Anticipation under the Human Right to Science: Concepts, Stakes and Specificities

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Abstract: Recent years have seen the emergence of dual-use technologies and, more generally, of scientific practices that are potentially beneficial to humanity, but that may also have an irreversible impact on human beings. In those circumstances, the issue of the adequate anticipation not only of the risks (of harm) of science, but also of its (opportunities for) benefits has become more pressing. One framework from which States may derive duties and responsibilities to anticipate both those 'risks' and 'benefits' of science is the human right to enjoy the benefits of scientific progress and to participate in that progress (in short, the 'human right to science'). Not only indeed does that right include everyone's right to participate in the scientific enterprise and its organisation and to access to and enjoy the benefits of scientific progress, but it also includes the right to be protected against the adverse effects of science. Interestingly, while some duties to anticipate grounded in the human right to science have been briefly mentioned in recent interpretations of the right, albeit not in those terms, their specific content, scope and bearers have not yet been addressed in depth. Nor has the tension between preventing the risks of science and promoting its benefits, created by their unique combination in the duties correlative to the human right to science, been clarified to date. Remedying this gap is the aim of this special issue and of its eight original contributions. This introduction explains the concepts, stakes and specificities of the human right to science in the context of anticipation of both the beneficial and adverse effects of science.

Introduction

Recent years have seen the increasing emergence of dual-use technologies and, more generally, of scientific practices that may have an irreversible impact on human beings, but that are also, and inextricably so, potentially beneficial to humanity and the future of human life. It suffices here to think of new techniques such as AI, genetic editing and, more broadly, of geo- and bio-engineering. In those circumstances, the issue of the adequate anticipation not only of the risks (of harm) of science, but also of its (opportunities for) benefits has become more pressing than ever.

One framework from which States and, arguably, other domestic and international (mostly public, but also arguably private) institutions may derive duties and/or responsibilities to anticipate both the 'risks' and 'benefits' of science is the human right to participate in and to enjoy the benefits of scientific progress and its applications (in short, the 'human right to science' or HRS), as it is guaranteed by Article 15(1)(b) International Covenant on Economic, Social and Cultural Rights (ICESCR).[1] Not only indeed does that

right include everyone's right to participate in the scientific enterprise and its organisation and to access to and enjoy the benefits of scientific progress, but it also includes the right to be protected against the adverse effects of science. Even if the latter and third prong of the right to science remains difficult to grasp, it has since been endorsed repeatedly, albeit in different terms, by various United Nations (UN) reports, statements and comments.[2]

Interestingly, however, those anticipation duties' and responsibilities' specific content, scope and bearers have not yet been addressed in depth by scholars and practitioners of the right. Nor has the tension between preventing the risks of science and promoting its benefits, created by their unique combination in the duties correlative to the HRS, been clarified to date. While some duties and responsibilities to anticipate grounded in the HRS are mentioned by, for instance, the UN Committee on Economic, Social and Cultural Rights' (CESCR) in its General Comment No. 25 of 2020 on Science and Economic, Social and Cultural Rights, it is not nominally, only in passing and without any sustained systematic attention.[3] Moreover, the notions of '(opportunities for) benefit' and '(risks of) harm' borrowed from the instrumentalist lexicon of anticipation, but also, more generally, the transposition of the 'costs versus benefits' balancing framework itself inside the human rights framework need to be interpreted and assessed critically. This is even more the case when the human right at stake is the human right to science whose *raison d'être* is precisely, as I will argue, to protect against the instrumentalisation of science.

Such is the point of this special issue and of its eight original contributions. Their aim is to specify the content, scope and bearers of the various duties and responsibilities to anticipate diligently the adverse effects caused by emerging technologies and other scientific innovations (including, albeit non-exclusively, 'precaution' and 'prevention' duties), but also to promote those technologies and innovations when beneficial to humanity. The articles in this special issue focus first and foremost on the HRS, but comparisons with various anticipation duties and responsibilities arising under other human rights (e.g. other social and cultural rights) and under other international law regimes (e.g. international environmental law and international biomedical law) and their limits are also explored.

After a first section devoted to the *concepts* underlying this special issue (1.), this introduction unpacks the *stakes* of the anticipation of the adverse effects of science in general (2.), before spelling out what could be the *specificities* of anticipation under the HRS (3.). A fourth and final section is dedicated to the articulation of the special issue and provides an *overview* of its contents (4.).

1. The Concepts: 'Anticipation' under the 'Human Right to Science'

This special issue revolves around two key concepts that need defining more specifically before one can understand how the human right to science can provide a fruitful framework in which to anchor the anticipation of both the beneficial and adverse effects of science: the concepts of 'human right to science' (1.1.) and 'anticipation' (1.2.).

1.1. The Human Right to Science

The last fifteen years have revealed a renewed academic interest in a long neglected human right and provision: Article15(1)(b) ICESCR's human right to science.[4]

The project to reinvigorate the right has now also spread across various UN bodies. The most important documents to that effect are, besides the UN General Assembly's 1975 Declaration[5] and the UN Educational, Scientific and Cultural Organization (UNESCO)'s 1974/2017 Recommendation,[6] 1999 and 2005 Declarations[7] and 2009 Venice Statement:[8] the UN Special Rapporteur on Cultural Rights' 2012 and 2014 reports on the right[9] and, most recently, the CESCR's 2020 General Comment No. 25 on Science and Economic, Social and Cultural Rights.[10]

The difficulty, however, is that State practice has itself never caught up with the HRS. By way of consequence, UN bodies' interpretations have not yet been in a position to consolidate a minimal consensus based on an evanescent State practice.[11] If this is to change, it is important to understand what happened to the HRS in the immediate post-war period and what prevented it from giving rise to State practice.

As I have argued elsewhere,[12] the HRS is best understood as the 'human right to participate in science', by reference to the first declaration of the right in Article 27(1) Universal Declaration of Human Rights (UDHR).[13] The idea back then, indeed, was that science should be guaranteed as a human right to an independent participatory good, a good requiring a strong institutional and normative structure. Amidst the cold war, and with the progressive individualisation of science, the human right to participate in science quickly lost its participatory dimension. As one may observe in its reframing in the guarantee of Article 15(1)(b) ICESCR,[14] the right has indeed become little more than a passive right to enjoy scientific benefits and a mere redistributive afterthought. Hence the short but inadequate denomination that is still widely used today when referring to the right: the human right *to* science. No wonder then that the right, thereby stripped of any social and participatory teeth, quickly became dormant.[15] More accurately said, it was put to sleep.[16]

Today, in our attempts at reinvigorating the right, we should aim at reviving the post-war consensus on the public and participatory good of science.[17] It is at this condition only that the human right to science could re-acquire some teeth in international and domestic law and play a role –both domestically and internationally– in the institutional and normative structure of science. The time for that (re-)institutionalisation of science is ripe.[18] It suffices to consider the contemporary individualisation, instrumentalisation and privatisation of science, but also certain scientists' counter-reaction akin to what happened every time science was instrumentalised in the course of history, that is, their tendency to 'self-validate'.[19] From pre-war institutionalism to post-war individualism, and back, we seem to have come full circle –yet again, Robert Merton would argue.

1.2. Anticipation

In a nutshell, the point of anticipation, turned into an individual and institutional imperative, is to foresee and control, as much as possible, the potential harms to come and to do so by identifying the risks of such harms, managing and containing them, and even accounting for not doing so.

