What we see on a small scale is reflected at a larger scale — meaning micro or local changes repeat overtime to macro scales. Open science as a movement is a good example of how small-scale focus and effort results in large-scale shifts and movements. Individuals working towards climate change solutions need to understand their own socialization within these systems and develop an equity-centered systems lens to evaluate their current environments and build solutions that center historically excluded communities. We must empower impacted communities in order to center their needs and work alongside them while we co-create community-driven solutions.

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Open science showed its benefits, but more action will be necessary to make it the "new normal".

The pandemic resulted in a broad perception that open science and open collaboration accelerate scientific discovery. The urgency of the pandemic prompted research communities to share research and results at an earlier stage and openly, for example via the posting of preprints, sharing of genome sequences and other data, or providing open access to publications. Compared to the Zika and Ebola outbreaks, the speed of preprint responses to the COVID-19 pandemic was over 100 times higher[1]. A number of publishers have also temporarily opened up some of their journals (although not making them permanently open access).

Despite this accelerated take-up of open science practices, they are some way off becoming the standard. An essential pre-requisite for moving forward in this direction is to reform the current research assessment system, which is too focused on the quantity of publications in high impact journals rather than rewarding the intrinsic quality of research, open collaboration, sharing of knowledge and data, and societal engagement. This calls for coordinated action by policy-makers, research funding and research performing organizations.

FAIR data can save lives.

The open and immediate sharing of the genome sequence of SARS-CoV-2 contributed to develop the first diagnostic test for the virus and the fastest vaccines ever developed in history. Yet, a lot of data that are useful to respond to other public emergencies and looming crises such as climate change or antimicrobial resistance are not sufficiently findable, accessible, interoperable and reusable (FAIR). Many publications (even the ones on COVID-19) do not make their underlying data available, which prevents the validation of the scientific conclusions and undermines the reproducibility of science. The pandemic also highlighted difficulties in combining heterogeneous data types (for example genomic with clinical data, or with data from the social sciences and humanities) and the need for an open science distributed data infrastructure that is sustainable and allows federation of resources. Initiatives in Europe and

1 Brierley, Liam. (2021). Lessons from the influx of preprints during the early COVID-19 pandemic. The Lancet Planetary Health. 5. E115-E117. 10.1016/S2542-5196(21)00011-5. https://doi.org/10.1016/S2542-5196(21)00011-5

worldwide are making quick steps in this direction. These challenges call for coordinated actions at the global level and for sharing of lessons learnt on good models for data governance and management.

Traditional publishing models are not fit for purpose.

The pandemic has demonstrated that traditional publishing models are not fit for purpose. While recognizing the value of peer review, many actors acknowledge that the traditional publishing process can be non-transparent and slow, taking months before a manuscript is approved and made available (often behind paywalls). This hampers research efficiency and speed, which are crucial especially in times of emergency. Studies[2] have shown the value of preprints for the wide and timely distribution of important research findings that have advanced the understanding of the biology of COVID-19, while open peer review is emerging as a more transparent and dynamic practice, allowing the wider research community to contribute to the review process. Several funders, including the European Commission, the Wellcome Trust and the Bill and Melinda Gates Foundation, have launched publishing platforms that operationalize open science principles, including the use of open peer review, and facilitate the early sharing of results. In going forward, there is a clear role for policy-makers and funders in exploring and supporting such publishing models that are more open and transparent.

2 https://www.thelancet.com/journals/lanplh/article/PIIS2542-5196(21)00011-5/fulltext

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In 2019, we spoke of the unrealized potential of open science. How making science more open, accessible and transparent could transform the speed of discoveries and shorten the time between results and applying the science.

We spoke of how preprints, versions of manuscripts that have not completed the peer review process, could be an essential tool in outbreaks when scientific data and information need to be communicated quickly to decision makers. We spoke about the potential for collaboration when the research life cycle is broken open. Then the world changed. We moved from speaking in hypotheticals to a real-world scenario. The entire world needed science and it needed it fast.

The Covid-19 pandemic in many ways facilitated the realization of open science's potential. From ideation to data collection, publication and knowledge mobilization, we opened each step of the research life cycle. Researchers were sharing protocols, open databases were popping up each week, publication of results in preprints became the standard and new collected knowledge was mobilized into policy decisions and the communication of science. That open science is actually possible at a global scale I would posit is the first lesson that we learned from the pandemic. Faced with a problem that could only be solved by openness and cooperation, the hurdles to open science were bested. The pandemic demonstrated that entrenched and closed scientific practices are constructs that are held up by incentives. When a stronger incentive comes into play practices from the individual researchers to consortiums of countries can shift. And when they do, open science can deliver on its promise to accelerate research. That is the second lesson we learned about open science from the pandemic. That open science really is a better way to do science. I believe its full potential is yet to be reached because even in a pandemic there are obstacles to fully transparent science.

We are now faced, however, with the challenge of how to maintain this momentum. In the absence of an incentive to eradicate the pandemic, how can barriers to open science be defeated? How can we eliminate all the barriers even those that remained during the pandemic? I believe open science is possible when

the incentives to do open science counteract those to not. Incentives can be the sums of rewards for open science but also tools and infrastructure that facilitate open science. Incentives are also multiplied when they are harmonized across the research landscape including across countries. We have proven that we can come together to sign joint statements on open science and share data but we need to come together to align incentives to make open science the status quo. Climate change promises to be an even bigger challenge than Covid-19. One open science could help tackle but only if we start today. 

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The CARE Principles for Indigenous Data Governance were developed to assert Indigenous Peoples right to participate in decision making processes that affect their territories and lives as these activities, including the prioritisation of resources, are increasingly informed by the outputs of open science (Carroll et al., 2020). While COVID-19 is the most recent of a series of global crises, the extent and impact of its spread has led to unprecedented international efforts to identify vaccines and ensure that they are shared with nations and communities across the globe. The role of research has been invaluable in this effort highlighting the value of sharing data and knowledge however not all uses of this data have been positive. Indigenous Peoples have diverse narratives of resilience and adaptability, and all have been acutely impacted by the negative social, economic, environmental and health outcomes of COVID-19 (UN Special Rapporteur on the rights of Indigenous Peoples, 2020). COVID-19 response activities including surveillance, research, planning, and policy should include Indigenous Peoples to ensure systems don't exacerbate ongoing marginalisation and mistrust of agencies and the data/research they produce (Carroll et al., 2021a; RDA COVID-19 Indigenous Data WG, 2020).

