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The Human Right to Science and Its Relationship to International Environmental Law

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Abstract

This article explores the potential contribution of international human rights law – specifically, the oft-neglected 'right to science' – to the interpretation, operation and progressive development of international environmental law. Science and its applications play a critical role in environmental protection. At the same time, society faces persistent controversies at this interface. Environmental regimes may lack sufficient norms and tools for regulating upstream science and innovation processes because they tend to focus narrowly on physical harms to the environment and may not address the wider ethical, legal, social and political concerns. The human right to science, which is codified in various international and regional human rights instruments, may serve to augment international environmental law and contribute to more effective, equitable and democratically legitimate and accountable processes and outcomes in relation to the application of science and technology in environmental regimes. The article begins by outlining the scope and contents of, as well as the limitations on, the right to science, focusing on Article 15(1)(b) of the International Covenant on Economic, Social and Cultural Rights (ICESCR) and its overlaps with the norms of international environmental law.[1] It then analyses the ways in which the right to science may influence the development of international environmental law by elucidating mechanisms for the integration of a human rights perspective in science and technology and by outlining its potential substantive contributions to the development of international environmental law.

1 Introduction

The saying goes that '[w]e shape our tools and afterwards our tools shape us'.[2] This statement reflects the relationship between science, technology and the law as one of

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1 International Covenant on Economic, Social and Cultural Rights (ICESCR) 1966, 993 UNTS 3.

2 J.M. Culkin, 'A Schoolman's Guide to Marshall McLuhan', *Saturday Review* (18 March 1967), at 70.

'co-production' – the idea that scientific and technical knowledge 'both embeds and is embedded in social practices, identities, norms, conventions, discourses, instruments and instructions'.[3] Science and its applications play a constitutive role in environmental regimes both as a means for identifying environmental problems, their causes and their solutions and as a source of environmental destruction (the object of regulation).[4] At the same time, law and legal processes serve to validate forms of scientific and technical knowledge and also limit and shape the scientific enterprise by creating demand for environmental knowledge and technologies.[5]

The process of co-production is clearly evident in the operation of science and technology in the field of international environmental law. Scientific research, monitoring and advice are legally mandated to inform the development and implementation of environmental treaties and institutions. Environmental agreements frequently address scientific or technical considerations through the adoption of obligations to promote scientific research, to encourage the exchange of scientific information and data about environmental protection, to support risk assessment processes, to allocate funds and other resources for technical assistance and capacity building, to promote science-based decision-making and to manage uncertainties through a precautionary approach. They also establish standing scientific and technical expert bodies to support the ongoing development and implementation of environmental treaty obligations.

At the same time, science and its applications may be the object of international law. Environmental regimes are increasingly faced with complex, uncertain, politically controversial issues of emerging science and technology, such as genetically modified organisms, synthetic biology, nanotechnologies and climate geoengineering. As these issues become more potent, pervasive and extensive in geographical reach, questions of law and governance increasingly find their way onto global environmental agendas. International environmental law constitutes an important site for the regulation of science and emerging technologies with the potential to cause environmental harm. Bound up in logics of precaution and anticipatory governance, environmental treaties are increasingly being called upon to 'pro-actively develop new forms of international regulation and governance capable of anticipating, assessing, minimizing and mitigating the risks posed by novel or emerging technologies'.[6]

Yet fundamental questions persist as to whether international environmental law, as currently conceived, is fit for the purpose of addressing other concerns associated with emerging science and technology. Primarily focusing on the prevention of physical harm, environmental treaties and norms are more limited in their means to capture the full spectrum of ethical, legal, social and political concerns that arise and to

[3] Jasanoff, 'The Idiom of Co-Production', in S. Jasanoff, *States of Knowledge: The Co-Production of Science and Social Order* (2014) 3.

[4] P. Sands and J. Peel, *Principles of International Environmental Law* (3rd edn, 2014), at 6–7.

[5] S. Jasanoff, *The Fifth Branch: Science Advisers as Policymakers* (1998).

[6] Rayfuse, 'Public International Law and the Regulation of Emerging Technologies', in R. Brownsword, E. Scotford and K. Yeung (eds), *The Oxford Handbook of Law, Regulation and Technology* (2017) 500.

mediate the inherent tensions and trade-offs associated with emerging science and innovation and their regulation. These include complex questions of values and ethics, scientific misconduct and controversial research practices, distributional impacts, discrimination and inequality, societal disruption and unintended consequences and the management of urgent, high-stakes decision-making.[7] International environmental law may lack sufficient principles and mechanisms to assess other kinds of harms arising from science and innovation, to identify the rights and responsibilities of different actors in relation to these processes and to provide a fair and effective framework for their operationalization.

Where might we look for other frameworks and principles to address these challenges and gaps with a view to advancing a more democratically legitimate, equitable and accountable role for science and technology in international environmental law? One place is international human rights law, which has long focused on issues of morality and ethics, human dignity and equality. Specifically, Article 15(1)(b) of the ICESCR recognizes the right of everyone 'to enjoy the benefits of scientific progress and its applications'.[8] Part of the corpus of economic, social and cultural human rights – the so-called 'right to science' – has long been overlooked, with the result that its legal development is rudimentary, at best.[9] However, given its growing contemporary relevance, legal academics and practitioners have turned their attention to the study and elaboration of the right to science with a view to bringing further conceptual clarity to this universal human rights norm.[10]

This article examines the relationship between the human right to science and international environmental law with a view to understanding how this right may add to existing conceptions of how science and technology are understood, practised and used in international environmental law.[11] It begins with an overview of the right to science as guaranteed in various international and regional human rights instruments and the extant commentary on it. It then analyses the scope, content and limitations on the right to science, as laid down in Article 15(1)(b) of the ICESCR, focusing, in particular, on the ways in which this covenant right overlaps with different instruments and norms of international environmental law. This analysis will form

7 For an overview, see European Commission, Taking European Knowledge Society Seriously: Report of the Expert Group on Science, Economy and Society Directorate, Directorate-General for Research, European Commission (2007), available at https://ec.europa.eu/research/science-society/document_library/pdf_06/european-knowledge-society_en.pdf; see also Ravetz, 'What Is Post-Normal Science', 31 *Futures* (1999) 647.

8 ICESCR, *supra* note 1.

9 Regarding the styling of Art. 15(1)(b) of the ICESCR as the 'right to science', see Mancisidor, 'Is There Such a Thing as a Human Right to Science in International Law?', 4 *European Society of International Law Reflections* (2015), available at http://esil-sedi.eu/wp-content/uploads/2015/04/Mancisidor-Reflection-Word.pdf.

10 See Parts 2 and 3.

11 For an overview of the interpretation and application of science and technology in environmental law generally, see Fisher, 'Sciences, Environmental Laws, and Legal Cultures: Fostering Collective Epistemic Responsibility', in J. Viñuales and E. Lees (eds), *Oxford Handbook of Comparative Environmental Law* (2019) 749.

the basis for a more extensive discussion of the ways in which the right to science may add to the existing corpus of international environmental law, its implementation and its progressive development.

2 The Right to Science in International Human Rights Law

Although legal protections for science and innovation are recognized in other international and regional human rights instruments, the legally binding obligations in Article 15 of the ICESCR constitute the most significant guarantee of the so-called 'right to science'. Specifically, Article 15(1)(b) of the covenant recognizes the right of everyone 'to enjoy the benefits of scientific progress and its applications'. States parties also have closely related duties in Article 15 to take steps 'necessary for the conservation, the development and the diffusion of science', 'to undertake to respect the freedom indispensable for scientific research and creative activity' and 'to recognize the benefits to be derived from the encouragement and development of international contacts and cooperation in the scientific and cultural fields'.[12]

Aspects of the right to science are also recognized in other international and regional human rights instruments. Article 27(1) of the Universal Declaration of Human Rights (UDHR) recognizes the right of everyone 'to share in scientific advancement and its benefits'.[13] In a regional context, Article 14 of the Additional Protocol to the American Convention on Human Rights in the Area of Economic, Social and Cultural Rights[14] and Article 42 of the Arab Charter on Human Rights[15] each adopt language substantially similar to the ICESCR. In a slightly different interstate formulation, the Charter of the Organization of American States provides that states parties 'shall extend among themselves the benefits of science and technology by encouraging the exchange and utilization of scientific and technological knowledge'.[16] The right to science is also recognized and elaborated upon in soft law instruments – notably, the UN Declaration on the Use of Scientific and Technological Progress in the Interests of Peace and for the Benefit of Mankind (UN Declaration on Scientific and Technological Progress), proclaimed by the United Nations General Assembly in 1975.[17] The United Nations Educational, Scientific and Cultural Organization (UNESCO) has also adopted several instruments relating to science and technology, including the Universal Declaration on the Human Genome and Human Rights,[18] the Universal Declaration

[12] ICESCR, *supra* note 1, Arts 15(2), (3), (4).

[13] GA Res. 217A(III), 10 December 1948. See further Claude, 'Scientists' Rights and the Human Right to the Benefits of Science', in A. Chapman and S. Russell (eds), *Core Obligations: Building a Framework for Economic, Social and Cultural Rights* (2002) 247, at 251.

[14] 1988, OAS Treaty Series no. 69.

[15] 2004, reprinted in 12 *International Human Rights Reports* (2005) 893.

[16] Charter of the Organization of American States 1995, 119 UNTS 3, Art. 38.

[17] GA Res. 3384(XXX), 10 November 1975 (Declaration on Scientific and Technological Progress).

[18] United Nations Educational, Scientific and Cultural Organization (UNESCO) Doc. 29 C/Resolution 31, 11 November 1997.

on Bioethics and Human Rights,[19] the Recommendation on the Status of Science and Scientific Researchers (UNESCO Recommendation)[20] and the Declaration of Ethical Principles in Relation to Climate Change.[21]

Despite being abundant in its sources, however, the right to science has largely been 'neglected',[22] with the result that its scope and normative content remain vague and 'underdeveloped'.[23] The last decade has seen somewhat of a shift, however, in light of the increased relevance of this right to contemporary societies. Following three expert meetings initiated by UNESCO, the 2009 Venice Statement on the Right to Enjoy the Benefits of Scientific Progress (Venice Statement) was adopted for the purpose of 'clarifying the normative content of the right to enjoy the benefits of scientific progress and its applications and generating a discussion among all relevant stakeholders with a view to enhance the implementation of this right'.[24] Subsequently, in 2012, the United Nations Human Rights Council's (UNHRC) special rapporteur in the field of cultural rights reported on the right to enjoy the benefits of scientific progress and its applications with a view 'to catalyz[ing] a robust discussion among states, scientific researchers and practitioners, civil society groups, and the private sector to further elucidate the right to science'.[25] In October 2018, the Committee on Economic Social and Cultural Rights (CESCR) commenced a consultative process with a view to clarifying the interpretation of this right though the drafting of a general comment on Article 15 on the right to enjoy the benefits of scientific progress and its applications.

