Towards a UNESCO Recommendation on Open Science
5th meeting of the UNESCO Open Science Advisory Committee
17 February 2021

Background and Objectives

In line with the Resolution 40 C/Resolution 24 of the UNESCO General Conference and to guide the consultative process towards developing the UNESCO Open Science Recommendation, the Director-General of UNESCO established an international Advisory Committee on Open Science in June 2020.

With the guidance of this Advisory Committee the first draft of the Recommendation on Open Science was developed in September 2020 and shared with the Member States by the UNESCO Director-General. The comments and observations on this text received by the UNESCO Member States were discussed in the previous meeting of the Advisory Committee, in order to prepare a second draft of the future Recommendation on Open Science.

The Advisory Committee met to discuss the integration of the comments during their fourth meeting on 1 February 2021. Based on the discussions, the second draft was prepared by the Secretariat with contributions from the members of the Advisory Committee and the UNESCO Intersectoral Task Team on Open Science. It was shared with the members of the Advisory Committee on 13 February 2021. The fifth meeting of the Advisory Committee was held on 17 February 2021. The main objectives of the meeting were to discuss and agree on the second draft of the UNESCO Open Science Recommendation to be submitted to the Director General of UNESCO for transmission to Member States.

The Chair of the Advisory Committee, Prof Fernanda Beigel from Argentina, chaired the meeting.

Report

After opening of the meeting by Dr Peggy Oti-Boateng, director Division of Science Policy and Capacity building, UNESCO, Prof Fernanda Beigel, Chair of the Advisory Committee, adopted the agenda.

Presentation and discussion of the second draft of the future UNESCO Open Science Recommendation

The UNESCO secretariat shared the preliminary second draft of the Recommendation with the Members on 13 February for consideration. Dr Ana Persic, Chief of section a.i. Science Policy and Partnerships section, presented the second draft of the Recommendation noting that most of the comments from Member States and partners were integrated in the text.

Under the Chairmanship of Dr Fernanda Beigel, the Members of the Advisory Committee shared their views and feedback on the preliminary second draft of the Recommendation, focusing on five general issues:

1. Reference to COVID-19 crisis in the preamble;

2. Defining the various key pillars of Open Science;
3. Use of the word actors, stakeholders, or agents of Open Science;
4. Reconciliation of Open Science with Intellectual Property Rights (IPR) legislation; and
5. Position of indigenous knowledge in relation to Open Science.

Regarding the reference to the current COVID-19 crisis in the preamble, the Advisory Committee agreed that this crisis has globally affected all aspects of life, and that the crisis very clearly exemplifies the necessity and importance of Open Science to study the coronavirus, investigate effective treatment and develop vaccines. However, the members also argued that the UNESCO Open Science Recommendation should be applicable to any global crisis, not just health crises or specifically the COVID-19 pandemic. In addition, there is a risk that referencing this specific crisis too extensively makes the document time-bound. The members of the Advisory Committee agreed to refer to the COVID-19 pandemic once in the preamble, as an example highlighting the paramount of Open Science.

For the definition section of the Recommendation, the Advisory Committee discussed the scope and links of the various key pillars of Open Science. Several members noted that Open Science should be defined broadly with a focus on collaboration, rather than narrowing the definition down to Open Access. Furthermore, the committee members agreed that although access restrictions should be acknowledged and defined, such restrictions should only be applied as exceptions to the rule of openness. They agreed on defining five key pillars of Open Science, namely: open access to scientific knowledge, open science infrastructures, open engagement of societal actors, open dialogue with other knowledge systems, and open science communication.

The members of the Advisory Committee discussed the choice of words regarding the actors, stakeholders, or agents of Open Science. The Advisory Committee reached a consensus on the use of the word actors, varying the term with stakeholders where appropriate. According to some members of the Committee, the term stakeholders carries negative connotations among Indigenous Peoples, as the term doesn't address the asymmetries in power between communities. The Committee agreed to list all Open Science actors in brief. The members of the Committee noted that the private sector should be added to the list in the Recommendation, acknowledging that the list cannot be exhaustive.

In order to discuss the reconciliation of Open Science with respect to Intellectual Property Rights (IPR) legislation in more depth, the Advisory Committee invited Brigitte Vézina, Director of Policy at Creative Commons, to join the discussion. She focused on the intersection between copyright laws and Open Science. She explained that copyright legislation protects scientific output by default, providing a monopoly to the creator (author) until 70 years after the creator deceases. After this period of protection, the work falls into the public domain. Creative Common licenses give authors the option to grant varying levels of permission for public use. The licenses are a solution to reduce access restrictions within the existing framework of copyright.

Furthermore, Ms Vézina explained that the current framework of copyright provides for exceptions and limitations of protection, e.g. for educational use and use in the public interest. This flexibility, however, is currently underused and private companies try to bypass exceptions through contracts. Instead, Ms Vézina recommended the use of Creative Commons in the context of Open Science. The cc-by license (openly available with author attribution) is

recommended for openly accessible publications and the cc-0 license (openly available for everyone to access and re-use) is recommended for data.

Regarding the Recommendation, the members of the Advisory Committee agreed that several Member States would benefit from an explanation on the reconciliation of IPR and the Open Science framework.

The Advisory Committee agreed that in the second draft text of the Recommendation, the position of indigenous knowledge in relation to Open Science is formulated better. Based on the consultation with Indigenous Peoples, in which it became apparent that some indigenous communities feel threatened by the Open Science movement, the focus changed from assimilation and incorporation of indigenous knowledge into the Western science system, to promoting an open dialogue between the different knowledge systems. The Committee agreed that the rights of Indigenous Peoples to restrict their knowledge are sufficiently addressed in the draft Recommendation and should not be emphasized more.

Next Steps

Dr Persic informed the members of the Advisory Committee about the timeline and the next steps in the process of the development of the UNESCO Recommendation on Open Science as presented below.