Access to good quality data is a key driver for Open Science including the implementation of the FAIR Principles supporting findability, accessibility, interoperability and reusability (Wilkinson et al., 2016). While the FAIR Principles facilitate increased data sharing, they ignore relationships, power differentials and the historical conditions that impact ethical and socially responsible data use. The people and purpose focused nature of the CARE Principles makes them complementary to the FAIR Principles across data lifecycles from collection to curation, from access to application. As the pandemic evolved, the Research Data Alliance (RDA) produced Guidelines for Data Sharing (RDA COVID-19 Working Group, 2020) to support international collaboration. The Global Indigenous Data Alliance (GIDA) partnered with the RDA to produce the chapter of the guidelines focused on respecting Indigenous data sovereignty. The aim was to improve the quality and responsiveness of data activities for Indigenous communities, and avoid harm, by setting minimum expectations for the governance and stewardship of Indigenous data. The CARE Principles promote Indigenous data rights which in the context of COVID-19 include data about COVID-19 testing, cases, hospitalisations, health service access, deaths, and comorbidities, as well as related Indigenous Knowledges, and socioeconomic

and environmental impacts of COVID-19 (RDA COVID-19 Indigenous Data WG, 2020). To further the focus on Indigenous data sovereignty, members of the GIDA working group developed recommendations to increase Indigenous Peoples access to data for self-determination (Carroll et al., 2021a):

A. Investment in Indigenous Community-Controlled Data Infrastructures and Technology to Support Community Capacity, Response, and Resilience;

B. Involvement of Indigenous Peoples' Leaders, Activists, and Scholars in the Mainstream Science/Data/Policy Nexus Decision-Making Processes;

C. Instituting Data Access and Sharing Protocols Between Indigenous Peoples and Other Governments and Data Holders;

D. Requiring Collection (and Validation) of Indigenous Identifiers or Affiliation (e.g., Nation, Tribe, Ethnicity); and

E. Increasing the Number of Indigenous Epidemiologists to Improve Information for Effective Public Health Response.

While the RDA guidelines and the recommendations above are framed around COVID-19 they deal with systemic issues that can support activities in other contexts. Capacity building, community infrastructure, Indigenous involvement, data access protocols, and access to Indigenous expertise, can be equally applied to the challenge of climate change and associated issues like maintaining genetic diversity (Welch et al., 2021). Indeed, Indigenous Peoples have been highlighting the environmental impacts of climate change for decades and calling for concerted effort from local, national, and international institutions to address the fundamental causes.

COVID-19 has demonstrated when situations are urgent, Indigenous participation can be marginalised, some stakeholders will take the opportunity to propagate racist stereotypes, and equity is a key challenge when prioritising the allocation of resources. These outcomes are repeated in the context of climate change. Findings from a global systematic review analyzing 20 years of climate studies that included Indigenous knowledges in their research found that 87% of studies were extractive, representing colonial practices (David-Chavez & Gavin, 2018). The sharing of data and traditional knowledge is central to providing an integrated approach to decision making however it also provides an opportunity for misappropriation. It is this lack of control over the potential uses of data and knowledge that create concerns for Indigenous Peoples when considering open science protocols. For open science to create equitable outcomes the CARE Principles must be advanced alongside the FAIR Principles (Carroll et al., 2021b). We must be FAIR and CARE when sharing data.

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Sharing knowledge is a fundamental human right. Open science – and in particular, open access to research outputs – is critical in fully realizing this right. It accelerates discovery, promotes collaboration, fuels innovation, and provides a critical foundation for quickly turning research outputs into actionable information to improve the health and well-being of the public.

Despite the fact that, globally, more than one hundred billion dollars in public funding are used to support basic and applied scientific research each year, the majority of articles reporting on the results of that research are still not readily accessible to the scientific community – often locked behind expensive paywalls on proprietary publisher websites. The COVID crisis has demonstrated both the importance of open science practices in making advances as quickly as possible and the terrible toll caused by unnecessary delays.

As the pandemic emerged, it became clear that making the relevant research openly available would be critical to find treatments and vaccines as quickly as possible. Because so much of this research remained behind paywalls, policymakers, led by the U.S. National Institutes of Health, had to spend time in the middle of a growing pandemic to negotiate with more than 50 publishers to identify relevant articles and secure the rights needed to use them. Experts then had to spend additional time converting articles to a standard format so that the community could use the latest computational technology to analyze and better understand the research on COVID-19.

The resulting open access subset of articles in the CORD-19 database has been accessed and used more than 160 million times by the scientific community and contributed to the faster understanding of the COVID-19 virus, the rapid development and deployment of therapeutics and the fastest vaccine development timeline in human history.

It also exposed critical limitations in the effectiveness of our current system of scientific communication. Researchers could not afford the months (and sometimes years) of delay that is so common in traditional peer reviewed journals and opted to use new and emerging rapid communication channels, like preprint servers. These platforms in turn struggled to keep up with the exploding demand, exposing a need for much greater investment in the technical and human infrastructure needed to quickly validate and communicate scientific research outputs.

As researchers around the world focused on COVID, they turned to open science practices to meet the urgency of the crisis – from openly sharing the virus' genome sequencing data, to creating and distributing open source PPE to revisiting IP restrictions on vaccine technology. Open science practices quickly became central to scientific communication, as researchers raced to collaborate in as close to real time as possible. To prevent the next pandemic from taking hold and to address other urgent crises like climate change, open practices must remain central to science moving forward.

The world has rapidly realized that there is no going back to the way things were pre-pandemic, and in the case of the previous closed, inefficient scientific communication system, society simply cannot afford to move backwards. To ensure that the research community can prevent future pandemics and address global public health challenges of all kinds, and to make progress towards combating climate change, fundamental changes need to be made. Specifically:

The current global policy framework on accessing scientific research should be updated to ensure equitable and open participation in knowledge sharing.

All research articles and the data, software, code, and algorithms needed to validate and/or reproduce their results should be required to be made immediately available with no embargo period to the public, at no cost, under an open license, and in an AI-ready, machine-readable format. This will provide scientists and the public with what the COVID crisis demonstrated is sorely needed: a free, immediately accessible, fully machine-readable collection of articles and data to accelerate discovery.