3 The Right to Science in the Context of Environmental Protection

A *Definitions*

The ICESCR does not expressly define key terms relevant to the interpretation of Article 15(1)(b) of the covenant. This is unsurprising since the task of defining the

[19] UNESCO Doc. 33 C/Resolution 15, 19 October 2005.

[20] UNESCO Doc. 39 C/Resolution 15 (UNESCO Recommendation), 13 November 2017.

[21] UNESCO Doc. 39 C/Resolution 15, 13 November 2017, Arts 7, 8.

[22] Müller, 'Remarks on the Venice Statement on the Right to Enjoy the Benefits of Scientific Progress and its Applications (Article 15(1)(b) ICESCR)', 10 *Human Rights Law Review* (*HRLR*) (2010) 765, at 765; Schabas, 'The Study of the Right to Enjoy the Benefits of Scientific and Technological Progress and Its Applications', in Y. Donders and V. Volodin (eds), *Human Rights in Education Science and Culture: Legal Developments and Challenges* (2007) 273, at 302.

[23] United Nations Human Rights Council (UNHRC), Report of the Special Rapporteur in the Field of Cultural Rights, Farida Shaheed: The Right to Enjoy the Benefits of Scientific Progress and Its Applications (Report on the Right to Science), UN Doc. A/HRC/20/26, 14 May 2012, at 3; see also Chapman, 'Towards an Understanding of the Right to Enjoy the Benefits of Scientific Progress and Its Applications', 8 *Journal of Human Rights* (2009) 1, at 3.

[24] Venice Statement on the Right to Enjoy the Benefits of Scientific Progress and Its Applications (Venice Statement), July 2009, Art. I(2), available at www.aaas.org/sites/default/files/VeniceStatement_July2009.pdf.

[25] Report on the Right to Science, *supra* note 23, at 4.

object of regulation and demarcating the material scope of provisions related to science and emerging technologies raises a host of conceptual and practical challenges. Issues of terminology related to science and its applications may be politically controversial, highly fact sensitive and subject to near constant change. Lawmakers and adjudicators may also be confronted with other thorny definitional issues, including the characterization of intent, dual-purpose activities and even bad-faith actions.

In the face of these challenges, though environmental treaties often incorporate language on science and technology, rarely, if ever, are such terms expressly defined.[26] Although perhaps lamentable for some, the absence of expressly defined terms within a treaty text may represent a deliberate choice on the part of lawmakers to leave a treaty text open-ended.[27] The result of this 'constructive ambiguity' is that the onus is passed to the law appliers – be it through subsequent state practice, international adjudication or other authoritative interpretations – to work out the meaning and scope of legal obligations on science and technology as the need arises.[28]

Even where terminology is central to a contentious dispute, interpretative guidance may be elusive. Notably, in the *Whaling in the Antarctic* case, the International Court of Justice (ICJ) was faced with the issue of whether Japan's scientific whaling programme, JARPA II, was conducted 'for the purposes of scientific research' in accordance with the exception to the prohibition against commercial whaling laid down in Article XIII(1) of the International Convention for the Regulation of Whaling.[29] In addressing the issue of whether the killing, taking and treating of whales was conducted for the purposes of scientific research, the ICJ declined to enquire into the merits of whether the programme constituted scientific research.[30] It also rejected Australia's argument based on expert opinion that 'scientific research' must exhibit certain essential characteristics in order to satisfy the exception and declined to provide its own general definition or to offer any alternative criteria of its own.[31] Instead, in deciding that the special whaling permits were not granted 'for the purposes of scientific research', the Court found that the design and implementation of JARPA II was not reasonably related to its objectives and that it was unreasonable for Japan not to consider non-lethal alternatives, taking into account its obligations to cooperate with the International Whaling Commission (IWC), its own scientific policy, the existence of new technologies to avoid lethal sampling, the principle of proportionality and underlying commercial motivations.

[26] R.B. Mitchell, *International Environmental Agreements Database Project*, 2002–2014, available at http://iea.uoregon.edu/, cited in *Whaling in the Antarctic (Australia v. Japan; New Zealand Intervening)*, Memorial of Australia, 31 March 2014, ICJ Reports (2014) 226, para. 4.43.

[27] E.g. see the drafting history of Part XIII of the United Nations Convention on the Law of the Sea (UNCLOS) 1982, 1833 UNTS 3. See M. Nordquist, *United Nations Convention on the Law of the Sea 1982* (1991), vol. 4, at 441–446.

[28] Fischhendler, 'When Ambiguity in Treaty Design Becomes Destructive: A Study of Transboundary Water', 8 *Global Environmental Politics* (2008) 111.

[29] (1946) 161 UNTS 72.

[30] *Whaling in the Antarctic*, *supra* note 26, para. 88.

[31] *Ibid.*, para. 86.

Interpretive materials may provide some insight into the legal meaning of 'science', 'its applications' and other terms of art related to the human right to science in Article 15(1)(b) of the ICESCR. The UNHRC's special rapporteur on cultural rights recommends that the term 'science' should broadly encompass 'knowledge that is testable and refutable, in all fields of inquiry, including social sciences, and encompassing all research'.[32] UNESCO's recently updated 2017 UNESCO Recommendation also provides express definitions for the terms 'science', 'the sciences', 'technology', 'research and development' and 'scientific researchers'.[33] Ultimately, however, whilst expressly defined terms in instruments may be partially instructive, in that they can provide relevant indicia of the characteristics of science and technology, generally, they leave ample scope for debate in concrete situations and thus provide limited practical guidance for drawing a bright line to distinguish between scientific and non-scientific activities in the particular circumstances.

One reason why it is so challenging to define science and technology as regulatory objects is that these present moving targets that are likely to evolve (or 'progress') over time. In some cases, states may see a need to provide for greater legal certainty in clarifying their rights and obligations. In the face of this tension, procedural approaches may offer a promising avenue for demarcating science and technology as regulatory objects of their ongoing evolution. One example is the 2013 amendment to 1996 Protocol[34] to the 1972 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention)[35] on marine geoengineering, which adopts a 'positive listing' approach to allow for the inclusion of new geoengineering proposals of concern on a case-by-case basis.[36] Accordingly, the regulation establishes a general definition of 'marine geoengineering' in the text. However, this definition is not determinative of whether a specific marine geoengineering technique is regulated under the London Protocol but, rather, merely sets out broad criteria for evaluating whether the placement of matter into the sea for marine geoengineering activities should be restricted.[37] Only those techniques that are expressly listed in a new annex are prohibited or subject to a permitting requirement.[38] The advantages

[32] Report on the Right to Science, *supra* note 23, at 18.

[33] UNESCO Recommendation, *supra* note 20, Arts 1(a)(i), 1(a)(ii), 1(b), 1(c), 1(d)(i)–(ii).

[34] London Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter London 1996, 36 ILM 1 (1996).

[35] 1972, 1046 UNTS 120.

[36] Resolution LP.4(8) on the Amendment to the London Protocol to Regulate the Placement of Matter for Ocean Fertilization and Other Marine Geoengineering Activities (London Protocol), 18 October 2013, reprinted in Report of the Thirty-Fifth Consultative Meeting and the Eighth Meeting of Contracting Parties, Doc. LC 35/15, 21 October 2015.

[37] *Ibid.*, Art. 5*bis*.

[38] The requirements for the amendment of the annexes are laid out in the London Protocol, *supra* note 34, Art. 22. In addition, the contracting parties also developed supplementary guidance for listing new marine geoengineering activities before a formal procedure to amend Annex 4 is submitted, pursuant to Art. 22 of the London Protocol. See Draft Guidance on a Procedure for Considering the Inclusion of New Activities in Annex 4 to the London Protocol, Report of the Thirty-Fifth Consultative Meeting and the Eighth Meeting of Contracting Parties, Doc. LC 35/15, 21 October 2015, Annex 5.

of this procedural approach to defining the material scope of an instrument is that it ensures that international lawmakers can properly engage with 'real-world disputes and social context' in the regulation of new scientific and technological proposals, permits the creation of bespoke laws and measures that take into account the particular environmental, ethical, legal and social considerations at stake and helps to ensure that measures addressing science and its applications are sufficiently proportionate to the legislative aims.[39] Moreover, in contrast to soft law approaches – another technique for addressing emerging issues and uncertainty in international law[40] – the London Protocol provides a legally binding architecture for the regulation of marine geoengineering techniques. In short, procedural approaches can facilitate legal certainty without compromising flexibility and policy responsiveness in the face of rapidly evolving science and technologies.

B *Normative Content of the Right to Science*

In view of its growing contemporary relevance, legal academics and practitioners have turned their attention to the study and elaboration of the right to science in Article 15(1)(b) of the ICESCR with a view to bringing further conceptual clarity to this international norm. To this end, UNESCO, in collaboration with academics and relevant organizations, developed the Venice Statement 'with the aim of clarifying the normative content of the right to enjoy the benefits of scientific progress and its applications and generating a discussion among all relevant stakeholders with a view to enhance the implementation of this right'.[41] The document reflects three core elements of the right to science: the freedom of scientific research and communication, the enjoyment of the benefits of scientific progress and protection from the adverse effects of science, all of which must be interpreted and applied in a non-discriminatory manner.[42] It also recognizes the implications of the right to science for interstate relations by mandating international cooperation in scientific and technological fields.

1 Freedom of Scientific Research

The freedom of scientific research is a key element of the right to science in Article 15(1)(b) of the ICESCR, which is reiterated later in Article 15(3) regarding the duty of states 'to undertake to respect the freedom indispensable for scientific research and creative activity'. It is also protected in other human rights instruments, such as Article 13 of the Charter of Fundamental Rights of the European Union, which

[39] Mandel, 'Legal Evolution in Response to Technological Change', in Brownsword, Scotford and Yeung, *supra* note 6, 234.

[40] See Viñuales, 'Legal Techniques for Dealing with Scientific Uncertainty in Environmental Law', 43 *Vanderbilt Journal of Transnational Law* (2010) 437; Boyle, 'Some Reflections on the Relationship of Treaties and Soft Law', 48 *International Comparative Law Quarterly* (*ICLQ*) (1999) 901, at 903.

[41] Venice Statement, *supra* note 24, Arts 1, 2.

