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The Human Right to Science: From Fragmentation to Comprehensive Implementation?

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THE HUMAN RIGHT TO SCIENCE: FROM FRAGMENTATION TO COMPREHENSIVE IMPLEMENTATION?

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SOUTH CENTRE AND SWISS COMMISSION FOR UNESCO

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ABSTRACT

In times when the role of science in society is more debated than ever in polarized, politicized and partial terms, what is the role for the human right to science and rights-based approaches? The right to science remains poorly understood and neglected in both national and global human rights processes. Beyond defending the freedom of scientific expression, upholding the right to science is arguably fundamental to resolving key sustainability challenges of our times from climate change and the biodiversity crisis to global health and pandemics. The global COVID-19 pandemic has revealed persistent global inequalities not least in terms of how the privatization of science and current intellectual property regimes hinder just and equitable responses to access science and its benefits. This prompts the need for a shift from single-issue approaches to comprehensive and systematic treatment of the right to science as a bundle of human rights across multiple arenas to counter fragmentation and silo-tendencies.

À une époque où le rôle de la science dans la société est plus que jamais débattu en des termes clivants, politisés et partiaux, la question se pose de la manière dont il convient d'appréhender le droit à la science et les approches fondées sur les droits ? Le droit à la science reste mal compris et négligé dans les processus nationaux et mondiaux relatifs aux droits humains. Au-delà de la défense de la liberté d'expression scientifique, le respect du droit à la science apparait fondamental pour faire face aux principaux enjeux de notre époque, qui vont du changement climatique à la crise de la biodiversité en passant par la santé mondiale et les pandémies. La pandémie mondiale de COVID-19 a révélé des inégalités persistantes, notamment en ce qui concerne l'accès équitable et juste à la science et à ses bénéfices, qui est rendu impossible par la privatisation de celle-ci et les régimes actuels de protection des droits de propriété intellectuelle. Il est donc nécessaire de passer d'une approche monolithique à une approche globale et systématique du droit à la science comme un ensemble de droits couvrant de nombreux aspects de la vie humaine afin de lutter contre le morcellement et les tendances au cloisonnement.

En una época en la que el papel de la ciencia en la sociedad se debate más que nunca en términos polarizados, politizados y parciales, ¿qué función desempeñan el derecho humano a la ciencia y los enfoques basados en los derechos humanos? El derecho a la ciencia sigue conociéndose poco y descuidándose en los procesos nacionales y mundiales en materia de derechos humanos. Más allá de defender la libertad de la expresión científica, puede decirse que velar por el derecho a la ciencia es fundamental para sortear dificultades esenciales de nuestra época, desde el cambio climático y la crisis de la biodiversidad hasta la salud mundial y las pandemias. La pandemia mundial de COVID-19 ha puesto de manifiesto desigualdades persistentes en todo el mundo, en particular en lo que se refiere al modo en que la privatización de la ciencia y los actuales regímenes de propiedad intelectual obstaculizan respuestas justas y equitativas que permitan el acceso a la ciencia y sus beneficios. Esto provoca la necesidad de adoptar un cambio para pasar de los enfoques centrados en una sola cuestión a un tratamiento amplio y sistemático del derecho a la ciencia como un conjunto de derechos humanos presente en diversos ámbitos que permita contrarrestar la fragmentación y las tendencias individualistas.

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INTRODUCTION

> "The Right to Science is a key tool for humanity to confront the triple crisis of pollution, climate change, and biodiversity."
>
> - Marcos Orellana, United Nations Special Rapporteur on Toxics and Human Rights (2021)

In times when the role of science in society is more debated than ever in polarized, politicized and often partial terms, what is the role for the human right to science and rights-based approaches? As the 2020 General Comment of the Committee on Economic, Social and Cultural Rights underlines:

> "The right to participate in and to enjoy the benefits of scientific progress and its applications contains both freedoms and entitlements. Freedoms include the right to participate in scientific progress and enjoy the freedom indispensable for scientific research. Entitlements include the right to enjoy, without discrimination, the benefits of scientific progress. These freedoms and entitlements imply not only negative, but also positive obligations for States." (CESCR, 2020)

The bundle of rights and obligations making up the right to science is inextricably linked to and interdependent with other human rights. Paradoxically as a field of rights, however, it remains poorly understood and neglected in both national and global human rights processes.

This research paper was initially shared as the background document for the Geneva Dialogue on the right to science organized by the Swiss Commission for the United Nations Educational, Scientific and Cultural Organization (UNESCO) in partnership with UNESCO, the United Nations (UN) Human Rights and the REGARD network involving a wide range of academic, intergovernmental and civil society actors.

Beyond defending the freedom of scientific expression, the analysis here calls for systematic attention to a wider set of challenges encountered by scientific practice as well as to challenges in the implementation of the right to science. This prompts the need for a shift from single-issue approaches to comprehensive and systematic treatment of the right to science as a bundle of human rights across multiple arenas to counter fragmentation and silo-tendencies.

Indeed, upholding the right to science is arguably fundamental to resolving key sustainability challenges of our times from climate change and the biodiversity crisis to global health and pandemics. However, multiple dimensions of the human right to science stand challenged today. The global COVID-19 pandemic has revealed persistent global inequalities not least in terms of how the privatization of science and current intellectual property regimes hinder just and equitable responses to access science and its benefits. More generally, the lack of scientific literacy, along with digitally enabled proliferation of false information and the systematic suppression of scientific information and inquiry by governments contribute to the decreasing trust in science. Scientists themselves are under attack as is their practice. Their freedom of expression and personal safety are endangered by threats and actual hostilities from both state and non-state entities. Their working conditions continue to deteriorate from cuts in public funding of research and development. While there has been growing normative attention to the right to science, national and global reporting on this right today covers only a small fraction of the much larger and systematic attacks against the right to science.

Whereas normative discussions and standardization have been substantive and on the increase in recent years, they are yet to be paralleled by adequate implementation measures and mechanisms. This is not to say that the right to science is absent from human rights discussions. Some cases are raised in the context of other human rights such as freedom of expression and the right to health. However, the discrepancy between the centrality and magnitude of right to science issues and the paucity of implementation mechanisms and reporting requires urgent attention.