Understood in this way, anticipation has become a ubiquitous dimension of modern society. Ulrich Beck's 'risk society'[20] and its related 'vigilance society' avatar have indeed turned into what may be described as the 'anticipation society'.[21] The law itself, including international law, has been deeply affected by those developments. It has also contributed to the consolidation of the anticipation concern in return. Hence, for instance, a more future-oriented approach to 'time' in the law, as epitomised by the emergence in recent years of new legal concepts such as 'intergenerational' equity or 'sustainability'. One should also mention the consolidation of new duties and principles of 'prevention' and 'precaution' and the related renaissance of the standard of 'due diligence'.[22]

It is beyond the scope of this introduction to address the legal concept of anticipation in full. It suffices for our purpose to present the two principles and corresponding duties of precaution and prevention, together with the standard of due diligence that qualifies both duties.[23] Those two principles and this standard constitute what one may refer to as the 'anticipation triptych' under contemporary international law. Anticipation may indeed be conceived as a tri-dimensional concern, composed of three panels: precaution on the left, due diligence in the middle and prevention on the right.

The first principle, and corresponding duty, of *precaution* requires the adoption of measures of avoidance or, at least, of mitigation and of reduction of risks of serious and

irreversible harm, and this even when, under the current state of scientific knowledge, the occurrence of that harm is only probable and remains uncertain. The duty of precaution's relationship to the second principle, and corresponding duty, of *prevention* is progressive and evolves with the degree of scientific knowledge. Indeed, once the risk of harm goes from being uncertain to becoming certain scientifically, the principle of precaution becomes one of prevention and a duty of prevention arises.[24]

The duties of precaution and prevention are duties of conduct by opposition to duties of result. The duty-bearers are not expected to guarantee the absence of harm, indeed, but only to do their best to avoid the harm or, at least, mitigate and reduce the risk of harm in the concrete circumstances. This is what is meant by the term 'best effort obligations'. The assessment of what amounts to the duty-bearer's best effort in each case is of the essence. It is at this point that the third, and central, panel of the anticipation triptych, i.e. the standard of *due diligence*, enters the scene. *Qua* standard of conduct, due diligence is grafted upon and qualifies the duties of precaution and prevention: it requires reasonable (or due) care (or diligence) in precaution or prevention. In other words, the duties of precaution or prevention are only breached in case of unreasonable or undue negligence.

More specifically, the standard of due diligence itself is breached if two conditions are fulfilled: (i) the foreseeability of the harm, which implies that the duty-bearer knew ('real knowledge') or should have known ('constructed knowledge') about the risk of harm; and (ii) the ability to prevent or protect against it, which entails that the duty-bearer had the capacity to do something about that risk.[25] The foreseeability and ability conditions are often qualified as 'reasonable' to the extent that they only amount to what a reasonable person (here, the 'well-organised State') could foresee and was able to do. Moreover, and this is constitutive of an upper threshold of due diligence, the two conditions are adapted to the specific conditions of the duty-bearer and need to be contextualised in each case.[26] In international human rights law, finally, and this is constitutive of a minimal threshold of due diligence, the kind of risks duty-bearers should be diligent about are usually limited to risks of 'real' and 'immediate' harm.[27]

2. The Stakes: Anticipating the Adverse Effects of Science Generally

There are many actual threats to address under the HRS. One may think here of threats to academic freedom, open access to science or indigenous knowledge, for instance. Given the pace of contemporary science, however, many of the threats we should be concerned about here and now are also emerging threats or even threats to come.

Of course, the concern over the future adverse effects of science and the need to anticipate them adequately is an *ancient one*. It led to various declarations and statements by the UN General Assembly as early as 1975.[28] The concern actually dates back to the 1940s when it was first expressed in the negotiations of the UDHR.[29] Since then, it has regularly been confirmed by UNESCO[30] and the CESCR.[31]

Back then, concerns over the adverse effects of science and the need to anticipate them as much as possible were triggered by three distinct realisations: the understanding that there could be a disjunction in practice between 'moral-social progress' and 'scientific progress';[32] a reaction to the development of 'dual-use' technology that could both benefit and harm humanity at the same time (as exemplified by nuclear energy), and, in some cases, a reaction to the 'abuse' or 'misuse' of science (as exemplified by racist biology);[33] and, last but not least, the critique of the political and legal instrumentalisation of science (as exemplified by various forms of 'scientific socialism' or the adoption of 'biological laws').[34]

Besides its long pedigree, anticipation of the adverse effects of science is also a *renewed* and *pressing* concern today. This has to do with important changes in the temporal and spatial framework of science, but also with changes in the relationship between law and science and the growing confusion between the so-called 'laws of science' and the law *tout court*.

Starting with the temporal framework of science, the pace of science has changed drastically in the last twenty years, as epitomised by fast-developing, high-risk science and technology, high-risk science that also comes with high uncertainty. The result is that new and emerging science actually merge, and so do anticipation and protection. One should also mention the changing impact of science over time as new technologies typically have more lasting consequences (including on future generations), and sometimes even irreversible ones. Think again of AI, genetic editing, but also of geo- and bio-engineering. Turning to the new spatial framework of science, secondly, science is now conducted on a global scale, thereby potentially globalising its adverse effects and the concern about them. Another related change pertains to the privatisation of science in a research-driven economy. Privatised science makes research less transparent and predictable, thereby fuelling the concern for its adverse effects.

As a matter of fact, the combination of those temporal and spatial developments has created important disparities in scientific advancement and different paces of scientific development and hence led to a certain degree of scientific polychrony. That polychrony makes the anticipation of the adverse effects of science particularly challenging.

Finally, a third development, which is related to the first two, is the emergence of what one may refer to as political and legal 'scientism'. While the instrumentalisation of science by law and politics used to be the problem, and still is to some degree, it has contributed to entrenching a reverse problem: the increasing role of science in the law[35] and, by extension, the pivotal role now played by science in the law pertaining to anticipation, including anticipation of the adverse effects of science.[36]

This is true of all regimes of domestic and international law, and especially in criminal law and in environmental law. The latest example, but not the least and one that should worry us given the fundamental role of human rights in the legal order, is the emergence of a form of scientific fundamentalism in international human rights law itself. According to this reading, the foundations of our human rights *qua* rights of human persons should be found in the latter's biology or genomics, and their interpretations should be aligned with the latest development of scientific knowledge on those issues. Think, for instance, of the increasing, albeit largely unnoticed, reference to the term human 'species' in international human rights law, instead of earlier references to the human 'person'.[37]

Importantly, the current stakes of anticipation under the HRS do not only pertain to the kind of high and lasting impact of modern science and its fast-developing pace. They also relate to the future of international human rights law itself.

Indeed, anticipation is a topic human rights lawyers should concern themselves more actively with if they do not want the doctrine of anticipation duties and due diligence merely to mirror the instrumental solutions identified in other international law regimes, such as international environmental law or international biomedical law. This is a risk that is actually being accentuated by the growing number of cases of climate change litigation before human rights courts and bodies.[38] What the lawyers and judges may resort to when arguing and deciding those cases, including the complex issues of diligent precaution and prevention duties they raise, are indeed ready-made solutions from other regimes of international law which they merely propose to transpose into human rights law. Instead, one may hope that the specificities of anticipation duties arising under the HRS contribute to stirring a deeper discussion on anticipation under (international) human rights law.[39] The time has come to turn to those specificities.

