Towards a UNESCO Recommendation on Open Science
2nd meeting of the UNESCO Open Science Advisory Committee
8 September 2020

Background and Objectives

In line with the decision taken by the UNESCO General Conference in November 2019, the UNESCO Open Science Advisory Committee on Open Science was established by the Director-General to provide guidance on the overall implementation of the consolidated Roadmap towards the UNESCO Recommendation on Open Science. The Advisory Committee is composed of 30 members (four representatives from each of the six UNESCO's electoral groups and six international experts from the key scientific bodies and institutions dealing with Open Science), taking into account regional and gender balance, transdisciplinary expertise, international recognition, and representation of key science stakeholder groups.

The **first meeting** of the Open Science Advisory Committee, took place online on 16 and 17 July 2020. At that meeting the Advisory Committee:

- Took stock of the open science opportunities, challenges and best practices from the global and regional perspectives;
- Decided on the priorities that the Recommendation needs to address based on the inputs from the ongoing online consultations and regional perspectives;
- Agreed on the drafting process and the below timeline for developing the draft text of the Recommendations taking into account the inputs from the global and regional online consultations.

Date	Action
3 August 2020	Submission of inputs from Advisory Committee Members
17 August 2020	Circulation of the consolidated draft text
31 August 2020	Submission of comments on the draft text
8 September 2020	Validation meeting
30 September 2020	Integration of inputs from regional consultations
30 September 2020	Draft text submitted to UNESCO Member States

In line with the agreed timeline, the **second meeting** of the Advisory Committee was held online on 8 September 2020. In this meeting that was participated by All members of the Advisory Committee, and 15 observers from UNESCO Permanent Delegations and the internal multisectoral UNESCO Open Science Team participated (Annex I List of Participants).

The **key objective** of the second meeting was to discuss the zero draft text of the Recommendation and agree on the first draft text to be submitted to the Director-General for consideration and subsequent transmission to the UNESCO Member States by the end of September 2020.

Report

Opening remarks

The meeting was opened by Dr Peggy Oti-Boateng, Director, Science Policy and Capacity Building Division who welcomed the Advisory Committee members and reiterated the importance of the meeting in the overall process towards a UNESCO Recommendation on Open Science. She thanked the members of the Committee for all their inputs, comments, suggestions and highly collaborative and dynamic virtual exchanges on the zero draft text of the Recommendation since the first meeting of the Committee.

Presentation and Discussion of the Zero draft of the UNESCO Open Science Recommendation

Dr Oti- Boateng introduced the item recalling that the zero draft was prepared by the UNESCO Secretariat based on the outline approved by the 1st Advisory Committee meeting and the inputs from i) the UNESCO Open Science Partners, ii) the Open Science Global online Consultation, held online from February to July 2020, iii) the thematic and regional consultations on Open Science held since December last, and iv) the Advisory Committee members' written inputs.

The preliminary zero draft was shared with the Members on 17 August and their numerous comments were integrated in the zero draft version of the text for consideration by the Advisory Committee at their second meeting.

The zero draft text of the Recommendation was then presented by Dr Ana Persic, Chief of section a.i., Science Policy and Partnerships section.

Under the Chairmanship of Dr Fernanda Beigel from Argentina, the Members of the Advisory Committee were determined to ensure that the draft text of the Recommendation captures the richness of views and expectations for the game-changing potential of Open Science. In their debates, they considered regional differences, the specific challenges of scientists and other Open Science actors in developing countries, and the role of Open Science in reducing the digital, technological and knowledge divides existing between and within countries.

In collaborative and creative spirit, they unanimously decided on a common framework with shared values and principles for Open Science. They agreed on the definition, and the key objectives and the key elements of Open Science for the purposes of the future UNESCO Recommendation, while acknowledging that Open Science cannot be fairly and equitably implemented around the world with a one-fits all strategy. They identified the numerous Open science actors and acknowledged their respective benefits and responsibilities in the transition to Open Science.

Finally, they outlined a number of recommendations to the Member States in the following key areas of action:

- promoting a common understanding of Open Science and diverse paths to it,
- developing an enabling policy environment for Open Science,
- investing in Open Science infrastructures, services and capacity building for Open Science,
- transforming scientific culture and aligning incentives for Open Science,
- promoting innovative approaches for Open Science at different stages of the scientific process, and
- promoting international cooperation on Open Science.

