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NEWSLETTER

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Open science

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▲ Top: A wall decoration from the forty-first session of UNESCO General Conference, held from 9–24 November 2021, in Paris (Photo: UNESCO/Luc Valigny)

Above: TYAN Meeting of 26 November 2018, Trieste, Italy (Photo: TYAN/Franco Cabrerizo)

Cover picture: A graphic illustration from the cover of UNESCO Recommendation on Open Science

▼ An artwork illustrating the idea of open science: a movement aiming to make the scientific process more transparent, inclusive and democratic. (Photo: Shutterstock.com via UNESCO website)

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EDITORIAL

OPEN SCIENCE: OPPORTUNITIES AND CHALLENGES

▲ Shamila Nair-Bedouelle, Assistant Director-General for UNESCO Natural Sciences Sector

The progress of science is a must to ensure that the way to sustainable and inclusive development is paved, and *de facto* provides equal opportunities for all to contribute to and to benefit from. It is in this context that science stakeholders around the world have recognized the potential of open science.

A fair and equitable implementation of the concepts of open science, however, requires a common understanding of its potential and challenges, which vary in different regions and among different groups of stakeholders. This is why UNESCO, as the United Nations specialized agency mandated to build a culture of peace through science, has led a consultation process—regionally balanced, multi-stakeholder, inclusive and transparent—to develop the first global standard-setting instrument on open science: an international framework to ensure that the benefits of open science are equitable.

Adopted on 23 November 2021 by all 193 Member States of UNESCO participating at the forty-first session of its General Conference, UNESCO Recommendation on Open Science outlines a common definition, shared values, and the principles of open science. It also identifies measures to make science more accessible and inclusive, and better linked with societal needs.

By including and valuing inputs of scientists from developing countries into the consultative process that led to the Recommendation, UNESCO-TWAS played an important role. Over the years, The World Academy of Sciences has in fact shaped a practice that recognizes not only disciplinary but above all regional differences in science perspectives. In connection to open science, The World Academy of Sciences has also highlighted the specific challenges faced by scientists in developing countries, and the consequent need for open science to contribute to reducing the digital, technological and knowledge divides between and within countries. And to avoid that, if applied wrongly, open science may compound inequities.

As conceived in UNESCO Recommendation, the aim of open science is ambitious, seeking, as it is to:

- Open up practices and tools that are part of the research cycle
- Extend collaboration between scientists and societal actors
- Develop new forms of collaboration, a collective intelligence for problem-solving, and
- Promote an enhanced dialogue between scientists, policymakers and practitioners, entrepreneurs and community members, giving all stakeholders a voice in developing research that is compatible with their concerns, needs and aspirations.

The Recommendation is even more ambitious in connection to developing countries, with its aim to:

- Acknowledge the transformative potential of open science for reducing the existing inequalities in science, technology and innovation and accelerate "progress towards the implementation of the 2030 Agenda and the achievement of the Sustainable Development Goals and beyond, particularly in Africa, least developed countries, landlocked developing countries, and small island developing States" and
- 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 regardless of location, nationality, gender, income, socio-economic circumstances, or any other grounds.

▲ UNESCO Director-General Audrey Azoulay speaking during the forty-first session of UNESCO General Conference in Paris, on 19 November 2021. [Photo: UNESCO/ Christelle Alix]

On such premises, open dialogue has become a key component of open science, based as it is on:

- The recognition of the richness of diverse knowledge systems and knowledge producers, including traditionally marginalized scholars and indigenous peoples
- Adherence to international human rights 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.

With the adoption of UNESCO Recommendation, governments have committed to promoting an enabling environment and investments in infrastructures and capacity-building for open science, a movement that has emerged from the scientific community. Last November, in Paris, governments also agreed to report back every four years on their progress: to this aim, the input and engagement of national scientific communities are crucial in understanding the national and international landscape of open science and in the implementation of the Recommendation. And UNESCO-TWAS has an exceptional potential for promoting and trailblazing that implementation in developing countries—a key contribution on which UNESCO Member States count. So that no one is left behind.

Shamila Nair-Bedouelle
Assistant Director-General
for UNESCO Natural Sciences Sector

SPECIAL REPORT: OPEN SCIENCE

ENTERING AN ERA OF OPEN SCIENCE

Graphic illustrating an abstract data network. Through the principles of open science, scientists would gain access to data networks that were once closed off to them. (Photo: Skeyndor/Flickr)

UNESCO Recommendation on Open Science presents an opportunity for the world's nations and institutions to revolutionize how science is done globally

by **Sean Treacy**

To face the challenges of today's world—from climate change to pandemics—science relies heavily on cooperation across borders, as well as willingness to collaborate and share scientific results openly. And now, the world's nations and scientific institutions have the opportunity to unite behind a new framework for conducting science openly and transparently.

Since about the turn of the twenty-first century, as Internet usage became increasingly common, academics, policymakers and the greater public have been engaged in a debate over how the rapidly increasing availability and fluidity of information should influence scientific practices. In time, advocacy for "open science" began to build into what is today a movement to make science, its methods, its data and its results more accessible and transparent to everyone, inside and outside of academia.

As a result, the international scientific community is more interested in ways to make science more open, a trend that could have an enormous impact on both the research community and the developing world. Efforts to push this change towards a more open scientific community culminated in an official framework set by the United Nations Educational, Scientific and Cultural Organization (UNESCO): the UNESCO Recommendation on Open Science. Adopted by the UNESCO General Conference in November 2021, the Recommendation identifies what open science means, and lays out standards for how it works in practice. It also proposes ways citizens can take part in the global effort to generate and share scientific knowledge.

Such a Recommendation is important, because this is how UNESCO General Conference sets the tone on critical matters, principles or norms that its Member States may draw on for legislation or policy.

At the heart of the Recommendation is its definition of open science: "an inclusive construct that combines various movements and practices aiming to make multilingual scientific knowledge openly available, accessible and reusable for everyone, to increase scientific collaborations and sharing of information for the benefits of science and society, and to open the processes of scientific knowledge creation, evaluation and communication to societal actors beyond the traditional scientific community. It comprises all scientific disciplines and aspects of scholarly practices, including basic and applied sciences, natural and social sciences and the humanities, and it builds on the following key pillars: open scientific knowledge, open science infrastructures, science communication, open engagement of societal actors and open dialogue with other knowledge systems."

And in the course of defining open science, the Recommendation has numerous goals. Mostly, it aims to provide an international framework for policy and a practice of open science that takes into account all the factors that might complicate it. These include academic freedom and specific challenges scientists might face in different countries, especially considering that some developing countries and emerging economies have greater access to resources than other scientifically or technologically lagging nations.

The Recommendation also lays out key objectives and areas of action, including bolstering a common understanding of open science, a policy environment for it, and investments in infrastructure and services for it.

So why is open science important, and how can it help not only scientists, but policymakers and laypersons alike? And how will accessible and transparent science influence efforts to build or conduct scientific research in developing countries, especially least developed countries (LDCs)?

> The traditional reasons for keeping data closed, including data-hoarding for career advantage, don't fly any more.
>
> *Simon Hodson, Executive Director of CODATA, the Committee on Data of the International Science Council*

OPEN SCIENCE FOR SOCIETY

The definition of open science is a holistic interpretation, one that represents a consensus and is more than the sum of its parts, said Simon Hodson, Executive Director of CODATA, the Committee on Data of the International Science Council (ISC), who was also Vice-Chair of the expert Advisory Committee for the UNESCO Recommendation.

