

Ref.: CL/4333

Subject: Preliminary Report on the first draft of the Recommendation on Open Science

Dear Sir/Madam,

At its 40th session in November 2019, UNESCO's General Conference decided to prepare an international standard-setting instrument on Open Science, in the form of a recommendation.

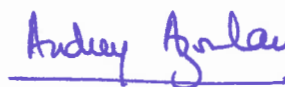
This is an essential commitment for our Organization, so that science and scientific progress truly constitute a common good that benefits humanity as a whole.

Since the last General Conference, UNESCO has worked actively on this issue, by establishing an Advisory Board and leading a global dialogue. These efforts have resulted in this Preliminary Report and draft Recommendation, which you will find enclosed herewith.

In accordance with our Constitution and the Rules of Procedure concerning recommendations, Member States are invited to forward their comments and observations on this text to the UNESCO Secretariat at least ten months before the opening of the 41st session of the General Conference.

I would therefore be grateful if you could send these contributions, no later than 31 December 2020, to Shamila Nair-Bedouelle, Assistant Director-General for the Natural Sciences Sector, at the following email address: openscience@unesco.org.

Thanking you for your commitment to this essential issue, please accept, Sir/Madam, the assurances of my highest consideration.



Audrey Azoulay
Director-General

Enclosures: 2

1. Preliminary report on the first draft of the Recommendation on Open Science
2. First draft of the Recommendation on Open Science

cc: National Commissions for UNESCO
Permanent Delegations to UNESCO

To Ministers responsible for relations with UNESCO



Preliminary Report of the Director-General on the first draft UNESCO Recommendation on Open Science

Following 40 C/Resolution 24 adopted by the Member States at the 40th session of the UNESCO General Conference in November 2019, this report summarizes the progress made towards the development of a draft UNESCO Recommendation on Open Science, in line with the Rules of Procedure concerning recommendations to Member States and international conventions covered by the terms of Article IV, paragraph 4, of the Constitution.

As agreed by the Member States, the process of developing the draft Recommendation on Open Science has been as consultative, inclusive and transparent as possible and took into account particular needs and challenges of scientists and other Open Science actors from developing countries. The process has been facilitated by an internal multisectoral UNESCO Open Science Team, supported by a broad Open Science Partnership, and steered by an Open Science Advisory Committee.

In line with the Consolidated Roadmap on the possible UNESCO Recommendation on Open Science, the key milestones in the process of developing the draft Recommendation from November 2019 to September 2020 include the following:

- development of communication tools and materials on the rationale, objectives and process of the development of the draft UNESCO Recommendation on Open Science;
- establishment and mobilization of the Open Science Partnership;
- establishment and deliberations of the Open Science Advisory Committee;
- collection of inputs through an online global consultation, as well as through a series of online multistakeholders' thematic and regional consultations;
- drafting of the first draft text of the Recommendation based on the inputs received.

The main achievements are presented in this preliminary report of the Director-General on the draft UNESCO Recommendation on Open Science.

Communication on the draft UNESCO Recommendation on Open Science

The information on the importance of building a global consensus on Open Science, the path towards the UNESCO Recommendation, and possibilities for involvement in the process have been communicated with the general public and a broad range of Open Science stakeholders through a wide range of communication materials, tools and mediums.

A dedicated [UNESCO Open Science website](#) has been developed and updated regularly and systematically with all the relevant information, resources and contacts. A brochure for the general public entitled “Towards a UNESCO Recommendation on Open Science” has been published in [English](#), [French](#) and [Spanish](#).

Across the world, the rationale and the path towards the UNESCO Recommendation on Open Science has been the subject of a series of presentations, seminars, webinars and technical proceedings and has been presented by the Secretariat at numerous scientific regional and international meetings.