While paths towards Open Science may differ in different parts of the world, taking into account the specific STI situations and capacity, it was clear from the Advisory Committee deliberations that Open Science requires a profound change in the scientific culture, moving from competition to collaboration.

Agreement on the draft text to submit to the UNESCO Director General

At the end of the discussions, the members of this Advisory Committee unanimously agreed on a first draft of the UNESCO Open Science Recommendation to be submitted to the UNESCO Director General as presented in Annex II.

Next Steps

The next steps in the process towards the development of a future UNESCO Recommendation on Open Science were presented by Dr Oti –Boateng.

In line with the Roadmap on the UNESCO Recommendation on Open Science, the draft text agreed by the Advisory Committee will now be presented to the Director-General of UNESCO for consideration and subsequent transmission to UNESCO Member States by the end of September 2020.

Member States will be given the chance to provide comments by end of January 2021. Other actors will also be invited to provide comments by the end of January 2021.

A revised draft text will be sent to Member States in April 2021

Member States will meet in a special committee meeting in July 2021 to negotiate the text of the Recommendation. The final draft text from that meeting will be presented to the 41st session of the General Conference for consideration and hopefully adoption.

With regards to the Advisory Committee, its members will continue their role of guiding the process by:

- Contributing to the remaining regional consultations and ensuring that all the major points from the later are reflected in the final draft Recommendation
- Contributing to the regional/national/expert meetings that may be organized by UNESCO and/or by Member States or actors to provide comments on the draft text
- Assist the Secretariat in the production of the revised draft
- Assist the Secretariat in building the Open Science community of practice worldwide which will have to be mobilized to implement the Recommendation

The next meeting of the Advisory Committee is foreseen for mid November 2020 to take stock of actions taken and needed to accompany Member States and the Secretariat in the next phases of the process.

Conclusion

The meeting was concluded by Dr Oti-Boateng thanking the members of the Advisory Committee for a very fruitful, dynamic and forward-looking discussion. The members expressed their enthusiasm in contributing to the UNESCO led process.

Annexes

I. List of participants

II. Draft text of the future Recommendation to be submitted to the UNESCO Director General

List of Participants

A. Members of The Open Science Advisory committee

1. **Mr Vincent Larivière**, Professor, School of Library and Information Science, Montreal, Canada
2. **Ms Sarah de Rijcke**, Scientific Director, Centre for Science and Technology Studies, Leiden University, Leiden, the Netherlands.
3. **Ms Hanne Monclair**, Policy Director, Department for Higher Education, Research and International Affairs, Ministry of Education and Research, Oslo, Norway
4. **Mr Delfim F. Leão**, Vice-rector for Culture and Open Science, Coimbra University, Portugal
5. **Ms Ausra Gribauskiene**, Chief Officer, Division of Science, Ministry of Education, Science and Sport, Vilnius, Lithuania
6. **Mr Jakub Szprot**, Head of the Open Science Platform, Interdisciplinary Center for Mathematical and Computational Modelling, University of Warsaw, Poland
7. **Mr Stanislav Stanislavovich Davydenko**, Deputy Head of Department, Institute of Applied Physics, Russian Academy of Sciences, Russian Federation
8. **Ms Aleksandra Barac**, MD, Scientific Associate, Clinic for Infectious and Tropical Diseases, Clinical Centre of Serbia, Faculty of Medicine, University of Belgrade, Belgrade, Serbia
9. **Ms Fernanda Beigel**, Researcher at CONICET and professor at the Faculty of Political and Social Sciences, National University of Cuyo, Mendoza-Argentina
10. **Mr Luiz Fernando Fauth**, Advisor to the Vice-Minister, Ministry of Science, Technology, Innovations and Communications (MCTIC), Brazil
11. **Mr Gregory Randall**, Professor, Institute of the Electronic Engineering, University of Republic, Uruguay
12. **Ms Griser Romero Hiller,** President of the National Observatory of Science, Technology and Innovation, Venezuela
13. **Mr Juncai Ma**, Director, Institute of Microbiology and the Information Centre, Chinese Academy of Sciences, China
14. **Mr Kazuhiro Hayashi**, Senior research fellow, National Institute of Science and Technology Policy, Japan
15. **Ms Noorsaadah Abd. Rahman**, Deputy Vice-Chancellor, Department of Chemistry, Faculty of Science, University of Malaya, Malaysia.
16. **Ms Eun Jung Shin**, Head of the Office of Institutional Innovation Research, Science and Technology Policy Institute (STEPI), Republic of Korea
17. **Ms Vivian Etsiapa Boama**, Senior lecturer at the Kwame Nkrumah University of Science and Technology (KNUST), Ghana
18. **Ms. Jane Mubanga Chinkusu**, Director of Science and Technology, Ministry of Higher Education, Zambia
19. **Mr Philemon Mphathi Mjwara,** Director-General of the South African Department of Science and Technology (DST), South Africa
20. **Ms Annette Ouattara**, Head of Capacity Building and Partnership at Strategic Support Program for Scientific Research (PASRES), Côte d'Ivoire
21. **Mr Essam Khamis Ibrahim Al-Hanash**, Advisor to President of Alexandria University for International Ranking and Scientific Research, Egypt
22. **Mr Mouïn Hamzé**, Secretary General, National Council for Scientific Research, Lebanon
23. **Mr Ahmed Ali Abdalla Murad,** Acting Associate Provost for Research, United Arab Emirates University (UAEU), United Arab Emirates