Hodson describes open science as "the necessary way of doing science in the twenty-first century", one that takes full advantage of the tools of the digital age, and is also engaged with the world and society. Indeed, by being transparent to the public and inclusive of its contribution, open science also focuses on how research affects society, and how science should be conducted not just for people, but with people.

"What a lot of people argue, and I agree with, is this: In a sense, open science is in line with and faithful to the fundamental principles of science," said Hodson. "It should be evidence-based, scrutinizable, transparent, and subject to critique and verification."

In the past, CODATA collaborated with UNESCO-TWAS on open science through Science International, an initiative that also included the InterAcademy Partnership, and the International Science Council, to promote strong policies for science at the global level.

▲ The forty-first session of UNESCO General Conference, held in Paris, from 9 to 24 November 2021. (Photo: UNESCO)

Part of this collaboration included a campaign for open-science principles for 'big data', including a 2016 accord: "Open Data in a Big Data World". That accord called for open-science practices to maximize use of the volumes of publicly funded big data—which are increasingly the basis of advanced research and policymaking—and was endorsed by over 120 scientific institutions. More recently, in 2020, CODATA was one of many international organizations that provided input to the UNESCO Recommendation, doing so through a submission to the UNESCO Open Science Consultation.

Now there is some sense of urgency around open science. The COVID-19 pandemic, Hodson said, helped to demonstrate how interconnected the world is. It also highlighted the need for data that arrives in real time and for guidelines on when institutions share data, as well as whom they should share it with, and how.

"In a pandemic of this nature, we need to not only know how many people tested positive, and how many have died, but also a mechanism providing more controlled access to clinical data, with necessary safeguards and anonymisation," noted Hodson. "Open science also requires trust on behalf of hospitals, and partnerships to use data for the public good."

But he cautioned against looking at open science as a simply "binary" matter, as if a scientific endeavour can either be open or closed and that's it. He suggested that open science is more like a practice that should take many nuances into account, that insists upon necessary protections, while working to ensure that data is as open as possible. Open science does not ignore the need to restrict access to certain data (including personal information), but it sets the default to open. Public bodies, research-performing organisations and other institutions with data important for research should seek to maximise both the availability and the usefulness of valuable data.

▲ Shamila Nair-Bedouelle, UNESCO Assistant Director-General for Natural Sciences Sector, participating in a Joint Appeal for Open Science, on 27 October 2020. (Photo: UNESCO)

▼ The forty-first session of UNESCO General Conference, held in Paris, from 9 to 24 November 2021. (Photo: UNESCO)

In a fast-moving and interconnected world, the pull toward more open scientific practices is strong.

"The traditional reasons for keeping data closed, including data hoarding for career advantage, don't fly any more," said Hodson. "We need to have transparency and the capacity to scrutinise data used for research. To address the global grand challenges of our age, we need to maximise access to data with research utility and we need to be able to combine data from many sources to understand complex systems."

Open science is also part of what Hodson called the "science-policy" interface. He described this as the relationship of scientific findings and advice to policymaking. While scientific findings can sometimes lead to policy options, ultimately, it's up to governments and public institutions to make those decisions. But principles for open science help guarantee that these findings are more robust, and more transparent.

Hodson also pointed out that open science is deeply interdisciplinary. For example, computer sciences provide the means to have troves of data that need to be open. Meanwhile, the social sciences provide sound practices for engaging with the public in the course of conducting research.

OPEN SCIENCE IN THE GLOBAL SOUTH

So, how can open science complement the growth of science in the developing world? One continent that has embraced open science as a golden opportunity for scientific growth and economic development is Africa. According to the United Nations Development Programme, in

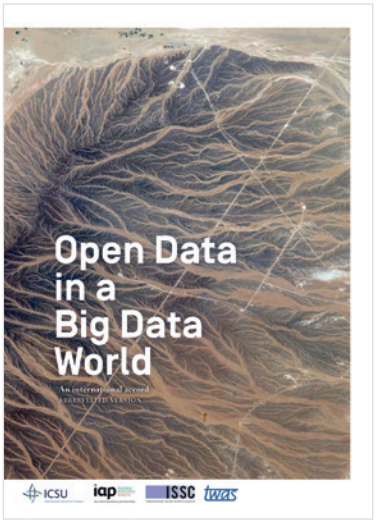
2021, sub-Saharan Africa alone had 33 of the world's 46 LDCs, so, scientific institutions there see open science as an opportunity to access knowledge they have been closed off from.

The principles of open science align seamlessly with the African Union's Agenda 2063, which envisions the continent's future as well governed and well educated, and supportive of inclusive growth through sustainable development, said Molapo Qhobela, Vice-Rector for Institutional Change, Strategic Partnerships and Social Impact at the University of the Free State in Bloemfontein, South Africa. Qhobela was also Chief Executive Officer of the National Research Foundation (NRF) of South Africa, a partner of UNESCO-TWAS for the award of post-doctoral fellowships since 2015. And since then, the Foundation has focused its attention to open science as a pan-African initiative.

"Open science advocates for the creation of an inclusive, integrated and collaborative culture," said Qhobela. "It also recognizes the social compact between science and communities. This interactive approach to research and the development of knowledge works across social boundaries and is fundamental to democratize knowledge and information."

To accommodate this need, the NRF joined forces with the Academy of Science of South Africa (ASSAf), CODATA and ISC to support a project to plan for the creation of an African Open Science Platform (AOSP). After being launched at the Science Forum South Africa in 2018, the vision and strategy for AOSP was also presented at a forum on Open Science for Africa in which both the African Union and UNESCO participated. Insights from the forum fed into the process behind the UNESCO Recommendation. In turn, the NRF has now launched the African Open Science Platform initiative with an initial five years of funding.

Science institutions in Africa, as well as in many developing countries in other continents, have many concerns that open science could help resolve. One Qhobela raised is that, historically, scientific teams from outside of Africa have often gone to the continent to gather data and information that, in the end, was not freely available to Africa or its scientists.



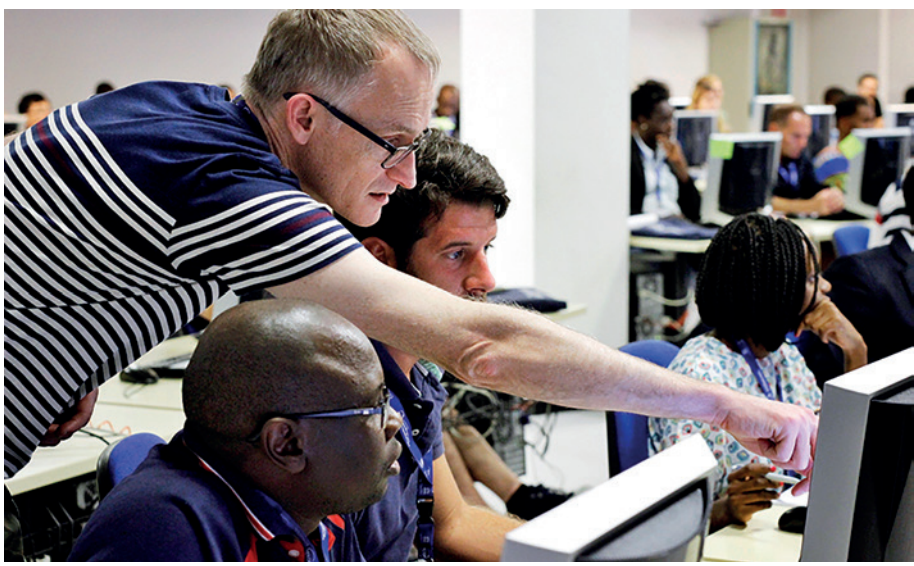
"So, that's where I think the real value of open science really comes into the fold," he explained, "We, particularly in the global South, can get access to a lot more information and knowledge and other resources that would historically have been closed."

