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RESEARCH HANDBOOK ON

Law, Governance and Planetary Boundaries

Edited by

Duncan French • Louis J. Kotzé

RESEARCH HANDBOOKS IN ENVIRONMENTAL LAW

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RESEARCH HANDBOOKS IN ENVIRONMENTAL LAW

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Edward Elgar PUBLISHING

Cheltenham, UK • Northampton, MA, USA

Cover image: Duncan French, Unmarked Path across Unsown Field, Aston, Sheffield, UK

Published by
Edward Elgar Publishing Limited
The Lypiatts
15 Lansdown Road
Cheltenham
Glos GL50 2JA
UK

Edward Elgar Publishing, Inc.
William Pratt House
9 Dewey Court
Northampton
Massachusetts 01060
USA

A catalogue record for this book
is available from the British Library

Library of Congress Control Number: 2020950939

This book is available electronically in the Elgaronline
Law subject collection
http://dx.doi.org/10.4337/9781789902747

ISBN 978 1 78990 273 0 (cased)
ISBN 978 1 78990 274 7 (eBook)

There comes a time when humanity is called to shift to a new level of consciousness ... that time is now.
Wangari Maathai (Nobel Peace Prize Winner, 2004)

At times I suffer from the strangest sense of detachment from myself and the world about me; I seem to watch it all from the outside, from somewhere inconceivably remote, out of time, out of space, out of the stress and tragedy of it all.
H.G. Wells, *The War of the Worlds* (1897)

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Foreword

Fundamentally, a framework such as planetary boundaries is inevitable – a necessity if we want to successfully navigate our future through the rising risk landscape of the Anthropocene. For millennia, humans exploited the environment and advanced societies, agriculture and in due course modern industry, while still remaining a relatively small world on a big planet. Sure, we experienced local and regional environmental problems, even collapse, but these never caused impacts at the Earth system scale – until we entered the Anthropocene in the 1950s, exponentially raising the human pressures on all Earth systems: from species loss, to overuse of water, degradation of land, eutrophication of water ways, depletion of the stratospheric ozone layer, to destabilising the climate system. And it was not until we were several decades into the Anthropocene that we started seeing signs of having reached a saturation point. We saw the first signs of hitting the biophysical ceiling of the capacity of the planet to uphold life support systems. We enter the new millennium with a novel scientific insight: we as humanity are at risk of destabilising the entire planet, thereby undermining the ability to support future generations on Earth.

The planetary boundaries framework is the natural, expected next step in the advancement of Earth system science, when laying all the evidence of rising global systemic risks on the table. We have no choice. To navigate our future in the Anthropocene, we need to scientifically define a safe operating space for a stable and resilient planet that can support human development in the twenty-first century and beyond.

Science is but one piece of the puzzle in achieving equity and prosperity for all on Earth. For too long, we have believed that the economy can, with gentle nudging from economic policies such as carbon taxes, solve environmental damage. It cannot do it alone, and it is here, I believe, that normative values and regulations which translate into law are a very powerful and important part of the solution. To be sure, law is critically important today, as we need legal 'rules of the game' of how to govern all planetary boundaries as a global community, while at the same time protecting the rights of individuals and local communities everywhere on Earth.

The need for a comprehensive volume on law, governance and planetary boundaries is long overdue; in fact, there is an urgent need to truly connect Earth system science, law and governance, to create legal planetary boundary frameworks, across all scales of jurisdiction in the world, which can accelerate transformations to provide a safe and just future for all human beings on our small planet.

Johan Rockström
Professor of Earth System Science, University of Potsdam
Director, Potsdam Institute for Climate Impact Research, Germany

Preface

It was a weekend road-trip around Wales, in part to mark our completion of a previously jointly edited collection – *Sustainable Development Goals: Law, Theory & Implementation* (Edward Elgar 2018) – which prompted the first initial thoughts for this project. While driving around South Wales we reflected on the multilateral nature of the Sustainable Development Goals, the innate political choices behind them, that multilateralism is often a shallow form of universalism and that although sustainable development is premised upon an integration of social, ecological and economic considerations at a project (or even programmatic) level, ultimately for development to be sustainable, it must also recognise the meta-ecological realities in which it occurs.

It was but a short step – if step is an appropriate metaphor in a car – from discussing the limits of multilateralism and the constraints of current international environmental law to considering the planetary boundaries approach developed out of the Stockholm Resilience Centre. Though recognising the inevitable social scientific scepticism of anything being presented, or otherwise considered, as objective, there was something appealing – if idealistic – in building normative regimes (or setting their objectives) around the fundamentally common-sensical premise of keeping humanity within the safe operating space of the planet. We, along with several lawyers, had been struck by the failure of many environmental rules to curtail ongoing degradation in almost all fields of our (sub-)discipline. Might there be some value in re-analysing what the law should be or, even more pertinently, *must become* in light of what the planet could safely bear, especially now that we were so obviously entering the Anthropocene? Even in the two years since we have started this project, the evidence for this has become more stark.

Of course, what invariably starts as idealistic and normative on a road-trip rightly becomes analytical and critical when further refined; so this peer-reviewed edited collection, we hope, demonstrates. We of course disregard neither the possibility that the planetary boundaries approach could – and should – prompt normative change, nor that law will have to play an increasingly important role in helping humanity to respect the planetary boundaries. But the relationship between them is not beyond contention. As both the introduction and many of the chapters indicate, there are invariably debates around what has been included, what has been omitted and how thresholds and boundaries have been set, measured and monitored. Nevertheless, as a framework for evaluating why law continues – almost entirely – to grapple inadequately with the most serious socio-ecological issues at a planetary scale, there is currently no better lens, we would argue, by which to consider current and putative legal developments. If law is unable to fully confront the myriad regulatory challenges flowing from the planetary boundaries, the past 50 years of innovation in law will have been in vain; we then must adapt to a life that is, by definition, inhospitable.

This motif of the road-trip, mirrored also by the image of the path on the front cover – a photo taken by Duncan – seems particularly pertinent. It reflects both the assumed linear progression that much of humanity remains convinced is its path, while simultaneously recognising the narrowness of the choices which humanity increasingly faces. The path, in particular, with limited vegetation on either side is a stark reminder of the risks we all face if we do not curtail our excesses and stick within those circumscribed limits which, in the language of the planetary boundaries approach, offer us a 'safe operating space'. The image is also a stark reminder of humanity's increasing isolation from other living beings and its self-inflicted desolation and vulnerability as a result of our Promethean arrogance as it plays out on our home, planet Earth. How can we escape our own folly, if not seemingly inescapable subjugation to nature's tyranny?[1]

As lawyers, we are particularly interested in the underexplored role of law in, and its contribution to, keeping humanity within the planetary boundaries' safe operating space. By drawing on the rich and diverse insights of leading law and governance scholars from around the world, the volume has been a group effort in so many ways. The completion of this project came at the height of the COVID-19 pandemic, and it is with admiration for – and immense gratitude to – the contributors that we managed to complete the project while we were all, at various stages, in lockdown and trying to find reassurance in the seemingly chaotic new normal. This was for all – and for many (as we write this) it continues to be – a hugely challenging time. It was also a time that highlighted the interconnectedness (and also the fragility) of the human family, while paradoxically – certainly in early 2020 as many countries were in 'lockdown' – it also indicated what it might take, and what it could mean, for humanity to decelerate the human development project in a time of socio-ecological decay.

We remain grateful to Ben Booth and Laura Mann of Edward Elgar, who have supported and sustained us, as they always do. We are also immensely grateful to Dr Gabriel Lopez Porras, Research Fellow in Earth System Law at Lincoln Law School, University of Lincoln, United Kingdom, for helping us finalise the manuscript before final submission. Finally, we wish to thank the anonymous peer reviewers for their constructive comments, which we believe further enriched this volume.

Duncan dedicates this book to his partner Alec, and Louis to his godchildren Christoff and Georg, the future generation.

Duncan (Sheffield) and Louis (Heidelberg), June 2020

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1 We recognise, at this point, that we are purposely challenging, if not subverting, Thomas Paine's belief that science would come to master the tyranny of nature (Thomas Paine, *The Age of Reason* (1794–1807)): 'The Almighty Lecturer, by displaying the principles of science in the structure of the universe, has invited man to study and to imitation. It is as if He had said to the inhabitants of this globe, that we call ours, "I have made an earth for man to dwell upon, and I have rendered the starry heavens visible, to teach him science and the arts. He can now provide for his own comfort, AND LEARN FROM MY MUNIFICENCE TO ALL, TO BE KIND TO EACH OTHER."'