Substantive funding for the development and ongoing sustainability of critical infrastructure must be provided.

Any policy update should be supported by consistent and substantive investment in research infrastructure so that scientists can quickly and openly disseminate knowledge and engage with other researchers and the public on their findings. Governments and national funding bodies should lead the way in leveraging existing funding mechanisms and in creating new avenues for collective global support, such as partnerships with philanthropies, research institutions, and scholarly societies to support critical community-driven, open infrastructure—including article, data, software, and code repositories.

The current evaluation and incentive system for research must be updated to support open science practices.

The current research incentive system is overwhelmingly skewed to reward a single research output: publication of articles in high impact factor journals. Reliance on publications as the sole proxy for quality erodes trust in science and further entrenches inequities in the scientific communication system. We recommend that governments support the expansion of incentives to include outputs beyond the journal article (e.g., data, code, preprints) and encourage the use of more qualitative factors for impact, such as influence on policy and practice, by including language supporting the sharing of a more diverse set of research outputs in all calls for funding, grant evaluation guidelines, and grant reporting systems.

We strongly agree with the UN High Commissioner for Human Rights' call for open science policy to be a cornerstone of the global approach to address climate change. The UNESCO Recommendations on Open Science, slated to be ratified in November, provide an excellent, detailed blueprint for achieving this policy framework.

Iryna Kuchma

OPEN ACCESS PROGRAMME MANAGER, ELECTRONIC INFORMATION FOR LIBRARIES (EIFL)

1. The growth of preprints; setting best practice standards for reporting research posted as preprints.
2. Data sharing and calls for sharing the benefits of research and sustainable open science infrastructure funding.
3. Local open access journals play an important role in sharing COVID-19 research that addresses the local needs

Preprints

In the past years we've seen the widespread adoption of preprints – authors sharing their effectively completed manuscripts ahead of submitting them for formal peer review and publication in journals (for example, the NIH's iSearch COVID-19 portfolio tool is updated daily and includes publications and preprints from arXiv, bioRxiv, ChemRxiv, medRxiv, Preprints.org, Qeios, Research Square, and SSRN https://icite.od.nih.gov/covid19/search/).

Funders, e.g. European Commission, recommended making COVID-19 research findings available via preprint servers before journal publication, or via platforms that make publications openly accessible before peer review and include clear statements regarding the availability of underlying data.

Journalists started citing preprints in their pandemic coverage but many of them didn't fully understand the difference between preprints, peer-reviewed articles, and different forms of peer review.

To address this issue, ASAPbio released a set of guiding principles for the communication of research in the media for preprint servers on preprints labeling, institutions, researchers, journalists and science writers. Preprint servers started implementing these guidelines.

From Tackling the Pandemic to Addressing Climate Change Recommendation: Make research findings available via preprint servers before journal publication and clearly label them as non-peer-reviewed research.

Data sharing, sharing the benefits of research and sustainable open science infrastructure funding

I was one of the co-authors of the RDA COVID-19 Recommendations and Guidelines for Data Sharing and co-facilitated the Social Sciences

research area of these Recommendations and Guidelines. They are aimed to help stakeholders follow best practices to maximize the efficiency of their work; help policymakers and funders to maximize timely, quality data sharing and appropriate responses in health emergencies, and act as a blueprint for future emergencies. Many recommendations from this document will be relevant to addressing climate change.

Coordinated, Cross-jurisdictional Efforts to Foster Global Open Science: Governments, research funders, and research or research-supporting institutions around the world must coordinate with one another, and support and promote Open Science through policy and investment to streamline the flow of data between local entities, and across international jurisdictions.

Incentivize the early publication/release of data outputs and the software used to produce them and design appropriate governance: There are motivational barriers to making data outputs available rapidly. There is a need for incentivizing the early publication/release of data outputs and the software used to produce them. The early publication/release of data outputs and the tools used to create them should be encouraged by building trust, providing incentives for sharing data and providing appropriate governance.

Infrastructure Investment and Economies of Scale: There is a need to invest in state-of-the-art information technology and data management systems infrastructure. The investment should also be directed towards people and skills to fully utilize the potential of large-scale infrastructure. The minimum required infrastructure in terms of technology, skills, people and frameworks should be accessible to all jurisdictions/sectors. Funders should require data sharing and provide support for infrastructure for data archiving and preservation. This includes striving for funding models that are applied equitably across projects, researchers, and countries. This is also a mandate for covering costs for infrastructure in the broadest sense (e.g. ensuring open access to data, curation services, research data management costs across the lifecycle, and long-term preservation, among others).

Enable interoperable cross-disciplinary and cross-cultural data collection, data use and collaboration for managing data during emergencies. Encourage public involvement throughout the data management lifecycle from research question to final data sharing and usage.

The importance of local open access journals

Guleid FH, Oyando R, Kabia E, et al. A bibliometric analysis of COVID-19 research in Africa. BMJ Global Health 2021;6: e005690. highlighted Africa's COVID-19 research and the continent's capacity to carry out research that addresses local problems. The most common research topics include "country preparedness and response" and "the direct and indirect health impacts of the pandemic". Three African journals were among the top 15 journals that published the highest number of articles: Pan African Medical Journal, South African Medical Journal and African Journal of Primary Health Care & Family Medicine (table 4).

From Tackling the Pandemic to Addressing Climate Change Recommendation: Encourage publishing in local open access journals and do not discriminate against such publications at tenure and promotion exercises. Journals should undergo an expedited review process for climate-change-related research.

Vincent Larivière

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MEMBER, UNESCO OPEN SCIENCE ADVISORY COMMITTEE

Despite its limitations, scientific research remains the most efficient tool humanity developed to solve global challenges.

Like other major threats, the COVID-19 pandemic needed a concerted scientific and governmental effort. In addition to funding research on the topic, governments across the world have developed initiatives to make sure that such knowledge was disseminated in the most efficient manner. Among those, the initiative led by the Wellcome Trust in early 2020 is worth recalling: realizing that COVID-19 was an "urgent threat", the Trust, along with several funders, publishers and scientific societies, pledged to share rapidly and openly the research papers and data relevant to the outbreak, in order to inform the public health response and help save lives.[1]

Such response for an open dissemination of research findings remains quite unique in the history of scholarly communication, and is worth contrasting with climate change research, which has been considered by many as the "greatest threat to global security"[2] as well as the "biggest threat modern humans have ever faced."[3] Indeed, despite this importance, no concerted effort similar to that of the Wellcome Trust for COVID-19 has been developed for climate change research. In this context, this short piece focuses on one of the challenges in scholarly communication—open access to research papers—and contrasts the levels of open accessibility of research literature of COVID-19 and climate change literature.