- Based on the discussion during the meeting, the UNESCO Secretariat, under the guidance of the Chair of the Advisory Committee, would finalize the revised draft Recommendation on Open Science, as provided in Annex II of this report, which the members of the Advisory Committee via email endorsed on 25 February.
- 30 March 2021: the revised draft of the UNESCO Recommendation on Open Science will be sent to Member States
- 6-7 and 10-12 May 2021: Intergovernmental meeting of experts to negotiate the UNESCO Recommendation on Open Science
- If necessary, additional intergovernmental meeting is foreseen for 5-7 July 2021
- The final text will be presented to the 41st session of the General Conference in November 2021 for consideration and adoption

Closing remarks

In her closing remarks, Dr Peggy Oti-Boateng, director Division of Science Policy and Capacity building, UNESCO, thanked the members of the Advisory Committee for a very fruitful, dynamic and forward-looking discussion.

Annex I – List of participants

A. Members of The Open Science Advisory committee

1. Ms Hanne Monclair, Policy Director, Department for Higher Education, Research and International Affairs, Ministry of Education and Research, Oslo, Norway

2. Mr Delfim F. Leão, Vice-rector for Culture and Open Science, Coimbra University, Portugal
3. Ms Ausra Gribauskiene, Chief Officer, Division of Science, Ministry of Education, Science and Sport, Vilnius, Lithuania
4. Mr Jakub Szprot, Head of the Open Science Platform, Interdisciplinary Centre for Mathematical and Computational Modelling, University of Warsaw, Poland
5. Ms Aleksandra Barac, MD, Scientific Associate, Clinic for Infectious and Tropical Diseases, Clinical Centre of Serbia, Faculty of Medicine, University of Belgrade, Belgrade, Serbia
6. Ms Fernanda Beigel, Researcher at CONICET and professor at the Faculty of Political and Social Sciences, National University of Cuyo, Mendoza-Argentina
7. Mr Luiz Fernando Fauth, Advisor to the Vice-Minister, Ministry of Science, Technology, Innovations and Communications (MCTIC), Brazil
8. Mr Gregory Randall, Professor, Institute of the Electronic Engineering, University of Republic, Uruguay
9. Ms Grisel Romero Hiller, President of the National Observatory of Science, Technology and Innovation, Venezuela
10. Mr Juncai Ma, Director, Institute of Microbiology and the Information Centre, Chinese Academy of Sciences, China
11. Mr Kazuhiro Hayashi, Senior research fellow, National Institute of Science and Technology Policy, Japan
12. Ms Noorsaadah Abd. Rahman, Deputy Vice-Chancellor, Department of Chemistry, Faculty of Science, University of Malaya, Malaysia.
13. Ms Eun Jung Shin, Head of the Office of Institutional Innovation Research, Science and Technology Policy Institute (STEPI), Republic of Korea
14. Ms Vivian Etsiapa Boama, Senior lecturer at the Kwame Nkrumah University of Science and Technology (KNUST), Ghana
15. Ms. Jane Mubanga Chinkusu, Director of Science and Technology, Ministry of Higher Education, Zambia
16. Mr Essam Khamis Ibrahim Al-Hanash, Advisor to President of Alexandria University for International Ranking and Scientific Research, Egypt
17. Mr Mouïn Hamzé, Secretary General, National Council for Scientific Research, Lebanon
18. Mr Ahmed Ali Abdalla Murad, Acting Associate Provost for Research, United Arab Emirates University (UAEU), United Arab Emirates
19. Mr Simon Hodson (UK), Executive Director of CODATA (Committee on Data for Science and Technology)
20. Ms Iryna Kuchma (Ukraine), Open Access Programme Manager, Electronic Information for Libraries (EIFL)
21. Ms Carolina Botero (Colombia), Director of the Karisma Foundation
22. Ms. Joji Carino (The Philippines), Senior Policy Advisor, Forest Peoples Programme
23. Mr Henri Edouard Zefack Tonnang (Kenya), Researcher, Member of the Open Science Working Group, Global Young Academy
24. Mr Stanislav Stanislavovich Davydenko, Deputy Head of Department, Institute of Applied Physics, Russian Academy of Sciences, Russian Federation
25. Ms Faiza Al-Kharafi (Kuwait), L'Oréal UNESCO FWIS 2011 Laureate, Board member of the Academy of Sciences for the Developing World (TWAS)

26. Mr Philemon Mphathi Mjwara, Director-General of the South African Department of Science and Technology (DST), South Africa

B. External speaker:

27. Ms Brigitte Vézina, Director of Policy at Creative Commons, the Netherlands

C. Observers:

28. Mr Marc Vanholsbeeck (Belgium), Director of the Directorate of Scientific Research of the Ministry of the Wallonia-Brussels Federation
29. Ms Dina Bacalexi (France), research engineer of French National Centre for Scientific Research
30. Mr Tommi Himberg (Finland), Counsellor of Education and Science in the permanent delegation of Finland to the OECD and UNESCO
31. Ms Luz Fabiola Gómez (Colombia), Advisor at the Ministry of Science, Technology and Innovation
32. Mr Ismael Madrigal (Delegation of Mexico)
33. Anna Chirkova (delegation of Russian federation)
34. Valentina Velasquez (delegation of Colombia)
35. Emma Rodriguez (delegation of Mexico)
36. Delegation of Argentina

D. Secretariat:

37. Peggy Oti-boateng (DIR/SC/PCB)
38. Ana Persic (Chief a.i. SC/PCB/SPP)
39. Rafieian Fereshteh (Associate Programme Specialist SC/PCB/SPP)
40. Annapaola Coppola (Project Officer SC/PCB/SPP)
41. Despoina Sousoni (Consultant SC/PCB/SPP)
42. Anne-Floor Scholvinck (Secondment SC/PCB/SPP)
43. Armelle WAFO GUEMGNE (Intern SC/PCB/SP)
44. Dinkov Martin (Conferences CLD/C/CCE)
45. Zeynep Varoglu (Programme Specialist CI/DIT)
46. Anna Bonetti (programme coordinator SC/EO/PCE)
47. Bhanu Neupane (programme specialist CI/UAI)
48. Davide Storti (PROGRAMME SPECIALIST CI/MID)

Annex II – Revised draft Recommendation on Open Science

Preamble

The General Conference of the United Nations Educational, Scientific and Cultural Organization (UNESCO), meeting in Paris, from ... to ... November 2021, at its 41st session,