[42] *Ibid.*, Art. 13. See further B. Saul, D. Kinley and J. Mowbray, *The International Covenant on Economic, Social and Cultural Rights: Commentaries and Cases* (2016), at 1214–1223.

requires that scientific research be 'free from constraint',[43] and is guaranteed in the national constitutions of some countries.[44]

Broadly defined, the freedom of scientific research 'means ensuring that the scientific enterprise remains free of political and other interference'.[45] This concept is echoed in the UNESCO Recommendation, which recognizes the right of scientists 'to work in a spirit of intellectual freedom to pursue, expound and defend the scientific truth as they see it, an intellectual freedom which should include protection from undue influences on their independent judgment' and 'to contribute to the definition of the aims and objectives of the programmes in which they are engaged and to the determination of the methods to be adopted'.[46] The Venice Statement articulates the normative content of the freedom of scientific research as including the 'freedoms of opinion and expression, to seek, receive and impart information, association and movement'.[47] This phrase recognizes the close link of this freedom to important civil and political rights laid down in other international treaties and domestic constitutional guarantees.[48] States have a duty to protect scientific expression 'to respect the freedoms indispensable for scientific research … including to seek, receive, and impart information and ideas of all kinds'.[49] These guarantees may be significant in an environmental context – for example, where governments seek to restrict the communications of scientists in their employ to speak to the media and public about politically sensitive environmental problems, such as climate change, air pollution, water quality and fisheries,[50] or where they decide to withdraw public funding for environmental research on ideological grounds.[51]

2 Enjoyment of the Benefits of Scientific Progress

The freedom of scientific research is not absolute, however, and must be balanced against the other elements of the right to science. A second element is the right of everyone to enjoy the benefits of scientific progress. Broadly understood, this element conveys 'the idea of a positive impact on the well-being of people and the realization of their human rights'.[52] The 'benefits' of science and its applications encompass 'not only scientific results and outcomes but also the scientific process, its methodologies and tools'.[53]

[43] OJ 2010 C 83/02, Art. 13.

[44] Report on the Right to Science, *supra* note 23, paras 13–15.

[45] *Ibid.*, para. 39.

[46] UNESCO Recommendation, *supra* note 20, Arts 16(a)(i), 16(a)(ii).

[47] Venice Statement, *supra* note 24, Art. 13(a).

[48] Schabas, *supra* note 22, at 299.

[49] Venice Statement, *supra* note 24, Art. 14(a). *Cf.* ICESCR, *supra* note 1, Art. 15(3).

[50] See, e.g., Kondro, 'Canadian Official to Investigate Allegations that Government Scientists Are Being Muzzled', *Science* (2013), available at www.sciencemag.org/news/2013/04/canadian-official-investigate-allegations-government-scientists-are-being-muzzled.

[51] *Ibid.*

[52] Report on the Right to Science, *supra* note 23, at 24.

[53] *Ibid.*; see also UNESCO Recommendation, *supra* note 20, Arts 4, 5c, 13d, 19, 20, 22.

The question of what constitutes a 'benefit' or 'scientific progress' in the circumstances will inevitably be subject to a plurality of views. In keeping with the recognition that 'everyone' has the right to the enjoyment of the benefits of scientific progress and its applications, the right to science in Article 15(1)(b) of the ICESCR not only protects the rights of scientific researchers to pursue their own ideas but also those of other stakeholders and the lay public to contribute to the definition and shaping of the scientific enterprise through democratic participation.[54] To this end, the Venice Statement recognizes the need to create 'an enabling and participatory environment for the conservation, development and diffusion of science and technology'[55] and calls upon states 'to provide opportunities for public engagement in decision-making about science and technology and their development'.[56] This aspect of the right to science recognizes that decisions about the direction of the scientific enterprise should not be a closed shop within the exclusive domain of career scientists and technologists[57] but, instead, that there should be 'equal access and participation of all public and private actors' in the development and use of science and technology.[58] It responds to an important critique that, despite growing impacts of science and technology on society, experts still play an outsized role in environmental decision-making. Professional judgment, risk assessment, predictive modelling and scientific standard setting are all heavily relied upon within the field of environmental law to avoid harms. However, these tools tend to obscure the normative side of decision-making and to sideline uncertainty.[59] Public participation, in its various forms, offers a starting point for governments to actively engage citizens, corporations and non-governmental organizations (NGOs) in decisions about science and technology.[60] Participatory processes may facilitate the early articulation and adjudication of values and interests surrounding science and its applications so that science can play a more effective role in resolving environmental controversies.[61]

It should also be noted that the recognition of a right of public participation in matters relating to science and technology closely aligns with an important trend towards the proceduralization of environmental rights as recognized in various global and

[54] See also International Covenant on Civil and Political Rights (ICCPR) 1966, 999 UNTS 171, Art. 19; Universal Declaration of Human Rights, GA Res. 217, 10 December 1948, Art. 27; Limburg Principles on the Implementation of the ICESCR, UN Doc. E/CN.4/1987, 8 January 1987, Principle 11, which further notes that the involvement of sectors of society is 'indispensable to achieving progress in realizing economic, social and cultural rights'. See also Chapman, *supra* note 23, at 15–16.

[55] Venice Statement, *supra* note 24, Art. 13(a).

[56] *Ibid.*, Art. 16(e).

[57] See, e.g., Sarewitz, 'Kill the Myth of the Miracle Machine', 527 *Nature* (2017) 139.

[58] Venice Statement, *supra* note 24, Art. 13(a).

[59] See Jasanoff, 'Technologies of Humility: Citizen Participation in Governing Science', 41 *Minerva* (2003) 223; Winickoff *et al.*, 'Adjudicating the GM Food Wars: Science, Risk and Democracy in World Trade Law', 30 *Yale Journal of International Law* (2005) 81.

[60] Jasanoff, *supra* note 59, at 238.

[61] Sarewitz, 'How Science Makes Environmental Controversies Worse', 7 *Environmental Science and Policy* (2004) 385.

regional instruments on environmental protection and sustainable development.[62] As Alan Boyle observes, 'the most important contribution existing human rights law has to offer with regard to environmental protection and sustainable development is the empowerment of individuals and groups affected by environmental problems, and for whom the opportunity to participate in decisions is the most useful and direct means for influencing the balance of environmental social, and economic interests'.[63] The right to science may be regarded as a precursor to guarantees of access to information, public participation and access to justice in environmental decision-making and thus may offer the possibility of strengthening upstream science and innovation processes in the service of environmental democracy and environmental governance generally.[64]

Guarantees of access to information also are necessary for the effective participation of scientific researchers, other stakeholders and the lay public in the conservation, development and diffusion of science and technology.[65] This aspect of the right to science is supported by a large body of social science literature that documents the importance of transparency in the governance of science and technology, including to enhance the substance, democratic legitimacy and accountability of governance processes and to engender public trust in, and the acceptance of, scientific processes and results.[66] However, beyond a mere right of access to information, Article 15(1)(b) of the ICESCR imposes a positive duty on states to support public awareness and to provide public education in support of appropriate, long-term policies pertaining to science and technology.[67] Similar obligations are echoed in various environmental treaties, such as the United Nations Framework Convention on Climate Change (UNFCCC),[68] which calls upon states parties to promote, at the national level and within their respective capabilities, public access to information on climate change and its effects and requires that states promote education, training and public awareness about climate change.[69]

[62] Important examples include Principle 10 of the Rio Declaration on Environment and Development 1992, 31 ILM 874 (1992), the Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters, 1998, 2161 UNTS 447 and the recently adopted Regional Agreement on Access to Information, Public Participation and Justice in Environmental Matters in Latin America and the Caribbean 2019, available at https://treaties.un.org/doc/Treaties/2018/03/20180312%2003–04%20PM/CTC-XXVII-18.pdf.

[63] Boyle, 'Human Rights and the Environment: Where Next?', 23 *European Journal of International Law* (EJIL) (2012) 613, at 625.

[64] *Ibid.*, at 622.

[65] Report on the Right to Science, *supra* note 23, para. 22.

[66] P. Kitcher, *Science in a Democratic Society* (2011), ch. 6; Royal Society, Science as an Open Enterprise, Royal Society Policy Centre Report no. 02/12, June 2012, https://royalsociety.org/~/media/policy/projects/sape/2012-06-20-saoe.pdf; Finel and Lord, 'The Surprising Logic of Transparency', 43 *International Studies Quarterly* (1999) 315, at 315.

[67] Chapman, *supra* note 23, at 25.

[68] 1992, 1771 UNTS 107, Art. 6(a)(iii).

[69] *Ibid.*, Art. 4(1)(i).

The right of everyone to enjoy the benefits of scientific progress also intersects with the rights of indigenous peoples and local communities to their accumulated scientific knowledge. For example, one concern relates to the need to protect the scientific and traditional knowledge of indigenous peoples from misappropriation as a result of 'bioprospecting' entailing the systematic search for biochemical and genetic information in nature in order to develop commercially-valuable products.[70] In this respect, the right to science intersects with the rights of indigenous peoples to maintain, control, protect and develop traditional knowledge, including 'manifestations of their sciences, technologies and cultures, including human and genetic resources, seeds, medicines, [and] knowledge of properties of flora and fauna'.[71] Aspects of these cultural human rights are echoed in environmental treaties, such as Article 8(j) of the Convention on Biological Diversity (CBD),[72] which requires that states parties 'preserve and maintain knowledge, innovations and practices of indigenous and local communities' and 'promote their wider application with the approval and involvement of the holders of such knowledge, innovations and practices'. Though heavily qualified, this provision in the CBD is also noteworthy for extending the participatory dimensions of the right to science to require that indigenous rights holders provide their consent to the use of indigenous knowledge and innovation in respect of biodiversity conservation.[73]

There are also complex questions about the relationship between substance and procedure in relation to the role of scientific and technical knowledge in environmental decision-making. Arguably, the realization of the 'benefits of scientific progress' in an environmental protection context entails more than the mere acquisition and dissemination of scientific knowledge. It also depends on the extent to which science and scientific advice are actually considered and used by states to support, monitor and assess the implementation of laws and policies. There are numerous examples where governmental decision-making clearly departs from the best available scientific evidence, as required under many environmental treaties. For example, although the Intergovernmental Panel on Climate Change has declared that the scientific evidence of humans warming the planet is 'unequivocal' and that climate change will have 'widespread impacts on human and natural systems',[74] states have not taken the requisite actions demanded by this knowledge to prevent serious and irreversible harms from the warming of the global climate system,[75] which may in turn result in

[70] Report on the Right to Science, *supra* note 23, at 17.

[71] United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP), UN Doc.61/295, 13 September 2007, Art. 31.

[72] Convention on Biological Diversity 1992, 1760 UNTS 79.

[73] Claude, *supra* note 13, at 267.

[74] Intergovernmental Panel on Climate Change, *Climate Change 2014 Synthesis Report Summary for Policymakers, Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (2014), available at www.ipcc.ch/site/assets/uploads/2018/02/AR5_SYR_FINAL_SPM.pdf.