'The planetary boundaries concept provides an ideal framework for connecting science with law at the global level. This book explores this connection in great detail, from our undeniable need for limits and the fundamental concepts of ethics, justice and governance to the comprehensive assessment of the legal implications of each of the individual boundaries.'
Will Steffen, The Australian National University, Australia

'Co-edited by Duncan French and Louis Kotzé – two of the foremost scholars in the field of environmental law in the era of the Anthropocene – this Research Handbook *is the first comprehensive attempt to investigate, from a legal perspective, the human dimensions of scientific concepts of planetary boundaries. The book brings together a fascinating series of contributions from some of the leading legal thinkers in the field. At a time when raging fires and other "unprecedented" environmental disasters are providing increasing evidence of the consequences of failing to respect planetary limits, this book is a timely and important reminder of the contribution that can be made by law in ensuring that humanity and our environment remain within the planet's "safe operating space".'*
Jacqueline Peel, University of Melbourne, Australia

'If international environmental law is to stay relevant in the face of overwhelming evidence of its inability to address the galloping environmental harms humanity is witnessing, it needs to embrace a fundamental reset of its premises, conceptual pillars, and governance models. Such a reset requires imagination – imagination that is outrageous in its ambition and fuelled by outrage. This Research Handbook*, edited by two of the finest international environmental law scholars of our time, Duncan French and Louis Kotzé, is a work of such outrageous imagination. It challenges legal boundaries in its quest to protect planetary ones, and in so doing takes us closer to law and governance fit for environmental purpose.'*
Lavanya Rajamani, University of Oxford, United Kingdom

'In the last two decades, a growing body of transdisciplinary research has brought to light the immense impact of certain human processes not just on "history" but on the Earth system. Yet, lawyers and legal researchers have remained conspicuously absent from this major effort, despite the very significant role that legal organisations play in enabling and, we must hope, controlling such impact. This ground-breaking volume fleshes out, for the first time, what law means for the Earth-shaping human processes that have come to characterise our epoch, the Anthropocene.'
Jorge Viñuales, University of Cambridge, United Kingdom

'A comprehensive, nuanced and expert examination of how international environmental law and governance should reflect the planetary boundaries that we are rapidly approaching or have already begun to violate, this volume could not be more timely. With interdisciplinary contributions from scholars in a wide variety of fields, the book is both an introduction of the concept of planetary boundaries to those who are not familiar with it, and a detailed exploration of its legal ramifications. It will be a foundational text for all future work in this area.'
John Knox, Wake Forest University School of Law, United States of America, and former United Nations Special Rapporteur on Human Rights and the Environment

'Duncan French and Louis Kotzé have assembled a must-read primer for anyone researching the legal context to the planet's environmental boundaries under unprecedented stress. Read this book for an accessible, insightful and comprehensive account from some of the world's foremost scholars of environmental law.'

Benjamin J. Richardson, University of Tasmania, Australia

'This collection is a profound and deep meditation by an esteemed panel of authors on the role of law at a time of extreme risk and uncertainty. As the planet's capacity to uphold life support systems becomes increasingly tenuous, the law is invoked to provide the normative and regulatory frameworks to constrain human behaviour. By reflecting on law as an instrument of governance, the authors question how to facilitate a convergence between planetary and legal boundaries. This might include a focus on responsibilities rather than rights, on Indigenous knowledge and the Rights of Nature. The editors are to be congratulated for stimulating these insightful responses.'

Rosemary Lyster, University of Sydney, Australia

'By now well into the Anthropocene, human societies are running up against the limits of what the Earth system can sustain. This excellent volume offers a thought-provoking and engaging set of reflections on the natural, conceptual and intellectual dimensions of our planetary boundaries, and on the capacity of international environmental law to articulate and protect them. A compelling, indispensable addition to the Research Handbook *series.'*

Jutta Brunnée, University of Toronto, Canada

'This is a welcome overview of existing efforts and future possibilities of legally regulating activities that threaten to violate the biophysical conditions for human survival in the Anthropocene. The chapters systematically review the ways in which national and international law can be applied to keep humanity within the so-called planetary boundaries that define the Earth's "safe operating space". In interweaving natural-science insights on the Earth system with legal options and ethical perspectives, this volume outlines feasible reforms and offers hope.'

Alf Hornborg, Lund University, Sweden

1. Staying within the planet's 'safe operating space'? Law and the planetary boundaries

Louis J. Kotzé and Duncan French

1. HUMANS NEED BOUNDARIES

Humans only seem able to function well if our actions are limited by boundaries. History seems to teach us that unconstrained free will is a recipe for disaster; if left to our own devices, we will do whatever we want without much consideration of actual or potential future consequences. This truism – always characterised with noble exceptions – seems to be as accurate at the community level as it is (often) for the individual. And that is why we need boundaries: boundaries set limits, and these limits are meant to achieve, maintain and/or return us to what is perceived to be a desired condition. Importantly, such limits have the dual benefit of protecting the individual and the wider community. Speed limits and prohibitions against driving under the influence are examples of boundaries that protect the driver and other road users. In 2020 we became used to a new concept, 'social distancing', to prevent the spread of COVID-19; such social distancing and other limitations were specifically designed to create safe spaces between people to keep them healthy. One of the most powerful messages heard during this period was 'act as if you have it' – thus very much personalising the responsibility which we all had to control the spread. Ultimately, whether it is speeding, drunk driving or controlling the spread of a pandemic, if we respect these boundaries, the underlying premise is that we should be safe; if we breach them, we must deal with whatever consequences ensue. In short, boundaries protect us from ourselves, from each other and sometimes even from forces and impacts beyond our immediate control.

Invariably blinded as we have hitherto been by false illusions of ecological abundance and by our self-satisfying greed, while humans have been effective at setting boundaries related to a dizzying array of internally framed, societally constructed issues, we have been surprisingly reluctant to limit ourselves with respect to the many planetary processes and components that we exploit to sustain the ever-expanding human development project, despite clear evidence that the Earth system is being irreversibly degraded at an unsustainable rate.[1] Ever since the paradigmatic Judaeo-Christian message of domination of the Earth, as set out in the Book of Genesis, the view has always been that the planet is there for the taking, exploited as it should be by laborious, possessive, self-interested humans, working away remarkably effectively in turning 'raw' materials into consumptive goods; taming an externalised 'wild nature'; domesticating and civilising 'savages'; and staking property claims in land and other non-human beings, while exploiting billions for the benefit of a privileged few. The past few centuries have exacerbated this exploitation, both ecologically and socially. The plain truth is that 'Without the trans-Atlantic flows of embodied African labour and embodied American land,

[1] United Nations Environment Programme, *Global Environmental Outlook 6: Healthy Planet Healthy People* (Cambridge University Press 2019).

and the African and American markets for British textiles, it is difficult to imagine a British Industrial Revolution'.[2]

And it is exactly the Industrial Revolution that is considered by many to mark the point in time at which human dominance of the Earth system accelerated at an unprecedented, and exponential, rate.[3] This dominance has occurred through a remarkably effective transformative process that propelled humans from being only a few localised dwellers foraging for food and living in makeshift shelters, to a global population of approximately 7.5 billion people inhabiting virtually every corner of the Earth; all fighting, with variously different degrees of relentless tenacity, for survival amid increasingly limited resources that sustain life.[4] Because of this unbounded consumption, exploitation and domination, humans are now thought to be causing a Sixth Mass Extinction, including, possibly, of our own species.[5] Such a global population is however far from equal; humanity's capacity to stay within limits – and to feed and house itself – is severely exacerbated by the structural inequalities that exist between societies. It is not incorrect to note that global injustice corrupts planetary integrity. But we must also acknowledge that inequity masks another truth: that the sustainability of the planet is distinct from any theory of justice we might construct. We have learnt – and are learning very quickly, and at our cost – that there are absolutes, which we cannot ignore.

Thus, we need to realise that there are limits to what we can do within a limited Earth system, and that there must be boundaries that cannot be crossed if the Earth system is to continue sustaining all forms of life. The need to visualise our planetary encroachment and socio-ecological destruction in terms of boundaries that clearly delimit how we interact with, use and exist as part of the Earth system, its components and processes, has therefore now become a critical existential concern.

2. SETTING ENVIRONMENTAL BOUNDARIES

The modern (re-)awakening of thinking about the Earth system as being limited and requiring us to set environmentally related boundaries is fortunately soon to enter its sixth decade of genuine political activism and legislative activity. Many still point to the 1972 United Nations Conference on the Human Environment, which, while it did not prescribe any enforceable prohibitive limits, marked the first significant global consensus[6] that the current trajectory of human development is ultimately unsustainable:

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2 Alf Hornborg, 'Colonialism in the Anthropocene: The Political Ecology of Political Ecology of the Money-Energy-Technology Complex' (2019) 10(1) Journal of Human Rights and the Environment 7, 10.