3. The Specificities: Anticipating the Beneficial and Adverse Effects of Science under the HRS

If the concern for the anticipation of the adverse effects of science has long been with us

and gained in urgency recently, the HRS presents specificities for those anticipation duties and responsibilities that need to be unpacked systematically here. The first sub-section addresses the main specificity of the HRS in terms of anticipation (3.1.). Sub-section two explores three additional characteristics of the HRS for anticipation purposes (3.2.), while sub-section three identifies two of its potential contributions that are still untapped and need to be further explored (3.3.).

3.1. The Main Specificity of the HRS in Terms of Anticipation

As alluded to earlier, the concept of anticipation is not unique to the HRS. Instead, anticipation duties and responsibilities pertaining to the risk of harm triggered by science are already well covered under international law. It is especially the case under international environmental law[40] and international biomedical law.[41]

Importantly, however, anticipation duties and responsibilities also arise under international human rights law and have been specified in that regime as well.[42] Actually, those duties have been the focus of most references to the duties to anticipate the adverse effects of science to date, and this both by UN bodies and scholars.[43] In those cases, anticipation of the adverse effects of science occurs through limits or *restrictions* to the HRS that may be justified in case of conflict with other human rights. This may occur in case of conflict between the HRS and, for instance, freedom of research, and other human rights such as, for example, the right to life, the right to health or the right to a healthy environment. In those cases, the anticipation duties and responsibilities arise under the latter rights, and not under the HRS itself. The HRS may then be restricted on that basis.

The specific anticipation duties that arise under the HRS are very different from the anticipation duties arising under other human rights, however. They do not amount to external limits to the HRS, but arise under that right itself; their objects are *objects* of the HRS. Accordingly, the main specificity of anticipation duties under the HRS is that they are not instrumental to the protection of other human rights, but are inherent to the protection of the HRS itself. The risk of harm at stake indeed does not pertain to harm to another interest and right such as life, health or privacy –although it may, of course, also do so–, but primarily to harm to the good of science itself and hence to one of the interests protected by the HRS.[44]

Of course, conflicts of rights and hence conflicts between the anticipatory duty (be it precautionary or preventive) under the HRS and other duties under the same right may arise.[45] One may think here of a conflict between the right to be protected against the

discriminatory effects of certain scientific experiments and the freedom of scientists to conduct those experiments. The resolution of such conflicts does, however, take place within the ambit of the right itself,[46] and this is what makes anticipation duties under the HRS so specific, as I will explain now.

3.2. Three Further Characteristics of the HRS in Terms of Anticipation

There are three additional specific characteristics of the anticipation duties that arise under the HRS by comparison to the duties to anticipate the adverse effects of science that arise under other human rights.

A first specificity of the HRS relates to the fact that the right is a *dualist right*: it protects at least two complementary interests, namely, the promotion of science's positive effects and the protection against its negative effects.[47] The first universal declaration of the human right to participate in science in 1948 was indeed as much a recognition of the existence of a fundamental and equal interest of all human beings in a certain kind of science, as it was a recognition of the vulnerability of that interest and of its need of protection against other kinds of science.[48]

Accordingly, anticipation duties under the HRS are both duties to identify and to promote the beneficial aspects of science, on the one hand, and duties to prevent and to protect against the adverse effects of science, on the other.[49] This means that, by contrast to what is the case of anticipation of the adverse effects of science under other human rights, anticipation under the HRS is not only negative and harm-oriented, but it is both positive and negative at the same time. What matters then is the balance between the potential beneficial and adverse effects of science when specifying the content of the HRS and that of the corresponding anticipatory duties. Again, this may of course lead to conflicts of rights and duties under the HRS, and hence to specifying conflicting anticipatory duties within the HRS itself.

A second interesting feature of the HRS for anticipation purposes pertains to the right's *participatory* dimension. The right indeed protects science as a public good[50] that is also a participatory one, and hence, as I have argued elsewhere, the right protects both individual and collective interests in participating in science.[51] This is true of all three dimensions of the HRS mentioned in the introduction: the right to participate in the scientific enterprise and its organisation *stricto sensu*, of course, but also the right to access to and to enjoy the benefits of scientific progress and the right to be protected against the adverse effects of science.

In turn, the participatory dimension of the HRS implies organising equal public participation in order to anticipate the effects of science together. This includes equal participation in the information, deliberation and decision over issues of anticipation of both the beneficial and adverse effects of science. As examples, one may mention the United Kingdom's or Australia's 'citizen juries on genome editing'[52] or, more generally, Switzerland's regular popular referenda or initiatives pertaining to research bans and moratoria, two types of participatory experiences which one may emulate elsewhere on a domestic, regional or universal plane. The participatory dimension of the HRS also requires securing enough transparency on all scientific questions, and hence more overall predictability in science and better anticipation.[53]

A third specific, and related, feature of the HRS for anticipation purposes is its *communal* dimension. The HRS does not only protect a public good and a participatory one, but also a communal one, as I have argued elsewhere. Science indeed is a kind of public good that is not only in the collective interest or right, but also amounts to a common or communal responsibility of all.[54]

The communal dimension of the HRS has two implications for the duties and responsibilities[55] to anticipate the adverse effects of science.

Domestically, first, this implies that the burden of the *responsibility* of anticipation should not only lie with the public institutional duty-bearers of the right, such as States, but also with all the members of the epistemic communities active in the scientific practice.[56] This does include the scientists, but also all of us. The communal dimension of the HRS therefore precludes leaving the responsibility of anticipation solely in the hands of the duty-bearing public authorities. However, it also, and even more importantly, precludes leaving that responsibility only in the hands of scientists, for instance in the name of expertise and of scientific complexity of the risks at stake. As a result, the legal and institutional framework for scientific anticipation under the HRS should clearly be public in the first place, but also encourage and organise further scientific self-regulation of issues of anticipation. As I have argued elsewhere, this may occur along the lines of a new form of 'social' law, law that is neither private nor public.[57] One may refer to that new body of social law as 'science law' or law pertaining to science.

Internationally, secondly, the HRS' communal dimension implies that the burden of the responsibility of anticipation should not only lie with individual States. It is rather a *collective* responsibility that should give rise to collective duties of States held together by

States, but also to collective responsibilities held together by all other institutions and subjects.[58] The importance of those collective duties and responsibilities for the human right to participate in science may actually explain the separate reference to international cooperation in Article 15(4) ICESCR itself.[59] If the proposed argument is correct, however, international 'cooperation' in the anticipation of the adverse effects of science is not only a recommendation to provide bilateral aid, but also amounts to a duty of multilateral coordination and international institution-building.[60]

Importantly, there are at least two gaps in the kind of anticipation duties one could specify under the HRS. They need to be addressed in the context of the right's reinvigoration processes. The first one pertains to the need for more intergenerational anticipation. This is no easy task in the absence of intergenerational rights in international human rights law unlike what is the case in international environmental law or international biomedical law.[61] It may, however, take the place of responsibilities to anticipate, albeit non-directed ones and ones that do not therefore correspond to actual human rights of future generations. The second gap concerns the lack of institutional framework for scientific anticipation, especially internationally. This is an important blind spot of the HRS and one that needs to be addressed urgently.[62] Some of the high-risk and high-uncertainty science addressed in this special issue is such that it can only properly be restricted through international law and institutions.

3.3. Two Additional Contributions of the HRS to Anticipation

There are two further opportunities to seize under the HRS for the future of the duties of anticipation of the adverse effects of science. They could help not only develop anticipation duties that are specific to the adverse effects of science, but also, more generally, weigh on and hopefully redirect the current debate about the content of anticipation duties under international human rights law in general.