Recognizing the urgency of addressing complex and interconnected environmental, social and economic challenges for the people and the planet, including poverty, health issues, access to education, rising inequalities and disparities of opportunity, increasing science, technology and innovation gaps, natural resource depletion, loss of biodiversity, land degradation, climate change, natural and human-made disasters, spiralling conflicts and related humanitarian crises,

Acknowledging the vital importance of science, technology and innovation (STI) to respond to these challenges by providing solutions to improve human well-being, advance environmental sustainability and respect for the planet's biological and cultural diversity, foster sustainable social and economic development and promote democracy and peace,

Further acknowledging the opportunities and the potential provided by the expansion of information and communication technologies and the global interconnectedness to accelerate human progress and foster knowledge societies and *highlighting* the importance of narrowing the STI and digital gaps existing between and within countries and regions,

Noting the transformative potential of Open Science for reducing the existing inequalities in STI and accelerating progress towards the implementation of the Agenda 2030 and the achievement of the Sustainable Development Goals and beyond,

Considering that more open, transparent, collaborative and inclusive scientific practices, coupled with more accessible and verifiable scientific knowledge subject to scrutiny and critique, is a more efficient enterprise that improves the quality, the reproducibility and impact of science and thereby the reliability of the evidence needed for robust decision-making and policy and increased trust in science,

Noting that the global COVID-19 health crisis has proven worldwide the urgency of fostering an equitable access to scientific information, facilitating the sharing of scientific knowledge, data and information, enhancing scientific collaboration and science- and knowledge-based decision making to respond to global emergencies and increase the resilience of societies,

Committed to leaving no one behind with regard to access to science and benefits from scientific progress by ensuring that the scientific knowledge, data, methods and processes needed to respond to present and future global heath and other crises are openly available for all countries, in accordance with the rights, obligations, exceptions and flexibilities under international agreements,

Affirming the principles of the Universal Declaration of Human Rights, notably those contained in Articles 27, 10 and 19 and *also affirming* the 2007 United Nations Declaration on the Rights of Indigenous Peoples,

Recalling that one of the key functions of UNESCO, as stipulated in Article I of its Constitution, is to maintain, increase and diffuse knowledge by encouraging

cooperation among the nations in all branches of intellectual activity, including the exchange of publications, objects of artistic and scientific interest and other materials of information and by initiating methods of international cooperation calculated to give the people of all countries access to the printed and published materials produced by any of them,

Building on the 2017 UNESCO Recommendation on Science and Scientific Researchers adopted by the UNESCO General Conference at its 39th session which recognizes science as a common good,

Recalling the 2019 UNESCO Recommendation on Open Educational Resources (OER) and the 1971 UNESCO Universal Copyright Convention, and *taking note* of the UNESCO's Strategy on Open Access to Scientific Research and the UNESCO Charter on the Preservation of Digital Heritage adopted by the UNESCO General Conference at its 36th and 32nd sessions, respectively,

Recognizing the importance of the existing international frameworks, in particular on intellectual property, protecting the rights of scientists to their scientific productions,

Acknowledging that the practice of Open Science, anchored in the values of collaboration and sharing, builds upon existing intellectual property systems and fosters an open approach that encourages the use of open licensing, adds to the public domain and makes use of flexibilities that exist in the intellectual property systems to amplify access to knowledge by everyone for the benefits of science and society and to promote opportunities for innovation and participation in the co-creation of knowledge,

Noting that Open Science practices fostering openness, transparency and inclusiveness, already exist worldwide and that a growing number of scientific outputs is already available in the public domain or made available under open license schemes that allow free access, re-use and distribution of work under specific conditions, provided that the creator is appropriately credited,

Recalling that Open Science originated several decades ago as a movement to transform scientific practice to adapt to the changes, challenges, opportunities and risks of the digital era and to increase the societal impact of science, and *noting,* in this regard, the 1999 UNESCO/ICSU Declaration on Science and the Use of Scientific Knowledge and the Science Agenda, the 2002 Budapest Open Access Initiative, the 2003 Bethesda Statement on Open Access Publishing and the 2003 Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities,

Recognizing the significant available evidence for the economic benefits and substantial return on investment associated with Open Science practices and infrastructures, which enable innovation, dynamic research and economic partnerships,

Agreeing that greater access to scientific process and outputs can improve the effectiveness and productivity of the scientific systems by reducing duplication costs in collecting, creating, transferring and reusing data and scientific material, allowing more research from the same data, and increasing the social impact of science by multiplying opportunities for local, national, regional and global participation in the research process, and opportunities for wider circulation of scientific findings,

Considering that the collaborative and inclusive characteristics of Open Science allow new social actors to engage in scientific processes, including through citizen

and participatory science, thus contributing to democratization of knowledge, fighting misinformation and disinformation, addressing existing systemic inequalities and enclosures of wealth, knowledge and power and guiding scientific work towards solving problems of social importance,

Acknowledging that Open Science should not only foster enhanced sharing of scientific knowledge solely among scientific communities but also promote inclusion of scholarly knowledge from traditionally underrepresented or excluded groups (such as women, minorities, Indigenous scholars, scholars from less-advantaged countries and low-resource languages) and contribute to reducing inequalities in access to scientific development, infrastructures and capabilities among different countries and regions,

Recognizing that Open Science respects the diversity of cultures and knowledge systems around the world as foundations for sustainable development, fostering open dialogue with Indigenous peoples and local communities and respect for diverse knowledge holders for contemporary problem-solving and emergent strategies towards transformative change,

Taking into account, in the adoption and application of this Recommendation, the vast diversity of the laws, regulations and customs which, in different countries, determine the pattern and organization of science technology and innovation:

1. Adopts the present Recommendation on Open Science on this … day of November 2021;
2. Recommends that Member States apply the provisions of this Recommendation by taking appropriate steps, including whatever legislative or other measures may be required, in conformity with the constitutional practice and governing structures of each State, to give effect within their jurisdictions to the principles of this Recommendation;
3. Also recommends that Member States bring this Recommendation to the attention of the authorities and bodies responsible for science, technology and innovation, and consult relevant actors concerned with Open Science;
4. Further recommends that Member States report to it, at such dates and in such manner as shall be determined, on the action taken in pursuance of this Recommendation.