3 Will Steffen et al, 'The Trajectory of the Anthropocene: The Great Acceleration' (2015) 2(1) The Anthropocene Review 1.

4 Louis J Kotzé, 'Coloniality, Neoliberalism and the Anthropocene' (2019) 10(1) Journal of Human Rights and the Environment 1.

5 See, eg, John Briggs, 'Emergence of a Sixth Mass Extinction?' (2017) 122 Biological Journal of the Linnean Society 243.

6 Recognising, however, the absence of the 'Second World' of the former Union of Soviet Socialist Republics (USSR) and its allies from that conference for reasons of 1970s geopolitics. Such *temporally situated* politics continues to bedevil long-term environmental proactivity.

> A point has been reached in history when we must shape our actions throughout the world with a more prudent care for their environmental consequences. Through ignorance or indifference we can do massive and irreversible harm to the earthly environment on which our life and well being depend. Conversely, through fuller knowledge and wiser action, we can achieve for ourselves and our posterity a better life in an environment more in keeping with human needs and hopes.[7]

As evidenced in particular by the spectacular growth of international environmental law, a period of intensive global rulemaking soon followed.[8] We saw the emergence – and subsequent critique – of concepts such as 'limits to growth'[9] and 'sustainable development',[10] both of which found their way into global law and policy regimes. Other ideas that more accurately, if not yet fully, captured the idea of environmental boundaries also emerged, such as the human 'ecological footprint',[11] 'planetary guard rails' and 'tolerable windows',[12] although these largely remained confined to the scientific/philosophical sub-genre discourse that invented them. To be sure, apart from 'sustainable development', which has since become the centrepiece of the world's future vision of development (as is apparent from the Sustainable Development Goals), and despite justified critique,[13] none of these ideas seemed to have gained broad popular traction, nor have they been able to prompt the type of urgent conversations we need to have about how to address the deepening socio-ecological crisis that we are causing on the back of neoliberal sustainable development for a few at the expense of vulnerable human and non-human living beings.

The more recent introduction of the notion of the 'Anthropocene' has managed to reignite vigorous discussions about the ever-linear human development project, and the socio-ecological devastation that such development is causing to the Earth system. On the one hand, the Anthropocene serves as the new name of the specific period in which the Earth system now finds itself in the geological time scale by 'classifying', as Biermann says, this new state of the Earth system.[14] In doing so, the Anthropocene trope illuminates the centrality of humans as a key aspect of the Earth system; we are not external to 'nature', but instead intrinsically part of an interlinked system that we also influence through our primal urges, cultures and beliefs, our efforts to survive and to dominate and our endeavours to master other vulnerable humans

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7 'Declaration of the United Nations Conference on the Human Environment' UN General Assembly (15 December 1972) UN Doc A/RES/2994, Preamble para 6.

8 For example, Philippe Sands and Jacqueline Peel, *Principles of International Environmental Law* 4th ed (Cambridge University Press 2018).

9 Donella Meadows, Dennis Meadows, Jørgen Randers and William Behrens, *The Limits to Growth: A Report for the Club of Rome's Project on the Predicament of Mankind* (Universe Books 1972).

10 World Commission on Environment and Development, *Our Common Future* (Oxford University Press 1987).

11 Mathis Wackernagel and William Rees, *Our Ecological Footprint: Reducing Human Impact on the Earth* (New Society Publishers 1998).

12 German Advisory Council on Global Change, *World in Transition: The Research Challenge* (1996).

13 Sam Adelman, 'The Sustainable Development Goals, Anthropocentrism and Neoliberalism' in Duncan French and Louis J Kotzé (eds), *Sustainable Development Goals: Law, Theory and Implementation* (Edward Elgar 2018) 15–40.

14 Frank Biermann, *Earth System Governance: World Politics in the Anthropocene* (MIT Press 2014) 4.

and non-humans.[15] The Anthropocene trope therefore clearly reveals the significant power of humans to upset Earth system equilibrium and the ability that humans have gained over time to change other components and processes of the Earth system. The Anthropocene's accelerating global socio-ecological crisis and the extent of Earth system decay suggest we urgently need to realise that there are in fact limits to what we can and cannot do within the narrowing range of an increasingly vulnerable Earth system that must support all life.[16]

It also heralds a moment of self-reflection for (international) environmental lawyers, as to the limitations of the law that we have so productively propounded and, if we are being brutally honest, often venerated. We have bestowed upon ourselves a self-assurance – nay, an arrogance – that our efforts are somehow of more moral worth than other legal disciplines. We are on a mission to save the planet, one piece of environmental law or treaty at a time. To speak truth: we are superior to those interested in tax law, commercial property transactions and the like. We are (uneasy) bedfellows with human rights lawyers, as we strive to make the world a better place. Though – if we were being honest, and just between ourselves – in the quiet, small hours, unlike human rights lawyers, our temporal vision is planetary and truly global in nature. But this arrogance, for let us call it what it is, is both false and hubristic. False, because the evidence is such that many of our normative endeavours are, in many respects, failing. And hubristic, because our very belief in our moral worth blinds us to those failures; we simply cannot see an alternative approach. We just believe in more of the same. And we must be cautious to do so. As Humphreys and Otomo remarked:

> International environmental law, then, is a principal locus for the dynamic that Raymond Williams remarked on forty years ago: a world split into an upwind of preservation and recreation and a downwind of waste and destruction, a pastoral idyll and a dump. International environmental law excoriates the dump, the waste, the loss of life and species – but it is not equipped to halt it.[17]

If that were completely true, law would have nothing to say about preventing planetary degradation. We do not believe that to be the case. But we do approach the role of law with scepticism and humility; past experience if nothing else would prompt us not to rush to find easy solutions in law. Moreover, we approach it as not distant observers – as we quote H.G. Wells at the start of this collection: 'from the outside, from somewhere inconceivably remote, out of time, out of space, out of the stress and tragedy of it all' – but as planetary citizens,[18] where our individual actions and academic insights must converge if either are to be meaningful.

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15 Louis J Kotzé, 'Earth System Law for the Anthropocene: Rethinking Environmental Law alongside the Earth System Metaphor' (2020) 11 *Transnational Legal Theory* 74–104.

16 Paul Crutzen, 'The Geology of Mankind' (2002) 415 Nature 23.

17 Stephen Humphreys and Yoriko Otomo, 'Theorizing International Environmental Law' in Anne Orford and Florian Hoffmann (eds), *The Oxford Handbook of The Theory of International Law* (Oxford University Press 2016) 819.

18 Tawhida Ahmed and Duncan French, 'Situating Climate Change in (International) Law: A Triptych of Competing Narratives' in Stephen Farrall, Tawhida Ahmed and Duncan French (eds), *Criminological and Legal Consequences of Climate Change* (Hart 2012) 263.

3. THE PLANETARY BOUNDARIES

It was on the back of the emerging Anthropocene trope and its rich scientific agenda that in 2009 a group of environmental scientists led by Johan Rockström proposed an entirely new approach to visualising Earth system limits.[19] They suggested it is possible to identify and quantify a set of nine 'planetary boundaries' that 'define the safe operating space for humanity with respect to the Earth system and [that] are associated with the planet's biophysical subsystems or processes'.[20] If these boundaries are crossed, the chance of maintaining the relatively stable pre-Anthropocene, Holocene-like state for human existence significantly diminishes as we step closer to 'dangerous levels' or, where applicable, 'tipping points' in Earth system processes. To this end, the planetary boundaries act as 'values for control variables that are either at a "safe" distance from thresholds – for processes with evidence of threshold behaviour – or at dangerous levels – for processes without evidence of thresholds. Determining a safe distance involves normative judgements of how societies choose to deal with risk and uncertainty.'[21]

The scientists identified nine Earth system processes and, where possible, associated thresholds, including: climate change; rate of biodiversity loss (terrestrial and marine); interference with the nitrogen and phosphorus cycles; stratospheric ozone depletion; ocean acidification; global freshwater use; change in land use; chemical pollution; and atmospheric aerosol loading. At the time, it was estimated that three of the nine boundaries have already been crossed (climate change, rate of biodiversity loss and interference with the nitrogen cycle), while we are fast approaching the boundaries for global freshwater use, change in land use, ocean acidification and interference with the global phosphorous cycle.[22] The framework has since attracted significant interest in academic, policy and social advocacy circles.