Building on growing calls for a human rights-based approach to science, there is an urgent need to more systematically address the implementation of the right per se and specifically enhance effective approaches towards qualifying rights and obligations in specific sectoral contexts in a far more comprehensive manner. Following a brief description of the normative framework of the right to science, this paper provides an overview of major challenges identified in the contemporary context. This is followed by a description of existing experiences with the right to science in global and regional human rights mechanisms and wider partnerships. Finally, the analysis explores the growing relevance of new approaches to cooperation and partnership.

THE NORMATIVE FRAMEWORK OF THE RIGHT TO SCIENCE

Enshrined in Article 27 of the Universal Declaration of Human Rights (UDHR) (1948), the fundamental right to science and culture seeks to guarantee that 1) "Everyone has the right… to share in scientific advancement and its benefits" and 2) "Everyone has the right to the protection of the moral and material interests resulting from any scientific, literary or artistic production of which he is the author". The right to science is also established in Article 15 of the International Covenant on Economic, Social and Cultural Rights (ICESCR) (1966), which mandates and creates binding obligations for ratifying states to:

- recognize the right of everyone to enjoy the benefits of scientific progress and its applications,
- conserve, develop, and diffuse science,
- respect the freedom indispensable for scientific research, and
- recognize the benefits of international contacts and co-operation in the scientific field.

Yet, as late as 2018, it was still argued in the journal of Science that the "right to science has never been legally defined and is often ignored in practice by the governments bound to implement it" (Wyndham & Vitullo, 2018, p. 975).

Thus even if the right to science, as such, "adds a normative and judicial dimension to issues at the intersection of science and society" (Porsdam & Mann, 2021, p. 3), this added value was far from clear or a given. Whether touching upon matters of funding, policy or academic freedom and access to knowledge, contemporary science-society dynamics are fraught with challenges where the right is potentially relevant (Mann *et al.,* 2018).

If definitions are up for debate, the complexities of science have long been a source of further normative thinking. The Declaration on the Use of Scientific and Technological Progress in the Interests of Peace and for the Benefit of Mankind (1975) acknowledged both socio-economic benefits and potential risks to the environment, humanity, and inequalities. The document emphasized non-discrimination on access to the benefits of science and outlined governments' responsibilities in preventing science and technology from being used to limit human rights and ensure that these are used for peace and development (Donders, 2011).

In 1997, UNESCO's General Conference adopted the Universal Declaration on the Human Genome and Human Rights emphasizing the protection of human rights in the conduct of research on the human genome. According to Article 10, "No research or research applications concerning the human genome, in particular in the fields of biology, genetics and medicine, should prevail over respect for the human rights, fundamental freedoms and human dignity of individuals or, where applicable, of groups of people" (UNESCO, 1997). Similarly, the UNESCO Declaration on Bioethics and Human Rights adopted in 2005 aims to "promote respect for human dignity and protect human rights, by ensuring respect for the life of human beings, and fundamental freedoms, consistent with international human rights law" in research in the fields of biology, life sciences, and medicine. Both declarations also emphasized on the importance of consent and privacy of individuals involved in research. Both declarations stipulate that freedom of science and research must always benefit the welfare of individuals and humankind as a whole, in recognition of human dignity and human rights[2]. The Venice Statement on the Right to Enjoy the Benefits of Scientific Progress and its Applications ('Venice Statement') in 2009 explained State's duty to

[2] International cooperation in ensuring that developing countries benefit from research and scientific development is also mentioned in both declarations. While both declarations mention that special attention needs to be given to the impacts of research on indigenous peoples, the Declaration on Bioethics and Human Rights has a wider elaboration on consent and benefit-sharing with respect to communities.

respect, to protect, and to fulfill the right to science, enjoined non-governmental organizations to also contribute to the achievement of the right, and raised the discussion on the impacts of privatization of science on the fulfillment of the right to science (Boggio & Romano, 2018).

It was only after more than five decades after the right to science was adopted in the ICESCR that a General Comment was elaborated by the Committee on Economic, Social and Cultural Rights (CESCR), seeking to spell out the right to science. Vigorous debates preceded the adoption of the General Comment (Wyndham & Vitullo, 2018).

The right to science has also been taken up in several regional instruments such as the revised Arab Charter on Human Rights (Article 42), the Association for Southeast Asian Nations (ASEAN) Human Rights Declaration (Article 32) and the Charter of the Organization of American States (Articles 17, 30, 34.i, 38, 45, 47 and 51)[3]. The European Union (EU) Charter of Fundamental Rights calls for scientific research to be 'free of constraint' (Boggio & Romano, 2018), whereas the Charter of the African Union emphasizes the importance of scientific and technological cooperation[4].

Normative discussions have both expanded upon the rights concerned and the institutional context. The report on the right to enjoy the benefits of scientific progress and its applications by the Special Rapporteur (SR) on Cultural Rights (Shaheed, 2012) highlighted the importance of freedom of research as a requirement to enjoy the right to science; linking the right to science to the achievement of human dignity and the ability to aspire for a better future; and discussing how the right to science is an enabler of other rights, including right to food, health, water, housing, education, and a clean and healthy environment (Boggio & Romano, 2018). The report also outlines the duty of States in relation to the achievement of the right to science, which include guaranteeing the freedom of scientific research and opportunities for all to contribute to the scientific enterprise, ensuring individual and collective participation in decision-making, and creating enabling environments for knowledge production and exchange. Scientific benefits may be conceived of in a holistic manner that includes not only the material outcomes of scientific inquiry and technological development (e.g. vaccines, fertilizers, technological instruments, etc.), but also comprehends both the scientific process and the inherent value that science and independent research provide (Wyndham *et al.,* 2017).

The 2017 UNESCO Recommendation on Science and Scientific Researchers, in turn, aims to model "appropriate policy frameworks and institutions and protocols for the practice of responsible science, technology and innovation, in a context of freedom and inclusion" not least by clarifying the terms of "science", "technology", and "scientific researchers". It represents a landmark effort to chart standards in the science field with a set of 10 core principles reflecting human rights in several articles.

1. Responsibility of science towards the United Nations' ideals of human dignity, progress, justice, peace, welfare of humankind and respect for the environment.
2. Need for science to meaningfully interact with society and vice versa.
3. Role of science in national policy and decision-making, international cooperation and development.
4. Promotion of science as a common good.