Using the Dimensions database from January 2000 to May 2021, we created two datasets: one of COVID-related research (including research on coronaviruses in general) and one on climate change research.

The contrast in accessibility of research across the two domains is stunning: while 80-90% of research on COVID published since 2012 is currently openly available, this percentage is, at best, of 59% (in 2019-

1 Interestingly, signatories of the Wellcome Trust statement agreed to follow those principles in similar contexts. https://wellcome.ac.uk/press-release/sharing-research-data-and-findings-relevant-novel-coronavirus-covid-19-outbreak

2 https://www.un.org/en/chronicle/article/greatest-threat-global-security-climate-change-not-merely-environmental-problem

3 https://www.un.org/press/en/2021/sc14445.doc.htm

2020) for research on climate change. Moreover, for most of the period (2000-2015), the majority of research papers related to climate change remained behind a paywall. Although the high percentage of bronze OA—that is, OA without a clear license—suggests that a sizeable percentage of currently available research on COVID may only be

higher than that of papers issued by other publishers. This suggests that the Wellcome Trust call indeed led to higher OA rates from those publishers who had signed the call. However, literature on climate change shows a totally opposite trend: only a small fraction of papers —about 46% for Springer-Nature and 30% for Elsevier in recent years—are openly available,

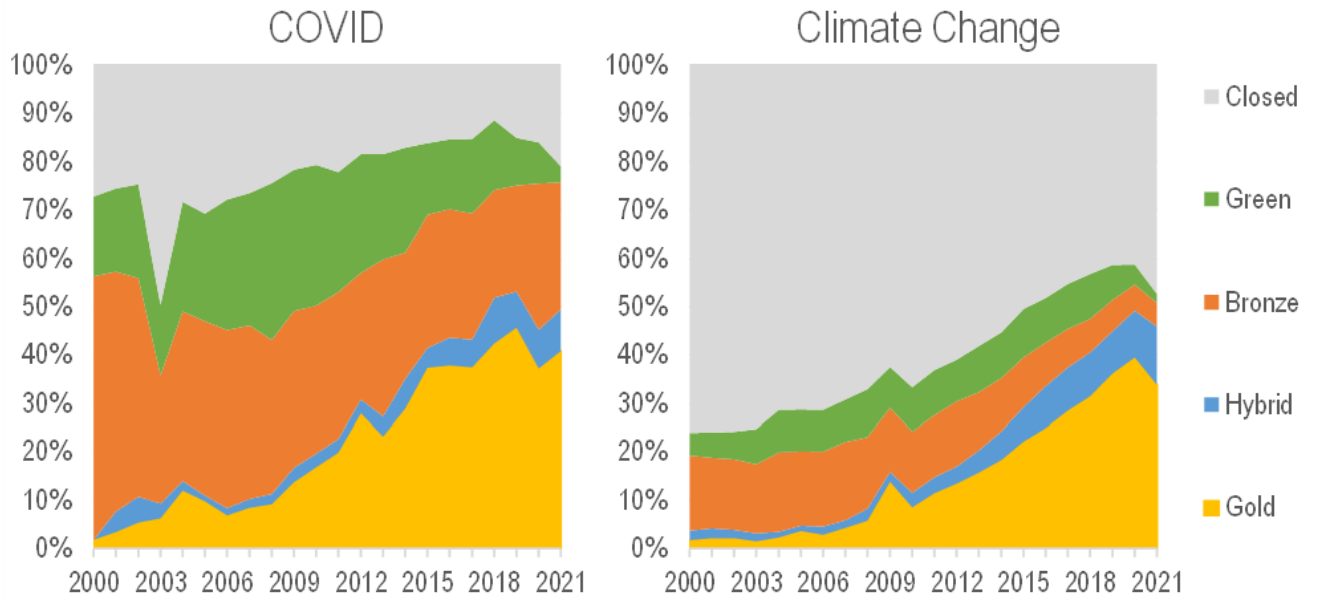

FIGURE 1. Percentage of open access (gold, hybrid, bronze and green) papers, for COVID-related and climate change research, 2000-2021

so temporarily, these results do show that various publishers have considered the COVID-19 pandemic to be a sufficient threat to remove paywalls. No such trend can be seen for climate change research.

Figure 2 confirms those findings. Analyzing the three publishers (Elsevier, Springer-Nature and Wiley) that account for the largest percentage of papers (more than 30% of all research papers published in 2020), it shows very different OA practices for COVID and climate change. Almost all COVID papers published by the three publishers—and especially by Elsevier and Springer-Nature—were openly available to the research community and the general public, and the percentage of OA of those two publishers was

and these percentages are much lower than those obtained by other publishers combined (about 60% in 2020). Despite the importance of the challenge at stake—the survival of the human race, according to many[4] —the vast majority of papers they publish on the topic remain closed. Given the fact that these for-profit publishers are home to most prestigious journals, these results suggest that the subset of the important research on the topic remains closed.

The general public holds scientific institutions to higher-than-average moral standards, and their actions should be driven by common good rather than personal advancement. Just like COVID-19, climate change is not only a scientific problem, but