I. AIM AND OBJECTIVES OF THE RECOMMENDATION

1. The aim of this Recommendation is to provide an international framework for Open Science policy and practice that recognizes disciplinary and regional differences in Open Science perspectives, takes into account gender-transformative approaches and the specific challenges of scientists and other Open Science actors in different countries and in particular in developing countries, and contributes to reducing the digital, technological and knowledge divides existing between and within countries.

2. This Recommendation outlines a common definition, shared values, principles and standards for Open Science at the international level and proposes a set of actions conducive to a fair and equitable operationalization of Open Science at individual, institutional, national, regional and international levels.

3. To achieve its aim, the key objectives and areas of action of this Recommendation are as follows:

i. promoting a common understanding of Open Science, associated benefits and challenges, as well as diverse paths to Open Science;
ii. developing an enabling policy environment for Open Science;
iii. investing in Open Science infrastructures and services;

iv. investing in human resources, education, digital literacy and capacity building for Open Science;
v. fostering a culture of Open Science and aligning incentives for Open Science;
vi. promoting innovative approaches for Open Science at different stages of the scientific process;
vii. promoting international and multistakeholder cooperation in the context of Open Science and in view of reducing digital and knowledge gaps.

II. DEFINITION OF OPEN SCIENCE

4. As per the 2017 UNESCO Recommendation on Science and Scientific Researchers, the term 'Science' signifies the enterprise whereby humankind, acting individually or in small or large groups, makes an organized attempt, by means of the objective study of observed phenomena and its validation through sharing of findings and data and through peer review, to discover and master the chain of causalities, relations or interactions; brings together in a coordinated form subsystems of knowledge by means of systematic reflection and conceptualization; and thereby furnishes itself with the opportunity of using, to its own advantage, understanding of the processes and phenomena occurring in nature and society.

5. While guaranteeing the academic freedom, research integrity and scientific excellence, Open Science sets a new paradigm for the scientific enterprise by opening scientific contents, tools and processes based on increased reproducibility, transparency, sharing and collaboration.

6. For the purpose of this Recommendation, **Open Science** is defined as an inclusive construct that combines various movements and practices aiming to make scientific knowledge openly available, accessible and reusable for everyone, to increase scientific collaborations and sharing of information for the benefits of science and society, and to open the processes of scientific knowledge creation, evaluation and communication to societal actors beyond the traditional scientific community. It includes all scientific disciplines and aspects of scholarly practices, including basic and applied sciences, natural and social sciences and the humanities, and it builds on the following key pillars: open access to scientific knowledge, open science infrastructures, open science communication, open engagement of societal actors and open dialogue with other knowledge systems. The key pillars of Open Science are defined as follows:

7. **Open access to scientific knowledge** generally refers to access to scientific publications, research data, software, source code and hardware that are available in the public domain or under copyright that has been released under an open licence that permits reuse, repurpose, adaptation and redistribution by others; provided to all actors in a timely manner regardless of location, nationality, race, age, gender, income, socio-economic circumstances, career stage, discipline, language, religion, disability, ethnicity or migratory status; and free of charge to the largest extent possible. Users therefore gain timely, free and affordable access to:

- ***Scientific publications*** that include among others peer-reviewed journal articles, research reports, conference papers, books and the related scientific outputs (e.g. original scientific research results, research data, software, source code, source materials, workflows and protocols, digital representations of pictorial and graphical materials and scholarly multimedia material), that are openly licensed or dedicated to the public domain and deposited, upon publication, in an open online repository, following suitable technical standards, that is supported and maintained by an academic institution, scholarly society, government agency or other well-established not for-profit organization devoted to common good that

enables open access, unrestricted distribution, interoperability, and long-term archiving.

- ***Open research data*** that include among others digital and analogue data, both raw and processed, and the accompanying metadata, as well as numerical scores, textual records, images, and sounds, protocols and workflows that can be openly used, reused, retained and redistributed by anyone subject to acknowledgement. Open research data are available in a timely and user friendly, human- and machine-readable and actionable format, in accordance with principles of good data governance and stewardship, such as for example the FAIR (Findable, Accessible, Interoperable, and Reusable) principles, supported by regular curation and maintenance.
- ***Open source software and source code*** that generally include software whose source code is made publicly available, in a timely and user-friendly manner, in human- and machine-readable and modifiable format, under an open license that grants others the right to use, access, modify, expand, study, create derivative works, and share the software and its source code, design, or blueprint. The source code must be included in the software release and made available on openly accessible repositories and the chosen license must allow modifications, derivative works, and sharing under equal or compatible open terms and conditions.
- ***Open hardware*** that generally include the design specifications of a physical object which are licensed in such a way that said object can be studied, modified, created, and distributed by anyone providing as many people as possible the ability to construct, remix, and share their knowledge of hardware design and function. In the case of both open source software and open hardware, a community-driven process for contribution, attribution and governance is required to enable reuse, improve sustainability and reduce unnecessary duplication of effort.

8. Access to scientific knowledge should be as open as possible. Access restrictions are only justifiable on the basis of national security, confidentiality, privacy and respect for subjects of study, legal process and public order, the protection of intellectual property rights, personal information and the protection of human subjects, of sacred and secret indigenous knowledge, and of rare, threatened or endangered species. Some research results, data or code that is not openly available, accessible and reusable, may nonetheless be shared among specific users according to defined access criteria made by local, national or regional pertinent governing instances. In cases where data cannot be openly accessible, it is important to develop tools and protocols for pseudonymising and anonymizing data, as well as systems for mediated access, so that as much data as possible can be shared as appropriate. The need for justified restrictions may also change over time, allowing the data to be made accessible at a later point.

9. **Open science infrastructures** refer to shared research infrastructures (including major scientific equipment or sets of instruments, knowledge-based resources such as collections, repositories, archives and scientific data, open computational infrastructures that enable data analysis and digital infrastructures) that are needed to support Open Science and serve the needs of different communities. Open labs, open science platforms and repositories are among the critical open science infrastructures, which provide essential open and standardised services to manage and provide access, portability, analysis and federation of data, scientific literature, thematic science priorities or community engagement. Different repositories are adapted to local circumstances, user needs and the requirements of research communities, yet should adopt interoperable standards and best practices to ensure

the content in repositories is appropriately vetted, discoverable and reusable by humans and machines. Open innovation testbeds, accessible research facilities, open license stewards, as well as science shops, science museums and exploratories are additional examples of open science infrastructures providing common access to physical facilities, capabilities and services. Open Science infrastructures are often the result of community building efforts, which are crucial for their long-term sustainability and therefore should be not-for profit and guarantee permanent and unrestricted access to all public to the largest extent possible.