[3] See also Article 13 of the American Declaration of the Rights and Duties of Man, and Article 14 of the Additional Protocol to the American Convention on Human Rights in the Area of Economic, Social and Cultural Rights also refer to the right to benefit from and participate in the intellectual progress and scientific discovery (Boggio & Romano, 2018).

[4] The Protocol on the Rights of Women in Africa of the African Charter on Human and Peoples' Rights also mandates States to provide an enabling environment for women to receive education in science and technology (Boggio & Romano, 2018).

5. Inclusive and non-discriminatory work conditions and access to education and employment in science.
6. Any scientific conduct is subject to universal human rights standards.
7. Balancing the freedoms, rights and responsibilities of researchers.
8. Scientific integrity and ethical codes of conduct for science and research and their technical applications.
9. Importance of human capital for a sound and responsible science system.
10. Role of Member States in creating an enabling environment for science and research.

The 2017 Revised Recommendation has been described as "codifying a single, common set of global norms and standards for the research and innovation system as a whole, thus constituting an overarching model for national law and policy" (Tash, 2021, p. 24). Aside from detailing the responsibilities of States in creating enabling environments for science and research, the Recommendation also includes the rights and responsibilities of researchers in both public and private institutions. It also qualifies academic freedom and scientific freedom, which includes autonomy, intellectual freedom, freedom of research, freedom of conscience, freedom of association, freedom of movement and freedom of expression, which are not contingent upon a scientist's academic tenure. Furthermore, the Recommendation emphasized the need for science to interact with society and vice-versa for the tackling of global challenges. Science and the principles underpinning scientific development are recognized as key drivers for the fulfillment of the 2030 Agenda for Sustainable Development. Finally, the Recommendation recognised science as a public good and, thus, all investments in science as serving the public interest.

The CESCR's General comment No. 25 (2020) on science and economic, social and cultural rights further fleshes out the right to science and contributes to the removal of its normative ambiguity (Donders & Tararas, 2021). Using the Vienna Convention on the Law of Treaties, the CESCR adopted a broader interpretation of science to include citizen science. The Committee also further elaborated the obligations of states in implementing the right, which includes allocating the maximum available resources; elimination of all forms of discrimination, including those present in laws and policies, that can prevent participation in science and accessing its benefits; and respecting the freedoms needed to conduct scientific inquiry (International Justice Resource Center, 2020). Additionally, the General Comment also discussed the interdependence of the right to science on other rights such as the rights to food and health and warned of the negative impacts of new technologies in rising inequalities. Likewise, the General Comment also emphasized the need for international cooperation for the implementation of the right. The General Comment No. 25 of the CESCR, in turn, represents a significant step forward in terms of defining an authoritative definition of the right to science in the context of a binding treaty:

> The right to participate in and to enjoy the benefits of scientific progress and its applications contains both freedoms and entitlements. Freedoms include the right to participate in scientific progress and enjoy the freedom indispensable for scientific research. Entitlements include the right to enjoy, without discrimination, the benefits of scientific progress. These freedoms and entitlements imply not only negative, but also positive obligations for States. (CESCR, 2020, para. 15)

In addition to an emphasis on the protection of freedom of scientific research, the General Comment stresses the importance of availability, accessibility, opportunity, quality and acceptability (the latter including ethics). In terms of freedoms, the General Comment highlights (1) the protection of scientists from undue influence, (2) the freedom to set up scientific institutions and set the objectives and methods of doing research, (3) freedom of scientists to openly question the ethical value of certain projects and withdraw from these, and (4) the freedom of scientists to cooperate and share data with other researchers, policy makers, and the public. The General Comment also clarified that "benefits" include (1)

material results of the applications of scientific research, (2) the scientific knowledge and information directly deriving from scientific activity, and (3) the role of science in forming critical and responsible citizens who are able to participate fully in a democratic society.

The right to science encompasses both the protection of the producers, enabling conditions for the production of scientific knowledge, on the one hand, and universal access to and use of science and its benefits, on the other. Yet, equally important here is to note the normative development and expansion of the legal meaning and significance of the right to science. This is particularly important when exploring the connections and mismatches with global challenges of our times.

SELECTED TRENDS AND EMERGING CHALLENGES

The central role of critical and independent science in addressing global challenges ranging from global pandemics, climate change and biodiversity loss to rising socio-economic inequalities, and geopolitical tensions is undeniable. However, multiple challenges from shrinking budgets and policy spaces, to misinformation, disinformation, and political polarization today not only shape and hamper the realization of the right to science, but also hinder realizing its full potential. Safeguarding the right to scientific progress and advancements has never been more important than it is today, yet the wide range of deep-running challenges faced are rarely addressed in a comprehensive manner. The following list portrays some of the challenges involved, recognizing the paucity in existing literature on the topic (for a short summary see Mann *et al.*, 2018).

Silencing Science

Worldwide, scientists and scholars face threats to their freedom to practice science, maintain independent research institutions as well as threats to their personal safety. The report Free to Think 2021 published by the organization Scholars at Risk documented 332 attacks on higher education communities by state and non-state actors, including armed militant groups, in 65 countries and communities. The attacks range from killings, violence, and disappearance; imprisonment, prosecution, loss of position; and travel restrictions (Scholars at Risk, 2021). The report which covers the period from September 2020 to August 2021 contextualizes these attacks amidst criticisms by scholars on governments' policies on COVID-19 as well as the decline of human rights in countries such as Myanmar and Turkey. Wars and conflict in the Middle East, and more recently in Ukraine, displaced millions including an unspecified number of scientists. At least 6,000 of Turkey's 150,000 academics were reportedly displaced in the aftermath of the failed coup in 2016, as a result of closing down of institutions or individual suspicion of lack of loyalty to the government (Martin, Chaverneff, Iyengar, & Gregorian, 2021). Repression is also committed against scientists involved in environmental research and grassroots activism. The American Association for the Advancement of Science (AAAS) has spoken out against personal attacks, including harassment, legal challenges, and death threats against climate scientists (AAAS, 2011). In the Philippines, scientists working with agricultural communities as well as communities opposing large extractive projects have been arrested and accused of being members of the local communist guerilla movement[5] [6]. While some governments did turn to the scientific community for guidance during the pandemic, others have sought to suppress independent research and scientific evidence on issues such as COVID-19 and climate change (Sabin Center for Climate Change Law & Climate Science Legal Defense Fund, 2022; Scholars at Risk, 2021). Such dynamics have accelerated with the explosion of social media. The algorithms of the new media environment reward ever more outrageous content allowing fake news to proliferate (Dornan, 2020). To counter this, it has been suggested that social media companies should be pressured to fulfill their responsibilities to the public, and that permanent public education campaigns are needed to counter misinformation (Dornan, 2020).