4 https://www.worldwildlife.org/threats/effects-of-climate-change

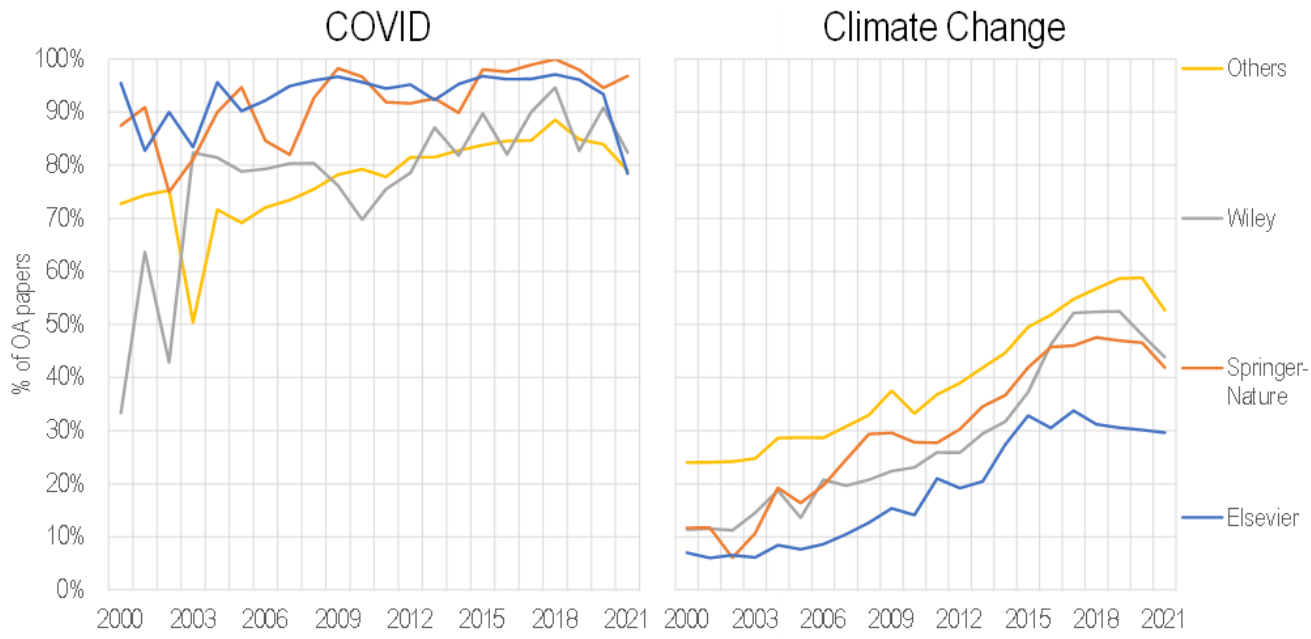

FIGURE 2. Percentage of open access (all types combined) papers published by the three publishers with the highest number of papers, for COVID-related and climate change research, 2000-2021

a social problem—as exemplified by the relatively important part of the population that express doubt on the mere existence of the phenomenon. Making climate change literature open to all could help both scientists and the general public understand what is at stake. COVID-19 has provided clear evidence that short- and long-terms health hazards do not lead to the same reactions by publishers and government. It is not too late to act.

Nyovani Madise

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The COVID-19 pandemic demonstrates the world's interconnectedness, and how vital it is for scientists to work together across national and regional boundaries.

Despite the pandemic's severity and impacts on economies, education, health, and social lives, it has illustrated important lessons on the value of scientific cooperation, research-policy partnerships, and building consensus on what matters — good health and life. These lessons are pertinent to achieving the Sustainable Development Goals.

COVID-19 has emphasised the importance of partnerships between researchers, communication specialists, the public, and policymakers. There have been collaborative papers from scientists across the globe, with the largest numbers coming from scientists from the USA and China. Most of this research has been published in open-access journals (OECD, 2021). Rose and Estes (2021) highlight the importance of trusted researcher-policymaker partnerships in the fight against COVID-19. Indeed, we have witnessed rapid responses in government decisions to provide funding for COVID-19 research and seen real-time use of scientific outputs in policy formulation and decision-making. Scientists and heads of governments have shared podiums in solidarity as they justify reasoning for unpopular decisions such as lockdowns. Science editors and communication experts have supported the translation of complex results for general audiences. Yet, challenges exist as not all scientists have benefitted from the expertise of science editors/knowledge translation scientists, such that research papers remain out of reach for the general public. Amid a global challenge, distilling scientific messages is important. Open science, while addressing the accessibility of scientific journal papers must also invest in capacity building for knowledge translation and packaging for different audiences.

Global commitments for climate change require the same approach to partnerships as seen with COVID-19. Climate change research needs to be translatable and generalisable, with a clear path to impacts. Of particular value is research that is replicable in diverse settings, indicating a clear path to policy/programmatic utilisation. Research knowledge from such projects should be open immediately so that it informs local decision-making. Furthermore, there is now greater expectation that research informing collective decisions like climate

change commitments should include researchers from low-and middle-income countries (LMICs). "Not without us," is the repeated cry when there are attempts to generalise findings from other parts of the world to local settings. Products from collaborative research must be accessible to LMIC researchers and communities who were party to the generation of the knowledge. It is ethically wrong to charge for access to knowledge generated this way.

There exists a need to agree on what is essential to humanity, including staying healthy longer. COVID-19 has illustrated that it is impossible to achieve this if we deny our interconnectedness and commonality of our destiny as co-inhabitants of earth. The creation of the COVAX initiative to ensure that people in LMICs have access to COVID-19 vaccinations, and renewed commitments at the G7 to provide them now instead of after rich countries' citizens are fully vaccinated, shows an understanding of this common destiny. The threats to human lives and health from climate change should be enough to propel the same urgency. Health effects from polluted natural resources are reducing life spans, and emergencies such as flooding and drought that are attributed to climate change are already killing millions of people in LMICs. The World Health Organization (2018) estimates that climate change is expected to cause approximately 250 000 additional deaths per year between 2030 and 2050, mostly in LMICs. But rich countries will not escape. Hauer et al. (2021) provide a conservative estimate of the reduction in life expectancy due to climate change of between 0.24 years to 1 year in European countries by 2100. Some of the climate change effects will give rise to future epidemics and pandemics like COVID-19. The major lesson from COVID-19 is that we have a shared destiny and collective responsibility.

Finally, innovative ways of financing the publication of research are needed so that scientists are not choosing a journal based on affordability of the Article Processing Charges (APC) but scientific fit. The UK government commissioned the international development charity, INASP, to consult on the challenges and opportunities that open access presents to LMIC stakeholders. Their report, published in October 2020, found that under the current open access models, high APC disadvantage researchers from LMICs who often have to pay out-of-pocket because unlike in high-income countries, there are no institutional funds to pay APC. To ensure equitable and open science, funders must continue working collaboratively to review their open-access policies and join up with initiatives like Plan S.

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Frank Miedema

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UTRECHT UNIVERSITY

Many may not yet be fully aware but we in academia are in transition to Open Science. Open Science is an international movement built on several local, large and small initiatives which have recently been brought together in one international and institutional movement.