Sadly, however, those opportunities were missed by the CESCR in its General Comment No. 25. The latter's treatment of anticipation duties and responsibilities is not only cursory and unsystematic, but it also brings together different threads from the international law of anticipation developed outside international human rights law. It does so without any concern for their justification in international human rights law or for their coherence once those different pieces are brought together.

First of all, the HRS is relevant to the future of anticipation of the adverse effects of science to the extent that it may help stall the process of quantification and proceduralisation

of anticipation and the *instrumental* cost-benefit approach to the corresponding duties that usually comes with it.

The approach to anticipation duties currently prevalent in international biomedical law and, as of late, in international human rights law, is indeed instrumental or consequentialist.[63] It relies on a 'cost and benefit' approach to harm and conceives the risks of harm as something to 'manage' in a 'maximisation' of benefits and a 'minimisation' of risks exercise.[64] Regrettably, it is also the approach that was chosen by the CESCR to conceptualise the anticipation duties arising under the HRS in its General Comment No. 25.[65]

One may criticise this prevailing approach in two respects. First, instead of treating human rights and interests as ends in themselves, this approach treats them as means one may quantify, balance with others and then maximise. Thereby, it contradicts the primary justification of human rights as a form of protection against the majority.[66] Secondly, applying such a quantitative balancing test to the anticipatory assessment of the beneficial and adverse effects of a given scientific development entrenches the already predominantly instrumental approach to science, whereas we should instead be working out how to protect science against that very kind of understanding of science. After all, this was the point of the independent human rights guarantee of the inherent value of science in 1948. Instead, the prevalent quantitative approach to anticipation of the adverse effects of science encourages the commodification of science into a set of end-products rather than approaching it as a never-ending cultural process of creation.[67]

The second potential contribution of the HRS that has not been sufficiently understood and explored so far is that it may assist us in escaping anticipatory technoscience and the self-validating *scientific* approach to anticipation duties.

As mentioned before, current duties of precaution and prevention under international law, as specified in international environmental law and international biomedical law,[68] but also lately in international human rights law, rely on a test of 'certainty' and 'foreseeability' of harm based on the current state of scientific knowledge. The same applies to the standard of due diligence where the reasonableness test is increasingly replaced by an 'impact assessment' exercise[69] that is proceduralised and technicised.[70] It is, of course, easy to understand why this may sound like an attractive move to many: it proceduralises and technicises complex normative assessments, thereby allegedly 'objectifying' or

'universalising' through science what would otherwise look 'subjective' or even 'parochial' to most.

Regrettably, this is precisely the kind of approach adopted by the CESCR in its General Comment No. 25.[71] Its definition of the precautionary principle is borrowed from the one developed by UNESCO in 2015.[72] What the CESCR fails to grasp, however, is that that definition was specified outside of an international human rights framework, on the one hand, and not specifically for the anticipation of the adverse effects of science, on the other. Transposed without adaptation into anticipation duties arising under the HRS, this principle is difficult to apply and interpret further. Not only does it bring in, without any explanation, the principle of intergenerational equity and a potentially conflicting concern for the environment, but it also defines the 'acceptability of the harm' by reference to the 'consideration of the human rights of those who are affected'. It thereby turns the latter rights and consideration for them into external and independent points of reference, while it is precisely the content of the affected people's right to science and the adequate consideration for that right that one is trying to establish when specifying those anticipation duties. This confirms once again that the kind of anticipation duties the CESCR seems to have in mind are in fact duties arising under other human rights and restricting the HRS, rather than anticipation duties grounded in the HRS itself.

More generally, what this kind of reductive scientific understanding of the international law of anticipation fails to understand is the value of legal reasoning and of reason giving in circumstances of pervasive and persistent disagreement about what it is reasonable and diligent to prevent or promote. It also ignores the value of contextualising the universal when interpreting indeterminate normative notions such as reasonable care, proportionality, dignity or equality differently in different contexts.[73]

Last but not least, applying an approach based on scientific predictability to the anticipation of the beneficial and adverse effects of science itself is clearly circular. It bases the normative assessment of the potential effects of science on a scientific assessment, i.e. that of scientific certainty. Not only does this assume the value-neutrality of science in circumstances of scientific disagreement, but it also encourages new research to provide more certainty about the risks, thereby locking in the deployment of the high-risk science at stake. All this contributes to turning 'scientific anticipation' into little more than an 'anticipation science'. It actually leads us straight back into the kind of scientific 'self-validation' criticised by Robert Merton[74] more than eighty years ago. Yet again, science (or a certain predominant form of science, at least) is in a position to determine its own ends and

value. What is new this time, however, is that it may even be in a position to use the law to do so, and not the least of legal guarantees but the most fundamental of all: a human rights guarantee.

This is a serious concern. Indeed, going down this path risks undermining the whole purpose of the independent guarantee of science as an inherent participatory good under international human rights law. Of all international lawyers, international human rights lawyers should be the ones resisting complicity in this endeavour. The cuckoo is already in the nest.

4. Overview of the Special Issue

This special issue entails eight original contributions written for the occasion. It is useful to briefly go over the articulation of those different contributions and to provide an overview of their respective content.

In his opening historical article *Codifying the Human Right to Science while Anticipating its Abuse*, William Schabas argues that anticipation of the adverse effects of science was an early concern of the drafters. The human right to science is set out in the UDHR and the ICESCR. The two texts, which were adopted consecutively, are similar but not identical. The *travaux préparatoires* indicate debate about whether the right was essentially about the freedoms of scientists or about the purposes of science, including concern about abuse. UNESCO's contribution to the UDHR was insignificant, but it had considerable influence on the text of the ICESCR. In 1950 and 1951, UNESCO issued important and influential expert statements challenging 'scientific' arguments of racial supremacists, confirming in practice its own understanding of the direction that science should take.

Moving the debate about anticipation away from the Global North's conception of science, Ro Hill's article *Anticipatory Co-Governance for Human Rights to Sciences across Knowledge Systems* argues that the interface between Indigenous and Western knowledge systems highlights the existence of diverse sciences, each with its own history, contexts and processes for validation, and with relevance to the HRS. The lens of intersectional universality helps identify how Indigenous peoples differ in important ways that affect the HRS, including through: 1) holding unique connections to territories, distinct cultures, worldviews and knowledge systems; 2) experiencing dispossession of their lands, territories and resources leading to great disadvantage in socio-economic status; 3) bearing a disproportionately high share of the negative impacts of colonial scientific practices that breach human rights; and 4) utilising Indigenous governance systems based on customary institutions for decision-

making. Human rights law requires that these institutions operate in ways that are consistent with principles of non-discrimination –the universal aspect. From this recognition of difference and sameness, the author argues that diligent anticipation of scientific risk needs to be based on recognition and support from States for the institutions that govern Indigenous sciences, on redress and reparation by relevant scientific organisations in relation to the negative impacts of colonial scientific practices and on capacity-building to overcome inequitable distribution of resources and power that results in the marginalisation of Indigenous people. Most importantly, anticipatory co-governance with Indigenous peoples at both national and international levels can empower Indigenous agency and provide a fertile ground for future thinking that will diligently anticipate risks and benefits of science and scientific progress.