[75] United Nations Environment Programme, The Emissions Gap Report (2018), available at www.unenvironment.org/resources/emissions-gap-report-2018https://www.unenvironment.org/resources/emissions-gap-report-2018.

serious human rights violations.[76] On the other hand, a strong substantive requirement that environmental decisions be based on the 'best available scientific knowledge' gives rise to concerns that this gives scientists and other experts too strong a voice in environmental decision-making processes and may undermine democratic values guaranteed in human rights instruments.[77]

3 Protection from the Adverse Effects of Science

In referring to the right to enjoy the 'benefits' of science and its applications, the plain language of Article 15(1)(b) of the ICESCR paints only half the picture. Various interpretations of the right to science also recognize that science and innovation processes may have adverse or uncertain consequences for individuals and communities. Structured as a due diligence obligation, the Venice Statement calls upon states to take measures to protect all sectors of society from the harmful effects and misuse of science and technology.[78] Specifically, it ties the right to science in Article 15(1)(b) of the ICESCR to procedural requirements to conduct impact assessments, to monitor the harmful effects of science and technology and to inform the public of potential threats, including in respect of the environment.[79]

The right to science also recognizes that states not only have a duty to refrain from interfering with the enjoyment of human rights but also must actively protect those rights from violation or abuse by third parties. This 'duty to protect' is significant in the context of the right to science given that 'private and non-state actors are increasingly the principal producers of scientific progress and technological advances' and may contribute to the violation of human rights in various ways.[80] Accordingly, states must 'take measures, including legislative measures, to prevent and preclude the utilization by third parties of science and technologies to the detriment of human rights and fundamental freedoms and the dignity of the person by human parties'[81] and 'take action to ensure compliance with legislation guaranteeing human rights and freedoms in the conditions of scientific and technological developments'.[82] In many cases, however, states still lack an effective system to protect people against the harmful effects and the misuse of science and technology by private actors. This failure may be attributed to many factors, including '[w]eak government, poor regulation, lax enforcement, corruption, or too simply too-close relationship between business and government'.[83]

[76] See International Bar Association (IBA), Climate Change Justice and Human Rights Task Force Report: Achieving Justice and Human Rights in an Era of Climate Disruption (2014), available at https://www.ibanet.org/PresidentialTaskForceClimateChangeJustice2014Report.aspx.

[77] Jasanoff, *supra* note 5.

[78] Venice Statement, *supra* note 24, Art. 15(a), (b); see also Declaration on Scientific and Technological Progress, *supra* note 17, Arts 2, 4, 6, 8.

[79] Venice Statement, *supra* note 24, Arts 12(f), 16(c).

[80] *Ibid.*, Art. 5; see also Chapman, *supra* note 23, at 24.

[81] Declaration on Scientific and Technological Progress, *supra* note 17, Art. 8.

[82] *Ibid.*, Art. 9.

[83] Boyle, *supra* note 63, at 619.

4 International Cooperation

Since World War II, national science and innovation systems have become increasingly globalized and integrated,[84] such that it is now possible to speak of the emergence of a 'true world-science'.[85] States' obligations under Article 15(1)(b) of the ICESCR are not limited to persons within their territory and jurisdiction. Rather, as confirmed in Article 15(4) of the covenant, the right to science also has implications for interstate relations by requiring international cooperation in scientific fields.[86] The United Nations' (UN) Declaration on Scientific and Technological Progress emphasizes the international aspects of knowledge and its applications, declaring that scientific and technological advancements are to be promoted with a view to 'strengthening international peace and security, freedom and independence, and also for the purpose of the economic and social development of peoples and the realization of human rights and freedoms in accordance with the Charter of the United Nations'.[87] Whilst this statement underscores the fact that the collective benefits of knowledge should be shared globally, international cooperation may also be necessary to address regional or global harms arising from scientific and technological developments, including those that threaten the environment.[88]

The right to science also encompasses considerations of international equity.[89] The distribution of the means and ends of science remain uneven across the globe, with the result that the benefits of scientific activity tend to cluster in wealthy developed nations and the harms in poorer, less developed ones.[90] Accordingly, the UN Declaration on Scientific and Technological Progress declares that '[a]ll States shall co-operate in the establishment, strengthening and development of scientific and technological capacity of developing countries with a view to accelerating the realization of the social and economic rights of the peoples of those countries'.[91] The Venice Statement further affirms that states should 'strengthen cooperation and assistance in science and technology for the benefit of all people'.[92] These duties overlap with other areas of international law, including international environmental law, through the recognition of duties to cooperate in scientific and technical matters such as through joint participation in the conduct of scientific research and monitoring,[93] the exchange

[84] Keenan *et al.*, 'Orienting International Science Cooperation to Meet Global "Grand Challenges"', 39 *Science and Public Policy* (2012) 166.

[85] LeClerc and Gagné, 'International Scientific Cooperation: The Continentalization of Science', 31 *Scientometrics* (1994) 261, at 261.

[86] See part on progressive realization earlier in this article. See also Müller, *supra* note 22, at 779–780.

[87] Declaration on Scientific and Technological Progress, *supra* note 17, Art. 1.

[88] *Ibid.*, Arts 6, 8.

[89] Chapman, *supra* note 23, at 14.

[90] Jasanoff, *The Ethics of Invention* (2016), at 49; Chapman, *supra* note 23, at 22.

[91] Declaration on Scientific and Technological Progress, *supra* note 17, Art. 5.

[92] Venice Statement, *supra* note 24, Art. 16(d).

[93] See, e.g., Convention for the Protection of the Ozone Layer 2001, 26 ILM 1529, Art. 3; Convention on Long-Range Transboundary Air Pollution (LRTAP Convention) 1979, 18 ILM 1442 (1979), Art. 7; Convention on the Protection and Use of Transboundary Watercourses and International Lakes 1992, 31 ILM 1312 (1992), Art. 5; Convention to Combat Desertification in Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa 1994, 1954 UNTS 3, Arts 10(4), 12.

of scientific information, including cooperation on scientific programmes, the generation of observations and data,[94] the publication and dissemination of scientific information[95] and scientific and technical capacity building.[96] Given these overlaps with other areas of international law, the Venice Statement calls on states to comply with their existing obligations under international law in relation to the duty of international cooperation in relation to science and technology.[97]

C *Limitations*

The right to science in Article 15(1)(b) of the ICESCR is not absolute and is subject to specific limitations under the covenant.[98] Limitations are imposed by means of the internal balancing of the substantive elements of Article 15(1)(b) on the basis of the principles set out in the general limitations clause in Article 4 of the ICESCR, the concurrent non-discrimination obligations in Article 1(1)–1(3) and the principle of progressive realization in Article 2(1).

1 General Limitations on the Right to Science

Article 4 establishes a general limitations clause that is applicable to all ICESCR rights, including the right to science in Article 15(1)(b). Accordingly, states are only permitted to restrict such rights where 'such limitations are determined by law only in so far as this may be compatible with the nature of these rights and solely for the purpose of promoting the general welfare in a democratic society'. However, 'in many cases there is little residual room to apply Article 4 because some of the ICESCR rights already contain specific limitations, others are inherently defined or interpreted to embody their own limiting criteria, and the principle of progressive realization already addresses resource-based constraints'.[99] As a result, resort to the express limitations clause may not be necessary in relation to Article 15(1)(b) since the primary right itself is interpreted as recognizing competing individual and public interests. In other words, the definition and interpretation of the right to science reflects the potential for internal conflicts within the right, for example, between the duty of states to not interfere with the freedom of scientific research and the positive duty of states to protect individuals from the adverse effects of science.[100]

[94] See, e.g., Antarctic Treaty 1959, 402 UNTS 71, Art. III; International Convention for the Regulation of Whaling (ICRW) 1946, 161 UNTS 72, IV; Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention) 1992, 2354 UNTS 67, Art. 9.

[95] E.g. Convention on the Protection of the Alps 1991, 1917 UNTS 135, Art. 4(4), is particularly far-reaching in requiring that 'Contracting Parties shall ensure that the public are regularly kept informed in an appropriate manner about the results of research, monitoring and action taken'. See also LRTAP Convention, *supra* note 93, Art. 4.

[96] See, e.g., LRTAP Convention, *supra* note 93, Art. 10; ICRW, *supra* note 94, Art. VIII; OSPAR Convention, *supra* note 94, Art. 8.

[97] Venice Statement, *supra* note 24, Art. 16(d).

[98] See Müller, *supra* note 22, at 765.

[99] Saul, Kinley and Mowbray, *supra* note 42, at 247.

[100] ICESCR, *supra* note 1, Art. 15(1)(b) may also be limited by rights and freedoms or other human rights instruments.

However, even where the substantive right itself is internally limited, the general criteria established for restricting rights in Article 4 of the ICESCR may provide a 'unified standard to evaluate the limitation of economic, social, and cultural rights'.[101] This approach prevents states from invoking a more liberal justification than what is permitted under the general limitations clause and promotes greater consistency and stability in the interpretation of limitations across the covenant.[102] Therefore, though the content and structure of Article 15(1)(b) effectively preclude the need to formally invoke the general limitations clause, restrictions on the right to science should nonetheless satisfy the elements laid down in Article 4 of the ICESCR.

First, the 'sole' basis for imposing limitations under Article 4 is the 'promotion of the general welfare',[103] which has been defined as 'the economic and social well-being of the community'.[104] What is problematic, however, is the lack of explicit recognition of environmental protection as a 'significant public interest' with the status of a right in the covenant. As Boyle concludes, this means that 'the environment can be trumped by those values which have that status, including economic development and resource exploitation', both of which are expressly recognized in the concurrent non-discrimination obligations in Article 1(1)–(3) of the ICESCR.[105] As a result, limitations on the right to science for the purposes of environmental protection may only be justified to the extent that they already find expression through existing rights, such as the right to human health. In response to this problem, Boyle argues that '[w]hat is needed here is a broader focus on environmental quality, which could be balanced more directly against the Covenant's economic and developmental priorities'.[106] This could be accomplished through the articulation of a right to a decent or healthy environment by 'reconceptualizing in the language of economic and social rights the idea of the environment as a common good',[107] a guarantee which could also inform limitations on the right to science relating to potential adverse effects of science and technology on the environment.

[101] Müller, 'Limitations to and Derogations from Economic, Social and Cultural Rights', 9 *HRLR* (2009) 557, at 590.

[102] *Ibid.*, at 590–591, arguing that the same criteria for limiting rights pursuing Art. 4 should be applied to regressive measures based on Art. 2(1). See also Alston and Quinn, 'The Nature and Scope of States Parties' Obligations under the International Covenant on Economic, Social and Cultural Rights', 9 *Human Rights Quarterly* (*HRQ*) (1987) 156, at 206.

[103] Alston and Quinn, *supra* note 102, at 570–571; Saul, Kinley and Mowbray, *supra* note 42, at 250.