Faranah Osman, NRF Executive Director of ICT and Knowledge Resource, seconded Qhobela's view, pointing out that, sometimes, while African scientists would contribute to research on issues such as Ebola and climate change, they wouldn't benefit directly from data collected in their continent.

"So, we started to think that the African Open Science Platform initiative was a means by which we could start linking current infrastructure for data management on the

▲ Left: Open Data in a Big Data World the outcome document of the first edition of Science International, held in 2015. Right: A graphic illustration from the cover of UNESCO Recommendation on Open Science.

▼ Students receiving guidance during the Committee on Data for Science and Technology (CODATA) - Research Data Alliance (RDA), School of Research Data Science in Trieste, Italy, from 1 to 12 August 2016. (Photo: CODATA International)



▲ Aid workers in Guinea preparing for contact with a person diagnosed with Ebola. (Photo: European Commission's Humanitarian Aid and Civil Protection department/ Flickr)

> Open science advocates for the creation of an inclusive, integrated and collaborative culture.
>
> *Molapo Qhobela, Vice-Rector for Institutional Change, Strategic Partnerships and Social Impact at the University of the Free State in Bloemfontein, South Africa*

continent, with national policies to support research, the collection of data, and future investments on big data infrastructure to enable African researchers to collaborate internally and globally," continued Osman.

Qhobela added that the need to "democratize" knowledge is not unique to Africa, and would have benefits across national boundaries and social structures. He expected that, as the world continues to recover from the economic impact of COVID-19, the need to do more with less will be greater. Open science and its related principles, he predicted, will help maximize the gains from research investments.

"Open science is a means to shape the global research enterprise for the future, and science diplomacy is a means to achieve the global cohesion required for this paradigm shift," said Qhobela. "TWAS is uniquely positioned to reach a cross section of the global scientific community, thus preparing them to not only embrace the necessary change as individuals, but also to support the becoming-change agents in the broader context, as scientists engage their peers, policymakers, research administrators and funders."

Looking forward, the Recommendation could pave the road for the new era in open science as an opportunity to not only be more cooperative and transparent, but to enable equalities among scientists, irrespective of the countries in which they work, by closing the current access gap between the North and the South. And in this endeavour, UNESCO-TWAS has a key role to play. ◘

UNESCO Recommendation on Open Science

At its fortieth session in 2019, UNESCO General Conference recognized "the need for a new standard-setting instrument on open science, in the form of a recommendation". It thus invited the Director-General to continue holding intergovernmental consultations for the elaboration of the recommendation, and to submit a draft text at its forty-first session. Two years later, UNESCO Recommendation on Open Science was *de facto* adopted by UNESCO General Conference during its forty-first session, held in Paris, from 9 to 24 November 2021.

Below are section I and part of section II of the Recommendation on Open Science, which describe the overall aim and objectives of the Recommendation, and define open science. The full document—which includes a preamble, as well as details on the core values, guiding principles, areas of action and means for monitoring progress on open science—is available at: www.bit.do/UNESCO-OpenScience

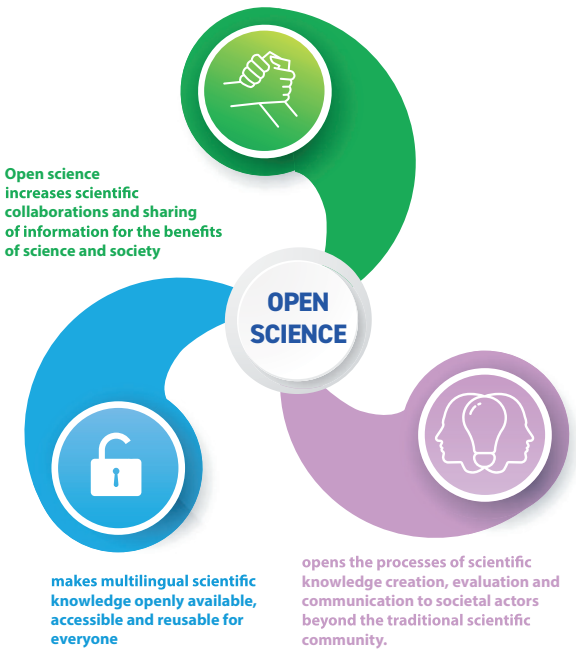
I. AIM AND OBJECTIVES OF THE RECOMMENDATION

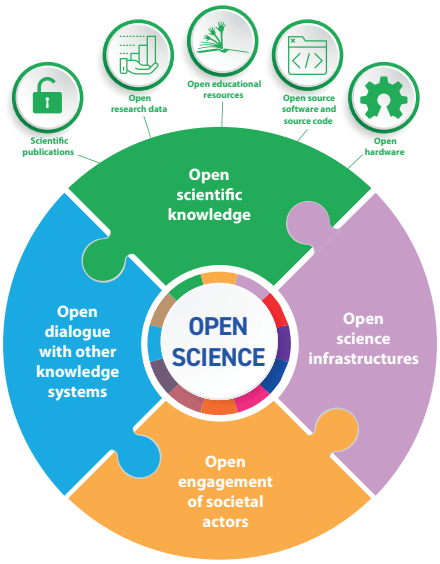
1. The aim of this Recommendation is to provide an international framework for open science policy and practice that recognizes disciplinary and regional differences in open science perspectives, takes into account academic freedom, gender-transformative approaches and the specific challenges of scientists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

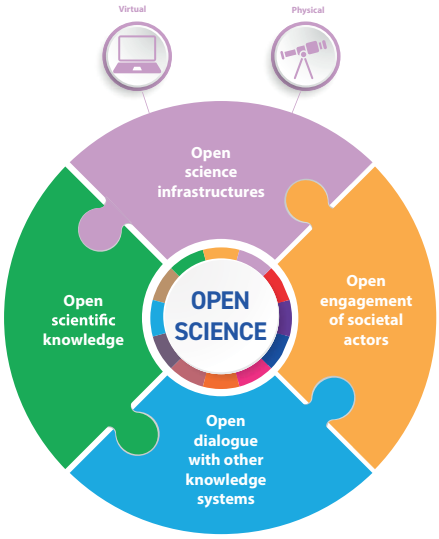
2. This Recommendation outlines a common definition, shared values, principles and standards for open science at the international level and proposes a set of actions conducive to a fair and equitable operationalization of open science for all at the individual, institutional, national, regional and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

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

i. promoting a common understanding of open science, associated benefits and challenges, as well as diverse paths to open science;
ii. developing an enabling policy environment for open science;
iii. investing in open science infrastructures and services;
iv. investing in human resources, training, education, digital literacy and capacity building for open science;
v. fostering a culture of open science and aligning incentives for open science;
vi. promoting innovative approaches for open science at different stages of the scientific process;







vii. promoting international and multi-stakeholder cooperation in the context of open science and with view to reducing digital, technological and knowledge gaps.