In their article *Look before you Leap: Prevention and Anticipation Duties and Responsibilities under the Human Right to Science*, Yvonne Donders and Monika Plozza argue that States have an obligation to prevent harm and to anticipate the risks of harm of scientific progress and its applications. These obligations are derived from the right to be protected against the harmful effects of scientific progress and its applications, a dimension of the HRS. The duties to prevent harm are well established in existing international instruments, while the duty to anticipate the risks of harm remains obscure. The precautionary principle and due diligence can provide guidance on when and under what circumstances State obligations to anticipate risks of harm exist. Both concepts involve a necessity and proportionality test, which is also inherent to limitations under international human rights law. The prevention or anticipation of risks of harm of scientific progress and its applications may stand in conflict with other human rights or, in the context of the right to science proper, with the right to benefit from scientific progress and its applications or scientific freedom. In such cases, limitations on one right might be required to protect another, whereby the different interests protected under the HRS need to be properly balanced when undertaking limitations.

Camila Perruso's article *The Right to Science in the Context of Anticipation: An Analysis of the Obligations and Mechanisms of Economic, Social and Cultural Rights* takes a second look at the issues of the content and scope of anticipation duties under the human right to science, albeit this time from a different angle: she adopts a comparative human rights law approach to compare anticipation under the HRS with the corresponding practice of other social and cultural rights. In her article, she explores how the right to science can benefit from the anticipatory obligations and mechanisms related to anticipation under those other rights. She argues, on the one hand, for the extension of some of the obligations of prevention,

precaution and due diligence developed for other social and cultural rights to the HRS. She further identifies mechanisms capable of addressing the anticipatory, institutional dimension required to implement the HRS. Her contribution explores, on the other hand, how mechanisms such as indicators and human rights impact assessments, that have been developed and considered useful in the framework of other social and cultural rights, could also play a role in the implementation of the anticipatory aspects of the HRS.

The special issue then turns to a comparison with two other regimes of international law where anticipation duties pertaining to science are more widespread: international biomedical law and international environmental law. Two articles address those two regimes by comparison to the HRS and hence partly respond to one another.

In her article *The Human Right to Science and Anticipatory Duties under International Biomedical Law*, Rumiana Yotova assesses the interplay between international human rights law and international biomedical law as two specialised regimes within international law. The focus lies specifically on the anticipatory duties arising under the human right to benefit from science and its applications, on the one side, and under international biomedical law, on the other. International biomedical law instruments adopt a human rights-based approach to the regulation of biology and medicine, so one of the questions is whether the anticipatory duties in biomedical law are indeed a specific application of the corresponding duties in international human rights law, modified, expanded and elaborated further to better address the distinctive subject-matter, namely, the interface between the individual and science and technology in a medical context. Or should the anticipatory duties in international biomedical law draw from international environmental law and/or general international law? The main question that the article addresses concerns the precise scope and content of the anticipatory duties under international biomedical law and their relationship to human rights.

Anna-Maria Hubert's twin article *Between Scylla and Charybdis: The Implications of the Human Right to Science for Regulating the Harms and Benefits of Environmental Science and Technology* explores whether the integration of human rights approaches, in particular the HRS in Article 15(1)(b) ICESCR, potentially offers a basis for improving existing approaches in international environmental law by widening the basis for democratic input and oversight in various decisions involving environmental science and its applications. It incorporates a case study relating to the international regulation of marine geo-engineering under the 1996 Protocol (London Protocol) to the 1972 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention). The analysis focuses on how the harms and benefits of marine geo-engineering research are conceived in the London

Protocol amendment, as well as on the norms and processes that have been adopted to address them. These same issues are then examined under the HRS, focusing on the recent interpretation of the right by the CESCR in its General Comment No. 25. It seeks to show in a particular case how the different areas of international environmental law and international human rights law both bring to bear different objectives, norms and processes in how they treat issues of environmental science and technology. It also examines the potential benefits of a more integrated approach to regulating emerging applications, and some of the challenges that arise in attempting this.

In her article *Anticipation under the Human Right to Science: Sketching the Public Institutional Framework*, Amrei Müller turns to the institutional dimensions of anticipation under the human right to science. In her article, she sketches the domestic and international institutional framework that States shall set up to implement their anticipatory duties flowing from the HRS and, at the same time, that enables international institutions to comply with their anticipatory responsibilities deriving from the HRS. The example of the scientific response to the appearance of SARS-CoV-2 in late 2019 is used to concretise the proposed institutional structure, including by highlighting the shortcomings of the current framework.

With the same institutional focus, this special issue closes with Helle Porsdam and Sebastian Porsdam Mann's article *Anticipation and Diplomacy (with)in Science: Activating the Right to Science for Science Diplomacy*. In their contribution, they argue that a hitherto underappreciated aspect of science diplomacy –diplomacy (with)in science– has significant potential to complement the anticipatory approaches to science discussed in the issue by furthering the same goals: addressing the negative impacts of scientific and technological developments and facilitating their benefits. The authors relate the concept of diplomacy (with)in science to the normative framework of the right to science under international human rights law and develop and motivate it further by illustrating two potential areas for its application.

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1 International Covenant on Economic, Social and Cultural Rights, New York, 16 December 1966, *United Nations Treaty Series*, vol. 993, p. 3.

2 See e.g. UNESCO, *Venice Statement on the Rights to Enjoy the Benefits of Scientific Progress and its Applications (art. 15 (1) (b) ICESCR)*, 17 July 2009, available from https://www.aaas.org/sites/default/files/VeniceStatement_July2009.pdf, §14(a)(b), §14(c) ('protection *from abuse and adverse effects of science and its applications*') (emphasis added), §16(c) ('monitor the potential

harmful effects of science and technology') (emphasis added); UN Human Rights Council (HRC), *Report of the Special Rapporteur in the field of cultural rights, Ms Farida Shaheed, on the 'Right to Enjoy the Benefits of Scientific Progress and its Applications'*, UN Doc. A/HRC/20/26 (12 May 2012), available from https://www.ohchr.org/en/special-procedures/sr-cultural-rights/right-benefit-scientific-progress-and-its-applications, §9 et seq., §43, §74(h) ('provide opportunities for all to make informed decisions after considering both the possible improvements and potentially *harmful side effects or dangerous usages of scientific advances*') (emphasis added), §74(m) ('protect all individuals against *any harmful effects of the misuse of scientific and technological developments*') (emphasis added). See also, albeit less specifically, UN Committee on Economic, Social and Cultural Rights (CESCR), *Guidelines on Treaty-Specific Documents to be Submitted by States Parties under Articles 16 and 17 of the International Covenant on Economic, Social and Cultural Rights*, UN Doc. E/C.12/2008/2 (24 March 2009), available from https://undocs.org/en/E/C.12/2008/2, §70; CESCR General Comment No. 25, *Science and economic, social and cultural rights (art. 15(1)(b), (2), (3) and (4))*, UN Doc. E/C.12/GC/25 (30 April 2020), available from https://undocs.org/E/C.12/GC/25, §6, §11, §75; CESCR General Comment No. 17, *The right of everyone to benefit from the protection of the moral and material interests resulting from any scientific, literary or artistic production of which he or she is the author (art. 15 (1) (c) ICESCR)*, UN Doc. E/C.12/GC/17 (12 January 2006), available from https://undocs.org/E/C.12/GC/17, §35. See also Audrey R. Chapman, 'Towards an Understanding of the Right to Enjoy the Benefits of Scientific Progress and Its Applications', *Journal of Human Rights* 8, no. 1 (2009): 1–36; William A. Schabas, 'Looking Back: How the Founders Considered Science and Progress in Their Relation to Human Rights', *European Journal of Human Rights*, Special issue on the Human Right to Science, 4 (2015): 504–18.