[104] Daes, The Individual's Duties to the Community and the Limitations on Human Rights and Freedoms under Art. 29 of the Universal Declaration of Human Rights, Study of the Special Rapporteur of the Sub-Commission on the Prevention of Discrimination and Protection of Minorities, UN Doc. E/CN.4/Sub.2/432/Rev.2 (1983), available at https://digitallibrary.un.org/record/52410/files/E_CN.4_Sub.2_432_Rev.2-EN.pdf.

[105] Boyle, *supra* note 63, at 629. See ICESCR, *supra* note 1, Art. 1, which reaffirms the right of peoples to 'freely pursue their economic, social and cultural development' and to 'freely dispose of their natural wealth and resources'.

[106] Boyle, 'Human Rights or Environmental Rights: A Reassessment', 18 *Fordham Environmental Law Review* (2007) 471, at 509–510.

[107] This argument is elaborated in Boyle, *supra* note 63.

Second, Article 4 of the ICESCR stipulates that limitations on economic, social and cultural rights must be 'determined by law'. This criterion is read as incorporating basic elements of the rule of law: limitations must 'not be arbitrary or unreasonable or discriminatory', must be 'clear and accessible to everyone', 'formulated with sufficient precision to enable the citizen to regulate his conduct'[108] and must ensure that 'adequate safeguards and remedies [are] provided by law against the illegal or abusive imposition or application of limitations of economic, social, and cultural rights'.[109] In some cases, however, it may be difficult to ensure that limitations on the right to science are prescribed by law in light of the multi-level, multi-actor (private and public) system of science governance. For example, an important mode of upstream governance of science are the government policies and administrative measures that channel public funding towards some priority research areas over others. Scientists may perceive the lack of public funding for specific research areas as a limitation on their autonomy to pursue specific ideas. These alleged limitations of scientific rights and freedoms may be difficult to trace back to any particular national 'law', but they are likely to be part of a more complex administrative system of science policy and governance in response to political pressures or perceived social needs and priorities.[110] In order to not run afoul of the 'determined-by-law' requirement in Article 4 of the ICESCR, 'the discretion given to national authorities by a law must be indicated with sufficient clarity, including the limits of such discretion'.[111] This point was affirmed by the UNHRC in its statement that 'laws authorizing the application of restrictions should use precise criteria and may not confer unfettered discretion on those charged with their execution'.[112]

Third, justifiable limitations on ICESCR rights must be acceptable 'in a democratic society'. According to the Limburg Principles on the Implementation of the International Covenant on Economic, Social and Cultural Rights (Limburg Principles), the state bears the burden of demonstrating that 'the limitations do not impair the democratic functioning of society'.[113] Importantly, this qualification on the limitation of substantive rights incorporates the principle of proportionality, according to which restrictions on economic, social and cultural rights must correspond to a 'pressing social need' and be 'proportionate to the legitimate aim being pursued'.[114] As noted above, the only legitimate aim for imposing a limitation is the promotion of general welfare. Accordingly, proportionality involves an enquiry into whether the state's reasons for limiting the right are relevant to the legitimate aim and sufficient with regard

[108] Müller, *supra* note 101, at 587.

[109] United Nations Commission on Human Rights, Note verbale dated 5 December 1986 from the Permanent Mission of the Netherlands to the United Nations Office at Geneva addressed to the Centre for Human Rights (Limburg Principles), UN Doc. E/CN.4/1987/17, 8 January 1987, paras 48–51.

[110] See also discussion on ICESCR, *supra* note 1, Art. 2(1).

[111] Müller, *supra* note 101, at 579.

[112] UNHRC, General Comment no. 27: Freedom of Movement (Art. 12), UN Doc. CCPR/C/21/Rev.1/Add.9, 2 November 1999, para. 13.

[113] Limburg Principles, *supra* note 109, paras 53, 54.

[114] Saul, Kinley and Mowbray, *supra* note 42, at 256–57.

to the nature, severity, effects and expected harm of the restriction. States must satisfy a higher standard to justify limitations on rights deemed more important.[115] Cultural rights, including the right to science, are generally considered less important than subsistence rights, such as a basic right to food and water.[116] However, in contrast to other human rights instruments, the proportionality test under the ICESCR is to be applied strictly, with a narrow margin of appreciation accorded to the state seeking to justify the limitation on the basis that 'the nature of economic, cultural and social rights does not easily admit restrictions'.[117]

Proportionality is an important consideration in balancing the various substantive elements and interests in relation to the regulation of science and innovation in environmental agreements. Commentators sometimes express concerns that extensive, or highly precautionary, regulatory and administrative requirements put in place to protect the environment will overburden scientists and, paradoxically, exert a chilling effect on research and innovation necessary to support environmental protection.[118] Some instruments directed at the environmentally responsible conduct of scientific research acknowledge this tension expressly. For example, the Oslo and Paris Commissions (OSPAR) has adopted a code of conduct that aims to promote sustainable marine research in the deep seas and high seas of the OSPAR maritime area, which recognizes, on the one hand, that 'marine research is a prerequisite and an integral component of an ecosystem-based management of marine resources and the effective conservation of biodiversity of the deep and high seas' and, on the other, that 'most forms of observation and investigation of natural systems involve some disturbance of the systems being studied'.[119] The proportionality analysis comes in through the balancing of competing objectives in the interest of environmental stewardship under the OSPAR code of conduct. Accordingly, 'it must be the goal of research scientists to minimize disturbances as much as possible, while still gathering the information necessary both to understand the systems and to form a basis for sustainable use strategies'.[120]

The final requirement of Article 4 is that limitations must be 'compatible with the nature' of ICESCR rights. The Limburg Principles suggest this criterion 'requires that a limitation shall not be interpreted or applied so as to jeopardize the essence of the right concerned'.[121] In other words, this element introduces 'a "non-derogable" component to Covenant rights which rules out any extreme restrictions'.[122] This element

[115] *Ibid.*

[116] Müller, *supra* note 101, at 584.

[117] Saul, Kinley and Mowbray, *supra* note 42, at 254.

[118] See Trute, 'Democratising Science: Expertise and Participation in Administrative Decision-making', in H. Nowotny *et al.* (eds), *The Public Nature of Science under Assault: Politics, Markets, Science and the Law* (2005) 87.

[119] OSPAR Commission, OSPAR Code of Conduct for Responsible Marine Research in the Deep Seas and High Seas of the OSPAR Maritime Area, Doc. OSPAR 08.24/1 (2008), Annex 6, para. 7.

[120] *Ibid.*

[121] Limburg Principles, *supra* note 109.

[122] Saul, Kinley and Mowbray, *supra* note 42, at 257.

has obvious application to survival and subsistence rights,[123] but there is no authoritative source identifying the 'minimum core' of the right to science that is protected from non-derogation.[124]

2 Progressive Realization in Article 2(1) of the ICESCR

The principle of progressive realization, laid down in Article 2(1) of the ICESCR, constitutes a key provision for defining the nature and extent of state obligations concerning the implementation of the covenant. It recognizes that resource constraints may hinder the immediate realization of substantive rights in the ICESCR[125] and thus is particularly salient to the right to science, which 'requires substantial human and material resources, capabilities, and infrastructure' for its implementation.[126] Article 2(1) sets out four key criteria with respect to the progressive realization of economic, social and cultural rights. First, states parties undertake 'to take steps' towards the attainment of the substantive rights in the covenant. Though implementation may be achieved progressively, steps should be 'deliberate, concrete and targeted', and states should take measures within a reasonably short time upon being bound. The current lack of authoritative guidance to clarify the meaning and scope of Article 15(1)(b) of the ICESCR constitutes a barrier to the progressive realization of the right to science since it remains unclear what steps states must take to fulfil their obligations under this provision.

With regard to aspects of international equity, states are not only required to 'take steps' in their own territory or jurisdiction but are also called upon to render international assistance and promote cooperation in the fulfilment of the right to science.[127] However, in interpreting this requirement, the CESCR has avoided stating that this amounts to a duty on wealthier states or international organizations to make financial and other resources available to states with greater needs, instead reading it as recognizing that individual states may use opportunities for international assistance to meet their own obligations under the covenant.[128] In this way, scientific and technical assistance in the areas of international environmental law and sustainable development provides a vehicle for implementing the right to science. Yet it should be considered that the 'sharing of the benefits' of science and its applications should entail more than a one-way flow of information and resources from developed to developing countries.[129] Broader focus on bilateral and multilateral knowledge

[123] Limburg Principles, *supra* note 109, para. 47.

[124] *Cf.* ICESCR, *supra* note 1, Art. 5(1).

[125] Roberston, 'Measuring State Compliance with the Obligation to Devote the "Maximum Available Resources" to Realizing Economic, Social and Cultural Rights', 15 *HRQ* (1994) 693; Felner, 'Closing the "Escape Hatch": A Toolkit to Monitor the Progressive Realization of Economic, Social, and Cultural Rights', 1 *Journal of Human Rights Practice* (2009) 402.

[126] Müller, *supra* note 22, at 782.

[127] ICESCR, *supra* note 1, Art. 15(4).

[128] Committee on Economic Social and Cultural Rights (CESCR), 'General Comment no. 3 on the Nature of States Parties' Obligations' (Art. 2 Para. 1 of the Covenant)' (General Comment no. 3), UN Doc. E/1991/23, 14 December 1990, para. 5.

[129] Report on the Right to Science, *supra* note 23, para. 68.

exchanges through North–South partnerships, joint research projects, scientific capacity building and training as well as efforts that focus not only on technology transfer but also on technology absorption may help to reduce the gaps between developed and developing countries in the context of the right to science.[130]

Second, a state party must use the 'maximum of its available resources' towards the realization of the substantive rights in the ICESCR. 'Resources' are construed as more than just financial resources, though budgetary appropriation and expenditures related to science and innovation are clearly important to the implementation of the right to science.[131] In assessing whether a state's allocation of resources is 'adequate' or 'reasonable' in the context of the periodic reporting process, the CESCR will take into account, *inter alia*, whether measures that have been taken were 'deliberate, concrete and targeted towards the fulfilment of economic, social and cultural rights', whether they were implemented in a non-discriminatory and non-arbitrary manner as well the time frame for implementation.[132] It will also consider whether resources have been prioritized for 'grave situations or situations of risk', a criterion that could be used to evaluate whether national science policy adequately addresses serious, potentially existential, environmental threats such as climate change.[133] The allocation of resources must also be in accordance with human rights standards and should take into account the situation of disadvantaged or marginalized groups. This criterion is significant insofar as a diversity of perspectives – including 'race, colour, sex, language, religion, political or other opinion, national or social origin, property, birth or other status'[134] – may impact the quality and legitimacy of the science on environmental protection and sustainability.[135]

In addition to the quantum of scientific resources, there is also the question of a state's capacity to deliver them efficiently and fairly through its system of governance, institutions and administration as well as in a way that furthers human rights. Government research agencies play an important role in distributing funding and other resources, and the rules, standards and practices that guide this process may be used to advance the right to science, including the interest of environmental protection. For example, national granting agencies may link funding requirements to environmental assessment legislation as a mechanism to allow for public input and

[130] See, e.g., Olawuyi, 'From Technology Transfer to Technology Absorption: Addressing Climate Technology Gaps in Africa', 36 *Journal of Energy and Natural Resources Law* (2017) 61.