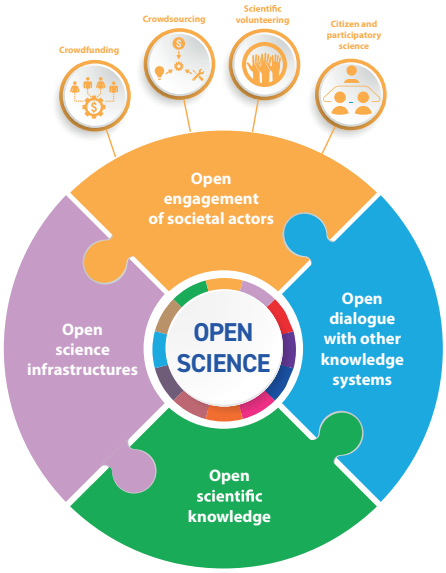
II. DEFINITION OF OPEN SCIENCE

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

5. Building on the essential principles of academic freedom, research integrity and scientific excellence, open science sets a new paradigm that integrates into the scientific enterprise practices for reproducibility, transparency, sharing and collaboration resulting from the increased opening of scientific contents, tools and processes.

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

7. Open scientific knowledge refers to open access to scientific publications, research data, metadata, open educational resources, software, and source code and hardware that are available in the public domain or under copyright and licensed under an open licence that allows access, re-use, repurpose, adaptation and distribution under specific conditions, provided to all actors immediately or as quickly as possible regardless of location, nationality, race, age, gender, income, socio-economic circumstances, career stage, discipline, language, religion, disability, ethnicity or migratory status or any other grounds, and free of



charge. It also refers to the possibility of opening research methodologies and evaluation processes. [...]

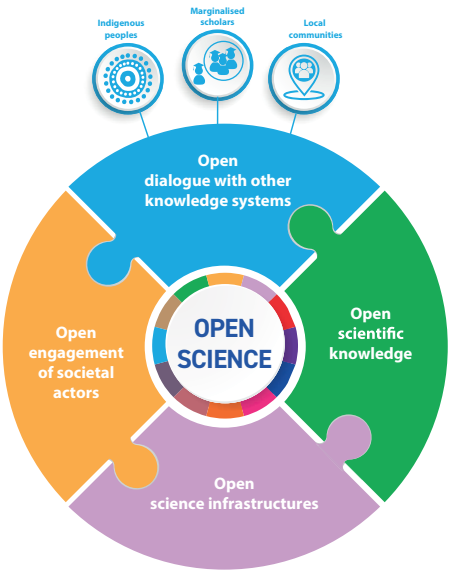
8. Access to scientific knowledge should be as open as possible. Access restrictions need to be proportionate and justified. They are only justifiable on the basis of the protection of human rights, national security, confidentiality, the right to privacy and respect for human subjects of study, legal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

9. Open science infrastructures refer to shared research infrastructures (virtual or physical, including major scientific equipment or sets of instruments, knowledge-based resources such as collections, journals and open access publication platforms, repositories, archives and scientific data, current research information systems, open bibliometrics and scientometrics systems for assessing and analysing scientific domains, open computational and data manipulation service infrastructures that enable collaborative and multidisciplinary data analysis and digital infrastructures) that are needed to support open science and serve the needs of different communities. Open labs, open science platforms and repositories for publications, research data and source codes, software forges and virtual research environments, and digital research services, in particular those that allow to identify unambiguously scientific objects by persistent unique identifiers, are among the critical components of open science infrastructures, which provide essential open and standardized services to manage and provide access, portability, analysis and federation of data, scientific literature, thematic science priorities or community engagement. Different repositories are adapted to the specificity of the objects they contain (publications, data or code), to local circumstances, user needs and the requirements of research communities, yet should adopt interoperable standards and best practices to ensure the content in repositories is appropriately vetted, discoverable and reusable by humans and machines. Open innovation testbeds including incubators, accessible research facilities, open license stewards, as well as science shops, science museums, science parks and exploratories, are additional examples of open science infrastructures providing common access to physical facilities, capabilities and services. Open science infrastructures are often the result of community-building efforts, which are crucial for their long term sustainability and therefore should be not-for-profit and guarantee permanent and unrestricted access to all public to the largest extent possible.

10. Open engagement of societal actors refers to extended collaboration between scientists and societal actors beyond the scientific community, by opening up practices and tools that are part of the research cycle and by making the scientific process more inclusive and accessible to the broader inquiring society based on new forms of collaboration and work such as crowdfunding, crowdsourcing and scientific volunteering. In the perspective of

developing a collective intelligence for problem solving, including through the use of transdisciplinary research methods, open science provides the basis for citizen and community involvement in the generation of knowledge and for an enhanced dialogue between scientists, policymakers and practitioners, entrepreneurs and community members, giving all stakeholders a voice in developing research that is compatible with their concerns, needs and aspirations. Furthermore, citizen science and citizens' participation have developed as models of scientific research conducted by non-professional scientists, following scientifically valid methodologies and frequently carried out in association with formal, scientific programmes or with professional scientists with web-based platforms and social media, as well as open source hardware and software (especially low-cost sensors and mobile apps) as important agents of interaction. For the effective reuse of the outputs of citizen and participatory science by other actors, including scientists, these products should be subject to the curation, standardization and preservation methods necessary to ensure the maximum benefit to all.

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



12. The public sector has a leading role to play in the implementation of open science. Nevertheless, open science principles should also guide the research funded by the private sector. In addition, there are multiple actors and stakeholders in research and innovation systems and each of them has a role to play in the operationalization of open science. Regardless of their nationality, ethnicity, gender, language, age, discipline, socioeconomic background, funding basis and career stage or any other grounds, open science actors include, among others: researchers, scientists and scholars, leaders at research institutions, educators, academia, members of professional societies, students and young researcher organizations, information specialists, librarians, users and the public at large, including communities, indigenous knowledge holders and civil society organizations, computer scientists, software developers, coders, creatives, innovators, engineers, citizen scientists, legal scholars, legislators, magistrates and civil servants, publishers, editors and members of professional societies, technical staff, research funders and philanthropists, policymakers, learned societies, practitioners from professional fields, representatives of the science, technology and innovation-related private sector. ◘

TYAN SUPPORTS UNESCO RECOMMENDATION

by **Raffaella De Lia**

In 2006, TWAS launched a programme to recognize the most accomplished young scientists in various regions of the developing world: TWAS Young Affiliates. Every year since 2007, each of TWAS five Regional Partners—responsible for Latin America and the Caribbean, East and South-East Asia and the Pacific, the Arab region, Central and South Asia, and sub-Saharan Africa—elect up to five outstanding young scientists from their region as TWAS Young Affiliates for a period of six years, after which they become alumni.

These 25 outstanding scientists must:

1. Be under the age of 40,

2. Be living and working in a developing country, and

3. Have an excellent track record of at least 10 international publications.

Since 2019, UNESCO-TWAS, in cooperation with the Islamic Development Bank, allowed also talented young scientists who are refugees or displaced to be selected as TWAS Young Affiliates.

As of March 2022, there was a total of more than 350 TWAS Young Affiliates and Young Alumni from 81 countries. All these scientists are part of a network referred to as TWAS Young Affiliates Network: TYAN.

The letter on the right (in the box), expressing TYAN support for the Recommendation on Open Science adopted by UNESCO General Conference in November 2021, is published for the first time.

TYAN LETTER OF SUPPORT TO UNESCO RECOMMENDATION ON OPEN SCIENCE

At the forty-first session of UNESCO General Conference held from 9 to 24 November 2021, UNESCO 193 member States adopted the first international framework on open science. UNESCO Director-General Audrey Azoulay emphasized that UNESCO Recommendation on Open Science will "drive the wider adoption of open practices, encourage greater endorsement of open science, and ensure that research findings are beneficial to all."

UNESCO conceives open science as:

1. A tool to increase scientific collaborations and sharing of information for the benefits of science and society

2. A means to make multilingual scientific knowledge openly available, accessible and reusable for everyone, and

3. An instrument that will open the processes of scientific knowledge creation, evaluation and communication to societal actors beyond the traditional scientific community.