[5] See https://www.facebook.com/agham.org/photos/scientists-green-group-condemn-continuing-detention-of-colleague-vigan-city-the-/1365557750295392/.
[6] See https://www.business-humanrights.org/es/latest-news/feny-cosico-advocates-of-science-and-technology-for-the-people/.

Science policy interface: facing mis/disinformation and declining trust

A key greyzone concerns the intersection between science, policy and decision-making. As SR Orellana (2021) recently noted:

> The creation of effective channels connecting science with policy-making is indispensable…, [yet] are too often undermined by politics, ideology, lack of transparency, vested economic interests and other conflicts of interest. (p. 2)

Defamation and science disinformation are among the attacks against evidence-based informed public policy and good governance at the science policy interface particularly pronounced in relation to the COVID-19 pandemic and climate change science. The lack of scientific literacy also worsens distrust in science and susceptibility to misinformation, disinformation or fake news. If social media platforms may facilitate access to science, they have also enabled the widespread transmission of disinformation and misinformation. A 2020 United Kingdom Parliament report noted the inconsistent application of community safety standards by platforms allowing "spreaders of misinformation to monetise their content, to the benefit of both platform and publisher" (para. 22) during the pandemic. The Special Rapporteur on the promotion and protection of the right to freedom of opinion and expression Irene Khan proposed that disinformation/misinformation be understood in a wider social context where the lack of media literacy, rising authoritarianism, economic crises, political disenfranchisement, and social inequalities interact, making individuals vulnerable to manipulation (Khan, 2021). Where people do have access to information, including through digital technologies, "people find it difficult to grasp new knowledge…but they also lack the necessary critical tools to question this knowledge (in terms of source and content) and assess its reliability" (Petitgand, Regis, & Denis, 2019, in Porsdam & Mann, 2021, p. 3). Pew Research noted a drop in Americans' trust in scientists from pre-pandemic levels (Kennedy, Tyson, & Funk, 2022). One study points to so-called "elite cues"[7] such as attacks against science advisory boards driving the fast decline in public trust in contexts of health (Hamilton & Safford, 2021) or climate skepticism (Jacques, Dunlap, & Freeman, 2008). If campaigning against science is by no means new (for tobacco see Brandt, 2012)[8], shrinking public finance and the privatization of research raise a wide range of questions about the role of ethics and the alignment with human rights standards (Donders, 2011).

Inequalities in access to science, finance and its benefits

During the COVID-19 pandemic, some governments mobilized the scientific community to advise policy; boosted the use of technology in health monitoring and delivery of services, including health, social assistance, and education; and enabled scientific cooperation to help contain the virus and its impacts (Schneegans, Lewis, & Straza, 2021). However, this is insufficient to reverse the worrying trend of the decline in government funding for research and development (R&D) and the stark inequalities that persist within and between countries in terms of access to science, research investments and benefits (Donders, 2011). Whereas global research spending has grown over the last decades, statistics hide inequalities in terms of actual levels of financing. Globally, R&D expenditures increased to USD 2.2 trillion in 2019 from USD 677 billion in 2000 (Sargent, 2021). UNESCO recommends that countries allocate at least 1% of their gross domestic product (GDP) to

[7] Elite cues are "top-down messages creating deep public divisions regarding science" (Hamilton & Safford, 2021).

[8] A historical example of this are the public relations campaigns by tobacco companies designed to produce scientific uncertainty and undercut health efforts targeting smoking-related harm reduction (Brandt, 2012).

R&D (UNESCO, 2021a). Global R&D expenditures in 2018 averaged 2.20% of GDP (World Bank, 2021). However, in the Organisation for Economic Co-operation and Development (OECD) countries, government financed R&D decreased from 28.26% in 2013 to 24.47% in 2019 while the business sector's share increased from 60.74% in 2013 to 62.83% in 2019 (OECDstat, 2021). Moreover, 90% of research expenditure, researchers, publications, and patents are concentrated in the Group of Twenty (G20) countries (Schneegans *et al.*, 2021). The top 10 countries[9] that had the highest R&D spending in 2019 accounted for 84.7% of the global R&D expenditures for the same year (Sargent, 2021). Meanwhile, developing countries are lagging behind. Available data in 2018 indicate that countries such as Mauritania (0.01%) and The Gambia (0.07%) spent less than 1% of their GDP on R&D. Spending on R&D in South Asia for the same year was at 0.65% of GDP, while it was 0.67% of GDP for Latin America and the Caribbean (World Bank, 2021). While the Sub-Saharan Africa's share of the world population is 14%, it contributed only 0.7% of the world's researchers (UNESCO, 2021b).

Meanwhile, gender inequalities in the employment in science, technology, engineering and mathematics fields (STEM) persist. Across the 69 countries that the International Labour Organization (ILO) has data for STEM employment until 2020, that share of females employed in the sector is constantly lower except for five countries (Cambodia, Dominican Republic, Kiribati, Mongolia, and Georgia) (ILO, 2020). Inequality between countries is also apparent in enrollment in tertiary education. In 2019, enrollment in tertiary education for both sexes was only 9.30% in low income countries, 26.12% in lower-middle income countries, 36.92% in middle income countries, 55.14% in upper-middle income countries, and 79.25% in high income countries (UNESCO Institute for Statistics, 2021). COVID-19 caused a rollback in the broad gains made to access to education. According to Save the Children and the United Nations Children's Fund (UNICEF) (2021), approximately 100 million more children in 2021 (compared to 2019) do not have access to education and/or health service. The implications from an intergenerational equality perspective on the right to science are massive. This is exacerbated by the digital divide. Digital technologies have been crucially important during the COVID-19 pandemic to access information as well as different services including education. However, "[a]lmost half the world's population, 3.7 billion people, the majority of them women, and most in developing countries, are still offline" (United Nations, 2021, para. 5).

