Statements on Open Science for Sustainable Development Goals

ESSAY

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ABSTRACT

This article attempts to practicalise Open Science (OS) to promote ideas and enhance efforts for the Sustainable Development Goals (SDGs). It delineates General Statements (n = 20) as guiding beacons and the Specific Statements (n = 70) that act as precision tools in OS orientated policymaking, research, innovations, and public engagement, and access to scientific knowledge. The authors hope to draw kindled and educated attention to OS besides underscoring the need for unbiased, inclusive, and diligent execution of the SDGs. By adopting these Statements accordingly and in appropriate stages within national strategies and ensuring transparent reporting of the progress, the authors envision a transformed world by 2030. With this appeal, scientific endeavours could be more effectively directed and optimised with OS, significantly advancing progress toward the SDGs.

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BACKGROUND

Open Science (OS) is a global movement that aims to make scientific research and data accessible, transparent, and collaborative for the benefit of society and the environment (UNESCO and CCUNESCO, 2022). OS fosters innovation, enhances research quality and reliability, and increases public trust and engagement with science (Rosman et al., 2022; Song et al., 2022). It plays a pivotal role in achieving the Sustainable Development Goals (SDGs), the 17 global goals adopted by the United Nations in 2015 to end poverty, protect the planet, and ensure peace and prosperity for all by 2030 (Vicente-Saez et al., 2021).

The interactions between OS and the SDGs are not sufficiently clear, despite both being well-described (see Supplementary File 1). OS allows policymakers, researchers, innovators, and the general public to access and use scientific information without barriers, accelerating the achievement of the SDGs (Tennant et al., 2020). As a key enabler, OS supports the vision of an integrated, prosperous, and peaceful world driven by its citizens, and represents a dynamic force in the global arena.

OS combines various movements and practices to make multilingual, cross-domain scientific knowledge openly available, accessible, and reusable for everyone. This increases scientific collaborations and information sharing, benefiting both science and society. It opens the processes of scientific knowledge creation, evaluation, and communication to societal actors beyond the traditional scientific community (UNESCO and CCUNESCO, 2022). OS is inclusive, encompassing all scientific disciplines and aspects of scholarly practices, including basic and applied sciences, natural and social sciences, and the humanities. According to UNESCO, OS includes the following pillars: open scientific knowledge, open science infrastructures, science communication, open engagement of societal actors, and open dialogue with other knowledge systems. OS directly contributes to achieving the SDGs by fostering innovation, enhancing research quality and reliability, and increasing public trust and engagement with science (Purić et al., 2019; Song et al., 2022).

The SDGs are a set of 17 global goals adopted by the United Nations in 2015 to end poverty, protect the planet, and ensure peace and prosperity for all by 2030 (United Nations, 2015). The action plans have 169 targets to stimulate actions in all countries and among all stakeholders in collaborative partnerships over 15 years (2015–2030). These targets focus on areas of critical importance for humanity and the planet, aiming to strengthen universal peace, eradicate poverty, realize human rights, and achieve gender equality and the empowerment of all women and girls. The SDGs are integrated, indivisible, and balance sustainable development's economic, social, and environmental dimensions.

There is limited literature on the role of OS in supporting SDGs, with the exception of some areas such as quality education, climate action, and regional disparities. Camkin et al. (2022) examined the status, prospects, and challenges of Open Science policies and infrastructure in Asia and the Pacific, providing valuable insights into regional successes and existing gaps. Similarly, Lane (2017) explored the impact of open educational resources on supporting SDGs through case studies and a proposed theory of change. Furthermore, Smith and Veldsman (2018) discussed the African OS Platform initiative, which aims to enhance low and middle-income countries' research participation, focusing on climate action and quality education. Lastly, Johnstone (2022) illustrated how OS practices accelerate climate action, detailing initiatives such as the Net-Zero concept and intersections with other SDGs. There are papers that provide detailed case studies or practical implementations of OS contributing to various SDGs (Ajates et al., 2020; Elias et al., 2023; Moczek et al., 2021; Queiruga-Dios et al., 2020; Wu et al., 2023); papers that discuss specific methodologies, frameworks, or tools that support the integration of OS practices with the achievement of SDGs (Arancio et al., 2022; De Agustin Camacho et al., 2023; Fritz et al., 2019; Jialu Chen, 2022; Parkinson et al., 2022; Sprinks et al., 2021); and others that discuss OS or SDGs in a way that is relevant but not fully aligned with the exact specificity of integrating both topics with detailed evidence or cases (ASSAf, 2019; Fritz, 2020; Jain, 2021; Woods et al., 2022).