24. **Ms Samia Charfi Kaddour,** Director-General, Scientific Research, Ministry of Higher Education and Scientific Research, Tunisia
25. **Mr Simon Hodson** (United Kingdom), Executive Director of CODATA (Committee on Data for Science and Technology)
26. **Ms Iryna Kuchma** (Ukraine), Open Access Programme Manager, Electronic Information for Libraries (EIFL)
27. **Ms Carolina Botero** (Colombia), Director of the Karisma Foundation
28. **Ms. Joji Carino** (The Philippines), Senior Policy Advisor, Forest Peoples Programme
29. **Mr Henri Edouard Zefack Tonnang** (Kenya), Researcher, Member of the Open Science Working Group, Global Young Academy
30. **Ms Faiza Al-Kharafi** (Kuwait), L'Oréal UNESCO FWIS 2011 Laureate, Board member of the Academy of Sciences for the Developing World (TWAS)

B. Observers:

31. **Mr Santiago Martin Saint Pierre,** Assistant to the Ambassador, Permanent Delegation of Argentina to UNESCO
32. **Ms Fabiola Gómez,** Permanent Delegation of Colombia to UNESCO
33. **Mr Tommi Himberg,** Counsellor for Education and Science, Permanent Delegation of Finland to the OECD and UNESCO
34. **Ms Emma Rodriguez,** Deputy Permanent Delegate, Permanent Delegation of Mexico to UNESCO
35. **Mr Ismael Madrigal-Monarrez,** Attaché of Science, Permanent Delegation of Mexico to UNESCO
36. **Ms Carolina Villarrubia,** Permanent Delegation of Uruguay to UNESCO
37. **Mr Marc Vanholsbeeck**, Director of the Directorate of Scientific Research of the Ministry of the Wallonia-Brussels Federation, Belgium

C. UNESCO Secretariat:

38. **Ms Peggy Oti-boateng**, Director, Division of Science Policy and Capacity-Building, Natural Sciences Sector
39. **Ms Ana Persic**, Programme Specialist, Section on Science Policy and Partnerships, Natural Sciences Sector
40. **Ms Rafieian Fereshteh**, Associate Programme Specialist, Section on Science Policy and Partnerships, Natural Sciences Sector
41. **Ms Despoina Sousoni**, Consultant, Section on Science Policy and Partnerships, Natural Sciences Sector
42. **Ms Annapaola Coppola**, Project Officer, Section on Science Policy and Partnerships, Natural Sciences Sector
43. **Mr Nigel Thomas Crawhall,** Chief of Section on Small Islands and Indigenous Knowledge, Natural Sciences Sector
44. **Mr Martiale Zebaze Kana,** Chief of Section, UNESCO Office in Harare
45. **Ms Anna Bonetti,** Programme Coordinator, Programme Coordination and Evaluation Unit, Natural Sciences Sector
46. **Ms Muchaneta Munamati,** Project Coordinator, UNESCO Office in Harare
47. **Ms Tendai Murenga,** Programme Assistant, UNESCO Office in Harare
48. **Ms Iulia Nechifor,** Programme Specialist, Section for Strategic Planning, Monitoring and Reporting, Bureau of Strategic Planning

49. **Mr Bhanu R. Neupane,** Programme Specialist, Universal Access to Information Section, Communication and Information Sector
50. **Mr Juste Jean-Paul Ngome Abiaga** Advisor for Natural Sciences and IOC, Office of the Director-General
51. **Mr Mama Plea,** Programme Specialist, UNESCO Office in Addis Ababa