10. **Open engagement of societal actors** refers to extended collaboration between scientists and societal actors beyond the scientific community, by opening up practices and tools that are part of the research cycle and by making the scientific process more inclusive and accessible to the broader inquiring society. In the perspective of developing a collective intelligence for problem solving, including through the use of transdisciplinary research methods, Open Science provides the basis for citizen and community involvement in the generation of knowledge and integration of concerns, values, and world-views of policymakers and practitioners, entrepreneurs, and community members, giving them a voice in developing research that is compatible with their needs and aspirations. Citizen and participatory science have developed as a model of scientific research conducted by non-professional scientists, but frequently carried out in association with formal, scientific programmes or with professional scientists with the web-based platforms and social media, as well as open source hardware and software (especially low-cost sensors and mobile apps) as important agents of interaction. For the effective reuse of the outputs of citizen and participatory science by other actors, including scientists, these products should be subject to the curation, standardization and preservation methods necessary to ensure the maximum benefit to all.

11. **Open dialogue with other knowledge systems** refers to the dialogue between different knowledge holders, that recognizes the richness of diverse knowledge systems and epistemologies and diversity of knowledge producers in line with the 2001 UNESCO Universal Declaration on Cultural Diversity. It aims to promote the inclusion of knowledge from traditionally marginalized scholars and enhance inter-relationships and complementarities between diverse epistemologies based on the principle of non-discrimination, adherence to international human rights norms and standards, respect for knowledge sovereignty and governance, and the recognition of rights of knowledge holders to receive a fair and equitable share of benefits that may arise from the utilization of their knowledge. In particular, building the links with Indigenous Knowledge Systems needs to be done in line with the 2007 United Nations Declaration on the Rights of Indigenous Peoples and the principles for Indigenous Data Governance, such as for example the CARE (Collective Benefit, Authority to Control, Responsibility, and Ethics) data principles. Such efforts acknowledge the rights of Indigenous peoples and local communities to govern and make decisions on the custodianship, ownership and administration of data on traditional knowledge and on their lands, and resources.

12. **Open science communication** refers to a range of science communication activities that accompany Open Science practices and that support the dissemination of scientific knowledge to scholars in other research fields, decision-makers, and the public at large. It includes dissemination of scientific information through scientific journalism, popularization of science, open lectures and various social media communications. These activities build public trust in science while increasing the engagement of societal actors beyond the scientific community. To avoid misinterpretation and dissemination of misinformation, the quality and appropriate

citation of original sources of information are the paramount of open science communication.

13. There are multiple actors and stakeholders in research and innovation systems and each of them has a role to play in the operationalization of Open Science. Regardless of their nationality, ethnicity, gender, language, age, discipline, socio-economic background, funding basis and career stage, Open Science actors include, among others: researchers, scientists and scholars; leaders at research institutions, educators, academia, members of professional societies, students and young researcher organizations, librarians, innovators, users and the public at large, including communities, indigenous knowledge holders and civil society organizations; information specialists, computer scientists, software developers, coders, creatives, innovators, engineers, citizen scientists, legal scholars, legislators, magistrates and civil servants, publishers, editors and members of professional societies, technical staff, research funders, policy-makers, learned societies, practitioners from professional fields and representatives of the science, technology and innovation related private sector.

III. OPEN SCIENCE CORE VALUES AND GUIDING PRINCIPLES

14. The core values of Open Science stem from the rights-based, ethical, epistemological, economic, legal, political, social, multistakeholder and technological implications of opening science to society and broadening the principles of openness to the whole cycle of scientific research. They include:

- ***Quality and Integrity***: Open Science should respect academic freedom and human rights and support high quality research by bringing together multiple sources of knowledge and making research methods and outputs widely available for rigorous review and scrutiny, and transparent evaluation processes;
- ***Collective Benefit****:* as a global public good, Open Science should belong to humanity in common and benefit humanity as a whole. To this end, scientific knowledge should be openly available and its benefits universally shared. The practice of science should be inclusive, sustainable and equitable, also in opportunities for scientific education and capacity development.
- ***Equity and Fairness***: Open Science should play a significant role in ensuring equity among researchers from developed and developing countries, enabling fair and reciprocal sharing of scientific inputs and outputs and equal access to scientific knowledge to both producers and consumers of knowledge regardless of location, nationality, race, age, gender, income, socio-economic circumstances, career stage, discipline, language, religion, disability, ethnicity or migratory status;
- ***Diversity and Inclusiveness***: Open Science should embrace a diversity of knowledge, practices, workflows, languages, research outputs and research topics that support the needs and epistemic pluralism of the scientific community as a whole, diverse research communities and scholars, as well as the wider public and knowledge holders beyond the traditional scientific community, including Indigenous Peoples and local communities, and social actors from different countries and regions, as appropriate;

15. The following guiding principles for Open Science provide a framework for enabling conditions and practices within which the above values are upheld, and the ideals of Open Science are made a reality:

- ***Transparency, scrutiny, critique and falsifiability***: increased openness should be promoted in all stages of the scientific endeavour to enhance the societal impact of science and increase the capacity of society as a whole to solve complex interconnected problems. Increased openness leads to increased

transparency and trust in scientific information and reinforces the fundamental feature of science as a distinct form of knowledge based on evidence and tested against reality, logic and the scrutiny of scientific peers.