TWAS Young Affiliates Network (TYAN), an organization of outstanding young scientists from the developing world under the auspices of The World Academy of Sciences (UNESCO-TWAS), strongly supports UNESCO Recommendation, and the overall practice and culture of open science (See pp. 5-13).

Open science guarantees equal access to scientific information and knowledge—a fundamental right that is not always assured in the developing world, where access to publications is limited by journal paywalls, and where dissemination of research outputs is hindered by excessive article processing charges. Timely availability of scientific information is very crucial in planning, developing and conducting research. Therefore, open science ensures that recent scientific findings are available to all researchers anytime and anywhere. Open science also ensures that sound scientific data are disseminated.

TYAN promotes research collaboration among young and early-career scientists in the global North and in the global South, thereby contributing to closing the scientific, technological and innovation gap between developed and developing countries. Open science can further strengthen this collaboration. TYAN fully supports the call on UNESCO Member States included in the Recommendation to set up international and regional funding mechanisms, and to invest in infrastructures for open science. TYAN believes that these strategies will enable growth and the development of research, and further encourage scientists and other stakeholders to understand, promote, and apply open science for the benefit of all. TYAN believes that open science opens new frontiers.

OPEN ACCESS: TYAN PERSPECTIVE

Thinking over the open-access publishing model, scientists of TWAS Young Affiliates Network and the Argentinian Young Academy urge a revision of current policies

by **Cristina Serra**

Access to knowledge and learning is a basic human right, as stated in Article 26 of the Universal Declaration of Human Rights, and reinforced through United Nations Sustainable Development Goal 4. Similarly, access to scientific publications is a basic need for scientists, who can contribute to the global knowledge-building more profoundly, rapidly and broadly, only if they can learn from colleagues' experience, hypotheses, experiments, successes and failures. In a word: from the scientific publications.

Scientific publications, however, and the subscriptions to them, have always been expensive, and not all the scientists can afford paying fees. This situation started changing when a movement called 'open access' (as opposed to closed access, or subscription access) emerged, in 1991.

The idea that everybody could read and share—and, more recently, also download—online material for educational and scientific purposes was welcomed with enthusiasm: Articles would be accessible, and protocols could be shared at no charge. This approach, however, soon raised the question of how to recover the costs of publications that publishers were recovering by charging authors, invoking the need for an "article-processing, or article-publishing, charge" (APC). By funding costs through payments made by authors or their institution, the open-access system penalizes scientists from developing countries and young scientists, whose research grants are often not substantial enough to cover such costs.

Scientists who have analyzed this situation note that "... richer research teams publish more OA articles in the most prestigious journals", which leads to the "... marginalization of authors from low-income countries."

A recent initiative has come from a group of young scientists who are members of TWAS Young Affiliates Network (TYAN) and of the Argentinian Young Academy (AJA): They circulated a text on the need to eliminate the inequities that the APC system has introduced.

▼ Participants in the twenty-second TWAS-LACREP Young Scientist Conference and first TYAN Regional Conference for Latin America and Caribbean Region, held 27 to 29 November 2019. (Photo: TYAN)

More importantly, they gathered consensus from more than 30 national academies and institutions of young scientists worldwide.

In addition to TYAN, AJA and The World Academy of Sciences (UNESCO-TWAS), other signatory institutions include the Global Young Academy, hosted by the German National Academy of Sciences Leopoldina, and the Youth Innovation Promotion Association of the Chinese Academy of Sciences.

In December 2021, members of TYAN and AJA released a statement that shows the imbalance that such a system creates, calling upon the creation of an ad hoc worldwide committee, working under the aegis of multilateral global academic institutions or similar bodies.

As of 17 March 2022, 15 Nobel laureates expressed their support for the statement released by TYAN and AJA young scientists by signing it: Richard Roberts, George Smith, Craig Mello, Lou Ignarro, Jerome Friedman, and Paul Berg of the United States of America; Aaron Ciechanover of Israel; Richard Henderson of the United Kingdom; Jean-Marie Lehn of France; Takaaki Kajita of Japan; Edvard Moser, and May-Britt Moser of Norway; Emmanuelle Charpentier of Germany; Brian Schmidt of Australia; and Giorgio Parisi of Italy.

Below is TYAN and AJA statement on the article-processing charge on the open-access model.

▼ First International Conference of UNESCO-TWAS Young Affiliates Network, held on 22-24 August, 2017, in Rio de Janeiro, Brazil. (Photo: TYAN)

ARTICLE PROCESSING CHARGE (APC) POLICIES ON OPEN ACCESS (OA) PUBLISHING MODEL: THE IMPACT ON DEVELOPING COUNTRIES AND THE NEED FOR A MULTILATERAL SOLUTION[1]

Over the past years, the Open Access (OA) publishing models have been shaping the way we publish, allowing scientific articles to be freely available online without any funding or legal barriers. At a first glance, the OA publishing model apparently universalizes science, making it accessible to everyone, in agreement with the human right to science, as recognized by Article 27 of Universal Declaration of Human Rights (UDHR, 1948). The economic model that seems to have gained prominence, particularly for flipping subscription-based journals to OA and/or adopted by many prominent new titles, is one where the financial burden is shifted to the authors. Most often, this is bundled into one article processing charge (APC); though some hybrid journal titles have a non-OA APCs, and an additional OA charge, in case the author(s) are interested in publishing into so-called Gold OA. So let us call this Author-Pays OA, keeping in mind that the author charges are most often, though not always, termed APCs.

This model (the economic model of Author-Pays OA, not OA in general) often incurs in extremely high publication costs for the authors. The exorbitant article processing charges (APC) that come hand-in-hand with the Author-Pays OA publishing model deepens the inequality between researchers from developed

countries and those in lower income countries. This is exacerbated by the policies included in the "Plan S" initiative promoted by many European and American science agencies, with the support of the European Commission and the European Research Council. This plan, announced in 2018, requires that from 2021 scientific publications resulting from research funded by public grants must be published in compliant OA journals or platforms. This regulation highlights the global trend towards publications in OA journals, which offloads the costs of publication on the authors even though these grants themselves do not necessarily pay for APC.

The Author-Pays OA model represents a large barrier for the global scientific community, with particular impact on the progress of early career researchers. In developing countries, APC associated with the publication of scientific articles could represent a large proportion of the annual grants (as much as 35-130%). In general, OA fees/charges are too high given that the publishing industry depends on the voluntary, non-paid, peer-review activities of the research community. Although biological and medical sciences are currently the most affected areas, in the near future, the OA model will impact other disciplines or fields of knowledge. Under this new paradigm, the ability to publish scientific research from developing countries in highly cited and reputable journals is at risk. To overcome this, researchers from developing countries may either not publish or share authorship with colleagues from developed countries to share the burden of the APC. It should be noted that although it is possible to request fee waivers, this option is often denied if the country does not qualify as a very low-income country.

Research and academic institutions also contribute to the problem by implementing evaluation methodologies based on journal-based metrics (such as journal impact factors). Therefore, as recommended by DORA through the San Francisco Declaration on Research Assessment, there is an urgent need for less biased new evaluation strategies.

Within the draft text of the UNESCO Recommendation on Open Science (CL/4363, of May 2021), an international framework for open science policy and practice was provided. The recommendation recognizes disciplinary and regional differences in open science perspectives, takes into account academic freedom, gender-transformative approaches and the specific challenges of scientists and other open science actors in developing countries, and emphasizes the need to advance towards open science reducing the digital, technological and knowledge divides between and within countries.