Draft UNESCO Recommendation on Open Science

Version 10 September 2020

Preamble

The General Conference of the United Nations Educational, Scientific and Cultural Organization (UNESCO), meeting in Paris XX November 2021,

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, natural resource depletion, loss of biodiversity, land degradation, climate change, natural and human-made disasters, spiraling conflicts and related humanitarian crises;

Acknowledging the vital importance of science, technology and innovation to respond to these challenges by providing solutions to satisfy human needs, improve living standards and human well-being, advance environmental sustainability, 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, to bridge the digital divide and to develop knowledge societies;

Noting that the global COVID-19 health crisis has proven worldwide the urgency of access to scientific information, 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 the scientific progress by ensuring that, for example, when a safe and effective vaccine or treatment for COVID-19 is developed, it is produced rapidly at scale and the data, scientific knowledge and methods needed to produce it are openly available for all countries;

Recalling that one 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;

Affirming the principles of the Universal Declaration of Human Rights, which state that all people have the right to freely to participate in the cultural life of the community, to enjoy the arts, and to share in scientific advancement and its benefits (Article 27);

Also affirming the 2007 United Nations Declaration on the Rights of Indigenous Peoples, which recognizes the rights of indigenous peoples to maintain, control, protect and develop their traditional knowledge and cultural expressions, as well as the manifestations of their sciences, technologies and cultures;

Building on the basis of the UNESCO Recommendation on Open Educational Resources, adopted by the UNESCO General Conference at its 40th session in 2019, and the UNESCO Recommendation on Science and Scientific Researchers adopted by the UNESCO General Conference at its 39th session in 2017;

Recognizing that science under the aforementioned Recommendation on Science is a global common good and, by the Universal Declaration of Human Rights and the International Covenant on Economic Social and Cultural Rights, is also an internationally-agreed fundamental human right which should be accessible to and bring benefit to all humankind;

Recognizing that Open Science originated as a movement to transform scientific practice to adapt to the changes, challenges, opportunities and risks of the 21st century digital era and to increase the societal impact of science in response to the growing and complex global issues facing humanity;

Further 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;

Considering that, produced in an open, collaborative and inclusive way, Open Science, as a source of knowledge that is accessible, transparent, verifiable and subject to scrutiny and critique, is a more efficient enterprise that improves the quality of science and thereby the reliability and the commensurability of the evidence needed for robust decision-making and policy;

Further considering that the collaborative and inclusive characteristics of Open Science allows new social actors to be actively involved in scientific production, democratizing knowledge, addressing existing systemic inequalities and enclosures of wealth, knowledge and power and guiding scientific work towards solving problems of social importance;

Acknowledging that greater access to scientific inputs 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 Open Science should not only foster enhanced sharing of scientific knowledge but also promote inclusion of scholarly knowledge from marginalized groups (such as women, minorities, Indigenous scholars, non-Anglophone scholars, scholars from less-advantaged countries) 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 and robust dialogue with indigenous peoples and local communities and diverse knowledge holders for contemporary problem-solving and emergent strategies towards transformative change;

Acknowledging the transformative potential of Open Science for reducing the existing inequalities in science, technology and innovation and accelerating progress towards the implementation of the Agenda 2030 and the achievement of the Sustainable Development Goals;

Taking fully into account, in the adoption and application of this Recommendation, the great 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 the Recommendation;

3. Also recommends that Member States bring the 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. Universal access to scientific knowledge, regardless of geography, gender, political boundaries, ethnicity or economic or technological barriers is an essential prerequisite for human development and progress towards planetary sustainability.

2. Driven by unprecedented advances in our digital world, and mindful of the associated risks, Open Science sets a new paradigm for the scientific enterprise based on transparency, sharing and collaboration, providing access to all outputs of research, adopting new ways of conducting and evaluating research, and including social actors beyond the scientific community in the creation of knowledge and its use for decision and policy-making.

3. As Open Science turns into a global movement, robust institutional and national Open Science policies and legal frameworks need to be developed by all nations to ensure that scientific knowledge, data and expertise are universally and openly accessible and their benefits universally and equitably shared.

4. To this end, the aim of this Recommendation is to provide an international framework for Open Science policy and practice that recognizes regional differences in Open Science perspectives, takes into account, in particular, the specific challenges of scientists and other Open Science actors in developing countries, and its potential contribution to reducing the digital, technological and knowledge divides existing between and within countries.