3 Especially CESCR General Comment No. 25, §53, §56–7, §71, §72–6.

4 See e.g. Samantha Besson, 'The "Human Right to Science" *qua* Right to Participate in Science: The Participatory Good of Science and Its Human Rights Dimensions', *International Journal of Human Rights*, 2023, forthcoming; Andrea Boggio, 'The Right to Participate In and Enjoy the Benefits of Scientific Progress and Its Applications: A Conceptual Map', *New York International Law Review* 34, no. 2 (2021): 43–77; Helle Porsdam and Sebastian Porsdam Mann, eds., *The Right to Science: Then and Now* (Cambridge: Cambridge University Press, 2021); Rumiana Yotova and Bartha M. Knoppers, 'The Right to Benefit from Science and Its Implications for Genomic Data Sharing', *European Journal of International Law* 31, no. 2 (2020): 665–91; Sebastian Porsdam Mann, Helle Porsdam, and Yvonne Donders, 'Sleeping Beauty: The Right to Science as a Global Ethical Discourse', *Human Rights Quarterly* 42, no. 2 (2020): 332–56; Andrea Boggio and Cesare P. R. Romano, 'Freedom of Research and the Right to Science', in *The Freedom of Scientific Research*, ed. Simona Giordano, John Harris, and Lucio Piccirillo (Manchester: Manchester University Press, 2020), 162–75; Samantha Besson, 'The Human Right to Science: Mapping the Issue', *European Journal of Human Rights*, Special Issue on the Human Right to Science, 4 (2015): 403–10; Lea Shaver, 'The Right to Science: Ensuring That Everyone Benefits from Scientific and Technological Progress', *European Journal of Human Rights*, Special Issue on the Human Right to Science, 4 (2015): 411–30; Jessica M. Wyndham and Margaret Weigers Vitullo, 'The Right to Science Whose Right? To What?', *European Journal of Human Rights*, Special Issue on the Human Right to Science, 4 (2015): 431–61; Samantha Besson, 'Science without Borders and the Boundaries of Human Rights – Who Owes the Human Right to Science?', *European Journal of Human Rights*, Special Issue on the Human Right to Science, 4 (2015): 462–85; Yvonne Donders, 'Balancing Interests: Limitations to the Right to Enjoy the Benefits of Scientific Progress and Its Applications', *European Journal of Human Rights*, Special Issue on the Human Right to Science, 4 (2015): 486–503; Schabas, 'Looking Back'; Eibe Riedel, 'Sleeping Beauty or Let Sleeping Dogs Lie? The Right of Everyone to Enjoy the Benefits of Scientific Progress and Its Applications (REBSPA)', in *Coexistence, Cooperation and Solidarity: Liber Amicorum Rüdiger Wolfrum*, ed. Holger P. Hestermeyer et al. (Leiden: Brill/Nijhoff, 2012), 503–21; Lea Shaver, 'The Right to Science and Culture', *Wisconsin Law Review* 1 (2010): 121–84; Amrei Müller, 'Remarks on the Venice Statement on the Right to Enjoy the Benefits of Scientific Progress and Its Applications (Article 15(1)(b) ICESCR)', *Human Rights Law Review* 10, no. 4 (2010): 765–84; Chapman, 'Towards an Understanding'; Richard P. Claude, 'Scientists' Rights and the Human Right to the Benefits of Science', in *Core Obligations: Building A Framework for Economic, Social and Cultural Rights*, ed. Audrey R. Chapman and Sage Russell (Antwerp/Oxford/New York: Intersentia, 2002), 247–78.

5 UN General Assembly Resolution 3384 (XXX), *Declaration on the Use of Scientific and Technological* Progress *in the Interests of Peace and for the Benefit of Mankind*, UN Doc. A/RES/30/3384 (10 November 1975), available from http://www.un-documents.net/a30r3384.htm.

6 UNESCO, *Recommendation on Science and Scientific Researchers* (1974 Revised Text), UNESCO Doc. 41 C/36 (13 November 2017), available from https://unesdoc.unesco.org/ark:/48223/pf0000260889.page=116.

7 UNESCO, *Declaration on Science and the Use of Scientific Knowledge*, UNESCO Doc. 30 C/15 (1 July 1999), available from https://unesdoc.unesco.org/ark:/48223/pf0000116994; UNESCO, *Universal Declaration on Bioethics and Human Rights*, UNSECO Doc. 33 C/Res. 15 (19 October 2005), available from https://unesdoc.unesco.org/ark:/48223/pf0000180371.

8 UNESCO, *Venice Statement*.

9 UN HCR, *2012 Report*; UN HCR, *Report of the Special Rapporteur in the field of cultural rights, Ms Farida Shaheed, on 'copyright policy and the right to science and culture'*, UN Doc. A/HRC/28/57 (24 December 2014), available from https://digitallibrary.un.org/record/792652.

10 CESCR General Comment No. 25. That comment closed the sequel initiated by the publication of two earlier general comments on the other two rights protected by Article 15(1) ICESCR: CESCR General Comment No. 21, *The right of everyone to take part in cultural life (art. 15 (1) (a) ICESCR)*, UN Doc. E/C.12/GC/2121 (21 December 2009), available from https://digitallibrary.un.org/record/679354; CESCR General Comment No. 17.

11 See CESCR General Comment No. 25, §2. For a first survey of that practice, see Yotova and Knoppers, 'The Right to Benefit from Science and Its Implications for Genomic Data Sharing', 677–85.

12 For a full argument, see Besson, 'The "Human Right to Science"', 2023. See also Chapman, 'Towards an Understanding'.

13 UN General Assembly Resolution 217 A (III), *Universal Declaration of Human Rights*, UN Doc. A/RES/217 A (III) (10 December 1948), available from https://documents-dds-ny.un.org/doc/RESOLUTION/GEN/NR0/043/88/PDF/NR004388.pdf?OpenElement, Article 27: 'Everyone has *the right* freely to participate in the cultural life of the community, to enjoy the arts and *to share in scientific advancement and its benefits*.' (emphasis added).

14 ICESCR, Article 15: '1. The States Parties to the present Covenant recognize the right of everyone: (a) To take part in cultural life; (b) *To enjoy the benefits of scientific progress and its applications*; (c) To benefit from the protection of the moral and material interests resulting from any scientific, literary or artistic production of which he is the author. 2. The steps to be taken by the States Parties to the present Covenant to achieve the full realization of this right shall include those necessary for the conservation, the development and the diffusion of science and culture. 3. The States Parties to the present Covenant undertake to respect the freedom indispensable for scientific research and creative activity. 4. The States Parties to the present Covenant recognize the benefits to be derived from the encouragement and development of international contacts and co-operation in the scientific and cultural fields.' (emphasis added).

15 On this term, see Porsdam Mann, Porsdam and Donders, 'Sleeping Beauty'; Riedel, 'Sleeping Beauty or Let Sleeping Dogs Lie?'

16 See Besson, 'The "Human Right to Science"', 2023.

17 See for a full argument, Besson, 'The "Human Right to Science"', 2023. For a confirmation, see also CESCR General Comment No. 25, §11: 'The right enshrined in article 15(1)(b) encompasses not only a right to receive the benefits of the applications of scientific progress, but also a right to participate in scientific progress. Thus, it is the *right to participate in and to enjoy the benefits of scientific progress and its applications*.' (emphasis added).

18 See my Swiss National Science Foundation Research Project entitled '*Institutionalizing the Human Right to Science*' (2022-25).