In 2015, a partially overlapping group led by Will Steffen published an update of the initial research with some adjustments and elaborations.[23] These include: introducing a two-tier approach for some of the planetary boundaries to account for regional-level heterogeneity; updating the quantification of most of the boundaries; elaborating a hierarchy for the boundaries by identifying two core boundaries, namely, climate change and biosphere integrity; and proposing a regional-level quantitative boundary for atmospheric aerosol loading.[24] Possibly reflecting a deeper graduated understanding of the boundary framework's Earth system processes, the update also led to some of the boundaries being elaborated and consequently renamed, namely: 'rate of biodiversity loss (terrestrial and marine)' to 'loss of biosphere integrity (biodiversity loss and extinctions)'; 'interference with the nitrogen and phosphorus cycles' to 'nitrogen and phosphorus flows to the biosphere and oceans'; 'global freshwater use' to 'freshwater consumption and the global hydrological cycle'; 'change in land use' to 'land system change'; and 'chemical pollution' to 'chemical pollution and the release of novel

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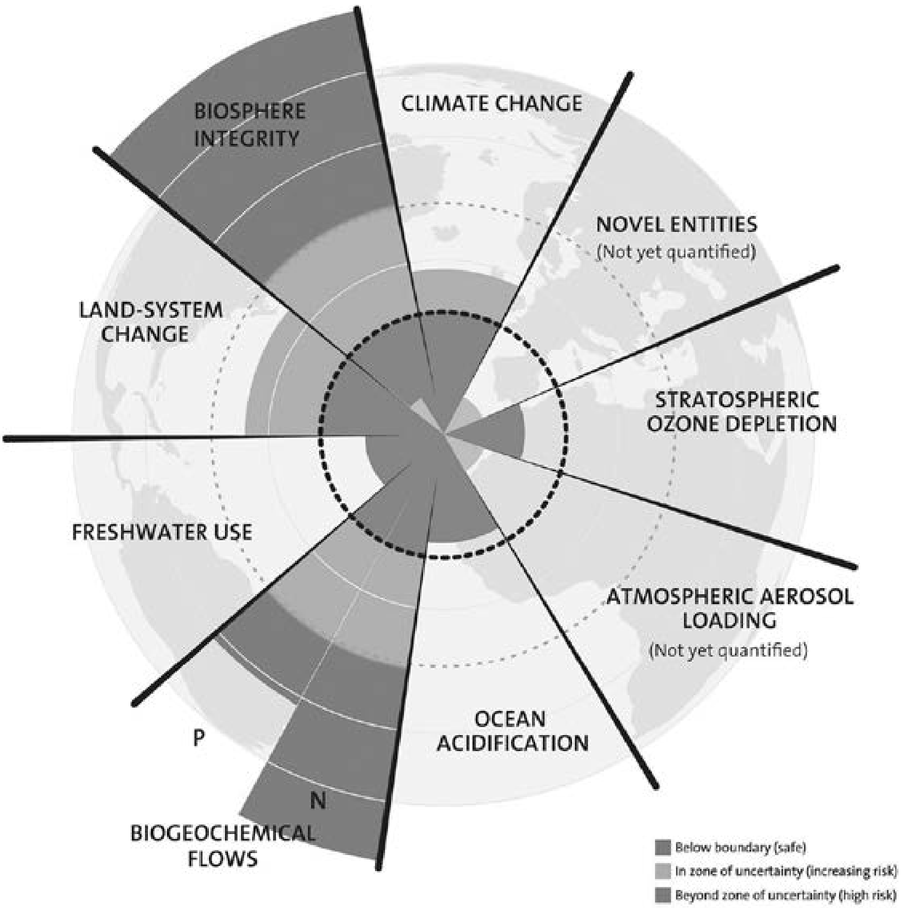
[19] Johan Rockström et al, 'A Safe Operating Space for Humanity' (2009) 461 Nature 472.
[20] Ibid at 472.
[21] Ibid at 472–73.
[22] Ibid at 473.
[23] Will Steffen et al, 'Planetary Boundaries: Guiding Human Development on a Changing Planet' (2015) 347 Science 1259855.
[24] Ibid at 1259855–1.

entities'.[25] Moreover, as reflected in Figure 1.1, the update now estimates that a fourth boundary has been crossed in addition to the earlier three, namely land system change.



Source: J Lokrantz/Azote based on Steffen et al, 'Planetary Boundaries: Guiding Human Development on a Changing Planet' (2015) 347 Science 1259855.

Figure 1.1 The nine planetary boundaries

[25] See The Stockholm Resilience Centre, 'The Nine Planetary Boundaries' <www.stockholmresilience.org/research/planetary-boundaries/planetary-boundaries/about-the-research/the-nine-planetary-boundaries.html> accessed 23 June 2020.

4. LAW AND THE PLANETARY BOUNDARIES

While the authors of the 2015 update reaffirmed the original understanding of the planetary boundaries framework, they also stressed:

> There is an urgent need for a new paradigm that integrates the continued development of human societies and the maintenance of the Earth system (ES) in a resilient and accommodating state. The planetary boundary (PB) framework contributes to such a paradigm by providing a science-based analysis of the risk that human perturbations will destabilize the ES at the planetary scale.[26]

But although they recognise the value of the planetary boundaries theory for Earth system science, as they clearly do, the authors are at once also very conscious of what this theory *cannot* achieve:

> The PB [planetary boundary] framework does not dictate *how* societies should develop. These are political decisions that must include consideration of the *human dimensions*, including equity, not incorporated in the PB framework. Nevertheless, by identifying a safe operating space for humanity on Earth, the PB framework can make a valuable contribution to decisionmakers in charting *desirable courses* for societal development.[27]

This chimes with the view of the original author group, namely that 'Determining a safe distance involves *normative judgements* of how societies choose to deal with risk and uncertainty'.[28] At first glance, then, the planetary boundaries framework seems to be most obviously relevant for the Earth system's 'physical world' (which consists of the geosphere, the hydrosphere and the cryosphere) and its 'biological world' (including the biosphere).[29] Its immediate relevance for the Earth system's 'mental world' (or the Anthroposphere), which describes the Earth system's human dimensions,[30] seems only to be implied. Steffen and colleagues therefore acknowledge that we need a set of different tools, possibly situated predominantly in the social science domain, to translate the significance and consequences of the planetary boundaries framework into the human dimension or social world of the Earth system.

While there are several such tools on offer, including economics, politics, religion and so forth, in this book we focus on *law*, and more specifically the *legal aspects* of planetary boundaries governance, including a critical evaluation of the ability of law to keep us within the planetary boundaries' safe operating space, as well as the ability of law to step up to the challenge above to 'make a valuable contribution to decisionmakers in charting *desirable courses* for societal development'. It is our hypothesis that the role that law has played and *could potentially play* in the range of 'normative judgements of how societies choose to deal

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26 Steffen et al (n 23) 1259855.

27 Ibid. Emphasis added.

28 Johan Rockström et al, 'A Safe Operating Space for Humanity' (2009) 461 Nature 472, 472–73. Emphasis added.

29 Peter Cox and Neboja Nakicenovic, 'Assessing and Simulating the Altered Functioning of the Earth System in the Anthropocene' in Hans Schellnhuber et al (eds), *Earth System Analysis for Sustainability* (MIT Press 2004) 295.

30 Peter Haff, 'Humans and Technology in the Anthropocene: Six Rules' (2014) 1 The Anthropocene Review 126–36; Bronislaw Szerszynski, 'Viewing the Technosphere in an Interplanetary Light' (2017) 4(2) The Anthropocene Review 92.

with risk and uncertainty' is significant, but also underexplored. And, as noted above, we must also recognise the limitations of the law, both in theory and in terms of what five decades of environmental law have taught us.

We are also very aware of the myopic risk of only focusing on one type of legal system, or legal form. International environmental law – whether as treaty rule or overarching, if generalised, customary international norm – has had an important part to play. But we must be careful not to equate 'planetary' only with 'global'; many other legal systems and forms are equally pertinent. Domestic environmental law, judicial decisions, regional frameworks and transnational networks of rules all can contribute both positively and negatively towards the goal of keeping us within a safe operating space. Moreover, though we focus on environmental law in this collection – and indeed predominantly international environmental law – we must also recognise the importance of 'greening' all areas of law, so that commercial, company, regulatory, and constitutional law among others do not pull against the broader goal of human survival. This indeed may be the larger normative challenge – what might be referred to as horizontal integration.[31]

Similar, but worthy of separate comment, are the linkages between human rights, development and planetary boundaries. Striving not to breach the latter has the potential, if unchecked, to not take into account the moral significance of human dignity and human development. This conundrum has been long identified, but historically only resolved with sweeping generalisations and a lack of detailed roadmaps for the way forward. This is beginning to change, though the essential paradox between anthropocentrism and planetary limits remains nuanced when placed at the planetary level of heightened industrialisation, a growing population and systemic inequalities. Nevertheless, we wish to avoid extreme positions of 'either/or'; human dignity and the human project will both be undermined if we live on a planet that is no longer hospitable. But equally, let us not underestimate the challenges – both socio-political and legal – of reconciling competing moral objectives; especially between the liberal orthodoxy of individual rights (often in the absence of corollary societal duties), and ecological realities that were not evident when the present world order evolved from the horrors of the Second World War.[32]

Our motivations for writing this book were driven by several considerations. First, we endeavour to pry open the epistemic closures of Earth system science for lawyers, and the epistemic closures of the law for Earth system scientists and Earth system governance scholars. The social sciences more generally, and law specifically, have been playing a decidedly

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[31] An endeavour that is expressly evident in calls for the development of new legal ontologies and forms of planetary-focused law. See, for example, Louis J Kotzé and Duncan French, 'A Critique of the Global Pact for the Environment: A Stillborn Initiative or the Foundation for *Lex Anthropocenae*?' (2018) 18 International Environmental Agreements: Politics, Law and Economics 811; Louis J Kotzé and Rakhyun E Kim, 'Earth System Law: The Juridical Dimensions of Earth System Governance' [2019] Earth System Governance 100003; Kotzé (n 15) 75.