[131] Saul, Kinley and Mowbray, *supra* note 42, at 143–144.

[132] CESCR, Statement: An Evaluation of the Obligation to Take Steps to the 'Maximum Available Resources' under an Optional Protocol to the Covenant, UN Doc. E/C.12/2007/1, 10 May 2007.

[133] CESCR, Climate Change and the International Covenant on Economic, Social and Cultural Rights: Statement of the Committee on Economic, Social and Cultural Rights (2018), available at www.ohchr.org/en/NewsEvents/Pages/DisplayNews.aspx?NewsID=23691&LangID=E.

[134] ICESCR, *supra* note 1, Art. 2(2).

[135] See, e.g., Gay-Antaki and Liverman, 'Climate for Women in Climate Science: Women Scientists and the Intergovernmental Panel on Climate Change', 115 *Proceedings of the National Academy of Science* (2018) 2060.

avoid harms from scientific experiments conducted in the ambient environment.[136] Such mechanisms, combined with reporting practices, may also 'give teeth' to soft law standards, best practices and codes of conduct on scientific research adopted at different levels.[137]

Third, Article 2(1) of the ICESCR recognizes the practical reality that the full realization of economic, social and cultural rights may need to be achieved progressively over time. Though this recognition acknowledges that covenant rights may not be realized immediately, states are obligated 'to move as expeditiously and effectively as possible toward the goal'.[138] The obligation is a continuing one given that the right to science itself presumes that science and innovation will continually advance ('progress') over time.

Fourth, states should employ 'all appropriate means' at their disposal to implement their obligations under the ICESCR. This phrase encompasses the full spectrum of financial, administrative, educational and social measures that are considered appropriate in the circumstances. In terms of the right to science, states parties may claim that any number of government plans, policies and programmes, administrative guidance, best practices and codes of conduct, funding measures and incentives will give effect to the obligations under Article 15(1)(b) of the ICESCR.[139] That being said, Article 2(1) specially mentions the adoption of legislative measures, and the practice of the CESCR indicates that it is 'especially keen to "urge" and "recommend" that states do more in terms of "hard law" implementation – that is, by way of statutes and courts' as a means of ensuring the full implementation of economic, social and cultural rights.[140] The programmatic nature of science and innovation means that legislation is seldom governments' preferred means for effecting science policy. However, it may be necessary in some situations; for example, to ensure that covenant rights are adequately protected in the face of potentially harmful research and development projects conducted by private actors.

The nature of economic, social and cultural rights and their formulation in the ICESCR raises the long-standing issue of whether they are justiciable or whether it should be left to political authorities rather than courts to allocate the necessary resources. Some elements of the right to science, broadly constructed, are clearly justiciable. Respect for the freedom of scientific research, for example, which stems from the civil and political guarantee of the freedom of expression, is capable of immediate application and can be

[136] For example, the Natural Sciences and Engineering Research Council of Canada (NSERC), as a federal authority, must comply with the Canadian Environmental Assessment Act, SC 2012, c. 19, by ensuring that funded research projects are not likely to have significant adverse environmental effects on federal lands or on countries outside Canada. See NSERC, Guidelines on Environmental Review and Assessment, available at www.nserc-crsng.gc.ca/NSERC-CRSNG/Policies-Politiques/enviroassess-enviroeval_eng.asp.

[137] See, e.g., Hubert, 'The New Paradox in Marine Scientific Research: Regulating the Potential Environmental Impacts of Conducting Ocean Science', 42 *Ocean Development and International Law* (2011) 329, at 339.

[138] General Comment no. 3, *supra* note 128, para. 9.

[139] Saul, Kinley and Mowbray, *supra* note 42, at 157.

[140] *Ibid.*, at 159.

invoked before the courts in many domestic legal systems.[141] Aggrieved scientists may have a claim that their right of scientific expression has been violated by governments who seek to muzzle them. In this way, the right to science may serve to backstop related obligations in environmental treaties that impose duties on states and add an additional layer of application and accountability at the domestic level.

Beyond this, the CESCR is of the view that 'there is no Covenant right which could not, in a great majority of legal systems, be considered to possess at least some significant justiciable dimensions. … While the respective competences of the various branches of government must be respected, it is appropriate to acknowledge that courts are generally already involved in a considerable range of matters which have important resource implications'.[142] In areas such as administrative law, courts routinely hold governments to account for their actions or inactions with respect to the allocation of resources.[143] Certainly, courts and human rights bodies, including through the use of the complaints procedure under the Optional Protocol, may play a meaningful role in ensuring protections at the far end of the spectrum 'where states fail to act, act unreasonably or otherwise in disregard of their rights' obligations', and they may be capable of adjudication.[144]

Compliance with economic, social and cultural rights is also monitored by the CESCR. The monitoring process has deficiencies, including the amount of deference given to states and inadequate reporting.[145] The committee also noted in a recent discussion paper that state reporting on the right to science lacks 'sufficient detail and coherence', a situation that will also impact the value of monitoring.[146] Nevertheless, the CESCR's oversight provides another mechanism for the progressive realization of the right to science. Boyle concludes in this regard that 'insofar as the [CESCR] does have some influence over governments, and can take into account agreed environmental standards, this model at least provides a mechanism for balancing environmental concerns against competing objectives'.[147]

4 Relationship between the Right to Science and International Environmental Law

How might a human rights perspective on the development and use of science and technology contribute to environmental protection? The analysis of the right to science, above, reveals significant caveats to the particular work that the right to science may be able to do to advance the development of international environmental law. It is clear that definitional issues and a lack of interpretive clarity are barriers to implementation, compliance and the enforcement of the right. Further elucidation of

[141] General Comment no. 3, *supra* note 128, para. 5.

[142] CESCR, General Comment no. 9 on the Domestic Application of the Covenant, Doc. E/C.12/1998/24, 3 December 1998, para. 10.

[143] Saul, Kinley and Mowbray, *supra* note 42, at 164–165.

[144] *Ibid.*, at 165.

[145] Boyle, *supra* note 106, at 509.

[146] CESCR, 'Discussion Paper on a Draft General Comment on Article 15 of the ICESCR' (2018), available at www.ohchr.org/Documents/HRBodies/CESCR/Discussions/2018/discussionpaper.pdf.

[147] Boyle, *supra* note 106, at 509.

the scope and contents of Article 15(1)(b) of the ICESCR is necessary if it is to have meaningful influence over the development of international environmental law. Legal limitations on the right to science may further curtail the impact of the right in the field of environmental protection. States are entitled to exercise a wide margin of appreciation in the balancing and implementation of Article 15(1)(b) of the covenant. Moreover, a lack of express legal recognition of a right to a healthy environment in the context of the protection of economic, social and cultural rights means that considerations of the development and use of resources may trump environmental protection in the balancing processes.[148] Finally, states only have the responsibility to implement the right to science progressively and insofar as resources permit.[149]

These qualifications notwithstanding, arguably, there is still a role for the right to science to play in the implementation and progressive development of international environmental law. The 2011 report from the Office of the High Commissioner for Human Rights observes that '[h]uman rights obligations and commitments have the potential to inform and strengthen international, regional and national policy-making in the area of environmental protection and promoting policy coherence, legitimacy and sustainable outcomes'.[150] Similar gains may be achieved through the right to science under Article 15(1)(b) of the ICESCR. However, it is important to be mindful of the fact that the right to science does not imply a commitment to environmental protection *per se.* Rather, its contribution to the development of international environmental law rests on the importance of science and its applications to support environmental protection in various ways. Accordingly, this raises the question of what mechanisms exist to allow for the right to science to be taken into account in the interpretation and application of international environmental norms. And what can the right to science add substantively that develops the corpus of international environmental law?

A *Mechanisms for Integration*

A human rights perspective on science and technology may contribute to the implementation and development of international environmental law through various mechanisms and pathways that contribute to the integration of norms within the larger system of international law. As a starting point, it is important to bear in mind that, unlike international environmental law, which primarily governs the relations between states, international human rights law confers rights directly on individuals. Under the ICESCR, states are required to put in place a framework to prevent violations of human rights, to establish planning, monitoring and oversight mechanisms, to hold the responsible to account and to provide a remedy to individuals and groups whose rights have been violated.[151] Insofar as the normative content of the right to

[148] ICESCR, *supra* note 1, Art. 1(1)–(3).

[149] *Ibid.*, Art. 2(1).

[150] Office of the High Commissioner for Human Rights, Analytical Study on the Relationship between Human Rights and the Environment, UN Doc. A/HRC/19/34, 16 December 2011, para. 2.

[151] General Comment no. 3, *supra* note 128, paras 2–8.

science overlaps with obligations of international environmental law, this framework may support the implementation of, and compliance with, obligations of international environmental law at the domestic level. Furthermore, state practice on the right to science may solidify the legal status and content of related norms of international environmental law where these coincide.

The right to science may also more directly influence the interpretation and development of international environmental norms. One mechanism is through treaty provisions that incorporate by reference laws and standards derived from other treaties. For example, Article 240(d) of the United Nations Convention on the Law of the Sea (UNCLOS) states that marine scientific research 'shall be conducted in compliance with all relevant regulations adopted in conformity with [the] Convention, including those for the protection and preservation of the marine environment'.[152] The language of this provision opens the door for the right to science to influence the interpretation of the regime for marine scientific research in Part XIII of UNCLOS.

More generally, international environmental law may interact with international human rights law, including Article 15(1)(b) of the ICESCR, through the application of the principle of systemic integration of international law. Systemic integration requires that treaty obligations be read in a mutually supportive manner with other relevant international rules. Consideration of issues 'beyond the individual case' prevents conflicts between legal norms and promotes cohesiveness in the international legal system.[153] According to the International Law Commission (ILC), systemic integration receives its 'clearest formal expression' in Article 31(3)(c) of the Vienna Convention on the Law of Treaties,[154] where, in addition to the context, treaty interpretation must take into account 'any relevant rules of international law applicable in the relations between the parties'.[155]

The principle of systemic integration is axiomatic for treaty interpretation.[156] However, it also has implications for international law-making. Systemic integration in a law-making context may simply be regarded as a corollary of modern treaty-making processes where 'the everyday reality in the practice of foreign ministries has the inevitable consequences that treaties are developed in an integrative process in which many normative elements are shared'.[157] However, instead of amounting to 'a mere political formula devoid of normative implications',[158] systemic integration may

[152] UNCLOS, *supra* note 27.