The European Commission (EC) since 2015, initially under the leadership of Carlos Moedas, has been instrumental in this. The EC has declared Open Science to be the way we do research and innovation in the EU. This is a comprehensive approach based on open access publishing, FAIR data and code sharing (open if possible, closed if necessary) and public engagement and citizen science. Public engagement in this context entails iterative co-creation, identifying problems with societal stakeholders and testing results and solutions in the real world. To allow for this, Open Science needs a transition to a fundamentally different way to do research and researcher evaluation, that incentivizes and rewards researchers to work according to the practices of Open Science. Changing the rewards system in academia is an integral and critical part of the Open Science program to allow for this culture change to happen. Will this be easy? Not at all.

Those who have been trained in the past thirty years in academia know that this is a major change which affects the current reward system and the base for the well-known hierarchies in academia. These are not primarily based on data or code sharing, open access, societal, clinical or public health impact but dominantly on classical ideas about quality, excellence and reputation, with a focus on papers for peers and typical abuse of metrics (journal impact factor, h-index, number of papers, etc.) that have been shown to be seriously flawed. Internationally this has led now to a major movement which is quickly gaining a lot of traction since many major international organizations (NGOs, UNESCO, EU, Wellcome Trust, charities, governmental funders and national institutes) realize that this is what will increase the impact of science for the stakeholders that they serve.

Many powerful examples, of how the practice of Open Science has in the past contributed to big societal challenges, have been brought up to try convince the skeptics. In my career it has been the response to HIV/AIDS, researchers working with patient advocates such as Act UP and local

partners in for instance Africa. But since February 2020 the pandemic has even more clearly been an eyeopener for the power of these different practices of Open Science. We have followed the immediate response from academia and commercial parties from day-to-day in the media. Publishers opened up their journals and pay walls to papers on COVID-19, preprint repositories for articles before peer review were increasingly used to accelerate access and to judge new knowledge. Data, on virus, transmission, data on viral spread, morbidity and mortality, vaccine development was quickly shared by most.

Why now and only temporarily for research on COVID? We ask ourselves. Why not for research on cancer, mental health, cardiovascular, immune disorders but also for research in general? Think of research on climate change, water and energy, inequality, education, child development, the UN Sustainable Development Goals.

https://www.uu.nl/en/research/open-science

https://www.frontiersin.org/articles/10.3389/fdata.2019.00043/full

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Open Science is a paradigm shift, or a game changer in scientific research methodology. Also it is a concept that will lead to a transformation in the culture and behavior of various science stakeholders.

It may be helpful and critical to consider that the science ecosystem is a kind of a societal system embedded in the general society. Since the publication of the world's first successful academic journal in England and France in 1665, the use of the printing press technology infrastructure (originally invented by Gutenberg) has changed the speed, method and cost of producing and disseminating information as media of books and printed matter. Gutenberg's printing press technology has enabled us to record and disseminate scientific knowledge eventually quickly and widely, and pass it down from generation to generation, thereby creating a modern scientific and technological civilization. Some say that Open Science today can be regarded as the "second Open Science revolution", which is changing the speed, methods, and cost of recording and disseminating scientific knowledge based on the electronic information infrastructure, the Internet, and ICT technologies.

In my past discussions of Open Science, I have mainly focused on the openness and sharing of research data. In this paper, again, the main focus will be on research data issues. Please note that these discussions may not necessarily be the subjects of my panel discussions at the conference.

1. The issue of permission for reuse when sharing data

Human beings have fought against the spread of COVID-19 through a global response (social, political, and scientific). Through the rapid international sharing of relevant data for its scientific research, results have been achieved in the investigation of the SARS-CoV-2 virus and its viral infection process, treatment methods, epidemiological studies, and vaccine research and development. However, the release and sharing of data does not necessarily mean that it permits free successive research and publication using the data. In some cases, the terms of use and licensing for data disclosure allow free distribution of the data generated as a result of research on the original data, while in other cases, the results may not be allowed to be published without the full permission of the original data provider.

In my opinion, part of the reason of this phenomenon may be due to the fact that the scientific community and related stakeholders have not yet adapted to the academic norms and cultural change that are best suited for the practice of Open Science.

In some research fields, the return of profits to the entity or country that acquired the original data may also become an issue.

In the field of climate change research, the sharing or publication of observational data and numerical model results tends to be relatively more acceptable in the research community than in other fields. However, depending on the policy of the researcher, research institution, or country, restrictions on data reuse and profit sharing may become an issue, as is the case with bio-research data.

Global, regional and local observational data are essential and critical resources to advance the global climate modeling, validation, as well as monitoring the current status. Numerical modeling is one of the most powerful tools to provide the scientific basis for the societal reactions against the climate change risks, although such models are always the human architect. The earth system always holds potential to behave in a way beyond the human beings' and even scientists' expectation. Monitoring with satellite, aircraft, balloon and ground-based techniques is critical to target the most efficient and beneficial balance point in aspects of economical investment and societal cost of science research, mitigation and adaption (and their political decisions) in the society.

2. Incentives and rewards

In the promotion of Open Science, it is important to consider the incentives and rewards for data providers or actors in Open Science, as well as digital data infrastructure and analysis tools. This is an issue that has been discussed by international communities and groups, including the G7 Science Ministers' Meeting.

In natural sciences and engineering fields, there tends to be a convention that an author pays the publication fee for publishing her/his own paper, while the mental barrier of the majority of scientists for open access journals seems to me relatively low. The norm and culture seem widely shared to allow other researchers to freely view and cite one's paper. So that this allows papers with a higher number of citations to result in a higher recognition of the original author as academic achievements. This is closely connected to researchers' career development, and research assessment in research institutions, funding agencies and science policy making officials.

In the field of atmospheric science and climatology, from my point of view, it is difficult to believe that such a culture is accepted as a standard norm of researchers. While behavioral and cultural changes, such as the release of data following publication, are gradually taking place, it remains important to check out whether they are being accepted by all national, regional, and international groups. Please note that communities to investigate adaptation and mitigation are beyond my own scope and observation at present and so we need to be careful in this aspect.

Currently, at least to my observation, the majority of researchers in many research fields may not necessarily accept, or, are on the way to accept, the concept and implementation of new data management, data sharing/publishing, and the resulting transformation of research ecosystems in line with the Open Science principles. The cultural change of scientists and science stakeholders takes a long time, as seen in the progress of the open access journal movement to date. We are in a period of new challenges about research data.