[32] Anna Grear and Louis J Kotzé (eds), *Research Handbook on Human Rights and the Environment* (Edward Elgar 2015); Lynda Collins, 'Sustainable Development Goals and Human Rights: Challenges and Opportunities' in Duncan French and Louis J Kotzé (eds), *Sustainable Development Goals: Law, Theory and Implementation* (Edward Elgar 2018) 66–90; Louis J Kotzé, 'The Anthropocene, Earth System Vulnerability and Socio-ecological Injustice in an Age of Human Rights' (2019) 10(1) Journal of Human Rights and the Environment 62.

unpronounced role in planetary boundary research.[33] We therefore offer here a first comprehensive attempt to investigate the human dimensions of the planetary boundaries from a legal perspective. In doing so we hope to reveal, especially to Earth system scientists, the significance of the law as a social regulatory institution by illuminating the important role that law plays in governing the planetary boundaries. Conversely, although the natural science-based planetary boundaries theory is increasingly gaining traction in the juridical science domain, it has not yet been fully embraced by lawyers to any significant extent. This book is therefore also an attempt to reveal the value of the planetary boundary theory to lawyers.

Second, law by its very nature is remarkably good at setting boundaries and limiting human behaviour, and it could therefore be used, alongside a range of other social regulatory interventions, to ensure humanity does not cross the planetary boundaries. Law, after all, is a prominent and critically important social regulatory institution, as it is central to our political, economic, religious and cultural systems. It is one of the key regulatory interventions we use to address many of the human dimensions of Earth system change.[34] In a broad sense, law includes 'the systematic regulation of the life of a community by standards treated as binding the members of the community and its institutions'.[35] To this end, 'law is a purposeful vehicle for shaping behavior to achieve desired ends';[36] it has been, still is, and will likely always be a foundational element of the social system that operates to ensure ordered co-existence wherever humans are present. Within the context of the planetary boundaries specifically, we support the idea that law could provide the 'legal boundaries that prevent human activities from reaching and breaching planetary boundaries'.[37] This book is therefore aimed at interrogating the epistemic space where planetary boundaries and legal boundaries converge.

Third, while law could offer solutions to governing many of the regulatory challenges that emerge from the planetary boundaries framework, it is also true that 'The challenges to … legal institutions to deal with the complexities of Earth System management are formidable'.[38] Law cannot therefore be a panacea for addressing the complex task of governing the Earth system and the regulatory challenges emerging from the planetary boundaries, but it will have a critically important role to play in this existential endeavour. We seek in this book to interrogate (often critically) what this role is, or could be, and we do so along three thematic areas: (i) the general legal, ethical and governance dimensions of the planetary boundaries; (ii) the diverse international law dimensions of the planetary boundaries and the challenges that the planetary boundaries raise for international law; and (iii) the extent to which the law already provides for some of the aspects illuminated by each of the planetary boundaries, and, where it does not, possible opportunities for legal reform.

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33 See specifically Bleby, Holley and Milligan, Chapter 2, and Kim and Kotzé, Chapter 3, in this book.

34 Louis J Kotzé and Rakhyun E Kim (n 31); Louis J Kotzé, 'Earth System Law for the Anthropocene' (2019) 11 Sustainability 1–13.

35 Timothy Endicott, *Law and Language* (Stanford Encyclopedia of Philosophy, 2016) 5. Available at <https://ora.ox.ac.uk/objects/uuid:971283aa-d36f-4ce9-831d-e52c58e8609f>.

36 Gillian Hadfield and Barry Weingast, 'What Is Law? A Coordination Model of the Characteristics of a Legal Order' (2012) 4(2) Journal of Legal Analysis 471, 473.

37 Guillaume Chapron et al, 'Bolster Legal Boundaries to Stay within Planetary Boundaries' (2017) Nature Ecology and Evolution 1, 1.

38 Will Steffen et al (eds), *Global Change and the Earth System: A Planet under Pressure* (Springer 2004) 297.

5. LEGAL, ETHICAL AND GOVERNANCE DIMENSIONS OF THE PLANETARY BOUNDARIES[39]

Part I casts the net wide by surveying some of the broader legal, ethical and governance dimensions related to the planetary boundaries. In Chapter 2, Alice Bleby, Cameron Holley and Ben Milligan show how the planetary framework has already begun to filter gradually into the *practice* and *practise* of law and governance. They argue, however, that its percolation into legal spaces is not occurring in a conceptual void. It is happening alongside established and competing frameworks such as sustainable development, the 'four capitals model' and rights of nature, which have all influenced environmental law in various ways. The chapter's authors believe that how, and to what extent, policy makers will depose, blend or transform existing concepts with the planetary boundaries framework accordingly remains an open question. In response, this chapter critically examines the potential benefits and challenges of planetary boundaries as a conceptual framework to inform environmental law and governance, and it explores some possible synergies with these other prominent framings.

Rakhyun Kim and Louis Kotzé explain in Chapter 3 that the planetary boundaries framework, although originating from within the natural science domain of Earth system science, is increasingly infiltrating the social sciences. This framework has, among others, informed the development of new research on earth system law and governance. They present a systematic review of the emerging social science literature that lies at the intersection of Earth system science, law and governance. The aim of the analysis is to provide a bird's eye view of the state of the art and identify and explore how the planetary boundaries framework is framed by social scientists and what they propose as challenges and implications for law and governance as far as these boundaries are concerned. The chapter identifies four key characteristics of the planetary boundaries framework that emerge from the literature, namely planetary boundaries as embodying environmental limits, as being interdependent and interacting phenomena, as being planetary in scale, and as being political constructs. The chapter further suggests that social science scholars tend to frame their planetary boundaries research around four themes as a response to the foregoing, namely: institutionalization of planetary boundaries; coordination of planetary boundaries; downscaling of planetary boundaries; and democratization of planetary boundaries.

In Chapter 4, Sam Adelman offers a deeply critical evaluation of the ethical aspects underlying the law and planetary boundaries interface by considering the need for what he calls a planetary ethics of survival that reflects the lessons of the planetary boundaries framework. The chapter first analyses the challenges of the Anthropocene, before turning to a reflection on the planetary boundaries framework as the basis for an ethics of loyalty to the planet and the species whose wellbeing depends upon its health. The chapter then discusses the difficulties involved in developing planetary ethics in a world struggling to escape unsustainable Holocene thinking and the depredations of neoliberal globalisation. The chapter concludes with views on how law in general, and international environmental law in particular, have operated as ethical vacuums, calling as this does for a legal paradigm shift to correct this state, while also considering alternatives for a sustainable future.

[39] We acknowledge with gratitude the summary contributions of each of the authors on which Sections 5, 6 and 7 are based.

The concept of planetary boundaries clearly exists at the intersection of research, science and public policy. As was shown earlier in this chapter, planetary boundaries were developed as a tool for communicating crucial scientific information and recommendations about the meta-level health of the Earth system to decisionmakers and members of the general public. In the inevitable ensuing public policy debates surrounding planetary boundaries, questions arise about the scientific credibility of the concept and the degree of (un)certainty involved in the various formulations of boundaries and in assessments about the degree to which anthropogenic disruption is approaching (or has already breached) them. Whether viewed through the lens of the natural sciences, the social sciences generally or juridical science specifically, planetary boundaries raise major empirical, normative and prescriptive questions. In an attempt to critically reflect on all these issues, in Chapter 5 Lynda Collins analyses the problem of scientific uncertainty in the context of planetary boundaries, with a focus on key philosophical, evidentiary and socio-cultural challenges in translating the science of planetary boundaries into legal policies and standards.