As the global COVID-19 pandemic reiterated the importance of international scientific collaboration and access to and sharing of scientific information, several initiatives were undertaken to highlight the critical importance of Open Science in the fight against COVID-19 and the need for a global standard setting instrument on Open Science. A UNESCO Ministerial meeting was held on 30 March 2020, mobilizing 122 countries to promote open science and reinforced cooperation in the face of COVID-19. A platform on Open access to facilitate research and information on COVID-19 has been developed and a social media campaign was launched to advocate for the importance of Open Science and sharing knowledge, in particular in the context of COVID-19 pandemics and to invite interested stakeholders to provide input to the process of developing the Recommendation.

Establishment and mobilization of the Open Science Partnership

A broad open-ended and geographically representative [Open Science Partnership](#) has been established bringing together all the relevant and interested Open Science stakeholders and institutions from all regions and from all disciplines of Basic and Applied Sciences, including Natural Sciences, and Social and Human Sciences, particularly taking into account local and indigenous peoples and their traditional knowledge.

In addition to UNESCO science related chairs and centers and partners specified in the Consolidated Roadmap towards the possible UNESCO Recommendation on Open Science approved by the General Conference, more than fifty international and regional scientific organizations and unions, academies and research institutes, university associations, libraries and library associations, Open Science Publishing Coalitions citizen and community science entities, research funders, data organizations and repositories, and intergovernmental organizations have joined the Open Science Partnership. The list of the members can be consulted on the [Open Science Partnership webpage](#).

The Partnership has been instrumental in mobilizing a worldwide Open Science community of practice and providing substantive and technical inputs in the draft Recommendation through written contributions or inputs in the global, regional and thematic consultations.

Multistakeholder consultations on Open Science

Global online consultation

In view of including inputs from all regions and all actors into the Recommendation, an electronic consultation on Open Science, in the form of an online survey, was conducted between February

and July 2020. The survey was available in three languages; English, French and Spanish. Open to all, the survey collected information from a broad range of interested contributors, individuals and institutions from across the world. The questions centred around the meaning and definition of Open Science, the practices of Open Science, the institutions and policies dealing with Open Science, as well as the possible negative impacts and barriers to Open Science. In March 2020, the survey was enriched to address Open Science in the context of the COVID-19 pandemic.

Published on the UNESCO Open Science website, the survey was broadly disseminated by UNESCO Member States, UNESCO Field Offices, UNESCO science related Chairs and Centers and the international, regional and national networks of the Open Science Partnerships.

The full report will be available on the UNESCO Open Science website in October 2020 and the key results from the consultation are hereby summarized.

Over 2900 participants from 133 countries from all the six electoral groups of UNESCO participated in the global consultation online survey and provided inputs and shared their views on the main topics that should be included in the UNESCO Recommendation on Open Science.

Europe and Latin America and the Caribbean had the highest number of respondents with the majority of respondents coming from Argentina, France, Ecuador, Brazil, Peru and Germany. Stakeholders from Academia and research institutions, comprising environmental, social and engineering sciences were the most represented in the survey.

While respondents ranked Open Access to journals, data and educational resources, science communication, and Open Source as the most important elements of Open Science, 46% of the respondents stated that Open Science did not have a clear definition for them.

According to the survey, the understating of Open Science is generally limited to increasing access to scientific outputs, including Open Access to scholarly publications and access to data. However, there is a clear interest in moving beyond Open Access and applying the principles of openness on the entire cycle of scientific research, and opening science to society through citizen science and interactions with indigenous knowledge systems among others.

The survey also revealed that although many respondents were familiar with Open Science initiatives, strategies and/or policies undertaken by their institutions, national entities dealing with Open Science are less established or less known.

Agreeing with the need for a global consensus on Open Science and an international framework for Open Science under the auspices of UNESCO, most of the respondents underlined the following as the priorities to be addressed in a possible UNESCO Open Science Recommendation:

- defining common principles and core values of Open Science;
- raising awareness and communicating on Open Science;
- investing in Open Science - Considering financial implications of open science and developing sustainable open science business models;
- harmonizing legal frameworks for intellectual property rights, copyrights and patents;
- supporting Open Creative Commons licenses;
- coordinating global Open Science efforts taking into account regional and disciplinary specificities;

- reviewing research and career evaluation and awards systems;
- promoting a new generation of innovative international scientific collaborations;
- fighting against misinformation and scientific misconduct;
- building institutional and individual capacities and investing in shared infrastructures;
- promoting innovative public-private partnerships;
- engaging with the broader society, including through citizen science and interactions with indigenous knowledge systems;
- building a culture of Open Science.