METHODS

In this article, we describe the relationship between OS and the SDGs, and provide concrete recommendations for how OS can support progress towards each SDG (European Commission. DG RTD, 2022; Chakravorty et al., 2022). These recommendations are the result of discussions

from the 3rd International Forum on Big Data for Sustainable Development Goals (FBAS, 2023), hosted in Beijing, China by the Chinese Academy of Sciences, the Committee on Open Data (CODATA), and others from August 28th to September 1st, 2023.

The following recommendations are meant as appeals to illuminate paths including, but not limited to, fostering global investment in the capacity building and policy needed to further individual, institutional, local, and global adoption of OS practices, open access policies, and platforms in order to deliver on the promise of OS for the SDGs. The Specific Statements (Table 1 in Supplementary File 2) provide a more focused illustration and examples of the General Statements and target specific SDGs based on discussions between researchers and experts from the relevant fields of expertise. These Statements are to be executed without prejudice and discrimination of any person's race and religion, aiming instead to empower people and ensure inclusiveness and equality. With utmost diligence and vigilance, allocated resources should be managed, and progress monitored using explicit qualitative and quantitative indicators within national strategic plans. Progress towards each SDG should be publicized periodically and intentionally. By following these steps, we believe the world would be a different and better place by year 2030. Without these guiding statements, the practice of science and research enterprise might continue without targeted effort on the SDGs (Camkin et al., 2022; Govaart et al., 2022), wasteful on distant basic research (Macleod et al., 2014), academic pursuit and striving for aesthetic instead of authentic gains (Yarborough, 2021). A compilation of critical open resources to assist the practice of OS is in Supplementary File 1.

GENERAL STATEMENTS

1. The best practice of science is OS. Science is primarily meant for the public good of SDGs, not for selfish gain.
2. When paired with equitable access to the benefits of OS and data reuse, OS can fulfil every human's fundamental right to science, scientific processes, knowledge, and related benefits.
3. OS encompasses data that are as open as possible and as closed as necessary to enable all stakeholders to benefit from the fair, ethical, and equitable reuse of data to address local and global problems in keeping with local and shared values.
4. OS does not mean indiscriminate openness or free of cost. Consent for data reuse, privacy-preserving approaches to the reuse of sensitive data, and licenses that enable individuals and groups to retain their rights in data (i.e., intellectual property) must be considered to ensure the equitable distribution of rights derived from OS approaches.
5. Free research/scientific products for the SDGs advocate the use of copyright to force the openness of the products. Authors of free works should be treated equally to those of closed works.
6. The openness of OS must benefit and involve the needful community within every country, not just that of a specific gender, country, or region in the world, with the effect on the disadvantaged group in certain SDGs.
7. OS engages the public in scientific research to produce sound evidence and valuable data that progress towards SDGs.
8. Common sense must prevail over the scientific approach in quickly and safely mitigating urgent problems in certain SDGs.
9. Science should be applied to resolve problems that hamper SDGs in the most effective, efficient, acceptable, and sustainable ways.
10. Recognizing that science cannot solve all human problems in the SDGs, a more holistic approach might be needed.
11. To accelerate the achievement of SDGs, all research endeavours must be relevant to the SDGs, from problem identification to study designs, implementation, monitoring, and evaluation.
12. Science for SDGs must be conducted with utmost integrity throughout its whole process.
13. Useful scientific evidence for SDGs is only produced following rigorous methodology.
14. All scientific research must undergo an open and collective process, including using shared knowledge infrastructure to improve relevance and efficiency towards the SDGs.
15. All research products and findings must be freely available (UNESCO and CCUNESCO, 2022; Wilkinson et al., 2016) and made easily understood and useful to all by committed and continuous support, with due respect to proper acknowledgement to the owner, the local legal system, and intellectual property rights.