3. Science administration

Good science requires good administration essentially for researchers, research supporters, publishers, funding agencies, and data managers of data repositories etc. Although science is global, administration is often highly dependent on the cultural background to which a country or region belongs, the historical background of its society, its policy makers, and its policy implementation.

In my opinion, interoperability is also an important keyword here. Scientists are generally in line with the global norms and cultures of the science, but work styles, institutional regulations and laws, and the norms and cultures shared by non-research staff within the same organization and stakeholders are not uniform globally. We may be careful to find that those systems and behaviors may become really critical to achieve the excellence of science.

It would be virtually impossible for all countries and regions to have the same norms, cultures, legal systems, and working environments for science. In multilateral conversations to promote Open Science and data sharing, it is important to keep in mind the possibility of differences in norms, cultures, and legal systems within each country or region which may exist behind visible scientific research and achievement. Mutual consideration will be important to make the research ecosystem in the Open Science paradigm interoperable globally in a real way.

For example, in Japan, as far as I observe, it is relatively easy to spend funds on research meetings that are explainable as activities directly linked to research achievement. However, funds for activities that are not easily explainable about links to research results, such as promoting the research community's understanding of Open Science, community engagement and promoting research cultural change, tend to be very limited. The difficulty to provide financial support to the international activities of this kind may be beyond expectations of science stakeholders in the western countries.

Kamran Naim

HEAD OF OPEN SCIENCE, CERN

The COVID-19 pandemic has brought deficiencies in the traditional model of science into sharp focus and has brought open science to the forefront of global science policy.

At the European Organization for Nuclear Research (CERN), we have mobilized our resources and expertise to aid the global fight against COVID-19. As this fight continues, it is incumbent upon the scientific community to recognize the potential for open science, not only in addressing global crises such as climate change, but in building a future scientific ecosystem that is optimized to achieve scientific progress for the benefit of all.

At CERN, the practice of open science has long supported our frontier research in high energy physics. With the values of openness enshrined in our founding convention and further espoused through organizational policies, our pursuit of open science represents an expression of our responsibility to our member states and the global scientific community to effectively deliver on our scientific mission and advance the boundaries of human knowledge. We were early adopters of open source (including releasing the software for the Worldwide Web in 1994), support open-source hardware, ushered in the preprint culture, pioneered global initiatives which have transitioned our discipline to open access (with the Sponsoring Consortium for Open Access Publishing in Particle Physics – SCOAP[3]), and systematically open our experimental data (through the CERN Open Data Portal). As policymakers look to build a resilient science infrastructure for the future, as strong advocates for open science we have two key lessons to share:

Open access must become the default.

The COVID-19 pandemic prompted an unprecedented response for the research community to rapidly and openly share research publications. This recognition was also shared by more than 50 academic publishers who mobilized to liberate their content, in what effectively represents a tacit admission that the traditional paywalled model of scientific research is clearly suboptimal in addressing global crises. However, the limited and temporary approaches adopted by many publishers to provide this access fail to address the systemic problems in scientific communication. Immediate open access must become

the default standard, with licenses that enable optimal scientific reuse. These principles underlie the SCOAP[3] initiative in high-energy physics, a global cooperation of librarians and publishers operating since 2014, which demonstrates that the transformation of entire disciplines to open access is indeed feasible and sustainable, and has inspired more progressive and cooperative approaches to open access.

When it comes to research data, open is not enough.

Similar to research articles, the embrace of open practices around research data relating to COVID-19 has demonstrated the importance of research data access and reuse. These datasets have been critical to informing public health strategies, their impact on socio-economic policies, as well as the testing and development of therapeutic drugs and vaccines. However, with a lack of harmonization across the diverse set of data sources, much valuable COVID-19 research data has remained under-exploited and efforts must be undertaken to ensure the research data is sufficiently findable, accessible, interoperable and reusable (FAIR). As the volume of research output has rapidly proliferated around COVID-19, there has been a warranted push for the release of associated research data, for purposes of reuse as well as ensuring the veracity and reproducibility of research. At CERN, we have learned that simply releasing scientific data or software alone is often insufficient to ensure that further scientific value can be derived from them. Open data must be accompanied by the associated knowledge—analyses, computational environments, workflows, notebooks, etc. Systematic analysis preservation (through systems such as CERN Analysis Preservation) can enable meaningful reuse and reanalysis, and support the reproducibility of results by future research teams and communities. The Zenodo platform, hosted by CERN, has enabled researchers to deposit data sets, software, workflows, reports, and any other research-related digital artifacts. During the COVID-19 pandemic, Zenodo utilized its unique proposition to help in the fight against the virus with the development of the Coronavirus Disease Research Community that collects artifacts of relevance to COVID-19 research, which contains billions of data points and findings related to COVID-19. Further, by enabling enhanced storage, Zenodo supported the data sharing needs of resource-deprived communities who lack the critical infrastructure for data provision.

Effectively leveraging open science to address global crises requires policymakers, research institutions and funding agencies to support, incentivize, and mandate open science practices. The devastating global impact of the pandemic must motivate us to build a global research ecosystem that is responsive, effective, transparent and dynamic, equipping us to better respond to current and future challenges.

Natalia Norori

DATA WRANGLER AND SYSTEMS MANAGER, OA.WORKS

Using open science for public good can help tackle some of the world's most pressing issues, including public health and climate change. The Covid-19 pandemic has brought to light the importance of open science in crisis response and recovery. Although Covid-19 has spread to all corners of the world, it has not affected everyone equally.

The pandemic has exacerbated pre-existing inequalities, causing greater damage to members from at-risk populations. In the context of Covid-19, open science has enabled us to research faster, but that does not mean research has been equally distributed.

For open science to help mitigate the impacts of climate change, it needs to be fairly and thoughtfully implemented, and have principles of trust and inclusivity at its core. Openly sharing the entire research process, along with its results, incentivizes participation and helps remove key barriers that prevent members of vulnerable or underrepresented groups from being part of the global scientific community. Similarly, including communities (such as Indigenous Peoples; people with disabilities; the LGBQ+ community; immigrants etc.) in the research process, and creating spaces for them to have their voices heard can ensure that the outcomes that can be achieved from open science directly benefit them.