[153] *Ibid.*, para. 480.

[154] 1969, 1155 UNTS 331.

[155] International Law Commission (ILC), Fragmentation of International Law: Difficulties Arising from the Diversification and Expansion of International Law (ILC Report on Fragmentation), UN Doc. A/CN.4.L.682, 13 April 2006, paras 420–421.

[156] Specific expressions of the principle of systemic integration are reflected in other international agreements such as UNCLOS, *supra* note 27, Art. 237. See *South China Sea Arbitration (Philippines v. China) (Merits)*, Award, 12 July 2016, PCA Case no. 2013–19, para. 945.

[157] McLachlan, 'The Principle of Systemic Integration and Article 31(3)(c) of the Vienna Convention', 54 *ICLQ* (2005) 279, at 284.

[158] Pavoni, 'Mutual Supportiveness as a Principle of Interpretation and Law-Making: A Watershed for the "WTO and Competing-Regimes" Debate?', 21 *EJIL* (2010) 649, at 678.

further impose a duty on states to 'cooperate in good faith in order to facilitate law-making processes, including amendment procedures, in respect of agreements which may generate systemic conflicts with other regimes safeguarding essential values of the international community'.[159] This interpretation of the principle of systemic integration opens the door for the right to science to be taken into account in new environmental law-making processes and to shape the development of environmental instruments and norms.

B *Substantive Contribution to International Environmental Law*

This discussion of the scope and contents of the right to science in Article 15(1)(b) of the ICESCR has provided several examples of how a human rights perspective on science and technology may mutually reinforce, or even amplify, the interpretation and application of existing international environmental norms and treaty regimes. In addition, because international human rights law targets different objectives and purposes, the application of the right to science may help to address lacunae in international environmental law regarding its treatment of issues of science and technology.[160] Importantly, while international environmental law tends to focus on the physical risks arising from developments in science and technology, often by means of conventional risk assessment procedures and cost–benefit analysis, international human rights law offers a different perspective on the relationship between science, its applications and society, which emphasizes the moral, social, political and institutional foundations of science and technology in society. Incorporation of this broader view of what is at stake may contribute to the progressive development of international environmental regimes and norms; for example, by promoting a more judicious use of scientific and technical knowledge and expertise in environmental decision-making, allowing for the input of a wider range of expert and non-expert (citizen) views and opening up regulatory responses to diverse definitions of risk and uncertainty.[161] The value added by the right to science in Article 15(1)(b) of the ICESCR is that consideration of other dimensions in governing science and technology is not merely justified by reference to extra-legal criteria such as effectiveness and legitimacy but is also guaranteed as a fundamental human right. From a legal standpoint, having the status of a right means that such interests can only 'be trumped by those values which have that status'.[162]

For instance, the conclusions put forward in a recent CBD technical report on synthetic biology highlight the limits of technocratic, expert-driven processes that remain favoured in international environmental regimes in governing emerging science and technologies. The report concludes that existing biosafety risk assessment frameworks, including the Cartagena Protocol on Biosafety,[163] which establishes

[159] *Ibid.*, at 666. *Cf.* Venice Statement, *supra* note 24, Art. 13(c).

[160] Shelton, 'Human Rights, Environmental Rights, and the Right to Environment', 28 *Stanford Journal of International Law* (1991) 103, at 111.

[161] Caney, 'Climate Change, Human Rights, and Moral Thresholds', in S. Humphries (ed.), *Human Rights and Climate Change* (2009) 69.

[162] Boyle, *supra* note 63, at 629.

[163] 2000, 2226 UNTS 208.

harmonized principles and procedures to protect human health and the environment from the possible adverse effects of the products of modern biotechnology, are likely sufficient to evaluate the risks of current and near-term applications on the conservation and sustainable use of biodiversity.[164] These principles and procedures rely on case-by-case technical risk assessments that consider the environment that is exposed to the organism, the characteristics of the organism and its intended uses.[165] However, the report also highlights other ethical issues raised by synthetic biology, such as whether the study and use of such techniques will 'change public perceptions of what is natural' and thus 'challenge the ethical basis for conservation action'.[166] It points out, for example, that 'de-extinction' projects may impact how conservation resources are directed and may promote the view that *in situ* conservation is less urgent due to the expectation that 'lost' species can be resurrected.[167] Yet 'sound science' and technical risk assessment processes alone are inadequate to resolve such questions, which are inherently normative in nature and deal with complex questions involving the governance of uncertain and politically contested applications of science.

Another example of how the human right to science in Article 15(1)(b) of the ICESCR could influence more directly the governance of science and technology at the international level concerns the 2013 amendment of the London Protocol on the Regulation of Marine Geoengineering (London Protocol; not yet in force).[168] In this case, international environmental law processes for deciding whether certain marine geoengineering 'placement activities' should be subject to the prohibition or permitting requirement under the 2013 regulation would have an effect on upstream science and research into these uncertain and controversial techniques.[169] In contrast to other multilateral environmental agreements, the strict technical, pollution-control framing of the London Protocol likely contributes to its heavy reliance on scientific and technical advice,[170] and harmonized risk assessment procedures,[171] as the primary basis for deciding whether a particular marine geoengineering technique should be regulated under the protocol. Through legal recognition of rights of public participation and access to information, a human rights-centred approach responds to this narrow technical risk framing adopted in the London Protocol on the regulation of marine geoengineering by opening up this conversation to a wider range of expert and non-expert views, guaranteeing a right of the public to be informed and to

[164] Secretariat of the Convention on Biological Diversity, Synthetic Biology: Technical Series no. 82 (2015), available at www.cbd.int/ts/cbd-ts-82-en.pdf.

[165] *Ibid.*, at 10.

[166] *Ibid.*, at 48.

[167] *Ibid.*, at 27–28.

[168] Resolution LP.4(8), *supra* note 36.

[169] K.E. Gannon and M. Hulme, 'Geoengineering at the "Edge of the World": Exploring Perceptions of Ocean Fertilization through the Haida Salmon Restoration Corporation', 5 *Geography and Environment* (2018).

[170] Description of Arrangements for a Roster of Experts on Marine Geoengineering in the Consultation Process (with regard to paragraph 12 of Annex 5 to the London Protocol), Doc. LC 36/16, 1 July 2013, Annex 4.

[171] Resolution LC-LP.2(2010) on the Assessment Framework for Scientific Research Involving Ocean Fertilisation, 14 October 2010; Resolution LP.4(8), *supra* note 36, Annex 5.

have a say in the development and distribution of resources for scientific research and innovation processes related to biodiversity conservation.

Overall, the procedural dimensions of the right to science may offer a pathway to promote more democratically legitimate, inclusive and accountable modes of decision-making[172] and allow for the upstream articulation and adjudication of the value bases that underlie environmental controversies surrounding science and its applications.[173] However, it is unclear whether 'bottom-up' forms of public engagement scale particularly well at the international level. Though a large body of social science literature argues for the inclusion of different normative preferences and values in decision-making on science and technology, such advice is not readily integrated into international law-making processes and practices because of a lack of legal and institutional mechanisms for achieving this representation.[174] Rarely, if ever, do environmental treaties guarantee a direct right of public participation in law-making processes at the international level. Though observer status is granted to some NGOs,[175] their participation in international environmental regimes raises important issues about the geographical interests and societal classes they represent.[176] Ultimately, the lack of a global *demos* to provide input into global environmental decision-making is problematic because it relies on public participation and engagement, in its various forms, as a primary source of input legitimacy for the regulation of science and technology at the international level.[177] The challenges are not merely limited to the lack of institutional structures and mechanisms to provide for transparency and more direct forms of public involvement in international environmental regimes.[178] More fundamentally, the question concerns whether these processes and institutions can be attuned to the 'diverse ways of knowing and reasoning that mature societies have come to accept as foundational',[179] whilst still maintaining some semblance of the collective global interest in decision-making relating to science and its applications.[180] What weight should be accorded to locally variant, cultural preferences in relation to the regulation of science and technology in the context of global

[172] Jasanoff, 'Technologies of Humility: Citizen Participation in Governing Science', 41 *Minerva* (2003) 223.

[173] Sarewitz, *supra* note 61.

[174] Jasanoff, 'Epistemic Subsidiarity: Coexistence, Cosmopolitanism, Constitutionalism', 4 *European Journal of Risk Regulation* (2013) 133.

[175] On the role of non-governmental organizations and public participation in international meetings, see Bodansky, 'Legitimacy', in D. Bodansky, J. Brunnée and E. Hey (eds), *Oxford Handbook of International Environmental Law* (2008) 704, at 718; Brunnée and Hey, 'Transparency and International Environmental Institutions', in A. Bianchi and A. Peters (eds), *Transparency in International Law* (2013) 23.

[176] See Charnovitz, 'Two Centuries of Participation: NGOs and International Governance', 18 *Michigan Journal of International Law* (1997) 183.

[177] For this reason, Bodansky, *supra* note 175, at 721, asserts that 'expertise may represent a more achievable basis of legitimacy' in global environmental regimes given that the 'commonalities of history, language and culture that democratic legitimacy presupposes' are largely lacking at the international level.

[178] See J. Peel, *Science and Risk Regulation in International Law* (2013), ch. 7.

[179] Jasanoff, *supra* note 174, at 141.

[180] See Brunnée, 'Common Areas, Common Heritage, and Common Concern', in Bodansky, Brunnée and Hey, *supra* note 175, 551; Simma, 'From Bilateralism to Community Interest', 250 *Recueil des cours* (1994) 221.

environmental protection? The principle of subsidiarity holds that 'any infringements of the autonomy of the local level by means of pre-emptive norms enacted on the higher level to be justified by good reasons'.[181] On the other hand, international institutional processes may have greater legitimacy where an important international community interest, such as the protection of the global environment, is at stake.[182]

Some of the issues raised in relation to the question of who should have a say in the international regulation of science and technology in an environmental protection context point to the practical and conceptual limits of the systemic integration of international law generally. International legal scholars observe that uncritical and perfunctory applications of the principle of systemic integration have drawbacks, such as undermining state consent, reinforcing existing legal and institutional preferences and biases and limiting the richness and diversity that is inherent in a non-hierarchal legal system.[183] Specifically, the application of individualistic, rights-based framings where the primary objective is environmental protection may be 'counter-productive in that [they tend] to reduce environmental values to the very limited sphere of individual interest, thus adulterating their inherent nature of public goods indispensable for the life and welfare of society as a whole'.[184] In addition, a human rights-centred approach may displace particular ethical perspectives, such as the recognition of the environment as intrinsically valuable and worthy of protection for its own sake.[185]

However, the extent to which the integration of the right to science in international environmental regimes would promote an anthropocentric view of nature is not entirely clear. International environmental law mainly focuses on human priorities already.[186] By contrast, many branches of the natural sciences provide evidence to support a more integrated perspective that 'humans are interlinked and interdependent participants with duties to protect and conserve all elements of nature'.[187] Insofar as the right to science reaffirms the wide dissemination of, and public access to, scientific results and information, its recognition may promote the idea that humans are themselves a part of nature and depend on a healthy environment in order to thrive. It also potentially facilitates a range of ethical perspectives on nature – including the value and protection of nature for its own sake – to be taken into consideration in environmental decision-making linked to emerging science and technologies. These normative perspectives may otherwise be excluded in expert-driven, technocratic approaches to environmental regulation.