Lack of common understanding of Open Science and communication among stakeholders; connectivity and access to infrastructures; evaluation and reward systems based on impact factor and quantity of publications; lack of incentives and coherent investment; Science, technology and Innovation (STI) commercial benefits versus common and public good; fragmented funding mechanisms/strategies and policy environment and lack of human and institutional capacities were pointed out as the most important barriers for the transition to Open Science.

Regional online consultations

In addition to the global online consultation, a series of regional multistakeholder consultations were also organized to take stock of the different regional perspectives on Open Science. Originally planned as face-to-face meetings, with the exception of the first African regional consultation held in December 2019, subsequent regional consultations were configured for virtual meetings due to the situation caused by the global COVID 19 pandemic.

As per the table below, six regional consultations were held in collaboration with the corresponding UNESCO Regional Field Offices and relevant partners from the region:

Date	Regional Consultation	Organized by
12 December 2019	African States	UNESCO Liaison Office in Addis Ababa in collaboration with the African Union
23 July 2020	Western European and North American States	UNESCO Natural Sciences Sector in collaboration with the International Centre for Theoretical Physics (ICTP) and the World Academy of Sciences (TWAS)
24 August 2020	Arab States	UNESCO Cairo Office, Regional Bureau for Sciences in the Arab States
15 September 2020	Asian and Pacific States	UNESCO Jakarta Office, Science Bureau for Asia and the Pacific in collaboration with the International Science, Technology and Innovation Centre for South-South Cooperation under the auspices of UNESCO (ISTIC).
23 September 2020	Latin-American and Caribbean States	UNESCO Montevideo Office, Regional Bureau for Science and Technology for Latin America and the Caribbean in collaboration with the Open Science Forum for Latin America and the Caribbean (CILAC)
24 September 2020	Eastern European States	UNESCO Natural Science Sector in collaboration with the UNESCO Venice Office, Regional Bureau for Science and Culture in Europe and the UNESCO Almaty Office.

The key objectives of these online regional consultations were to:

- bring together the scientists, policy makers and the main stakeholders of Open Science in the different regions;
- advance the discussion from regional perspective on the meaning, scope and opportunities of Open Science between policy makers, experts from academia, private sector and citizens;
- identify the key aspects of Open Science that are most relevant in the global context and should be addressed by the UNESCO Recommendation;
- share lessons learned from development and implementation of the regional Open Science strategies, policies and other initiatives;
- identify the key challenges and necessary infrastructures for Open Science with suggestions on how to overcome them;
- identify areas for international collaboration and networking to advance Open Science globally.

Across the regions, the potential of Open Science to make the scientific process and outputs more open, accessible, efficient, democratic, and transparent and to ensure that science truly benefits the society as a whole, has been duly recognized. However, regional differences exist in some specific priorities areas and challenges were identified as prerequisites for a fair and just transition to Open Science.

For example, in Western Europe and North America, the need for aligning incentives for Open Science, including by reviewing the current systems of scientific evaluation and rewards based on the principles of Open Science, has been identified among the key priorities. Other priorities include the promotion of new generation of innovative collaborations, including with societal actors beyond the scientific community; respect for bibliodiversity; harmonization of data protection policies and investment in shared and coordinated open science infrastructures taking into account regional and disciplinary specificities.

In Eastern Europe, some of the key priorities include developing and aligning national initiatives on Open Science based on good practices from other regions and the European Union in particular. In addition, addressing some of the possible unintended consequences of Open Science, such as, for example, high Article Processing Charges for individual researchers or their research institutions, publication of data and knowledge without proper quality control and oversimplification of science have been identified as important challenges for the transition to Open Science.