Chapter 6 is the final chapter in Part I and it seeks to resituate the 'planetary' dimensions of the planetary boundaries framework within a very localised urban or city context. Helmut Aust and Janne Nijman argue that the relationship between planetary boundaries and cities is obviously obscure at first glance. After all, responding to the *planetary* boundaries in a holistic and integrated manner seems to call for global solutions, not city-level interventions. Yet, they show that it is important to downscale governance approaches, if only to solicit support for governing planetary boundaries at all levels of governance, and that cities could make an important contribution in this respect. In critically canvassing the relationship between cities, planetary boundaries and the Anthropocene, the chapter portrays some of the many promises that a turn to the city seems to bring in this respect, in particular through forms of innovative urban governance. The authors are, however, also careful to contextualise these promises, and they critically reflect on some of the potential shortcomings that are associated with the recent adoration of cities as more responsible and benign units of governance. The chapter ultimately shows how cities are inevitably bundled up in the processes which bring us closer to the planetary boundaries and which have created the Anthropocene: the planetary boundaries run right through them, as the authors show.

6. INTERNATIONAL LAW AND THE PLANETARY BOUNDARIES

While Part I mostly, though not exclusively, reflects on law in a more generic sense, Part II of the book turns its focus more explicitly towards the interaction between *international* law and the planetary boundaries. We have deliberately decided on such a focus because, as noted above, international law, despite all its shortcomings (as many of the chapters in this book show), will invariably be the legal type to offer (at the very least) the legal foundations for planetary boundaries law, especially considering its inter-state geographical focus (see Part III).

In Chapter 7, Dario Piselli and Harro van Asselt lay the foundations for examining the relationship between international law and the planetary boundaries. They argue that one of the main challenges in the study of planetary boundaries is the fact that Earth system processes are often closely intertwined. These biophysical interactions also raise important questions for the international legal regimes that govern each individual boundary. For example, how do these regimes interact with each other, and what effect do governance interactions have on the complex feedbacks and loops that occur between planetary boundaries? Can different regimes work in conjunction and prevent 'problem-shifting' between one boundary and the next? And what tools does international law offer to manage these interacting regimes? By linking the literature on planetary boundaries to that of regime interaction in international law, the authors seek to provide preliminary answers to such questions. The chapter first illustrates the variety of regime interactions that can occur in practice by drawing on two case studies of coupled planetary boundaries – related to interactions between climate change and stratospheric ozone depletion, on the one hand, and freshwater use and biogeochemical flows on the other. The chapter then suggests that managing regime interactions cannot be limited to the solution of norm conflicts or the creation of overarching legal frameworks, but must also emphasise the promotion of conceptual, regulatory and operational synergies between the different types of actors and institutions involved in the relevant legal response.

In Chapter 8, Giovanna Frisso and Elizabeth Kirk turn our attention to international environmental law and the planetary boundaries. They show how legal discourse focuses on the potential to improve law to prevent breaches of the planetary boundaries and on the adoption of new measures to give the Earth system time to recover from the impacts of human actions. That analysis, however, tends to rest on the assumption that we can modify our existing laws in ways that will prompt individuals and States to modify their behaviour so as to reduce the risk of breaching the planetary boundaries. The authors examine the roots of this approach and present alternative approaches which may prove more fruitful. In particular, they propose a move within law to focus more on responsibilities and less on rights, and consequently to embracing other approaches, such as within indigenous and other cultures, which also focus on responsibilities.

The planetary boundaries framework informs us that the Earth system is adversely impacted by human activities, which in turn endangers human life on Earth. However, as Steffen and colleagues pointed out in their 2015 update of the planetary boundaries framework, given that not all humans, historically or extant, contribute equally to the transgression of planetary boundaries, this message involves deeper issues of equity and causation which planetary boundaries research, as such, does not address. Ellen Hey suggests in Chapter 9 that adding teleconnections as a conceptual framework to our analytical toolkit has the potential to add nuance to our analysis by pointing to the deeper issues of equity and causation within the context of the planetary boundaries. She uses the concept of teleconnections to show how, despite its inter-state nature, the international law-based free trade rule connects producers anywhere on Earth to consumers everywhere on Earth. The concept of teleconnections enables the identification of localities at which harm to the Earth system arises (such as in the production of soy in the Amazon) and facilitates the linking of these to the root causes of that harm (for example, meat consumption in China and Europe), which are often located elsewhere.

Planetary and legal boundaries can only be effective if they are observed, respected and complied with. In Chapter 10, Jonas Ebbesson addresses the critical issue of compliance with planetary boundaries in international law. He shows that although the planetary boundaries have no formal status in international law, they are *legally relevant*. Therefore, if they obtained a more robust status in international law, though planetary boundaries would not per se create legal standards and it would still be problematic to hold States' performance or compliance directly against them, they would amount to objectives to be achieved and operationalised through other norms, whether rules set out in treaty law with examinable criteria for compliance, or principles of customary law. Alternatively, the planetary boundaries could influence legal concepts, principles and obligations more subtly through jurisprudence and doctrine. The chapter shows that compliance with international environmental law involves a broad range of considerations, including practical reasons for failure to comply, the legal implications of non-compliance, the institutional procedures for compliance control and the effectiveness of compliance reviews. The main concerns in this respect are whether the planetary boundaries as such can be complied with in the first place, and if not, how can compliance in relation to planetary boundaries be meaningfully examined in legal terms?

Michael Hennessy Picard and Olivier Barsalou conclude Part II with a reflection in Chapter 11 on international law and what they call the 'Molysmocene'. The Molysmocene is a neologism which defines the toxic, irradiated and polluted era we live in. It shows how social configurations not only assemble life and nature, that is, productive forces on a global scale, but also organize the redistribution and dispersion of pollution around the globe. We inhabit waste, dirt and pollution, and – perhaps more telling – waste, dirt and pollution inhabit us. The Molysmocene tells us that waste is a fundamental physical determinant of life and death in all known ecosystems. The authors show how waste and its contaminants have now irreversibly encroached on planetary boundaries. In the light of this dilemma, they propose that calls for global ecological reform must accordingly consider toxic waste as the primary threat to the preservation of planetary boundaries, consider international environmental law's historic role in facilitating waste accumulation and dispersion, and acknowledge how waste is shifting and reordering the boundaries of law itself.

7. PLANETARY BOUNDARIES AND THE LAW

Part III is dedicated to a discussion of the current law as it most directly pertains to the nine planetary boundaries, that is, those (mostly international, and some regional) legal rules that particularly relate to a specific planetary boundary. These laws are usually found within specific regimes of international environmental law that already exist, such as the climate law regime – as Dario Piselli and Harro van Asselt show in Chapter 7, these regimes often overlap (and have the potential to interact) to a considerable extent, even if such interaction is not yet optimal. Given the complexity of the Earth system (as evidenced in particular by its nine planetary boundaries) and the complexity of the human dimensions of the Earth system – including, in particular, the myriad potential multi-dimensional and multi-scalar impacts that humans have on the Earth system – a whole range of laws could apply to each boundary. There are other factors as well that might determine which laws are relevant to a specific boundary and which are not. Examples include: geographical factors (international, regional, national and local law); considerations around the subject area and regulatory object (oceans governance, biodiversity conservation, air pollution and so on); spectrum of normativity (binding norms versus non-binding norms); relatedly, law's source of legitimacy, authority and its executing agent (state versus non-state law); and temporal considerations (the past, present and future application of law).

All of this is to say that the analysis in this part does not pretend to be exhaustive: it would be close to impossible to cover all the laws related to all the aspects of all the planetary boundaries in a single book. The authors of the chapters in this final part of the book instead had the flexibility to be selective, to focus on those aspects of the law they deem to be most relevant to each boundary and to focus on those laws that most accurately capture what a legal response to the regulatory challenges of each of the boundaries could look like. In some cases, such selection meant only tackling one aspect of the planetary boundary – thus itself suggesting a disconnect between how law and policy conceives of an environmental challenge, and (at least) the scientists behind the planetary boundary project. What the analysis in this part also does is to offer a view not only on what the law is with respect to each boundary, but also what it should be, or could become, if law were to more effectively govern each of the boundaries.

The discussion commences with 'loss of biosphere integrity (biodiversity loss and extinctions)', which is the first of two core boundaries. Han Somsen and Arie Trouwborst argue in Chapter 12 that the accelerating rate of biodiversity loss and extinctions should be of existential concern. Challenges to measure biodiversity and articulate thresholds notwithstanding, the planetary boundary of biosphere integrity has an important role to play for both present and future environmental law. For current law, first, the state of transgression of the biosphere integrity boundary amounts to a strong claim in support of a teleological interpretation of nature conservation legislation and its rigorous enforcement. Second, they show that it brings into sharp focus obvious gaps and weaknesses of current legal regimes, in particular in terms of levels of legal commitment towards achieving concrete results. The planetary boundary of biosphere integrity should therefore be central on the transformative agenda heralded by the Anthropocene. The authors conclude that nature rights, substantively expressing the planetary boundary of biosphere integrity, and procedurally operationalised and enforced with the help of existing and emerging technologies, are an important – if not an indispensable – part of that future endeavour.