Integrating human rights in technological development

New and improved technologies present science with unprecedented capabilities to effect positive change, yet also bear within them great potential for unleashing unintended consequences and new risks. While emerging technologies may enhance the enjoyment of and access to economic, social, and cultural rights by means of gains in productivity, efficiency, or the ability to treat diseases, for example, these innovations could also fundamentally alter society, human behaviour, and humans themselves (e.g. through genetic engineering or integration of devices into the body, etc). The rapid pace of technological advancement is now producing innovations that are "blurring the boundaries between the physical, digital and biological worlds, because of the growing fusion of scientific and technological advancements in areas such as artificial intelligence, robotics, 3D printing, biotechnology, genetic engineering, quantum computers and management of big data" (CESCR, 2020, para. 72).

For example, among the solutions being proposed to mitigate climate change are geoengineering methods which include ocean fertilization, carbon dioxide removal (CDR),

[9] US - USD 657.5 billion current purchasing power parity (PPP) (2021), China - USD 525.7 billion, Japan - USD 173.3 billion, Germany – USD 147.5 billion, South Korea - USD 102.5 billion, France – USD 72.8 billion, UK - USD 56.9 billion, Russia - USD 44.5 billion, Taiwan -USD 44 billion, Italy - USD 38.8 billion.

and solar radiation management (SRM). Technical debates on geoengineering discuss the feasibility of such technologies in helping address global warming. The Intergovernmental Panel on Climate Change (IPCC) for example has tackled the issue in its report, including in its Fifth Assessment Report (2013), Special Report on Global Warming of 1.5°C (2019), and the Sixth Assessment Report (2021). While these reports acknowledge the potential of CDR and SRM to help mitigate global warming, the reports also highlight the potential risks and side-effects on Earth's other biogeochemical processes and biodiversity. These adverse effects pose negative impacts on the rights to health, water, food, and life[10] (Burns, 2016) which will be unevenly distributed among affected populations (Adelman, 2017). Additionally, geoengineering has the potential to divert attention away from solutions geared towards reducing greenhouse gas (GHG) emissions (Adelman, 2017) alongside nature-based solutions. The risks and their impacts on human rights raised the call for effective governance mechanisms and ethical frameworks that will apply the precautionary principle in applying geoengineering technologies and address power imbalances in decision-making between would-be affected communities and those that control the development and deployment of these technologies (Burns, 2016; Adelman, 2017). As such, there is a need to consider the benefits of these technologies while simultaneously reducing their risks, building on a human rights framework (CESCR, 2020).

The integration of human rights in data collection and storage is also important to ensure that emerging technologies, such as Artificial Intelligence (AI), serve to advance development goals. While AI can help improve efficiency, monitor epidemics, or aid economic growth, it can also have built-in discriminatory effects. Algorithmic bias which can be rooted in what types of data is collected and how this is done, can result in the violation of human rights. It can lead to a person being unfairly treated, or even discriminated, based on characteristics such as race, age, sex or disability (Santow, 2020). For example, a review of a healthcare-based risk prediction algorithm that was used on about 200 million American citizens showed a racial bias. Because the algorithm was not properly tested, the system favored white patients over black patients when making decisions on who needs extra medical care (Obermeyer, Powers, Vogeli, & Mullainathan, 2019). The negative impacts of AI on human rights prompted the Special Rapporteur on the promotion and protection of the right to freedom of opinion and expression in 2018 to provide recommendations for States and companies on how to align the deployment of AI technologies according to human rights principles (Kaye, 2018). Similarly, UN High Commissioner for Human Rights Michelle Bachelet called for banning AI applications that cannot comply with human rights (UN News, 2021).

Intellectual property and access to benefits of science

The critical importance of the human right to science continues to be highlighted by the COVID-19 pandemic and climate crisis. The right to science underpins the development of evidence-based decision-making in climate policy, as well as access to new climate mitigation and adaptation technologies including those that facilitate sustainable production and consumption (OHCHR, 2021). The right to enjoy the benefits of science and its applications also supports wider access to scientific knowledge and technology related to medicines, vaccines and other products and services needed for prevention and the cure of patients infected by COVID-19. Access to COVID-19 vaccines further reflects the North-South divide and profound inequalities in enjoying the benefits of science and technology. As of April 2022, only 15% of the population in low-income countries received at least one dose of COVID-I9 vaccine compared to 80% of the population in higher and upper-middle-

[10] Geoengineering projects may require massive amounts of land and can result in adverse side-effects which include changes in precipitation patterns, may alter freshwater availability, and deplete the ozone layer. These have potential impacts on food security, water availability, and land rights of farmers and indigenous peoples (Burns, 2016; Adelman, 2017).

income countries (Holder, 2022). Lack of access to treatment in large parts of the world has revealed not just unequal global vaccine distribution, but equally the underlying inequalities in terms of enjoying benefits from science, the right to health, the right to development as well as constraints posed by intellectual property rights (IPRs) regimes. As such, securing universal access to the benefits derived from advances in science and technology is crucial not only to mitigate rising inequalities within many developed and developing economies, but also to tackling wider health challenges (such as neglected diseases), building resilient health systems and assuring greater pandemic preparedness in the future. The current IPRs regime embodied in the World Trade Organization (WTO) Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) presents real challenges to ensuring universal access to technologies that help contain COVID-19 and tackling economic and social inequalities head-on. Despite global calls to waive TRIPS temporarily to facilitate the increase of access to vaccines in developing countries, several developed countries and corporate lobbies continue to block the proposal for a waiver in the WTO (IBON International, 2021).

With regards to climate change, some authors (Hutchison, 2006; Littleton, 2008; Zaman, 2012) have warned of the dangers of the negative impacts of strong intellectual property protection on the transfer of climate-related technologies to developing countries. Authors have argued the need for rebalancing the global IPRs regime by strengthening the pro-competition provision of TRIPS and exploiting its flexibilities in favour of developing countries. Former Special Rapporteur on Cultural Rights Farida Shaheed on the other hand called for the need to prevent the privatization of knowledge to a degree that it can impede the enjoyment of the right to science (Shaheed, 2012). She also proposed the "public good approach to knowledge innovation and diffusion and [suggested] reconsidering the current maximalist intellectual property approach to explore the virtues of a minimalist approach to IP protection" (Shaheed, 2012, p.17)[11].