5. The 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 Open Science transition at individual, institutional, national, regional and international levels.

6. 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 and diverse paths to Open Science
    ii. Developing an enabling policy environment for Open Science
    iii. Investing in Open Science infrastructures
    iv. Investing in capacity building for Open Science
    v. Transforming scientific culture and aligning incentives for Open Science
    vi. Promoting innovative approaches for Open Science at different stages of the scientific process
    vii. Promoting international cooperation on Open Science

II. DEFINITION OF OPEN SCIENCE

7. 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.

8. The term 'Open Science' refers to an umbrella concept that combines various movements and practices aiming to make scientific knowledge, methods, data and evidence freely available and accessible for everyone, increase scientific collaborations and sharing of information for the benefits of science and society, and open the process of scientific knowledge creation and circulation to societal actors beyond the institutionalized scientific community.

9. For the purposes of this Recommendation, 'Open Science' means a complex of at least the following key elements:

    i. **Open Access**: Open access generally involves users being able to gain full and immediate access to and unrestricted use of scientific outputs including scientific publications, data, software, source code and protocols, produced in all parts of the world, free of charge to the user and re-usable. Subject to the users' properly attribution of source and authorship, all users are granted free, irrevocable, worldwide rights to access, copy, retain, use, distribute, transmit and display the work publicly and to make and distribute derivative works, in any medium for any responsible purpose. In the case of scientific publications, the publication and all related scientific outputs (e.g. original scientific research results, raw data and metadata, software, including source code, source materials, digital representations of pictorial and graphical materials and scholarly multimedia material), should be deposited, upon publication, in at least one online repository using suitable technical standards that is supported and maintained by an academic institution, scholarly society, government agency, or other well-established non-profit organization devoted to common good that seeks to enable open access, unrestricted distribution, interoperability, and long-term archiving.

    ii. **Open Data**: data that can be freely used, reused and redistributed by anyone, subject only, at most, to the good practice of acknowledgement, attribution and citation. To ensure the openness of data, it is necessary that data and databases, as appropriate, are clearly described as 'in the public domain', assigned a public domain waiver, or an open license. Data should be available in a human- and machine-readable and modifiable format, in accordance with principles of good data governance, such as for example the FAIR (Findable, Accessible, Interoperable, and Reusable) principles. When access to data needs to

be restricted for security, privacy or other reasons, it should be in line with Article 10 of this Recommendation.

iii. **Open Source/Software and Open Hardware**: open software describes software that is publicly available under an open license that grants others the right to access, modify, expand, study, create derivative works, use and/or share the software and its source code, design, or blueprint. The source code must be included in the software release or made available upon request and the chosen license must allow modifications, derived works, and sharing under equal conditions. Similarly open hardware refers to 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 software and open hardware, a community-driven process for contribution, attribution and governance should be in place to enable reuse, improve sustainability and reduce unnecessary duplication of effort.

iv. **Open Science Infrastructures**: digital infrastructures that are needed to support Open Science and serve the needs of different communities. Open Science platforms and repositories are among the critical Open infrastructures, which provide essential services to manage and provide access to 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. Some repositories and infrastructure provide 'science ready' data products, sometimes using high-level analytic and artificial intelligence procedures, to support analysis and research in the community they serve. Open Science infrastructures should be non-profit and they should guarantee permanent and unrestricted access to all public.

v. **Open Evaluation**: organized assessment of research with highly transparent and participatory peer review process, 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. Additionally, to further transparency of the scientific enterprise, Open Notebooks include the opening of the whole research process and insights in every stage. Entire research projects are made openly available from the beginning, granting others access to virtual research workspaces.

vi. **Open Educational Resources**: learning, teaching and research materials in any format and medium that reside in the public domain or are under copyright that have been released under an open license, that permit no-cost access, re-use, re-purpose, adaptation and redistribution by others.

vii. **Open Engagement of Societal Actors**: Open Science extends collaboration with societal actors beyond the scientific community by opening up practices and tools that are part of the research cycle. 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 integration of concerns, values, and world-views of policymakers and practitioners, entrepreneurs, activists and citizens, 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 and social media 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. While active involvement of citizens and communities has direct dividends for science, the benefits are further multiplied by increasing the fraction of the population knowledgeable about science and supportive of it.

viii. **Openness to Diversity of Knowledge:** Open science recognizes the richness of diverse knowledge systems and epistemologies and diversity of knowledge holders and producers. It aims to enhance inter-relationships and complementarities between diverse scholars and 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, Open Science promotes:

- ***Openness to Indigenous Knowledge Systems*** in line with the 2007 UN 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 right 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.
- ***Openness to all Scholarly Knowledge and Inquiry*** in line with principles of non-discrimination established by international human rights law, including income, gender, age, race, ethnicity, migratory status, disability, and geographic location.