- ***Equality of opportunities***: all scientists and other Open Science actors and stakeholders, regardless of location, nationality, race, age, gender, income, socioeconomic circumstances, career stage, discipline, language, religion, disability, ethnicity or migratory status, have an equal opportunity to access, contribute to and benefit from Open Science.
- ***Responsibility, respect and accountability***: with greater openness comes greater responsibility for all Open Science actors, which, together with public accountability, sensitivity to conflicts of interest, vigilance as to possible social and ecological consequences of research activities, intellectual integrity and respect for ethical principles and implications pertaining to research, should form the basis for good governance of Open Science.
- ***Collaboration, participation and inclusion:*** collaborations at all levels of scientific process, beyond the boundaries of geography, language, generations, disciplines and resources, should become the norm, together with the full and effective participation of societal actors and inclusion of knowledge from marginalized communities in solving problems of social importance.
- ***Flexibility***: due to the diversity of science systems, actors and capacities across the world, as well as the evolving nature of supporting information and communication technologies, there is no one-size fits all way of practicing Open Science. Different pathways of transition to and practice of Open Science need to be encouraged while upholding the above-mentioned core values and maximizing adherence to the other principles hereby presented.
- ***Sustainability***: to be as efficient and impactful as possible, Open Science should build on long-term practices, services, infrastructures and funding models that ensure the equal participation of scientific producers from less privileged institutions and countries. Open Science infrastructures should be organized and financed upon a non-for profit, long-term vision, which enhance Open Science practices, and guarantee permanent and unrestricted access to all to the largest extent possible.

IV. AREAS OF ACTION

16. To achieve the objectives of this Recommendation, Member States are recommended to take concurrent action in the following seven areas, taking into account their individual political, administrative and legal contexts.

(i) Promoting a common understanding of Open Science, associated benefits and challenges, as well as diverse paths to Open Science

17. Member States are recommended to promote and support the common understanding of Open Science as defined in this Recommendation, within the scientific community and among the different Open Science actors, and strategically plan and support Open Science awareness raising at institutional, national and regional levels while respecting diversity of Open Science approaches and practices. Member States are encouraged to consider the following:

a. Ensuring that Open Science incorporates the values and principles as outlined in this Recommendation to ensure that the benefits of Open Science are shared and reciprocal, and do not involve unfair and/or inequitable extraction of data and knowledge by technologically and economically more advanced countries and entities;
b. Ensuring that publicly funded research is undertaken based on the principles of Open Science and that, in line with the provisions of this Recommendation, the scientific knowledge from the publicly funded research, including scientific

publications, open research data, open software, source code and open hardware, is openly licensed or dedicated to the public domain with minimal embargo;
c. Encouraging bibliodiversity, as the diversity of publications and publishing models, as well as multilingualism in the practice of science and in scholarly communications;
d. Ensuring that the needs and rights of communities, including the rights of Indigenous Peoples over their traditional knowledge, as expressed in the 2007 United Nations Declaration on the Rights of Indigenous Peoples should not be infringed on in Open Science practices;
e. Enhancing Open Science communication to support the dissemination of scientific knowledge to scholars in other research fields, decision-makers, and the public at large;
f. Engaging the private sector in the discussion about the ways in which the scope of Open Science principles and priorities can be enlarged and mutually shared;
g. Enabling open multistakeholder discussions on Open Science benefits and its real and apparent challenges as regards, for example, competition, extraction and exploitation of data by more advanced technologies, links to intellectual property rights, privacy, security and inequalities between publicly and privately funded research, in order to constructively address these challenges and implement Open Sciences practices in line with the values and principles outlined in this Recommendation.

(ii) Developing an enabling policy environment for Open Science

18. Member States, according to their specific conditions, governing structures and constitutional provisions, should develop or encourage policy environments, including those at the institutional, national, regional and international levels that support operationalization of Open Science and effective implementation of Open Science practices. Through a transparent participatory, multistakeholder process that includes dialogue with the scientific community and other Open Science actors, Member States are encouraged to consider the following:

a. Developing effective institutional and national Open Science policies and legal frameworks that are consistent with existing international and regional legislations and that are in line with the definition, values and principles as well as actions outlined in this Recommendation;
b. Aligning Open Science policies, strategies and actions from local to international levels;
c. Encouraging research-performing institutions, particularly those in receipt of public funds, to implement policies and strategies for Open Science.
d. Encouraging research-performing institutions, universities, scientific unions and associations, and learned societies to adopt statements of principle in line with this Recommendation to encourage Open Science practice in coordination with national science academies and the International Science Council;
e. Enhancing the inclusion of citizen and participatory science as integral parts of Open Science policies and practices at the national, institutional and funder levels;
f. Designing models that allow co-production of knowledge with multiple actors and establishing guidelines to ensure the recognition of non-scientific collaborations;
g. Encouraging responsible research and researcher evaluation and assessment practices, which incentivize and reward quality science and recognize the diversity of research outputs, activities and missions;
h. Fostering equitable public-private partnerships for Open Science and engaging the private sector in Open Science, provided that there is appropriate certification and regulation to prevent vendor lock-in, predatory behaviour and unfair and/or inequitable extraction of profit from publicly funded scientific activities. Given the

public interest in Open Science and the role of public funding, Member States should ensure that the market for services relating to science and Open Science functions in the global and public interest and without market dominance on the part of any commercial entity;

i. Designing, implementing and monitoring funding and investment policies and strategies for science based on the core values and principles of Open Science. The costs associated with operationalization of Open Science relate to the support of Open Science research, publishing and data practices, the development and adoption of Open Science infrastructures and services; capacity building of all actors and innovative, highly collaborative and participatory approaches to the scientific enterprise.

(iii) Investing in Open Science infrastructures and services

19. Open Science both requires and merits systematic and long-term strategic investment in science technology and innovation, with emphasis on investment in technical and digital infrastructure and related services. Considering science as a global public good, Open Science services should be viewed as essential research infrastructures, 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. Member States are encouraged to promote non-commercial Open Science infrastructures and ensure adequate investment in:

a. Science, technology and innovation, with at least 1% of national gross domestic product (GDP) dedicated to research and development expenditure.
b. Reliable internet connectivity and bandwidth for use by scientists and science users across the world.
c. National research and education networks (NRENs) and their functionality, encouraging regional and international collaboration to ensure maximum interoperability and alignment between NREN services.
d. Non-commercial infrastructures, including computing facilities and digital public infrastructure supporting Open Science in order to ensure the long-term preservation, stewardship, and community control of research products, including scientific information, data and source code. Any research supporting infrastructure or service should have a strong community-led base and ensure interoperability and inclusivity. These open infrastructures could be supported by direct funding or through an earmarked percentage of each funded grant.
e. Federated and diversified information technology infrastructure for Open Science, including high performance computing and data storage where needed, and robust, open and community managed infrastructures, protocols and standards to support bibliodiversity and engagement with society. While avoiding fragmentation by enhancing the federation of existing Open Science infrastructures and services, attention should be given to ensuring that this infrastructure is accessible for all, internationally interconnected and as interoperable as possible, and that it follows certain core specifications, such as for example the FAIR and CARE principles for data stewardship. Technical requirements for every digital object of significance for science, whether a datum, a dataset, metadata, code, a publication should also be addressed. Due care should also be given to persistent identifiers of digital objects. Examples include the definition and attribution of open persistent identifier as appropriate for each type of digital objects, the necessary metadata for their efficient assessment, access, use and re-use, and proper stewardship of data by a trusted global network of data repositories.
f. Community agreements, concluded in the context of global research communities, and which define community practices for data sharing, data formats, metadata standards, ontologies and terminologies, tools and infrastructure. International Scientific Unions and Associations, regional or

national research infrastructures, and journal editorial boards each have a role to play in helping develop these agreements. In addition, convergence between the various semantic artefacts (particularly vocabularies, taxonomies, ontologies and metadata schema) is essential for the interoperability and reuse of data for interdisciplinary research.

g. South-south collaborations to optimize infrastructure use and joint strategies for shared, multinational, regional and national Open Science platforms. Such initiatives are a mechanism to provide coordinated support for Open Science covering: access to Open Science services and research infrastructures (including storage, stewardship, data Commons), alignment of policies, educational programmes and technical standards. With a number of initiatives underway in different regions, it is important that they should interoperate from the perspective of policy, practices and technical specifications. It will also be important to invest in funding programmes to enable scientists to create and use such platforms, particularly in low- and middle-income countries.
h. A new generation of open information technology tools that automate the process of searching and analysing linked publications and data, making the process of generating and testing hypotheses faster and more efficient. These tools and services will have maximum impact when used within an Open Science framework that spans institutional, national, and disciplinary boundaries, while addressing potential risks and ethical issues that may arise from the development and use of such artificial intelligence technologies.
i. Innovative approaches at different stages of the scientific process and the international scientific collaboration as outlined, respectively, in Articles 24 and 25 of this Recommendation.
j. Platforms for exchanges and co-creation of knowledge between scientists and society, including through predictable and sustainable funding for volunteer organizations conducting Citizen Science and participatory research at the local level.
k. Community-based monitoring and information systems to complement national, regional and global data and information systems.

(iv) Investing in human resources, education, digital literacy and capacity building for Open Science

20. Open Science requires investment in capacity building and human capital. Transforming scientific practice to adapt to the changes, challenges, opportunities and risks of the 21st century digital era, requires targeted research, education and training in the skills required for new technologies and in the ethos and practices of Open Science. Member States are encouraged to consider the following:

a. Providing systematic and continuous capacity building on Open Science concepts and practices, including broad comprehension of the Open Science guiding principles and core values as well as technical skills and capacities in digital literacy, data science and stewardship, curation and archiving, information and data literacy, web safety, content ownership and sharing, as well as software engineering and computer science.
b. Agreeing on a framework of Open Science competencies aligned with specific disciplines, researcher career stages and specific actors' needs and developing recognized skills and training programmes in support of the attainment of these competencies. A core set of data science and data stewardship skills, as well as skills needed to ensure open access and engagement with society as appropriate should be regarded as part of the foundational expertise of all researchers and incorporated into higher education research skills curriculum.
c. Investing in and promoting advanced education and the professionalization of roles in data science and data stewardship. To take advantage of the

opportunities offered by Open Science, research projects, research institutions and civil society initiatives need to call on advanced data science skills including analysis, statistics, machine learning, artificial intelligence, visualization and the ability to write code and use algorithms with scientific and ethical responsibility. Enabling Open Science also requires advanced and professional data stewards who manage and curate data and ensure that the data are FAIR and looked after by trusted institutions or services.

d. Promoting the use of Open Educational Resources as defined in the 2019 UNESCO Recommendation on Open Educational Resources (OER), as an instrument for Open Science capacity building. OER should therefore be used to increase access to Open Science educational and research resources, improve learning outcomes, maximize the impact of public funding, and empower educators and learners to become co-creators of knowledge.

(v) Fostering a culture of Open Science and aligning incentives for Open Science

21. Member States, according to their specific conditions, governing structures and constitutional provisions, in a manner consistent with international and national legal frameworks, are recommended to actively engage in removing the barriers for Open Science, particularly those relating to research and career evaluation and awards systems. Assessment of scientific contribution and career progression rewarding good Open Science practices is needed for operationalization of Open Science. Attention should also be given to preventing and mitigating the unintended negative consequences of Open Science practices, such as increased costs for scientists, high article processing charges, predatory behaviours, migration, exploitation and privatization of data from technologically more advanced countries and entities, loss of intellectual property and knowledge. Member States are recommended to consider the following:

a. Combining efforts of many different stakeholders, including research funders, universities, journals, and scientific societies across disciplines and countries, to change the current research culture and to reward researchers for sharing, collaborating and engaging with society;
b. Reviewing research assessment and career evaluation systems in order to align them with the principles of Open Science. Considering that a commitment to Open Science requires time, resources and efforts that cannot be automatically converted into traditional academic output such as publications, but which can have a significant impact on science and society, evaluation systems should take into account the wide breadth of missions within the knowledge chain: basic research, curiosity-driven research, research that furthers technological innovation, and research that contributes to understanding and solving social problems. These missions come with different forms of knowledge creation and communication, not limited to publishing in peer reviewed international journals;
c. Promoting the development and implementation of evaluation and assessment systems that:
    - build on the existing efforts to improve the ways in which the scientific outputs are evaluated, such as the 2012 San Francisco Declaration on Research Assessment, with an increased focus on the quality of research outputs rather than quantity and by using indicators more wide-ranging than journal-based metrics and that go beyond the Journal Impact Factor;
    - give value to all relevant research activities and scientific outputs including high quality FAIR data and metadata; well-documented and reusable software, protocols and workflows; and machine-readable summaries of findings;

- take into account evidence of research impact and knowledge exchange, such as widening participation in the research process, influence on policy and practice and engaging in open innovation with partners beyond academia;
- take into account the diversity of disciplines and different stages of research careers, with particular attention to researchers at the beginning of their careers.