Shaheed's three reports on the right to science and the CESCR's General Comment No. 25 emphasized the States' duty to protect traditional knowledge from unscrupulous foreign appropriation and to ensure that this knowledge is under the control and ownership of local and traditional communities and indigenous peoples. Some authors have argued however that the current legal mechanisms and intellectual property regimes are inadequate/inappropriate because they are based on the concepts of individual ownership whereas traditional knowledge is often collectively held (Farran, 2014; Hossain & Ballardini, 2021).

[11] In 2014, Shaheed submitted her report on the "Copyright policy and the right to science and culture" to the 28th Session of the Human Rights Council. The report "examines copyright law and policy from the perspective of the right to science and culture, emphasizing both the need for protection of authorship and expanding opportunities for participation in cultural life" (Shaheed, 2014, p. 1) and "proposes to expand copyright exceptions and limitations to empower new creativity, enhance rewards to authors, increase educational opportunities, preserve space for non-commercial culture and promote inclusion and access to cultural works…[and] promote cultural and scientific participation by encouraging the use of open licences, such as those offered by Creative Commons" (p. 1). Shaheed's report to the 70th Session of the UN General Assembly expounded on the implications of patent policies on the attainment of the right to science. The report distinguishes the different intellectual property and human rights and emphasized that "there is no human right to patent protection" (Shaheed, 2015, p. 1).

REALIZING THE RIGHT TO SCIENCE: WHAT WE KNOW ABOUT INSTITUTIONAL EXPERIENCES, OPPORTUNITIES AND CHALLENGES

> …science is one of the areas of the Covenant to which States parties give least attention in their reports and dialogues with the Committee. (CESCR, 2020, para. 2)

Although the right to science is already recognized in international human rights law and ratifying states of the CESCR are bound by the obligation to respect and promote it, the right to science is relatively little-known, poorly understood, and neglected (Porsdam & Mann, 2021). According to the AAAS, "governments have largely ignored their Article 15 obligations and neither the human rights nor the scientific communities have brought their skills and influential voices to bear on the promotion and application of this right in practice" (AAAS, n.d.). Despite the potential of the right to science to defend science and its use to enable other rights such as the rights to health, education, and development, "[i]t has remained an inefficient legal norm, which neither informs major policy and governance issues, nor gives guidance to practicing scientists and the public" (Porsdam & Mann, 2021, p. 3).

There is wide consensus about the implementation gap in terms of shifting from normative debates towards a deeper understanding of how states (may) apply obligations to respect, protect and fulfill the right to science. Whether explained as the lack of interpretative clarity, vested interests, mistrust or the disconnect between scientific practice and human rights actors, overall, there is an urgent need to address institutional bottlenecks at global, regional, and national reviews. Beyond a discussion of whether standards and obligations are binding or not, it fundamentally concerns whether and to what extent a wider set of public policy, legislative and administrative measures and financial resources are put in place addressing the full bundle of rights dimensions concerned.

The scarce attention granted through UN human rights mechanisms further demonstrates its relative neglect, as already argued by the CESCR General Comment 25. Under the Human Rights Council's (HRC) Special Procedures, only five reports by three special rapporteurs elaborated on the right. These are Farida Shaheed's (Special Rapporteur in the field of cultural rights 2009-2015) reports in 2012, 2014, and 2015; Karima Bennoune's (Special Rapporteur in the field of cultural rights 2015-2021) report in 2021; and Marcos Orellana's (Special Rapporteur on the implications for human rights of the environmentally sound management and disposal of hazardous substances and wastes 2020-2023) report in 2021. The UN Human Rights Index (UHRI) database contains over 170,000 observations and recommendations from the Universal Periodic Review (UPR), Treaty Bodies, and Special Procedures from the 2000s and onwards.[12] It is important to note that none of the documents currently uploaded in the database contains the phrase "right to science". The word "science" which is used in different contexts is mentioned only in 159 documents. In comparison, the "right to health" is mentioned in 364 documents while "civil and political rights" is mentioned in 731 documents. This indicates relative paucity, although certain right to science issues - such as scientific freedom of expression - are raised without direct reference to the right to science. This paucity clearly demonstrates a real question and enigma about the future potential of judicial mobilization of UN human rights mechanisms such as the UPR, or the filing of individual complaints in the CESCR, as well as in regional human rights bodies in promoting the right to science (Boggio & Romano, 2018).

Some organizations have used the UPR process as an opportunity to promote the right to science. UNESCO makes regular submissions to the UPR containing recommendations on

[12] Although the content of the UHRI is already extensive, the database is not yet complete. As of April 2022, it only contains observations and recommendations. Issues and statements are not yet uploaded.

how countries can achieve the right to science as well as encouraging them to submit reports on their implementation of the Recommendation on the Status of Scientific Researchers (1974). The Treatment Action Group (TAG) has submitted reports analyzing the tuberculosis (TB) policies in China, Mexico, and United Arab Emirates (2018), including the right to science. In 2019, the Associazione Luca Coscioni and Science for Democracy submitted a UPR report on Italy's violations of the right to science, in relation to the scientists' right to conduct science in fields such as biotechnologies and controlled substances. The report also criticized Italy's insufficient funding and investment for scientific research, non-transparent rules for scientific evaluations, as well as several laws that impede scientific advancement for the right to health.

Although decisions taken in some of these mechanisms are not legally-binding, there are no clear reasons why such processes should not be mobilized in a more substantive manner by professional science organizations and national human rights institutions to help clarify, exchange and build a body of international jurisprudence in support of the right to science. Also, there is considerable potential for further complementarity between such human rights mechanisms and national reporting undertaken in the context of the UNESCO Recommendation.