10. Scientific outputs should be as open as possible, and only as closed as necessary. Open Science affords necessary protection for sensitive data, information, sources, and subjects of study. Proportionate access restrictions are justifiable on the basis of national security, confidentiality, privacy and respect for subjects of study. This includes legal process and public order, trade secrets, intellectual property rights, personal information and the protection of human subjects, of sacred indigenous knowledge, and of rare, threatened or endangered species. Some research results, data or code that is not opened may nonetheless be made accessible to specific users according to defined access criteria made by local, national or regional pertinent governing instances. The need for restrictions may also change over time, allowing the data to be made accessible at a later point. Open Science reflects the need to respect protections and the right of communities and nations to preserve the

use and development of their knowledge and traditions, and to do so proportionately.

11. The key objectives of adhering to Open Science are:

    i. maintaining and promoting good practice and scientific rigour, as well as accelerated discovery by maximizing access to robustly described data, software, including source code and methods underpinning scientific conclusions;

    ii. maximizing access to scientific knowledge and the reuse and combination of data and software, including source code, and thereby maximizing the common good achieved through public investment in scientific resources and infrastructures; and

    iii. maximizing the engagement and participation of all people and cultures in the scientific process, thus fostering the democratization of the scientific process and the increased societal impact of the scientific endeavor for the greater common good.

12. There are multiple actors in research and innovation systems and each of them has a role to play for Open Science, and responsibilities associated with that role and some or all of the aforementioned objectives. The present Recommendation specifically addresses the following key Open Science actors:

    i. **Researchers**, regardless of their nationality, ethnicity, gender, discipline and socio-economic background, who are at the center of Open Science activities.

    ii. **Leaders** at research institutions who are key to developing a supportive structure and reward system for Open Science practices.

    iii. **Educators**, including university faculty, experts in the ethical conduct of science, members of professional societies, and innovators in the private sector, who all have a role to play in the training related to open science principles and practices, and in educating all actors about open collaboration at all levels.

    iv. **Information scientists**, including librarians and computer scientists, who play a role in developing tools for Open Science practices and for ensuring that the products of research are appropriately stewarded and preserved for future use.

    v. **Software developers, coders, creatives, innovators, engineers** and all people that engage in peer production of science contributing to the dynamic hybrid interdisciplinary spaces where open science is practiced and advanced.

    vi. **Legal scholars, legislators, magistrates and civil servants** who by their services enable the smooth functioning of the legal frameworks benefitting Open Science practices.

    vii. **Publishers, editors and leaders of professional societies**, who ensure a transition toward publication models that support Open Science.

    viii. **Technical staff** who ensure the appropriate functioning of the infrastructure, so that production and dissemination of outputs can be in line with Open Science.

ix. **Research funders** who provide the necessary resources for the broad range of Open Science practices.

x. **Policy makers, societal actors and communities** that provide the policy foundation and political support for changes in the practice of science and for ensuring the public benefit.

xi. **Users and the public at large** who appreciate available scientific outputs, provide relevant feedback, and/or create value-added outcomes in collaboration with or without the original producers of scientific outputs.

13. Open Science exists today with scientific outputs already available in the public domain or under open license schemes, such as for example Creative Commons licenses, that allow re-distribution and re-use of a licensed work under specific conditions, including that the creator is appropriately credited.

14. Open Science critiques and transforms the boundaries of intellectual property to increase access to knowledge by everyone. The open approach does not contradict the use of intellectual property as a route to benefit through private exploitation and use of knowledge to create competitive new products or services and possibly bringing tangible economic benefits.