'Climate change' is the second core boundary. In Chapter 13, Jonathan Verschuuren shows how the planetary boundary on climate change has been firmly codified in international law with the adoption of the 2015 Paris Agreement on Climate Change. Remaining within this boundary, he believes, is nevertheless a collective responsibility of all States. Recent developments within domestic law have shown that the adoption of a legally binding planetary boundary also has consequences for States individually, and possibly even for individual business corporations. He shows how some courts have now linked the planetary boundary to human rights, allowing them as this does to provide for an effective legal remedy for citizens and non-governmental organizations against insufficient domestic climate change policies. Other courts have also forced authorities to implement policies with the objective to remain within the planetary boundary, while some legislatures have codified this planetary boundary in domestic climate change laws, requiring all authorities to achieve full carbon neutrality by 2050. In other instances, some States have instituted a non-political expert committee that plays an important role in monitoring progress towards achieving the long-term climate goals alongside climate change boundary considerations. He concludes that these emerging developments show significant potential, although much more remains to be done.

The planetary boundary of 'stratospheric ozone depletion' is closely related to climate change. Generally considered one of international environmental law's few success stories, Louise du Toit analyses in Chapter 14 the extent to which the international environmental law regime for the protection of the ozone layer is enabling us to remain within this planetary boundary. The chapter reflects on some of the causes and impacts of ozone depletion, as well as the extent of historic ozone depletion. It then discusses the legal regime for ozone protection, focusing specifically on ongoing efforts to refine and strengthen the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer. She argues that the Montreal Protocol has not only responded effectively to the problem of ozone depletion, but has also – thus far – enabled us to remain within the 'safe operating space' of this particular boundary. However, the rapidly rising emission of greenhouse gases (in particular, carbon dioxide, methane and nitrous oxide), and inadequate human responses to global warming present uncertainties in regard to their potential impacts on stratospheric ozone. The chapter highlights, in the final instance, the interdependence of the planetary boundaries, and argues that coordinated international environmental law responses to such challenges will be crucial to ensure that we do not transgress the planetary boundary on stratospheric ozone depletion.

Another planetary boundary that is related to the foregoing two boundaries is that of 'atmospheric aerosol loading', and it is the focus of Chapter 15. Leslie-Anne Duvic-Paoli and Emily Webster detail how the global concentration of aerosol particles has more than doubled since pre-industrial times, and that their harmful impacts on human health and the climate justify the specific inclusion and elaboration of this specific planetary boundary. In this chapter, the authors map the international legal landscape applicable to aerosol loading and identify two categories of responses: one concentrating explicitly on limiting aerosol emissions, including by regulating air pollution; the other indirectly targeting emissions by governing their sources, such as fossil fuel combustion and land use changes. They show how, in response to improved public awareness of air pollution, the international community has recently started to mobilize to protect this planetary boundary. However, they also believe it is arguably one of the more elusive planetary boundaries for policy makers and lawyers, due to the complexity and remaining uncertainties surrounding scientific knowledge on aerosol loading. The planetary boundary is also difficult to apprehend because it concentrates only partially on the air pollution problem and proposes a global frame to respond to a primarily regional problem. They show that a further hurdle lies in a lack of political appetite for an international, legally binding framework to govern aerosol loading. As a result, a complex international legal landscape has emerged, characterised by its fragmentation and reliance on non-treaty alternatives, which has, so far, been unable to provide an optimal and comprehensive response to protect the planetary boundary.

In Chapter 16, Tim Stephens directs attention to the 'ocean acidification' boundary, which refers to the changing carbon chemistry of the oceans as they absorb carbon dioxide (CO_2) from the atmosphere. This boundary is closely linked to the climate change boundary, as both relate to human disturbances to Earth's carbon cycle. However, the chapter shows that there are important differences, and argues that the safe threshold for climate change may not necessarily be equivalent to that for ocean acidification. The chapter also examines the definition of the ocean acidification planetary boundary and assesses its strengths and limitations. It then sets out the global legal and policy frameworks applicable to ocean acidification and considers the extent to which these are capable of keeping changes to ocean chemistry within the limits of the ocean acidification planetary boundary. It is seen that this planetary boundary has greatest relevance to the climate regime built around the 1992 United Nations Framework Convention on Climate Change and the 2015 Paris Agreement on Climate Change, as this is the primary forum where efforts to limit CO_2 emissions are being pursued.

Keeping the focus on the global oceans, Daniela Diz investigates the legal framework related to the 'nitrogen and phosphorus flows to the biosphere and oceans' boundary in Chapter 17. She assesses the extent to which the law of the sea regime is equipped to control some of the key drivers of biogeochemical cycle alterations. Given the diffuse nature of the entry points of nutrients into the marine environment, including through agricultural run-offs and atmospheric emissions, aggravated as this is by unsustainable patterns of consumption and production and system inefficiencies, this poses a significant challenge for the global law and governance regime. The implementation of the ecosystem approach, as elaborated by decisions of the Conference of Parties to the Convention on Biological Diversity of 1992, linking watersheds and seas, and supported by cooperation at all scales – from local to regional to global levels – is necessary, albeit difficult to operationalise, especially in light of a fragmented regulatory regime. This chapter then explores the role of the 1982 United Nations Convention on the Law of the Sea in addressing this issue in a holistic manner, while recognising not only its strengths, but also its limitations. It further explores synergies between the 1982 Convention's obligation to protect and preserve the marine environment from land-based sources of pollution and relevant global and regional legally and non-legally binding instruments, including global goals and targets, such as the Sustainable Development Goals, with a particular focus on the use of fertilisers as a significant source of nitrogen and phosphorus into the marine environment.

Another water-related planetary boundary is 'freshwater consumption and the global hydrological cycle'. Nathan Cooper considers in Chapter 18 the current state of law and governance relating to freshwater conservation and consumption, including in particular the application and evolution of an international human right to water, integrated water resources management and Sustainable Development Goal 6: Clean Water and Sanitation. Between them, these regulatory domains make explicit claims to the fundamentality of a right to water, to water's essential developmental role and to the need for sustainable water governance over the long term. The chapter details the many institutional and operational challenges facing efforts to realise sustainable water use through each of these domains. It also argues that implicit assumptions exist within each of these domains around limitless supply and commodification. Such assumptions support an anthropocentric cosmology, which fetishizes a neoliberal market paradigm, and in so doing drains the transformative power latent in each of these domains. Central to this is the myth that humanity can continue to consume and develop, unbounded by the physical finitude of Earth's systems, while it significantly undermines the ability of the international legal order to adequately respond to the Anthropocene challenge of fast approaching planetary boundaries. The chapter proposes that the destructive myth of human mastery must be rejected if water security is to be achieved. In its place we must reconnect our societies with the realities of the biosphere's limits, so that safe and just water governance, across regulatory domains, can emerge.

In Chapter 19, Karen Morrow considers the legal framework related to the 'land system change' boundary, and shows in particular how this boundary directs attention towards the conversion of land for multifarious human purposes. In addition to being hugely significant in itself, land use change also exhibits marked interaction with many of the other planetary boundaries. As distinct from some of the more technical boundaries, land use change is directly and visibly rooted in intentional human activities. In consequence, addressing it requires encapsulating multiple dimensions, beyond the quantitative, extending to qualitative, functional and spatial elements. This multi-dimensionality and the fact that the nature of land use change brings the social aspect of the boundary very much to the fore make selecting an appropriate indicator for it particularly challenging. The current indicator, global forest area, is well established in legal scholarship as contentious in its own right. The choice of forests as an indicator also serves to dramatize the more fundamental difficulty of finding an effective way to marry the science of planetary boundaries to human social systems. The challenges faced in this regard are profound, but not insuperable, and having highlighted the nature of the task in hand, the chapter concludes by examining possible future directions of epistemic travel.