As a specialized agency with a specific mandate for science, UNESCO has adopted different instruments that directly or indirectly promote the right to science. These include the 1974 Recommendation on the Status of Scientific Researchers, the 1974 Recommendation concerning Education for International Understanding, Cooperation and Peace and Education relating to Human Rights and Fundamental Freedoms, the 1997 Universal Declaration on the Human Genome and Human Rights, the 2003 International Declaration on Human Genetic Data, the 2005 Universal Declaration on Bioethics and Human Rights, the 2017 UNESCO Declaration of Ethical Principles in relation to Climate Change, the 2017 Revised Recommendation on Science and Scientific Researchers, the 2021 Recommendation on Open Science, and the 2021 Recommendation on the Ethics of Artificial Intelligence. These recommendations and declarations are important standard-setting instruments that link science and human rights, advice on developing enabling environments for scientists and doing science, and reinforce international and national policies and regulatory frameworks to ensure that emerging technologies and scientific knowledge benefit humanity as a whole. These instruments link scientific progress to "ethical and human rights standards and principles…[which] include academic freedom and protection of the rights of scientists, protection against harm, sharing benefits of scientific and technological advancements, including related knowledge and their applications, international cooperation and, more recently, science-based decision-making" (Donders & Tararas, 2021, p. 136). While such instruments are non-binding, they reflect "a large degree of consensus among States on the need to promote science as a public good accessible to all and to integrate human rights norms and principles into the advancement and promotion of science and technology and related policies" (Donders & Tararas, 2021, p. 137).

An important field is that of translating such normative consensus into national action in conjunction with global monitoring and support. National reporting process on the implementation of the Recommendation on Science and Scientific Researchers launched in 2020 is illustrative of the complexity involved.

UNESCO guidelines for reporting and indicators include process, outcome and perception indicators. Key Area 6 on adherence to human rights standards specifically refers to the right to science, yet does not spell out outcome indicators in substantive terms.

Figure 1. Indicators for Key Area 6

6. Human Rights Standards

*Human Right to Science

Criteria	Performance indicators		Perception indicators
	Process indicators	Outcome indicators	
Article 27 para. 1 of the Universal Declaration / Article 15 of the Convention on Economic Social and Cultural Rights	-Policies exist with explicit objective to ensure protection and respect of range of issues of the human right to science for all (Access to the benefits Opportunities for all to contribute and freedom indispensable for scientific research Participation of individuals and communities in decision-making An enabling environment fostering the conservation, development and diffusion of science and technology). -appeals body exists - Number of measures taken to bridge and reduce knowledge divides, working towards the realization of article 27(1) of the Universal Declaration of Human Rights	[to be determined]	Human rights of scientific researchers, as well as their freedoms are duly guaranteed, protected and respected. A quality of education is guaranteed to all children in which each has an opportunity to attain qualifications in STEM subjects so as to later become a researcher

This lack of a clear outcome orientation is perhaps indicative of the general need for a far more substantive implementation and reporting approach for the right to science[13]. Currently, the text of the draft guidelines proposes the joint preparation of reports with science observatories. A process that engages a wider set of stakeholders such as scientific organizations, civil society organizations advocating for the right to science, and even national human rights institutions can potentially enrich the indicator development and reporting process.

A third leg to this implementation discussion involves how these bodies of normative standards of the right to science are articulated with and inform standard-setting and wider decision making in relevant fields. The recognition of the importance of science in achieving the Sustainable Development Goals (SDGs), particularly SDG 9.5[14] provides an obvious case offering policy impetus for the implementation of the right to science. SDG 12 on sustainable consumption and production, particularly SDG 12.9 highlights the need to support the scientific and technological capacities to shift to more sustainable patterns of consumption and production. SDG 17 on the means of implementation and global partnership, particularly Targets 17.6 and 17.8 emphasize the need for North-South, South-South, and triangular partnerships and operationalizing the technology bank and science, technology and innovation capacity-building mechanism for least developed countries to foster access to science, technology, and innovation. The Financing for Development's (FfD) Addis Ababa Action Agenda (AAAA) provides a vital framework for strengthening the means of implementation for sustainable development. Its action area on science and technology supports SDG 17.6 commitment to enhance cooperation on science and technology by establishing the multistakeholder Technology Facilitation Mechanism. Through the AAAA, UN Member States committed to enhance cooperation on science and technology in different areas such as vaccines, food security, ocean health, and climate mitigation and adaptation through international partnerships as well as official development

[13] Other indicator areas to be considered in conjunction are Key Area 7 on scientific freedom and responsibility particularly on the criteria 'human rights, freedoms, and responsibilities of scientific researchers', and Key Area 8 on ethics, particularly on the criteria 'ethical governance'.

[14] SDG 9.5 calls on governments to "Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, by 2030, encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending."

assistance (ODA) specially to least developed countries, landlocked developing countries, small island developing States, and countries in Africa.

Other examples include how the right to science can be mainstreamed in global processes related to the pandemic, toxic substances, or the biodiversity crisis to name three. The report of former Special Rapporteur in the field of cultural rights, Karima Bennoune on "COVID-19, culture and cultural rights" includes a section on the importance of the right to science in controlling COVID-19 and the enjoyment of other human rights. The report also raises the misuse of information, and false information, and attacks against scientists working on COVID-19 (Bennoune, 2021). The Special Rapporteur on the implications for human rights of the environmentally sound management and disposal of hazardous substances and wastes, Marcos Orellana, submitted his report on the *Right to science in the context of toxic substances* to the 48th Session of the Human Rights Council held from 13 September–1 October 2021. The report discussed the "risks and harms associated with the life cycle of hazardous substances and wastes, [and examined] the dynamics and interconnections between scientific progress, the diffusion of scientific information and the science-policy interface" (Orellana, 2021, p. 1). On biodiversity, the Post-2020 Global Biodiversity Framework is being negotiated as we write, just as there have been efforts to raise the role of Open Science in the context of the COVID-19 pandemic.

Open Science is understood as principles aiming to "optimize scientific conduct and communication by exposing the scientific process, and results thereof, to the scientific community and broader public" (Besançon *et al*., 2021, p. 2). These principles include a number of core practices, such as: 'open source', 'open data', 'open access', and 'open peer-review', among others (Besançon *et al.*, 2021). Open Science offers a new normative avenue to help achieve the right to science as well as other human rights by addressing the intellectual property barriers to accessing valuable information and by promoting cooperation among scientists. The World Health Organization (WHO), UNESCO, and the Office of the High Commissioner for Human Rights (OHCHR) in the context of COVID-19 and solidarity, have called on Member States to "ensure the fundamental right to access scientific research and its applications, with a view to creating a global knowledge commons and closing existing gaps in science, technology and innovation, especially in developing countries and with respect to women; [and to] commit to supporting the international scientific community by fostering a culture of collaboration and solidarity, rather than competition, and by sharing research outcomes and knowledge wherever possible in order to make science widely accessible to everyone" (WHO, UNESCO, OHCHR, 2020, p. 1). Member States and stakeholders were also asked to join the "Solidarity Call to Action and the WHO COVID-19 Technology Access Pool that seeks to facilitate sharing of knowledge, intellectual property and data for the response to the pandemic" (WHO *et al.,,* 2020, p. 1).