III. OPEN SCIENCE CORE VALUES AND GUIDING PRINCIPLES

15. The core values of Open Science stem from the ethical, epistemological and socio-technological implications of opening science to society and broadening the principles of openness to the whole cycle of scientific research. They include:

i. ***Collective Benefit****:* as a global public good, Open Science belongs to humanity in common and benefits humanity as a whole.

ii. ***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 geography, gender, ethnicity or socio-economic circumstances.

iii. ***Quality and Integrity***: Open Science should support high quality research by bringing together multiple sources of knowledge and making research methods and outputs widely available for rigorous review and scrutiny.

iv. ***Diversity***: Open Science should embrace a diversity of practices, workflows, languages, research outputs and research topics that support the needs and epistemic pluralism of diverse research communities, scholars, knowledge holders and social actors from different countries and regions.

v. ***Inclusiveness***: In the common pursuit of new knowledge, Open Science should meaningfully engage the scientific community as a whole, as well as the wider public and knowledge holders beyond the institutionalized scientific community, including indigenous peoples and other traditional communities, engages the scientific community as a whole, as well as the wider public and knowledge holders.

16. 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:

    a) ***Transparency, scrutiny, critique and verifiability***: increased openness in all stages of the scientific endeavor enhances the societal impact of science and increases 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. It is important to reaffirm, for a globally interdependent world, with new technologies, the epistemological skepticism, which is the foundation of Open Science and the source of its success.

    b) ***Equal opportunities and access***: all researchers and societal actors regardless of country of origin, gender, field of research, funding basis, or career stage have an equal opportunity to contribute to and benefit from Open Science. Research outputs should be open by default, with immediate and machine-readable access in open formats to content, metadata and usage statistics, subject to constraints of safety, security and privacy.

    c) ***Respect, responsibility and accountability***: with greater openness comes greater responsibility for all Open Science actors, which, together with accountability and respect forms the basis for good governance of Open Science.

    d) ***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 excluded and marginalized knowledge in solving problems of social importance.

    e) ***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.

    f) ***Sustainability***: to be as efficient and impactful as possible, Open Science needs to build on sustainable 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 non-profit, and they should guarantee permanent and unrestricted access to all public.

IV. AREAS OF ACTION

17. To achieve the objectives of this Recommendation as stated in Article 6, 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 and diverse paths to Open Science

18. Member States are recommended to promote and support the common understanding of Open Science as defined in this Recommendation, and strategically plan and support Open Science awareness raising at institutional, national and regional levels. Member States are encouraged to consider the following:

    a) Promoting a common understanding of Open Science as defined in this Recommendation within the scientific community and among the different Open Science actors at the institutional, national and regional levels.

    b) 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 extraction of data and knowledge by technologically and economically more advanced countries.

    c) Encouraging Open Science practices within publicly funded research practices.

    d) Incorporating Open Science into national science technology and innovation policies and strategies and other national and regional policy frameworks for the public advancement of science.

    e) Ensuring that the needs and rights of communities, including the rights of indigenous peoples over their traditional knowledge, as expressed in the UN Declaration on the Rights of Indigenous Peoples should not be infringed in Open Science practices.

    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.

II) Developing an enabling policy environment for Open Science

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

    a) Developing and implementing national Open Science policies and strategies in line with the definition, values and principles as well as actions outlined in this Recommendation.

    b) Ensuring that public research funders require Open Science practices and that all scientific outputs from publicly funded research are as open as possible, and only as closed as necessary.

    c) Encouraging research-performing institutions, particularly those in receipt of public funds, to implement policies and strategies for Open Science.

    d) Encourage academies, 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) Promoting multilingualism, to embrace worldwide inclusiveness, information-sharing, collaborative knowledge construction and equity, by enabling global interaction with multinational and multidisciplinary researchers, and other Open Science actors.

f) Including citizen and participatory science as integral parts of Open Science policies and practices at the national, institutional and funder levels.

g) Designing models that allow co-production of knowledge with heterogeneous actors and establishing guidelines to ensure the recognition of non-scientific collaborations.

h) Supporting the development of national/international legal instruments to allow for sharing across repositories without regard to national or regional boundaries.

i) 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 behavior and extraction of profit from publicly funded activities. The importance of commercial providers of services and data renders the call for open availability of information and data as well as transparency about their quality and provenance even more urgent. 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 properly in the global and public interest and without market dominance on the part of any commercial organizations.

j) Designing and implementing funding and investment policies and strategies for Open Science based on the core values and principles of Open Science. The costs associated with the transition to Open Science relate to the necessary cultural change in research settings to support Open Science 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. Where Open Science receives public funds, it is vital to consider how such funds are disbursed most effectively for public benefit and maximum return on investment.