In the midst of this complex scenario, we believe that the international community should assume the challenge of exercising multilateral governance and academic cooperation in the face of the inequities that arise from this new OA publication model. To that end, the signing global organizations promote the creation of an *ad hoc* worldwide committee (Global Initiative for Equitable OA Models), working under the umbrella of multilateral global academic institutions or similar bodies. The Committee aspires to:

1. Establish a fluid dialogue between the various members of the scientific community, policy makers and representatives from governments, to further discuss options and implement joint actions for an equitable model of OA for the global scientific community.

2. Draft a global agreement aimed at enforcing equitable access to publishing in OA Journals moving away from Author Pays OA and toward models that either a) repurpose existing subscription funds to fund e.g., sponsored OA or b) subscribe-to-open OA; or obtain funding for academic publishing from institutions or other public sources (diamond/platinum OA). Regulation should include guidelines aimed at setting copyrights.

3. Create a global economic containment network to financially support the least developing countries and scientifically lagging countries in order to strengthen national scientific R&D systems in line with objectives previously established by the countries at the multilateral level, such as the United Nations Sustainable Development Goals (UN SDGs).

4. Set up a network of existing or new diamond journals from developing countries, aimed at promoting non-commercial open publishing practices with clear and transparent regulations and strong standardized peer review processes. This can lead to new prestigious and recognized options where scientific communication will prevail over the interests from the publishing industry. ◘

[1] The statement was published as received, without editing.

Q&A TYAN CHAIR ON OPEN ACCESS

by **Cristina Serra**

Franco Cabrerizo, Chair of TWAS Young Affiliates Network (TYAN), commented on the statement released last December by TYAN and the Argentinian Young Academy

There are previous examples of open-access statements, endorsed in Delhi, Granada, Berlin and Budapest. What is the added value of this particular initiative?

● Over the years, a large number of online repositories and open-access journals have been launched, which represent an apparent achievement for the scientific community. However, the lack of regulations and concerted actions to address the OA led the system to evolve in unforeseen directions.
Our initiative is built on all the previous statements and declarations, but it aims to give voice to early-career researchers, particularly those from developing countries, emphasizing the extremely high and, in most cases, unfair publication costs for authors. Our proactive approach strives to trigger concrete, coordinated and multilateral actions to better address this issue.

▼ Franco Cabrerizo, Chair of TWAS Young Affiliates Network and a Professor at the National University of San Martín, Argentina.

The idea of an international committee that eases the dialogue among different stakeholders is a promising one. Will this body be effective enough in making everyone agree on a matter that has financial and political implications?

● We believe that the creation of a worldwide committee working under the umbrella of multilateral global academic institutions might have a positive impact. Its lack of effectiveness is a risk to be taken into account, but there are no 'silver bullet' solutions and the systematic appearance of new challenges forces us, in our turn, to explore new strategies like, precisely, an international committee. Its role would be even more decisive with researchers from developing countries.

Do you have any personal experience with open-access publishing and its downside?

● Biological and medical sciences are the areas most affected by the article-processing charges of the open-access model. In developing countries, the costs associated with the publication of scientific articles could impact between 35 and 130 per cent of the national research grants. I personally work in a field of chemistry, where the traditional reader-subscription model is still ongoing in a large number of well-recognized journals. Thus, at the moment, article-processing charges do not represent a barrier to sharing my research with the global community. In the near future, however, such a model might have a strong impact on other disciplines, putting at risk the ability to publish scientific research from developing countries in reputable journals. ◘

Read more: www.twas.org/node/15338/

KNOWLEDGE AS A PUBLIC GOOD

Based on the notions of accessibility, transparency and integrity, open science is the key to accelerating the participation of developing countries in global progress

by **Cristina Serra**

Open science and open access have entered the common language and, oftentimes, they are used interchangeably. They are not synonyms, though. Rather—as it happens with the colourful Russian dolls that are placed one inside the other—the former term has a much wider significance that includes the latter.

The idea of open access refers to a model of publishing based on which scholarly articles should be accessed freely and at no charge for scientists (See article on p. 15). Open science, on the other hand, embodies key notions like inclusion, equity, fairness and, most importantly, sharing of scientific data and achievements, all of which go well beyond the, still relevant, access to scientific publications.

Open science, in essence, calls for collaboration across fields, countries and scientific communities. It is a means to global progress, rather than a goal per se. A recent example of the transformative power of open science was offered by the COVID-19 pandemic, which laid the groundwork for data sharing among laboratories and for fruitful collaborations among institutes from different nations, united by the same goal: finding a vaccine to halt the coronavirus.

Even though there isn't a precise date to trace the first spark of this movement, scholars maintain that it might have been initiated in 1665, when the first academic journal titled *Journal des sçavans* was published on the initiative of the French humanist and scholar Denis de Sallo.

Across the centuries, and with the changes that science and society have gone through, open science has gained a broader meaning that is summarized in the acronym FAIR, which refers to four important features of scientific data: they should be findable, accessible, interoperable and reusable.

In other words, scholars should be able to find data through established identifiers, such as the digital object identifier (DOI), from reputable repositories, in formats that are manageable by everybody, and under certified conditions that grant potential reuse.

Since 2016, open science is a strategic goal of the European Union: it launched the European Open Science Cloud, a pilot initiative to strengthen research through the establishment of a repository to host and allow the processing of research data, ensuring trust and safeguarding the public interest.

▼ "Science is great, open it [open science]", a graphic artwork by Martin Clavey, calling on sharing scientific data. Photo produced 6 September 2011. (Image: Martin Clavey/Flickr)

International organizations like the United Nations Educational, Scientific and Cultural Organization (UNESCO) have taken concrete steps towards expanding and regulating open science, in such a way as to become the accelerator for achieving the United Nations Sustainable Development Goals.

Through its Recommendation on Open Science, adopted by 193 countries attending the forty-first session of UNESCO General Conference, in November 2021, UNESCO aimed at setting international standards that define shared values and principles for open science, promoting global participation in science, and bringing citizens and science closer through the dissemination of scientific knowledge. (See p. 10)

But what about the rest of the world, and, in particular, the developing countries? What initiatives did they undertake to flow along with the open science movement?

FROM DAKAR

Science in developing countries is important because, generally speaking, scientists' investigations aim to solve problems affecting their local communities, and have an immediate impact. Their projects, however, are often penalized by the lack of funding and equipment, limited or no access to scientific publications (See p. 15) and inadequate infrastructures. Open science and its derivatives are, thus, an urgent life-changer for these scientific communities.

On 15 March 2016, in Dakar, Senegal, the Association of African Universities, in collaboration with the West and Central African Research and Education Network and with the support of the European Commission, organized

▼ An artwork illustrating the idea of open science: a movement aiming to make the scientific process more transparent, inclusive and democratic. (Photo: UNESCO)

▲ UNESCO Director-General Audrey Azoulay during her opening remarks at the 2021 Open Science Forum for Latin America and the Caribbean, 26-28 April 2021 (CILAC Forum).

> We must create the conditions for global consensus to emerge around new models of dissemination of scientific information and knowledge transparency.
>
> *Audrey Azoulay, UNESCO Director-General*

a workshop titled Promoting Open Science in Africa.