16. Science outputs for the SDG agenda must be timely and effectively communicated by all appropriate means to the target and research communities.
17. When available, scientific evidence must be translated into practice and implemented as soon as possible to the respective SDGs.
18. Outline and execute policy in consistent investment and manners at all levels to enable adequate OS infrastructures and human capacity for all SDGs.
19. Assess scientific contribution towards SGDs and career progression of researchers by rewarding good OS practices, research outputs including high-quality FAIR (Wilkinson et al., 2016) and metadata, well-documented and reusable software, protocols and workflows, machine-readable summaries of findings, teaching, outreach, and engagement of societal actors with qualitative evidence of research impact and knowledge exchange, influence on policy and/or community, and engaging in open innovation with partners beyond academia, rather than quantity of publications and journal impact factors, and/or the amount of funding.
20. Promote creative solutions and innovation towards SDGs by ensuring the security of living spaces, embracing digital technology, big data, and artificial intelligence, respecting personal intellectual property, and effective commercialization and business models.

DISCUSSION

Strengthening capacity and ensuring equitable resource distribution is crucial for leveraging OS to advance the SDGs (UNESCO and ICEE, 2021). Successful implementation of OS requires active involvement from all stakeholders, including governments, local communities, and marginalized groups, with appropriate technical skills and resources (Chan et al., 2020; Fallah Shayan et al., 2022). Equitable access to digital technologies, internet connectivity, and educational resources is essential to maximize OS's benefits (Haleem et al., 2022).

While OS offers significant opportunities, disparities in resource availability between high-income countries and low- and middle-income regions can hinder its effectiveness (Bezuidenhout et al., 2017; Czerniewicz, 2014). Addressing these disparities through targeted investments and inclusive policies is crucial to ensuring that the benefits of OS are shared equitably. This includes sharing research protocols, making public research tools accessible, involving diverse stakeholders in research, and maintaining transparency and integrity in scientific practices.

To fully harness OS for the SDGs, a focused approach that considers the diverse needs and contexts within the OS and SDG ecosystems is necessary. We urge researchers and institutions to support and practice OS, fostering a culture of transparency, collaboration, and innovation to realise its potential.

CONCLUSION

OS holds great promise for advancing the SDGs, especially in the latter half of the 2020s. Its principles—openness, inclusivity, sustainability, and flexibility—can significantly enhance scientific research and social impact. OS has the potential to simultaneously impact all 17 SDGs by facilitating collaborative and interdisciplinary solutions, thus optimizing resource use and avoiding redundant efforts. The adaptable nature of OS allows for timely responses to evolving challenges in social, economic, and environmental contexts. To fully leverage OS for the SDGs, it is vital to address challenges such as unequal access to digital technologies and gaps in digital literacy. By promoting capacity building, equitable practices, and adequate resourcing, OS can become a powerful driver of inclusive and sustainable development by 2030.

ADDITIONAL FILES

The additional files for this article can be found as follows:

- **Supplementary File 1.** Open resources to assist the practice of OS and SDGs. DOI: https://doi.org/10.5334/dsj-2024-049.s1
- **Supplementary File 2.** Table 1: Specific Statements to the SDGs. DOI: https://doi.org/10.5334/dsj-2024-049.s2

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COMPETING INTERESTS

The authors have no competing interests to declare.

AUTHOR CONTRIBUTIONS

BHC drafted the General Statements and Conclusion, revised critically by LM, FEA, and AM, and approved by all authors. LM and BHC drafted the Discussion, revised it critically and approved by all authors.

SDG 1 was drafted by MRS and revised critically and approved by all authors.

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SDG 15 was drafted by KD and revised critically and approved by all authors.

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SDG 17 was drafted by LM and AM, and revised critically and approved by all authors.

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