d. Ensuring that the practice of Open Science is a known, well-understood and standardized element in academic recruitment and promotion criteria;
e. Encouraging funders, research institutions, journal editorial boards, learned societies and publishers to adopt policies that require and reward the open access to scientific knowledge, including scientific publications, open research data, open software, source code and open hardware, in line with the provisions of this Recommendation;
f. Ensuring diversity in scholarly communications with adherence to the principles of open, transparent and equitable access and supporting non-commercial publishing models and collaborative publishing models with no article processing charges or book processing charges;
g. Enforcing effective governance measures and proper legislation in order to address inequality and prevent related predatory behaviours as well as to protect the intellectual creation of Open Science methods, products and data;
h. Promoting public domain and existing open licensing schemes that allow distribution and re-use of a copyright work, including partial or derivative use, on the condition that the creator is appropriately credited;
i. Promoting high quality and responsible research in line with the 2017 UNESCO Recommendation on Science and Scientific Researchers and exploring the potential of Open Science practices to reduce scientific misconduct, including the fabrication and falsification of results, violation of scientific ethical norms, and plagiarism;

(vi) Promoting innovative approaches for Open Science at different stages of the scientific process

22. Open Science requires changes in scientific culture, methodologies, institutions and infrastructures, and its principles and practices extend to the entire research cycle, from formulation of hypothesis, development and testing of methodologies, data collection, analysis, management and storage, peer-review and other evaluation and verification methods, to communication, distribution and uptake and use and re-use. To promote innovative approaches for openness at different stages of the scientific process, Member States are encouraged to consider the following:

a. Promoting Open Science from the outset of the research process, and extending the principles of openness in all stages of the scientific process including the encouragement of preprints, clearly distinguished from final peer-reviewed publications in order to accelerate dissemination and encourage rapid growth in scientific knowledge;
b. Promoting as appropriate open peer review evaluation practices including possible disclosure of the identity of the reviewers, publicly available reviews and the possibility for a broader community to provide comments and participate in the assessment process;
c. Encouraging and valuing publication and sharing of negative scientific results and data;
d. Developing new participatory methods and validation techniques to incorporate and value inputs from social actors beyond the traditional scientific community, including through citizen science, crowdsource-based scientific projects, citizen involvement in community owned archival institutions, and others forms of participatory science;

e. Developing participatory strategies for identifying the needs of marginalized communities and highlighting socially relevant issues to be incorporated into the STI research agendas;
f. Developing strategies that facilitate the deposit of data in archives in order to promote their curation and preservation and make them usable and reusable for the appropriate time period;
g. Promoting the development of shared infrastructures for the collection, preservation and user-friendly access to the open source software and source code;
h. Supporting scientists and other societal actors in accumulating and using open data resources in a transdisciplinary mode to maximize scientific, social, economic and cultural benefits, and stimulate the creation of hybrid disciplinary spaces where scientists from different disciplines interact with software developers, coders, creatives, innovators, engineers, artists etc;
i. Encouraging sharing, promote interoperability, and enhance open access of large-scale research infrastructures, such as international infrastructure in physics, astronomy, and space science, as well as collaborative infrastructures in other fields, such as health and social sciences, among others;
j. Promoting open innovation practices that connect the practices of Open Science to more rapid translation and development of its discoveries. Like Open Science, open innovation assumes broad and effective engagement and participation in the innovation process as well as the discovery and development of a business model for effective commercialization of new knowledge.

(vii) Promoting international and multistakeholder cooperation in the context of Open Science and in view of reducing digital and knowledge gaps

23. To foster Open Science globally, Member States should promote and reinforce international cooperation among all Open science actors mentioned in paragraph 13 of this Recommendation, whether on a bilateral or multilateral basis. While recognizing merits of ongoing efforts and activities in the context of Open Science for the benefit of science and society, Member States are encouraged to consider the following:

a. Encouraging international scientific collaborations, as one of the integral practices of Open Science and the most important driving factor for an intensive exchange of scientific knowledge and experience, as well as the paramount for the openness of science;
b. Promoting and stimulating cross-border multistakeholder collaboration on Open Science, leveraging existing transnational, regional and global collaboration mechanisms and organizations. This should include joining efforts towards universal access to the outputs of science, regardless of discipline, geography, gender, ethnicity or socio-economic circumstances; development and use of shared Open Science infrastructures, as well as capacity building, repositories, communities of practice, and solidarity between all countries regardless of their state of Open Science development;
c. Establishing regional and international funding mechanisms for promoting and strengthening Open Science and identifying those mechanisms, including partnerships, which can support international, regional and national efforts;
d. Supporting the creation and maintenance of effective collaborative networks to exchange best Open Science practices and lessons learned from the design, development and implementation of Open Science policies, initiatives and practices;
e. Promoting cooperation among countries in capacity building for Open Science, including infrastructure development, software sustainability and data management and stewardship and to prevent the exploitation and misuse of open data across borders;

f. Promoting international collaboration on metrics for monitoring Open Science;
g. Entrusting UNESCO with the mission to coordinate, in consultation with stakeholders and Member States, the development and adoption of a set of Open Science Goals, which will guide and stimulate international cooperation to advance Open Science for the benefit of humankind and planetary sustainability.

V. MONITORING

24. Member States should, according to their specific conditions, governing structures and constitutional provisions, monitor policies and mechanisms related to Open Science using a combination of quantitative and qualitative approaches, as appropriate. Member States are encouraged to consider the following:

a. deploying appropriate monitoring and evaluation mechanisms to measure the effectiveness and efficiency of Open Science policies and incentives against defined objectives;
b. collecting and disseminating progress, good practices, innovations and research reports on Open Science and its implications with the support of UNESCO with a multistakeholder approach;
c. developing monitoring framework with qualitative and quantitative indicators and within national strategic plans with objectives and actions in the short, medium and long term for the implementation of the present Recommendation;
d. developing strategies to monitor the effectiveness and long-term efficiency of Open Science, which include a multistakeholder participatory approach. Such strategies could focus on strengthening the nexus between science, policy and society, increased transparency, and accountability for inclusive and equitable quality research, which effectively responds to global challenges.