The actors in Latin America and the Caribbean argued for the need for a comprehensive and globally coordinated approach to Open Science, addressing structural needs of emerging and developing countries and ensuring that benefits of Open Science are fairly shared among all the nations. Ensuring access to and sustainability of open science infrastructures, regulation of the commercialization of open data, compatibility with national priorities, multilingual engagement and fair and equitable inclusion of historically marginalized knowledge holders in Open Science practices have been identified as key actions to be addressed in the UNESCO Recommendation on Open Science.

In Asia and the Pacific, the actors pointed to the need for a clear common vision for Open Science, a coherent regional Open Science policy framework and practical guidelines on different Open Science elements, practices and policies. Strengthening regional cooperation on Open Science,

including through establishment of a regional platform for Open Science accompanied by regional capacity building programmes were highlighted as critical actions needed to enable all the actors from the region to benefit from Open Science opportunities, regardless of geographical locations, gender, political boundaries, ethnicity or economic or technological barriers. The lack of consistent incentives and funding for Open Science practices have also been identified as a key barriers to transition to Open Science in the region.

For the African Open Science actors, it is critical not to lock down the revolution of Open Science by barriers in infrastructure and connectivity. Access to internet, hardware and software must be made available, and it has to be accompanied by strategic investments in individual and institutional STI capacity and enabling policy environment. More efficient scientific collaborations and networking, including sharing and scaling up of good practices in regional collaboration have been identified as critical to counteract the negative impacts of high dependence on international collaboration, difficulties to retain data and information in Africa to generate new knowledge and the urgent need for research funds and collaborations at the regional level.

In the Arab States, the transition to Open Science would require a cultural change in the practice of science, shifting from competitive to collaborative mode. This needs to be accompanied by technical, strategic and policy actions dealing with managing intellectual property rights in relation to Open Science, enabling access to outputs of science while ensuring the quality of science and fair evaluation; and promoting Open Science as a key enabler of innovation and prosperity. Building infrastructures, establishment of regional repositories, and increasing the transparency and the societal impact of the scientific enterprise have also been identified as important aspects of Open Science transition.

The full reports from all the regional consultations will be available on the UNESCO Open Science website in October 2020.

In addition to global and regional consultations, a series of consultations focusing on perspectives from specific key actors such as young scientists, citizen scientists, United Nations system were also organized to ensure inclusiveness and capture the views of all the relevant stakeholders.

Further thematic consultations with specific groups of stakeholders, such as indigenous knowledge holders and the private sector will be organized in the next months to gather additional feedbacks on the first draft text of the Recommendation.

Establishment and deliberations of the Open Science Advisory Committee

In accordance with the Terms of Reference adopted by the General Conference, the [Open Science Advisory Committee](#) was established by the Director-General of UNESCO in June 2020 to guide the consultative process leading to the Recommendation by:

- providing expert and strategic advice;
- ensuring delivery of the process milestones;
- providing support with fundraising.

Four representatives of Member States from each of the UNESCO electoral groups, and six representatives of key scientific bodies and institutions dealing with open science, were selected by the Director-General taking into account geographical and gender balance, expertise, international recognition, and representation of key Open Science stakeholder groups.

The Advisory Committee met twice virtually, on 16-17 July 2020 and 8 September 2020.

Dr Fernanda Beigel, Researcher at CONICET and Professor at the Faculty of Political and Social Sciences, National University of Cuyo, Mendoza, Argentina (representing Group III) was elected as the Chairperson. Dr Simon Hodson, Executive Director of CODATA (the Committee on Data of the International Science Council), international expert from the United Kingdom was elected as Vice-Chair. The Advisory Committee also appointed two rapporteurs: Dr Samia Charfi Kaddour, Director-General, Scientific Research, Ministry of Higher Education and Scientific Research, Tunisia and Dr Vivian E. Boamah, Senior Lecturer at the Kwame Nkrumah University of Science and Technology (KNUST), Ghana.