19 See Robert K. Merton, 'The Normative Structure of Science', in *The Sociology of Science* (Chicago: University of Chicago Press, 1982), 268: '[...] A tower of ivory becomes untenable when its walls are under prolonged assault. After a long period of relative security, during which the pursuit and diffusion of knowledge had risen to a leading place if indeed not to the first rank in the scale of cultural values, scientists are compelled to vindicate the ways of science to man. Thus they have come full circle to the point of the reemergence of science in the modern world. Three centuries ago, when the institution of science could claim little independent warrant for social support, natural philosophers were likewise led to justify science as a means to the culturally validated ends of economic utility and the glorification of God. The pursuit of science was then no self-evident value. With the unending flow of achievement, however, instrumental was transformed into the terminal, means into the end. Thus fortified, scientist came to regard himself as independent of society and to consider science as a self-validating enterprise which was in society but not of it. A frontal assault on the autonomy of science was required to convert this sanguine isolationism into realistic participation in the revolutionary conflict of cultures. The joining of the issue has led to a clarification and reaffirmation of the ethos of modern science.'

20 Ulrich Beck, *Risk Society: Towards a New Modernity* (London/Newbury Park/Calif: Sage Publications, 1992).

21 See Mireille Delmas-Marty, *Résister, responsabiliser, anticiper, ou, comment humaniser la mondialisation* (Paris: Seuil, 2013).

22 On the latter, see Samantha Besson, *La due diligence en droit international*, Collected courses of the Hague Academy of International Law (vol. 409) (Leiden/Boston: Brill/Nijhoff, 2020), §60–85. For an English version of the book, see Samantha Besson, *Due Diligence in International Law* (Leiden/Boston: Brill/Nijhoff, 2023).

23 On the relationship between those three dimensions in international environmental law, see Besson, *La Due Diligence*, §432.

24 On that continuum, see International Law Association (ILA) Resolution 2/2014, *Declaration of Legal Principles Relating to Climate Change*, 7-11 April 2014, available from https://www.ila-hq.org/en_GB/documents/conference-resolution-no-2-english-washington-2014, Article 7A, Article 7B. See also Gerhard Hafner and Isabelle Buffard, 'Obligations of Prevention and the Precautionary Principle', in *The Law of International Responsibility*, ed. James Crawford et al., Oxford Commentaries on International Law (New York: Oxford University Press, 2010), 521–34.

25 On the conditions of due diligence, see Besson, *La Due Diligence*, §199–206.

26 On the variability of due diligence in general, see Besson, *La Due Diligence*, §247–77.

27 On the variability of due diligence in international human rights law, see Besson, *La Due Diligence*, §531–3.

28 See e.g. UN General Assembly Resolution 3384 (XXX), §2: 'All States shall take *appropriate measures to prevent the use of scientific and technological developments, particularly by the State organs, to limit or interfere with the enjoyment of the human rights and fundamental freedoms of the individual* as enshrined in the Universal Declaration of Human Rights, the International Covenants on Human Rights and other relevant international instruments.' (emphasis added).

29 See William Schabas, 'Codifying the Human Right to Science while Anticipating its Abuse', in this special issue; Schabas, 'Looking Back'.

30 See UNESCO, *Venice Statement*, §14(a) ('The duty to respect should include: a) to 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 human person by third parties*') (emphasis added), §14(d) ('[…] to take appropriate measures to prevent the use of science and technology *in a manner that could limit or interfere with the enjoyment of the human rights and fundamental freedoms*') (emphasis added). See also UNESCO, *1974/2017 Recommendation*, preamble: '*Recognizing* that: (a) scientific discoveries and related technological developments and applications *open up vast prospects for progress* made possible in particular by the optimum utilization of science and scientific methods for the benefit of humankind and for the preservation of peace and the reduction of international tensions but *may, at the same time, entail certain dangers which constitute a threat*, especially in cases where the results of scientific research are used against humankind's vital interests in order to prepare wars involving destruction on a massive scale or for purposes of the exploitation of one nation by another, or to the detriment of human rights or fundamental freedoms or the dignity of a human person, and in any event give rise to complex ethical and legal problems.' (emphasis added).

31 See CESCR General Comment No. 17, §35: '[…] States parties should *prevent the use of scientific and technical progress for purposes contrary to human rights and dignity*, including the rights to life, health and privacy, e.g. by excluding inventions from patentability whenever their commercialization would jeopardize the full realization of these rights.' (emphasis added). See also CESCR General Comment No. 25, §6: '[…] Thus, the development of *science in the service of peace and human rights* should be prioritized by States over other uses.' (emphasis added).

32 See Chapman, 'Towards an Understanding'.

33 See Porsdam Mann, Porsdam, and Donders, 'Sleeping Beauty'.

34 See Hannah Arendt, *The Origins of Totalitarianism* (New York: Harcourt Brace Jovanovich, 1973), 350.

35 With the encouragement of the CESCR lately: see e.g. CESCR General Comment No. 25, §72.

36 See Besson, *La Due Diligence*, §132, §228–31, §277, §417.

37 See Bartha M. Knoppers and Henry T. Greely, 'Biotechnologies Nibbling at the Legal "Human"', *Science* 336, no. 6472 (2019): 1455–57.

38 See e.g. Benoit Mayer, 'Climate Change Mitigation as an Obligation Under Human Rights Treaties?', *American Journal of International Law* 115, no. 3 (2021): 409–51.

39 For a presentation of each regime and a comparison, see Rumiana Yotova, 'The Human Right to Science and Anticipatory Duties under International Biomedical Law', in this special issue; Anna-Maria Hubert, 'Between Scylla and Charybdis: The Implications of the Human Right to Science for Regulating the Harms and Benefits of Environmental Science and Technology', in this special issue.

40 See Hubert, 'Between Scylla and Charybdis', in this special issue; Anna-Maria Hubert, 'The Human Right to Science and Its Relationship to International Environmental Law', *European Journal of International Law* 31, no. 2 (2020): 625–56; Elisa Morgera, 'Fair and Equitable Benefit-Sharing at the Cross-Roads of the Human Right to Science and International Biodiversity Law', *Laws* 4, no. 4 (2015): 803–31.

41 See Yotova, 'The Human Right to Science and Anticipatory Duties under International Biomedical Law', in this special issue; Yotova and Knoppers, 'The Right to Benefit from Science and Its Implications for Genomic Data Sharing'.

42 See Camila Perruso, 'The Right to Science in the Context of Anticipation. An Analysis of the Obligations and Mechanisms of Economic, Social and Cultural Rights', in this special issue.

43 See e.g. CESCR, *2009 Guidelines*, §70(b) ('the measures taken *to prevent the use of scientific and technical progress for purposes which are contrary to the enjoyment of human dignity and human rights*.') (emphasis added); CESCR General Comment No. 17, §35. For a recent confirmation, see CESCR General Comment No. 25, §56.

See also Yvonne Donders and Monika Plozza, 'Look before you Leap: Prevention and Anticipation Duties and Responsibilities under the Human Right to Science', in this special issue.

44 See Besson, 'The "Human Right to Science"', 2023.

45 On human rights conflicts in general, see Samantha Besson, 'Human Rights in Relation: A Critical Reading of the ECtHR's Approach to Conflicts of Rights', in *When Human Rights Clash at the European Court of Human Rights: Conflict or Harmony?*, ed. Stijn Smet and Eva Brems (Oxford: Oxford University Press, 2017), 23–37.