Put vulnerable populations at the center of open science

To be able to apply lessons learned from Covid to climate change, the movement needs to work in ensuring that those who have the important questions can access and produce research, and transform it into real world impact for the people they care about. There is a critical need to include the needs of local communities, immigrants, women, Indigenous Peoples, people with disabilities, and other vulnerable populations in open science to ensure no one is left behind.

Health disparities, and economic and social inequalities can be mitigated if different communities and vulnerable groups are meaningfully engaged and made visible in research, while protecting against surveillance and profiling. Two important points for action are investing in resources to expand the collection and analysis of relevant

disaggregated data, and creating safe spaces that incentivize the participation of vulnerable groups and minorities in the research process.

There are around 7.8 billion people in the world, and only about 1.3 million of them speak English. More than three-quarters of scientific papers are published in English. Technically, only around 16% of the world population could read and understand the vast majority of the scientific literature if they wanted to.[1] By making sure the information relevant to certain communities is available in a language and format they can understand, we can help lower the language barriers that prevent a subgroup of researchers whose mother tongue is not English from being part of the conversation. This, combined with opening up research methods, fosters reproducibility.

Apply open science practices to policy drafting processes

Implementing the principles of open science into crisis mitigation and response plans could help strengthen collaboration between multiple stakeholders, and open up the space for diverse voices to participate in AI deployment for medicine. From Covid-19, we have learned that representatives of certain groups are not involved in the policy drafting process, and are only contacted during the final consultation process.

To understand the needs of minority groups in terms of climate change and future health emergencies, we need to develop a framework that supports the engagement with different communities and organizations around their current needs during all parts of the policy-making process. This promotes open science and collaboration, and contributes to the creation of effective actions.

Applying the principles of open science to policy drafting and consulting strengthens collaboration between sectors and facilitates the participation of diverse voices.

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1. Growth of #preprints
2. Need for sustainable Open Science infrastructure
3. Importance of Open Access journals disseminating #COVID19 research

For the research networks, providing stable and secure infrastructure is obviously the top priority so the pandemic accelerated and shaped plans we already had. A dedicated work package in AfricaConnect3 to "Establish a framework for sustainable Open Access repository and journal development in Africa" became "Establish a framework for sustainable Open Science infrastructure in Africa".

The increased calls for sustainable open infrastructure funding were also instructive. In Africa, to be sustainable, these have to be open collaborative multilingual shared public infrastructures - not for profit/non-commercial, governed and owned by the community, and funded collectively by governments, funders and institutions, reflecting the diverse interests and needs of the research community and society.

The LIBSENSE "Open Science Africa: Principles and Actions for Global Participation" statement describes this further: https://spaces.wacren.net/display/LIBSENSE/

In AfricaConnect3, we are deploying demonstrators to enable further best practice and policy enactment to occur and be documented, and also enable further digital skills development. Noteworthy pilots are:

- National Shared Platform for Journals, Micropublications and Preprints in Nigeria (national level)
- National Shared Research Data Repository Platform in Côte d'Ivoire (national level)
- Continental Shared Agricultural Data and Publications Platform with RUFORUM (regional, multi-institutional level)
- Pan-African Identity Management Federation program (eduID.africa) for secure access (continental level)

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1. Open access to content is vital but this should be discoverable and include good metadata. More can be done to increase data availability.
2. Preprints can play an important role in the communication of research but peer review is still needed to ensure trust.
3. Recent trends present an opportunity to study publishing itself, and to learn from experiences to create a more transparent and equitable global system.

Open and efficient publishing

As researchers all over the world worked to learn more about COVID-19 and its impact, there was no question that content should be published open access, supporting the belief that this is the best approach for sharing findings, for others to build on them and to reduce duplication of efforts. More than 90% of the early literature was open access, including content opened up by some publishers which would ordinarily have been paywalled.

We saw attempts to speed up publication but retain quality, such as the move by the journal eLife to include preprint publishing by default and to reduce some of the pressures of the journal article peer review process, while at the same time underscoring its importance. Further adaptations to journal peer review were demonstrated by the group of publishers and related organisations who collaborated to ensure that COVID-19 papers are reviewed and published as quickly and openly as possible, by expanding the reviewer pool, porting reviews between publishers, actively encouraging preprints, and strengthening data requirements.

Other initiatives focussed on adding review to preprints themselves, such as Outbreak Science PREreview and Rapid reviews COVID-19. These have potential to improve transparency and equity in publishing, but they are not well-funded and will need support in order to have stability in the long term.

The use of preprints was already growing and studies have tracked the acceleration during the pandemic. Many authors used preprints for the first time during this period and preprint servers hosted almost 25% of COVID-19 related science. But there is caution too that the limitations of preprints without peer review are made clear to non-academic audiences, and are considered across all formats by which preprints are downloaded and shared, especially given the growing usage of preprints in the media and in policy decision making.

Studies monitoring preprints and subsequent journal publication show that journals still play an important role, but also highlight the lengthy time to publication and much slower peer review within the journal publishing environment, even for COVID-19 papers.

The volume of COVID-19 submissions put a strain on the journal publishing system and also led to issues with data and code availability. Overall, data sharing was low – less than 30% of articles provided a link to at least one dataset. Adoption of open science practices would have avoided research duplication, dubious quality and retractions. But centralised data sharing has been a success: Open sharing of data in the CORD-19 database has been hailed as a strength of the global response, becoming a de facto standard for text and data mining.

What does this mean for open publishing and climate research?

Access to published research remains a problem. Lacking the emergency status of COVID-19, only 38% of published climate science is openly available and this includes "free to read" versions which don't necessarily comply with the agreed definition of open access for reuse. In order to have the widest possible benefit, research findings need to be discoverable, reusable and have associated data.

Preprints provide a successful mechanism for more rapid sharing of results, but peer review remains fundamental for trust in scholarly communication. Experiments show, however, that it can be applied to varying degrees and at different stages in the publishing process to reduce burden and increase efficiency.

As for all global challenges, there is an imperative to share knowledge across and within countries and, crucially, to ensure that none are excluded from participating, accessing and contributing to research and development of solutions, whether that be by a financial or language barrier. Continued work is needed on the financial mechanisms underpinning research communication and open science – both publishing and the supporting infrastructure – to ensure a fair and equitable system.

Open access and reuse of content is a building block of open science, but it is not possible to pre-determine what research should be open in order to be useful. Full open access of all content may have led to faster solutions in both medical and socio-economic contexts during the pandemic, and the same will be true for every other challenge facing humanity.