Limited funds to support Open Science remains a key barrier, which can put early career researchers and those from developing countries at a greater disadvantage. For example, limited grants on open access publishing often lead to authors paying hefty fees to make their works accessible by the public (Greussing *et al.*, 2020; Massarani *et al.*, 2021). In developing countries, particularly in Africa, language barriers and the lack of infrastructure also prevent the participation of researchers in open science (Mwelwa, Boulton, Wafula, & Loucoubar, 2020). Meanwhile, some authors argue that the success of open access initiatives are limited to "'niche' fields or products of low social value, [or] …are eventually replaced with a property model" (Kapczynski, 2017, p. 1612). The case of the WHO's Flu Network on the other hand provides an emblematic case of how Open Science can work at a global level (Kapczynski, 2017).

CONCLUSIONS

Whereas the last few years have seen substantive normative progress and clarification on the legal meaning and significance of the right to science as part of a broader process of standardization in the science and human rights fields, there is wide-held consensus about the implementation gap involved. The challenged nature of the right to science is arguably central to understanding the global governance failure in tackling COVID-19, climate change, and the biodiversity crisis. Furthermore, scientists and independent scientific practice are today confronted with shrinking budgets, political pressure, corporate attacks, and personal threats in a context of massive global inequalities in terms of funding and outdated infrastructure. This paper calls for more substantive discussion and attention to emerging trends and dynamics affecting the right to science.

How do we ensure that adequate resources are available to enable scientific enquiry, guarantee that it can be conducted in an independent and impartial manner, and make the fruits of science available and accessible without discrimination? Overall, critical policy gaps include (1) the need for governments to systematically include scientific knowledge in national policy and decision-making; (2) ensuring that scientific research and institutional development is adequately resourced while addressing inequalities within and between countries in the conduct of science as well as the enjoyment of its benefits; (3) protection of the basic freedoms needed for scientific inquiry; (4) the need for open/transparent, and participatory science and technology governance mechanisms to help ensure scientific inquiry and technological applications comply with human rights; and (5) accountability processes that will monitor the implementation. Given the major cross-sectoral challenges involved, the paradoxical paucity of dialogue and exchange on the right to science is not only problematic itself, it constitutes a major obstacle towards achieving sustainability goals in a more general sense.

If global guidance underlines how the human right to science refers to “all rights, entitlements and obligations related to science” (CESCR, 2020, para. 1), in practice, much implementation remains fragmented and partial. On the one hand, the analysis presented here demonstrates the central, yet neglected role, of science, and the right to science, in understanding and fostering effective rights-based responses to key sustainability challenges of our times. On the other hand, the right to science, such as the right to access and benefit from scientific innovation, can clearly play a catalyst role in enabling more just, sustainable and effective solutions. However, securing progress on the realization of the right to science, requires a far more substantive policy response in terms of increasing budgets for independent research, tackling inequalities of access to science and enjoyment of its benefits, and enhancing enabling institutional environments.

Another priority reinforced by the increasing attention to a rights-based approach to science is the need for greater coherence and coordination in the UN System. Rights-based approaches to science have several converging roles to play between the binding obligations of the CESCR, other human rights mechanisms such as Special Rapporteur recommendations, and the growing field of science standards hosted by UNESCO. How do we make full use of international human rights mechanisms, progress reviews on the SDGs and other appropriate platforms and mechanisms in order to advance the implementation of the right to science? This is not merely about securing further attention to the right to science in UPR processes, changing dynamics at the regional levels are equally important. This will entail gathering relevant data allowing for a situation analysis, assessment of progress and the development of context specific recommendations that contribute to a greater uptake of the right and guide targeted action on the ground. Much can be done to harness synergy-building across different rights mechanisms, monitoring and reporting procedures to ensure more systematic attention. The work of UNESCO should converge with and complement

with that of the UN Human Rights Council and the Committee on Economic, Social and Cultural Rights so that monitoring can become mutually beneficial.

Another critical area of concern will involve introducing and harnessing the role of the right to science into the mechanisms and processes shaping global agendas such as those concerned with the global pandemics, climate change, and environmental dynamics. Identifying key challenges, needs, and opportunities were key subjects for discussion in the Geneva dialogue. Integrated approaches should imperatively spill over into the efforts to implement the Agenda 2030 where science technology and innovation are recognized as foundations of making the promise to leave no one behind a reality. The development of operational approaches and tools that will inform decision-making and practice at the country level remains critical. This will be indispensable if the comprehensive vision is to be translated convincingly and soon into action, so that the momentum gained is not lost. The importance of addressing this gap was confirmed by the first monitoring of the recommendation on science and scientific researchers concluded in 2021.

All actors and stakeholders, starting with States, international organizations, and civil society should fully embrace the right to science. Further work with the private sector is also critical. This implies its full recognition as an autonomous right to be respected, protected, and fulfilled in all relevant contexts, and particularly as a key reference for pandemic recovery. In addition, this entails the promotion of the right to science as an enabler for the realization of many other rights.

Guided by the General Comment No. 25 and drawing also on UNESCO's relevant normative instruments, including the 2017 Recommendation on Science and Scientific Researchers, the Recommendation on Open Science (2020), and the Recommendation on the Ethics of AI (2021), pursuing the development of normative guidance can help clarify concepts relating to the right to science that require further elaboration. These include the scope of scientific freedom, its relationship with scientific responsibility, the linkages with the protection of intellectual property, and open science, to name a few. This is also critical to foster international cooperation to strengthen through all appropriate means transborder scientific exchanges and partnerships, to reinforce the science policy nexus, and to increase trust in science. The final segment of the Geneva Dialogue will focus on the role of partnership and programme initiatives in the implementation of the right to science. This, for one, expands the field of action beyond human rights mechanisms and notably opens up possibilities for further leadership in the space of science standards, cooperation, and professional organizations. It also raises, again, the urgent need to engage with vital issues of sustainability. All these together, comprise critical steps to facilitate the shift from fragmentation to comprehensive implementation of the right to science - for the greater good of all humanity.

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