III) Investing in Open Science infrastructures and services

20. 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 Open 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 ensure adequate investment in:

    a) National science technology and innovation systems, with at least 1% of national 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) Computing facilities and digital public infrastructure supporting Open Science in order to ensure the long-term preservation, stewardship, and community control of research products. 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. Examples include attribution of persistent identifier for digital objects, metadata required for their efficient assessment, access, use and re-use, and the stewardship of data by a trusted global network of data repositories.

f) Community agreements 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.

g) Joint strategies for shared, multinational, regional 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 analyzing linked articles 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 Article 24 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 capacity building for Open Science

21. 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 education and training in the skills required for new technologies and in the ethos and practices of Open Science. This should have as its objective to develop the critical mass of scientists respecting gender, geographical and disciplinary balance with specific capacity building and training in Open Science. Member States are encouraged to consider the following:

    a) Providing systematic and continuous capacity building on Open Science concepts, principles and practice, including 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) 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, ML/AI, 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.

    c) Agreeing on a standardized set of Open Science competencies aligned with specific researcher career stages and specific actors' needs and develop recognized skills and training programmes in support of the attainment of these competencies. A core set of data science and data stewardship skills should be regarded as part of the foundational expertise of all researchers and incorporated into the 'research skills' curriculum starting at least at the undergraduate level.

    d) Promoting the use of Open Educational Resources 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) Transforming scientific culture and aligning incentives for Open Science

22. Member States, according to their specific conditions, governing structures and constitutional provisions, are recommended to actively engage in removing the barriers and disincentives 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 a perquisite for transition to Open Science. Attention should also be given to

preventing and mitigating the unintended negative consequences of the transition to Open Science, such as increased costs for scientists, migration, exploitation and privatization of data from the global South by the global North, loss of intellectual propriety and knowledge, and premature sharing of research results. Member States are encouraged to consider the following:

a) Combining efforts of many different actors, 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 and attention 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 systems that:

- use 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.

d) Ensuring that the practice of Open Science is a known, well-understood and standardized element in academic recruitment and promotion criteria.

e) Ensuring diversity in scholarly communications with adherence to the principles of open, transparent and equitable access and supporting collaborative publishing models with no article processing charges (APCs) or book processing charges (BPCs), as many low- and middle- income countries would find it difficult to fund APCs or BPCs so that, though their researchers would be able to read freely, they would be largely unable to publish.

f) Enforcing effective governance measures and proper legislation (such as for example those proposed via the CARE principles on indigenous data governance and the Nagoya protocol for the exchange of biological materials) in order to address inequality and prevent related predatory behaviors as well as to protect the intellectual creation of Open Science methods, products and data.

g) Promoting creative commons licensing schemes that allow re-distribution and re-use of a licensed work on the condition that the creator is appropriately credited.

h) 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 and plagiarism.

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

23. 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/re-use. To promote innovative approaches for openness at different stages of the scientific process, Member States are encouraged to:

    a) Promote 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 in order to accelerate dissemination and encourage rapid growth in scientific knowledge.

    b) Develop new participatory methods and validation techniques to incorporate and value inputs from the broader public, including through participatory and citizen science.

    c) Support scientists and other societal actors in accumulating and using open data resources in a transdisciplinary mode to maximize scientific, social and economic benefit, and stimulate the creation of hybrid disciplinary spaces where scientists from different disciplines interact with software developers, coders, creatives, innovators, engineers, etc.

    d) Enhance open access to large-scale research infrastructures, such as international infrastructure in physics and astronomy, as well as collaborative infrastructures in other fields, such as health and social sciences.

    e) Promote Open Science as an enabler of open innovation, with the objective of accelerating the transformation of scientific and research results for social economic and environmental benefits, and of providing spaces for engagement of a whole spectrum of actors in the research value chain, from individual researchers to research institutions, public and private organizations and small and medium scale enterprises, start-up firms and consolidated large commercial enterprises.

VII) Promoting international cooperation on Open Science

24. To promote Open Science globally, Member States should promote and reinforce international cooperation among all relevant actors, whether on a bilateral or multilateral basis. Member States are encouraged to consider the following:

    a) Promoting and stimulating cross-border 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.

b) 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.

c) 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.

d) Promoting cooperation among countries in capacity building for data management and stewardship and to prevent the exploitation and misuse of open data across borders.

e) 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

25. 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 research 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 multi-stakeholder approach;

    c) developing strategies to monitor the effectiveness and long-term efficiency of Open Science, which include a multi-stakeholder approach. Such strategies could focus on strengthening the connections between science, policy and society, increased transparency, and accountability for inclusive and equitable quality research, which effectively responds to global challenges.