At the workshop, leading African scientists debated about the progress in open-science services that had been developed for the continent's scientific communities. A couple of weeks later, from 29 March to 1 April, delegates to the Fourth Council for the Development of Social Science Research in Africa (CODESRIA) Conference on Electronic Publishing gathered again in Dakar. After three days of intense discussion, a panel comprising representatives of CODESRIA, UNESCO, the Latin American Council of Social Sciences (CLACSO) and eminent African scholars drafted the Dakar Declaration on Open Access Publishing in Africa and the Global South. The declaration recommends that:

- Publicly funded research in Africa and the global South should be made freely available to the public
- Multi-stakeholder mechanisms for collaboration and cooperation should be established to amplify and increase the voice and influence of research from Africa and the global South
- Institutions and governments in Africa and the global South should urgently develop open-access policies and initiatives, and should provide the enabling environment, infrastructure and capacity-building required to support open access.

... TO MALLORCA

A few months later a similar initiative was taken, but in Europe. From 24 to 26 May 2016, the Research, Innovation, and Science Policy Expert (RISE) Open Science High-Level Group gathered at the University of Balearic Islands, in Palma, Balearic Islands, Spain, where they met with 12 external specialists and acknowledged the role that open science should play in addressing the new world challenges.

The Mallorca Declaration, as it was named, focused in particular on four barriers that prevent open science to be effective: research funding, publishing, open data, and research integrity.

Open science, the signatories noted, cannot be based on extreme competition, hence it would be important to support especially early-career scientists with properly allocated funds, taking into account not only the number of publications and the journals' impact factor but also the individual's work and its quality.

The RISE group advocated also the need for a new open-access publishing system, the development of training programmes teaching best practices for data management, and research integrity that grants the reliability and reproducibility of research outcomes.

THE PAN-AFRICAN INITIATIVE ON OPEN SCIENCE

Africa is a complex continent where science systems do not always cooperate due to very different policies and practices in each country, and partially to language barriers created by the many languages and dialects. One way to catch up with foreign competitive regions would be the adoption by African countries of initiatives that implement data sharing and cloud computing, in order to encourage active participation in what is known as the Fourth Industrial Revolution.

One such digital initiative came one year after the Dakar Declaration: in 2017, a three-year pilot phase of an African Open Science Platform was launched, funded by the South Africa National Research Foundation under the direction of the Committee on Data of the International Science Council, and managed by the Academy of Science of South Africa.

On 6 June 2017, in Accra, Ghana, international stakeholders and scientific bodies—including TWAS—met at the Association of African Universities General Conference to discuss the values and the potential downsides of an

> May this Declaration be a guiding light for scholars/researchers and students, and, policymakers and other stakeholders in the Global South.
>
> *From the "Dakar Declaration on Open Access Publishing in Africa and the Global South"*

African platform. On 27 and 28 March 2018, the city of Pretoria, South Africa, hosted the African Open Science Platform Strategy Workshop, the first of a series that would debate the strategy leading to the creation of the African Open Science Platform.

Today, four years later, the platform is operational and implementation activities are ongoing. The aim of the platform has remained unchanged, namely, "to position African scientists at the cutting edge of contemporary, data-intensive science by stimulating interactivity and creating opportunity through the development of efficiencies of scale, building critical mass through shared capacities, and amplifying impact through a commonality of purpose and voice." All fundamental resources for a modern society.

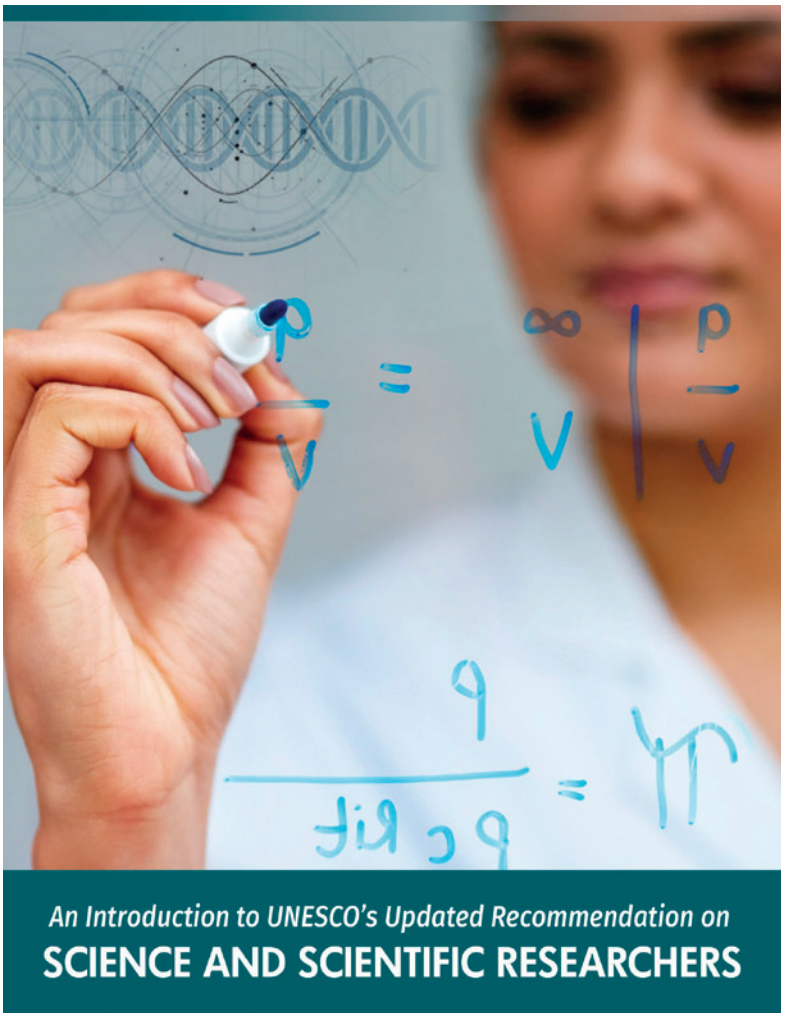
THE PANAMA OPEN SCIENCE DECLARATION

Despite the relatively young age of its scientific communities, the Latin America and Caribbean region is not new to initiatives on open science. In 2018, a group of advocates and civil society organizations, called by Fundación Karisma, met in Panama City to discuss the role of open science in Latin America's development. This is how the Panama Declaration on Open Science was born.

In their 11-point statement, participants to the meeting stated that knowledge is a public good and that science drives democracy, freedom and social justice. They mentioned the importance of equitable access to quality education, and in the list of elements that are essential to open science they included open access, open education and strategic national policies to sustain open science.

The active participation in the open-science process of scientists from Latin America and the Caribbean, as well as the Panama Declaration itself, have been praised by UNESCO Director-General Audrey Azoulay in her opening remarks at the 2021 Open Science Forum for Latin America and the Caribbean, (min. 10:20).

"The region has proven its long-term commitment to open science, which it had already demonstrated in the 2018 CILAC Forum, with the Panama Declaration," Azoulay said. "Open science isn't just about science equity. As the pandemic has shown us, open science is a vital matter of public health, a matter of justice between the North and the South, men and women, and present and future generations." A moral issue that confronts us with our responsibilities.



▲ UNESCO Recommendation on Open Science defines shared values and principles for open science, and identifies concrete measures on open access and open data.

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IN THE NEWS

COVID spurs Africa to plan vaccine revolution

Prompted by the pandemic, Africa's leaders are on a path to ramp up capacity in vaccine manufacturing and boost the continent's regulatory bodies for medicines.

For decades, Africa has imported 99 per cent of its vaccines. On 13 April 2021, at the end of a two-day vaccines summit co-organized by the Africa Centres for Disease Control and Prevention and the African Union, the continent leaders pledged to increase the share of vaccines manufactured in Africa from 1 to 60 per cent by 2040. This includes building factories and bolstering capacity in research and development.