46 See Besson, 'The "Human Right to Science"', 2023. See also, albeit from a strictly democratic perspective, Zeynep Pamuk, 'Dangerous Science and the Limits of Free Inquiry', in *Politics and Expertise. How to use science in a democratic society* (Princeton: Princeton University Press, 2021), 161–84; Zeynep Pamuk, 'Risk and Fear: Restricting Science under Uncertainty', *Journal of Applied Philosophy* 38, no. 3 (2021): 444–60.

47 On the dualist dimension of the HRS, see UN HCR, *2012 Report*, §43; CESCR General Comment No. 17, §35; CESCR, *2009 Guidelines*, §70. See also CESCR General Comment No. 25, §6, §74 ('States parties have to adopt policies and measures that *expand the benefits* of these new technologies while at the same time *reducing their risks*.') (emphasis added), §57 ('The precautionary principle should not hinder and prevent scientific progress, which is *beneficial for humanity*. Nonetheless, it should be able to address available *risks for human health and the environment, inter alia*.') (emphasis added).

48 See Besson, 'The "Human Right to Science"', 2023. See also Christopher G. Weeramantry, 'The Problems, the Project, and the Prognosis', in *Human Rights and Scientific and Technological Development: Studies on the Affirmative Use of Science and Technology for the Furtherance of Human Rights*, ed. Christopher G. Weeramantry (New York: United Nations University Press, 1990); Chapman, 'Towards an Understanding'; Schabas, 'Looking Back'; Schabas, 'Codifying the Human Right to Science while Anticipating its Abuse', in this special issue. Note that I am not distinguishing here between the 'science' itself and its later 'uses' or 'applications'. It is very difficult to do so, indeed, especially in areas of research that purport to be applied and used eventually. So, scientific knowledge itself may be considered to be able to harm as much as to benefit once it is applied and hence may be restricted with regard to that harm to come or risk of harm. Of course, this is not a matter of the scientists themselves knowing or foreseeing their research will harm or benefit, but of the human right duty-bearing State(s) only. As a result, we are not only considering cases of direct harming or benefiting by scientists in the course of the research, for instance through medical experiments.

49 See also Boggio, 'The Right to Participate in and Enjoy the Benefits of Scientific Progress and Its Applications: A Conceptual Map', 49.

50 On science as a public good, see e.g. Shaver, 'The Right to Science and Culture'; Besson, 'The "Human Right to Science"', 2023.

51 Besson, 'The "Human Right to Science"', 2023, by reference to Denise G. Réaume, 'Individuals, Groups, and Rights to Public Goods', *University of Toronto Law Journal* 38, no. 1 (1988): 10–11.

52 See e.g. 'Global Citizens' Assembly on Genome Editing: Connecting Citizens, Science and Global Governance', *Global Citizens' Assembly on Genome Editing* (blog), n.d., available from https://www.globalca.org/.

53 See CESCR General Comment No. 25, §56–7: '56. Participation also includes the *right to information and participation in controlling the risks* involved in particular scientific processes and its applications. […] 57. […] Thus, in controversial cases, *participation and transparency become crucial because the risks and potential of some technical advances or some scientific research should be made public in order to enable society, through informed, transparent and participatory public deliberation, to decide whether or not the risks are acceptable*.' (emphasis added).

54 See Besson, 'The "Human Right to Science"', 2023.

55 On the distinction between the human rights 'duties' of the States of jurisdiction and the 'responsibilities' for human rights of all other institutions and individual or collective subjects to cooperate and assist States in complying with their (jurisdictional) duties under international human rights law, see Samantha Besson, 'The Bearers of Human Rights Duties and Responsibilities for Human Rights – A Quiet (R)Evolution', *Social Philosophy and Policy* 32, no. 1 (2015): 244–68. For an application to the HRS, see Besson, 'The Human Right to Science', 2015.

56 See Besson, 'The "Human Right to Science"', 2023.

57 See Besson, 'The "Human Right to Science"', 2023.

58 See Besson, 'The Human Right to Science', 2015; Besson, 'The "Human Right to Science"', 2023.

59 See e.g. UN HRC, *2012 Report*, §68. See also CESCR General Comment No. 25, §52. See also Müller, 'Remarks on the Venice Statement on the Right to Enjoy the Benefits of Scientific Progress and Its Applications (Article 15(1)(b) ICESCR)', 781–82.

60 See e.g. CESCR General Comment No. 25, §74: '[...] Nevertheless, there are no easy solutions given the varied nature of these new technologies and their complex effects. The Committee will therefore constantly monitor the impact of these new technologies on the enjoyment of economic, social and cultural rights. For the Committee, three elements remain very important: firstly, *international cooperation*

should be enhanced in this field as these technologies need *global regulations* in order to be effectively managed.' (emphasis added).

61 See Yotova, 'The Human Right to Science and Anticipatory Duties under International Biomedical Law', in this special issue.

62 See Christopher G. Weeramantry, 'Conclusions and Recommendations', in *Human Rights and Scientific and Technological Development: Studies on the Affirmative Use of Science and Technology for the Furtherance of Human Rights*, ed. Christopher G. Weeramantry (New York: United Nations University Press, 1990); Besson, 'The Human Right to Science', 2015. See also Amrei Müller, 'Anticipation under the Human Right to Science: Sketching the Public Institutional Framework', in this special issue.

63 See Yotova, 'The Human Right to Science and Anticipatory Duties under International Biomedical Law, in this special issue; Hubert, 'Between Scylla and Charybdis', in this special issue.

64 See Besson, *La Due Diligence*, §273, §436.

65 See e.g. CESCR General Comment No. 25, §74, §56.

66 See Samantha Besson, 'Human Rights and Justification: A Reply to Mattias Kumm', in *Human Rights: Moral or Political?*, ed. Adam Etinson, vol. 1 (Oxford: Oxford University Press, 2019), 262–68.

67 See Besson, 'The "Human Right to Science"', 2023, by reference to Réaume, 'Individuals, Groups, and Rights to Public Goods', 10, 15: 'there is no end product because, in a sense, [participatory goods] are never completed, but are continuously reinterpreted and re-created by each generation'. See also Michela Massimi, 'A Human Rights Approach to Scientific Progress: The Deontic Framework', in *New Philosophical Perspectives on Scientific Progress*, ed. Yafeng Shan (New York/London: Routledge, 2022), 392–412.

68 See Yotova, 'The Human Right to Science and Anticipatory Duties under International Biomedical Law, in this special issue; Hubert, 'Between Scylla and Charybdis', in this special issue.

69 On those assessments, see Perruso, 'The Right to Science in the Context of Anticipation. An Analysis of the Obligations and Mechanisms of Economic, Social and Cultural Rights', in this special issue.

70 See Besson, *La Due Diligence*, §223 et seq., §233.

71 See CESCR General Comment No. 25, §56: '[…] In this context, the precautionary principle plays an important role. *This principle demands that, in the absence of full scientific certainty, when an action or policy may lead to unacceptable harm to the public or the environment, actions will be taken to avoid or diminish that harm. Unacceptable harm includes harm to humans or to the environment that is: (a) threatening to human life or health; (b) serious and effectively irreversible; (c) inequitable to present or future generations; or (d) imposed without adequate consideration of the human rights of those affected.* Technological and *human rights impact assessments* are tools that help to identify potential risks early in the process and the use of scientific applications.' (emphasis added).

72 See UNESCO and World Commission on the Ethics of Scientific Knowledge and Technology (COMEST), 'The Precautionary Principle' (Paris: UNESCO, March 2005), available from https://unesdoc.unesco.org/ark:/48223/pf0000139578.

73 See Besson, *La Due Diligence*, §555.

74 Merton, 'The Normative Structure of Science', 268.