[181] Kumm, 'The Legitimacy of International Law: A Constitutionalist Framework of Analysis', 15 *EJIL* (2004) 907, at 921.

[182] *Ibid.*

[183] Rachovista, 'The Principle of Systemic Integration in Human Rights Law', 66 *ICLQ* (2017) 557.

[184] Francioni, 'International Human Rights in an Environmental Horizon', 21 *EJIL* (2010) 41, at 55; see also Rachovista, *supra* note 183, at 584; Boyle, *supra* note 63, at 642.

[185] L. Leib, *Human Rights and the Environment: Philosophical, Theoretical and Legal Perspectives* (2011), at 40.

[186] Shelton, *supra* note 160, at 109–110.

[187] *Ibid.*, at 110; see also World Charter for Nature, GA Res. 37/7, 28 October 1982, preamble, stating that '[m]ankind is a part of nature and life depends on the uninterrupted functioning of natural systems which ensure the supply of energy and nutrients'.

The potential negative effects of systemic integration may also be mitigated by the fact that the process of systemic integration is not meant to be 'automatic' or 'mechanical'; rather, a closer reading of the ILC's work on fragmentation suggests that adjoining rules must simply be 'considered'.[188] The determination of whether an external norm is 'relevant' to the interpretation of another norm is essentially a process of legal reasoning.[189] The normative weight to be given to 'other rules' or general international law is but one factor to be weighed against others in the particular circumstances. Accordingly, in the absence of a clear normative hierarchy, the balancing implied by harmonizing mechanisms – the principle of systemic integration chief amongst them – opens up new sites for political debate and legal argumentation and democratic deliberation about international law and its evolution.[190]

Another example of the potential substantive contribution of the right to science to international environmental law concerns the large scientific uncertainties associated with emerging science and innovation and the application of a precautionary approach. The Venice Statement incorporates precaution as part of the human right to science, stating that 'in the absence of scientific consensus, caution and the avoidance of steps are required in case an action or policy might cause severe or irreversible harm to the public or the environment'.[191] A precautionary approach is important in regulating science and emerging technologies because it covers situations where a potential risk of an activity may be anticipated or identified, often using traditional risk assessment or scientific evaluation, but where scientific data is insufficient to fully demonstrate or quantify the risk or causal relationships.[192] Champions of developing the precautionary approach as a possible framework for addressing issues of science and innovation point out that, in the face of incomplete knowledge about the implications of science and emerging technologies, the application of precaution can 'help "broaden out" attention to greater diversities of options, practices and perspectives in policy debates over technology' and assist in '"opening up" more deliberate, mature and robust policy debates over the implications of different interpretations of uncertainty'.[193]

It is doubtful, however, that precaution is a panacea for the regulation of science and technology, and the 'piling on' of normative expectations concerning the material scope and content of the precautionary approach bears the risk of watering down the

[188] ILC Report on Fragmentation, *supra* note 155, para. 210.

[189] *Ibid.*, para. 243.

[190] Peters, 'The Refinement of International Law: From Fragmentation to Regime Interaction and Politicization', 15 *International Journal of Constitutional Law* (2017) 671.

[191] Venice Statement, *supra* note 24, Art. 12(f); see also Report on the Right to Science, *supra* note 23, para. 50.

[192] Hafner and Buffard, 'Obligations of Prevention and the Precautionary Principle', in J. Crawford, A. Pallet and S. Olleson (eds), *The Law of International Responsibility* (2010) 525; Freestone, 'Satya Nandan's Contribution to the Development of the Precautionary Approach in International Law', in M.W. Lodge and M.H. Nordquist (eds), *Peaceful Order in the World's Oceans: Essays in Honour of Satya N Nandan* (2014) 302, at 311–312.

[193] Stirling, 'Precaution in the Governance of Technology', in Brownsword, Scotford and Yeung, *supra* note 6, 645, at 662.

principle's conceptual clarity. According to its orthodox formulation in environmental law and sustainable development, set out in Principle 15 of the Rio Declaration, 'where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation'.[194] Rio Principle 15 is triggered by 'plausible indications of potential risks' to the environment, which must be 'serious' or 'irreversible' in magnitude.[195] Many research activities fall below this physical risk threshold and, thus, would not trigger the principle, even if they may raise other societal issues, which might be related to the protection of human rights. By contrast, the right to science in Article 15(1)(b) of the ICESCR provides a more comprehensive framework for addressing science and its applications (particularly where scientific uncertainty is not the predominate concern) and for balancing the rights and obligations of the various actors involved.

The right to science also draws attention to the need to achieve proportionality in the balancing of the elements of harm prevention against other elements of the right to science, such as the freedom of scientific research.[196] Again, the regulation of marine geoengineering under the London Protocol nicely demonstrates this point. The marine geoengineering regulation adopts a strongly precautionary stance in regulating marine geoengineering by requiring that all research proposals on ocean fertilization (currently, the only listed marine geoengineering technique in the new regulation) be assessed on a case-by-case basis, regardless of the scale and duration of the proposed environmental perturbation from the outdoor experiment.[197] Applying the proportionality requirement between the aim and limitation, though scientists must satisfy certain administrative requirements in order to lawfully conduct ocean fertilization research under the regulation, it is significant that the London Protocol does not impose a complete prohibition on all ocean fertilization research. A ban would be more difficult to justify as proportionate, particularly in light of the benefits of ocean fertilization research, which include the contribution of this field to understanding the basic structure and functioning of marine ecosystems and to knowledge about marine-based mitigation measures for addressing dangerous climate change.[198] Nonetheless, in view of the significant public controversy surrounding ocean fertilization and the potential for harm to the marine environment, the limitations imposed on

[194] Rio Declaration, *supra* note 62.

[195] In the ITLOS, *Responsibilities and Obligations of States Sponsoring Persons and Entities with Respect to Activities in the Area – Request for an Advisory Opinion Submitted to the Seabed Disputes Chamber*, Advisory Opinion, 1 February 2011, ITLOS Case no. 17, para. 3. The idea that risks must be 'plausible' also raises the question of how imminent a risk to the environment must be in order to reasonably justify the application of a precautionary approach.

[196] Regarding potential environmental harms from field research, see Wallace *et al.*, *Ocean Fertilization: A Scientific Summary for Policy Makers*, Doc. IOC/BRO/2010/2 (2010), available at http://unesdoc.unesco.org/images/0019/001906/190674e.pdf.

[197] London Protocol, *supra* note 34, Arts 4.1, 4.2.

[198] See Group of Experts on the Scientific Aspects of Marine Environmental Protection, Working Group on Marine Geoengineering, available at www.gesamp.org/work/groups/41.

scientific freedoms in the London Protocol appear to strike a reasonable balance and satisfy the protective element of the right to science in Article 15(1)(b) of the ICESCR.

5 Conclusion

Though long considered to be the 'poor cousins' of civil and political human rights, it is now 'beyond doubt that there is … a fairly comprehensive, integrated and sophisticated international law of social, economic, and cultural rights'.[199] Within this system, however, the right to science embodied in Article 15(1)(b) of the ICESCR and other human rights instruments has existed in relative obscurity. Article 15(1)(b) establishes only a shell of an obligation for which further normative development is necessary. Moreover, the right is subject to limitations, and states are only required to implement Article 15(1)(b) progressively and insofar as resources permit. Nonetheless, the very idea that science and innovation processes are the subject of a free-standing human rights obligation is significant and, if better realized, could enhance the existing framework for how law and legal processes mediate society's relationship with science, its applications and environmental protection.

The relationship between the human right to science and international environmental law, however, is far from simple or straightforward. This article has attempted to trace some of the ways in which the right may contribute to environmental protection, and has discussed different examples of how these two areas of international law intersect and may be mutually reinforcing. It underscores that international human rights law entails a different perspective on the relationship between science, its applications and society than is envisaged by international environmental law. The thrust of the argument presented here is that the right to science in Article 15(1)(b) of the ICESCR departs from the harm prevention orientation of international environmental law, which tends to focus narrowly on physical conceptions of risks and harm thresholds. Consideration of the different elements of the right to science in international environmental law processes may open up the possibility to frame and weigh the risks and benefits of scientific and technological developments differently. Lawmakers and adjudicators should heed concerns that the integration of human rights considerations in international environmental law does not result in hegemonic 'mainstreaming' of individual human rights over collective international interests and the protection of the environment for its own sake.[200] By the same token, consideration of the right to science may ameliorate the preference for expert-driven, technocratic approaches that remain prevalent in international environmental law and may contribute towards a more prudent, equitable, democratically accountable and legitimate use of scientific knowledge and expertise in international environmental agreements.

[199] *Ibid.*, at 10.

[200] Koskenniemi, 'Hegemonic Regimes', in M.A. Young (ed.), *Regime Interaction in International Law: Facing Fragmentation* (2015) 305.

From a broader perspective, the idea that everyone has a right to share in the benefits of scientific progress and its applications represents one expression of the common good of humankind. But this is not a vision that is fixed.[201] Departing from more instrumental understandings, reflection and debate about how to balance the different elements of the right to science in international environmental regimes may allow societies to contribute to, and collectively reimagine, a wider set of 'choices about how we choose to imagine the world and how we live in it'.[202] In the absence of a clear normative hierarchy, the balancing envisaged through harmonizing mechanisms for international law – the principle of systemic integration chief amongst them – opens up new sites for political debate and legal argumentation and democratic deliberation about alternate visions of the good life.[203] With regard to the consideration of the human right to science in the development of international environmental law, this may include debate about the role of different kinds of knowledges and expertise in decision-making about the protection of the global environment and shine a light on legal and policy 'blind spots', strengthen the effectiveness, legitimacy and accountability of science and its applications in environmental regimes and promote a more equitable and just international legal order.

[201] Fisher, 'Imagining Technology and Environmental Law', in Brownsword, Scotford and Yeung, *supra* note 6, 360.

[202] *Ibid.*, at 376.

[203] ILC Report on Fragmentation, *supra* note 155, at para 480.