Nature News:
www.bit.do/AfricaVaccines

Sites in China hosted over 20 launches in 2021

A Long March-7A rocket carrying two satellites was sent to space successfully from the Wenchang Spacecraft Launch Site in China's Hainan Province on 23 December 2021. Further satellites were launched on 12 March, 29 April, 29 May and 20 September.

The December achievement means that the total launches carried out at the two launch sites under Xichang Satellite Launch centre, Wenchang and Xichang, exceeded 20 for the first time.

China News Service:
www.bit.do/ChinaLaunchRecord

New dietary tool could help stem heart disease

Researchers have created a dietary tool, called the Double Health and Climate Pyramid, to aid healthy food choices and cut climate change risks.

Unhealthy food choices cause annually 9.1 million premature deaths globally from heart disease, one of several non-communicable diseases, which are collectively responsible for almost 70 per cent of all deaths worldwide. The tool provides healthy messaging on nutrition and has been applied in regions including sub-Saharan Africa, South Asia and Latin America.

SciDev.Net:
www.bit.do/DietaryTool

Rain in Africa leads to butterflies in Europe

Wet years appear to have produced European butterfly booms in 2009, 2015, and 2021, a team of scientists reported in the *Proceedings of the National Academy of Sciences*.

Spring vegetation levels in North-Western Africa can also affect the number of painted lepidopterans, one of the planet's most widespread butterflies, in Europe.

Science Magazine:
www.bit.do/ButterflyNumbers

Report estimates cost of climate change for India

India may lose 3–10 per cent of its gross domestic product annually by 2100 due to climate change, according to a report released by a London-based global think tank Overseas Development Institute on 8 June 2021.

The report, titled "The costs of climate change in India: a review of the climate-related risks facing India, and their economic and social costs", looked at the economic costs of climate-related risks in the country, but also at how lower-carbon development could yield immediate benefits such as cleaner air, greater energy security and rapid job creation.

Down to Earth:
www.bit.do/ClimateCosts

PEOPLE, PLACES & EVENTS

NEW SECRETARY-GENERAL OF THE PAKISTAN ACADEMY OF SCIENCES, A TWAS FELLOW

Tasawar Hayat, elected as TWAS Fellow in 2010, is the new Secretary-General of the Pakistan Academy of Sciences. A distinguished Professor of mathematics at Quaid-i-Azam University in Islamabad, where he also earned his PhD, Hayat pioneered a mathematical field that investigates diversified non-linear models in the physiological world, with applications to blood circulation problems.

He serves as a reviewer, associate editor and/or member of many editorial boards of international journals, and has produced more than 2,550 contributions to international publications. He has received more than 40 national and international awards, including the International Obada Prize 2021—endowed by the Natural Sciences Publishing supported by the African Academy of Sciences—for his outstanding research contribution in the field of mathematics.

Hayat plays also a leading role in the creation of scientific cooperation: He, for example, promoted the establishment of fruitful collaborations among the member institutions of the Federation of the Universities of the Islamic World. He has supervised almost 200 students pursuing a BSc or a PhD, and has currently almost 20 students under his direct supervision.

NEW LEMUR SPECIES NAMED AFTER A TWAS FELLOW

Ten years of work and passionate investigation led to the production of a short film about a new species of lemur, *Microcebus jonahi*, named after **Jonah Ratsimbazafy**, a Faculty Lecturer at the University of Antananarivo, in Madagascar, and a TWAS Fellow since 2021. The film is titled "Good news in bad time: Welcome *Microcebus jonahi*," and is available on YouTube.

Ratsimbazafy is a passionate environmentalist, serving as the Director of Houston Zoo's Madagascar Program, in the United States; and President of the Madagascar Primate Research Group. He earned his PhD from the State University of New York, USA, in 2002, and in 2011 gained the Accreditation to Supervise Research at the University of Antananarivo, in Antananarivo, Madagascar.

His conservationist activity earned him a number of international awards and honours, which include the Rockefeller Foundation Global Fellowship Program on Social Innovation, in 1998; the Galante Family Winery Conservation Scholarship of the International Primatological Society, in 2002; the Disney Conservation Hero Award, in 2015; the African Primatological Society Award, in 2019.

In February 2020, he was elected President of the International Primatological Society.

IN MEMORIAM

Paul Crutzen, Director Emeritus at the Max-Planck-Institute for Chemistry in Mainz, Germany, and a TWAS Fellow since 2004, passed away on 28 January 2021, at the age of 87.

Crutzen earned a PhD in meteorology from Stockholm University, in 1973, and from 1980 to 2000, he served as the Director of the Atmospheric Chemistry Department of the Max Planck Institute for Chemistry. He was among the promoters of the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer, whose signatory States committed to introducing a gradual elimination of ozone-depleting substances.

In 1995, Crutzen was awarded the Nobel Prize in Chemistry (with Mario J. Molina and F. Sherwood Rowland) for his pioneering theory postulating that human activities and the emission of industrial gases such as nitrogen oxides are responsible for the thinning of the ozone layer surrounding the Earth. Crutzen's work raised awareness about the importance to achieve nuclear disarmament and avoid a nuclear war, which would darken the Earth's atmosphere, leading to a nuclear winter. In 2000, he coined the word "Anthropocene" to indicate the current times in which the activities carried out by human beings are severely damaging the Earth, with an impact on the atmospheric and biological processes.

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Please, send an email to Cristina Serra [cserra@twas.org] with a brief explanation, link to more details, photos with credits and contact information.

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United Nations Educational, Scientific and Cultural Organization

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The World Academy of Sciences for the advancement of science in developing countries (UNESCO-TWAS) works to support sustainable prosperity through research, education, policy and diplomacy.

TWAS was founded in 1983 by a distinguished group of scientists from the developing world, under the leadership of Abdus Salam, the Pakistani physicist and Nobel laureate. Today, UNESCO-TWAS has more than 1,300 elected Fellows representing 108 countries; 11 of them are Nobel laureates. It is based in Trieste, Italy, on the campus of the **Abdus Salam International Centre for Theoretical Physics (ICTP)**.

Through more than three decades, the Academy's mission has remained consistent, namely to:

- Recognize, support and promote excellence in scientific research in the developing world
- Respond to the needs of young scientists in countries that are lagging in science and technology
- Promote South-South and South-North cooperation in science, technology and innovation and
- Encourage scientific and engineering research and sharing of experiences in solving major problems facing developing countries.

TWAS and its partners offer 260 fellowships per year to scientists of the developing world for PhD studies and postdoctoral research. TWAS awards are among the most prestigious given for scientific work in the developing world. The Academy distributes over $2 million in research grants every year to individual scientists and research groups.

It supports visiting scientists and provides funding for regional and international science meetings.

UNESCO-TWAS hosts and works in association with two organizations, also hosted on the ICTP campus: the **Organization for Women in Science for the Developing World (OWSD)** and the **InterAcademy Partnership (IAP)**.

At its founding in 1989, OWSD was the first international forum uniting women scientists from the developing and developed worlds. Today, the Organization has more than 8,200 members. Their objective is to strengthen the role of women in the development process and promote their representation in scientific and technological leadership.

IAP represents more than 140 national and regional science and medical academies worldwide. It provides high-quality analysis and advice on science, health and development to national and international policymakers and the public; supports programmes on scientific capacity-building, education and communication; leads efforts to expand international science cooperation; and promotes the involvement of women and young scientists in all its activities.

TWAS, a programme unit of UNESCO, receives its core funding from the Italian Ministry of Foreign Affairs and International Cooperation.

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iap SCIENCE HEALTH POLICY
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