At their first 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 future UNESCO Recommendation on Open Science needs to address based on the inputs from the Open Science Partnership and the online consultations;
- agreed on the draft outline of the Recommendation;
- agreed on the drafting process and the timeline for developing the draft text of the Recommendation.

After the online exchanges on the draft text of the Recommendation prepared by the UNESCO Open Science Intersectoral Team based on the inputs from the Open Science Partnership, and global, regional and thematic consultations, the second meeting of the Advisory Committee provided the occasion to incorporate the final comments of the Advisory Committee and agree on the draft text of the Recommendation to be submitted to the Director-General of UNESCO for consideration and transmission to Member States.

The full reports from the Advisory Committee meetings are available on the UNESCO Open Science website.

First draft of the UNESCO Recommendation on Open Science

Based on the preliminary study of the technical, financial and legal aspects of the desirability of a UNESCO Recommendation on Open Science as contained in the UNESCO General Conference document 40 C/63 and the discussions held at the 206th and 207th sessions of the UNESCO Executive Board and the 40th session of the UNESCO General Conference and considering the draft text received from the Open Science Advisory Committee, which built on the inputs received from the global, regional and thematic consultations, the UNESCO Director-General is hereby presenting the first draft of the UNESCO Recommendation on Open Science.

This first draft Recommendation on Open Science defines shared values and principles for Open Science, and identifies concrete actions to:

- facilitate a more equitable, transparent and democratic production, dissemination and uptake of scientific knowledge around the world,
- bring science closer to society,
- contribute to closing the gaps in science, technology and innovation existing between and within countries.

It sets a common international policy framework for Open Science, reinforcing the human right to science and science as a global public good.

While outlining its key objectives and elements, Open Science is defined as 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.

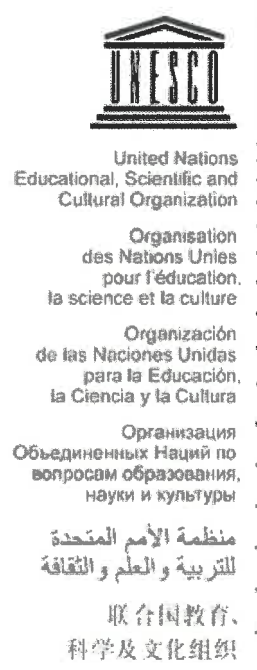
This first draft Recommendation argues that the scientific outputs should be as open as possible, and only as closed as necessary, mindful of the issues relating to security, privacy and respect for subjects of study.

The text identifies the richness of Open Science actors acknowledging their respective benefits from and responsibilities in the transition to Open Science. It also calls for equity and inclusion in all stages of the scientific process and fair and equitable sharing of benefits from the outputs of science.

Finally, the first draft Recommendation spells out a number of recommendations to the Member States in the following key areas of action:

- promoting a common understanding of Open Science,
- 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.

The text makes it clear that while paths towards Open Science may differ in different parts of the world, reflecting the specific STI situations and capacity, Open Science requires a profound change in the scientific culture across the borders, moving from competition to collaboration and from having to sharing.



First draft of the UNESCO Recommendation on Open Science

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, spiralling 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 scientific progress by ensuring that, for example, when a safe and effective vaccine or treatment for COVID-19 is developed, it is produced rapidly on scale and the data, scientific knowledge and methods needed to produce it are openly available for all countries;

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;

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 allow 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 and beyond;

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 contributes to reducing the digital, technological and knowledge divides existing between and within countries.

5. 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 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 paragraph 10 below 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 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 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, communicate science 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 set out in paragraph 6 above, 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 2007 United Nations 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 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) 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 paragraph 24 below 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 research, 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, machine learning (ML) / artificial intelligence (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 prerequisite 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 2010 Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity) 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;
- (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, astronomy, and space science, as well as collaborative infrastructures in other fields, such as health and social sciences, among others;
- (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.