The book concludes with Chapter 20 that focuses on the boundary of ‘chemical pollution (and the release of novel entities)’. In this chapter, Tiina Paloniitty, Chukwukpee Nzegwu and Duncan French describe how the international legal, policy and institutional framework on chemical pollution, while having evolved noticeably over time, has remained piecemeal, and arguably is still reflective of a lack of political will to truly tackle the seriousness of what is undoubtedly a global problem. As one component of this planetary boundary – the other element being the release of novel entities, which is not covered in this chapter – chemical pollution is a significant ecological and human health risk, exacerbated by its cumulative impact, its toxicological build-up over time and the geographical ease by which it spreads. Notwithstanding the current lack of consensus on a planetary boundary threshold, the global challenge is acute. This chapter also considers the state of current international chemicals law, as well as the relevance of transnational attempts to control chemical pollution, most notably the European Union ‘REACH’ (Registration, Evaluation, Authorisation and Restriction of Chemicals) Regulation. Recognising the complexity of chemical pollution, the chapter proposes a move away from a single global regime, to embrace the plurality of regulatory responses, both international and regional, as effective means to tackle this particular challenge. Nevertheless, such regimes must recognise the innate inequity in the present global economic and political structure, and address the current lack of substantive solidarity towards, especially, the global South.

8. FUTURE DIRECTIONS

The innate strength of the insights that social scientific and legal analyses provides on an issue such as the planetary boundaries is also their weakness. We are rarely able to conclude with definitive recommendations, or solutions. Many of the chapters have identified gaps in the law – implicitly, gaps that should be filled – as well as indicating structural limitations in the governance and regimes that presently exist, which should also be addressed if we are to effectively tackle law’s incapacities in this most global set of problems. Whether rectifying such challenges will prevent the limits being breached, and Earth’s capacity being exhausted, is difficult to say. Of course, failure of the law is a strong indicator of a failure of political intention – where, in fact, such intention exists.

Law also has a secondary rhetorical function in this instance, along with other factors, such as the emergence of popular movements and political discourse. It can translate the difficult to apprehend – and admittedly many of the planetary boundaries are surrounded in technicality and scientific jargon – into more easily digestible instructions. True, regulatory law can itself be opaque; but at the level of principle (and, an important subset of this, the particular role of both *ratio* and *obiter* in judicial decision-making) law can help support and supplement the broader dissemination of key ideas, and threats. And that is something on which international law is especially strong; just as it is perceived – rightly or wrongly – as being relatively weak in enforcement, it has a strong moral inducement.

But as we have been at pains to stress throughout, international law is not the only legal type from which to take inspiration, or on which to base a normative solution. More and more national courts are finding a proactive judicial voice, and many domestic legal systems (including at the sub-national level) are beginning to recognise that the traditional jurisprudential conceptions of environmental law are no longer proving effective. One interesting example is the Well-Being of Future Generations (Wales) Act 2015, adopted by the National Assembly for Wales.[40] Though it does not reference planetary boundaries, it indicates a future where it might. One of the wellbeing objectives which Welsh public authorities must pursue[41] is a 'globally responsible Wales', which it defines as 'A nation which, when doing anything to improve the economic, social, environmental and cultural well-being of Wales, takes account of whether doing such a thing may make a positive contribution to global well-being'.[42] The Act requires such wellbeing objectives to be supplemented with the establishment of measurable indicators, for public bodies to report annually on progress, for external auditing to assess compliance and for a Future Generations Commissioner to be established. Hortatory or meaningful legislation? Only time will tell. As one example among an increasing number of a different means by which to hold the polity to account through governance and law, it is certainly worth further exploration. Could the model be extended to the planetary boundaries? Absolutely. Similarly, could constitutional norms be enlarged – through legislative amendment or judicial interpretation – to include more expressly the planetary boundaries inherent within Gaia, or other such nomenclature? Equally, why not?[43]

But this simply question-begs a further, and broader, question: is planetary boundaries the appropriate framework on which to base a global strategy? Some of the chapters have highlighted some specific concerns with the framing of the planetary boundaries as they currently exist. Some contributions have critiqued whether the planetary boundaries go sufficiently far, or will be able to prompt radical enough change. None have suggested that they are not an improvement on the status quo, or do not highlight key challenges facing the planet, or the human family that presently inhabits it. They invariably reflect some of our current best guesses as to what we face and when we must act. As we note above, the authors of the framework very expressly have decided not to tell us how we should act.

The Sustainable Development Goals were adopted in 2015 as a 'new universal Agenda' and as 'a plan of action for people, planet and prosperity'.[44] We make no bold claim to the reconciliation of the planetary boundaries and the Sustainable Development Goals: in part they reconcile, to the extent that they cover similar ground, but in part they do not, nor were they intended. Rather we merely repeat, as quoted above, the pronouncement of some of the leading authors of the planetary boundary framework.

> There is an urgent need for a new paradigm that integrates the continued development of human societies and the maintenance of the Earth system (ES) in a resilient and accommodating state. The

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40 Deddf Llesiant Cenedlaethau'r Dyfodol (Cymru) 2015; 2015 anaw 2.

41 Ibid, section 3(2): 'The action a public body takes in carrying out sustainable development must include – (a) setting and publishing objectives ("well-being objectives") that are designed to maximise its contribution to achieving each of the well-being goals, and (b) taking all reasonable steps (in exercising its functions) to meet those objectives.'

42 Ibid, section 4 and Table 1.

43 Louis J Kotzé, 'A Global Environmental Constitution for the Anthropocene?' (2019) 8(1) Transnational Environmental Law 11.

44 Transforming Our World: The 2030 Agenda for Sustainable Development, GA Res 70/1, UN Doc A/RES/70/1 (25 September 2015) UN Doc A/RES/70/1, preamble.

> planetary boundary (PB) framework contributes to such a paradigm by providing a science-based analysis of the risk that human perturbations will destabilize the ES at the planetary scale.[45]

In short, the planetary boundaries have highlighted the ecological reality in which we can – if we so wish – craft our desired human society. Transgressing those boundaries will create untold and planetary-level perturbations which will 'destabilize the [Earth system] at the planetary scale'. That is not something we should want to test empirically.

[45] See Steffen et al (n 23) 1259855.

PART I

LEGAL, ETHICAL AND GOVERNANCE DIMENSIONS OF THE PLANETARY BOUNDARIES

2. Exploring the planetary boundaries and environmental law: historical development, interactions and synergies[1]

Alice Bleby, Cameron Holley and Ben Milligan

1. INTRODUCTION

The Earth and its communities of life face the mounting toll of planetary ecological degradation. We live in a time characterised by multiple and increasing environmental catastrophes, the threat of uncertain and possibly devastating consequences in the long term and anxiety about whether and when the Earth may reach a 'tipping point' of no return. In this context, the possibility of identifying a 'safe operating space for humanity' is an appealing aim.[2]

This objective is at the heart of the planetary boundaries concept, proposed by Rockström and colleagues in 2009. Drawing on Earth system science, ecological economics and frameworks of resilience, complex dynamics and self-regulation,[3] Rockström and colleagues identified nine 'key Earth System processes' critical to the functioning, self-regulation and resilience of the Earth and made 'a first attempt at identifying planetary boundaries … associated with dangerous thresholds, the crossing of which could push the planet out of the desired Holocene state'.[4] Remaining within the planetary boundaries for climate change, ocean acidification, stratospheric ozone, nitrogen and phosphorus cycles, freshwater, land system change, biodiversity, chemical pollution and atmospheric aerosol loading, it was argued, creates for humanity 'the freedom to pursue long-term social and economic development'[5] (albeit that such freedoms will likely differ for different parts of humanity, such as the global south versus the global north).[6]

Since its publication in 2009, the planetary boundaries framework has received substantial academic attention and is gaining traction in public discourse. While the majority of this attention has been in the scientific domain,[7] it is increasingly the subject of discussion and investigation in the social sciences, including human development, economics, law and governance (as evidenced by this edited collection). Of course, the idea of limiting human activity to

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1 We are grateful to Georgia Regan for her research assistance in the preparation of this chapter. This research was supported by two Australian Research Council Discovery Project grants (project numbers DP170100281 and DP190101584).

2 Johan Rockström et al, 'Planetary Boundaries: Exploring the Safe Operating Space for Humanity' (2009) 14 Ecology and Society 32.

3 Ibid 35.

4 Ibid 33.

5 Johan Rockström et al, 'A Safe Operating Space for Humanity' (2009) 461 Nature 472, 475; for further critique on this issue see Adelman, Chapter 4 in this book.

6 See on the issue of equity and justice, Kim and Kotzé, Chapter 3 in this book.

7 Fred P Saunders, 'Planetary Boundaries: At the Threshold … Again: Sustainable Development Ideas and Politics' (2015) 17 Environment, Development and Sustainability 823, 826.

protect the environment is not new: from early conceptions of safe minimum standards,[8] to the Limits to Growth debate catalysed by the 1972 report of the Club of Rome,[9] the Gaia hypothesis and habitability,[10] the guardrails and tolerable windows approach posited by the German Advisory Council on Global Change,[11] and into the contemporary Sustainable Development Goals (SDGs) and international climate commitments,[12] scientists, policy-makers and environmental advocates have sought to restrain human activity in the interests of the environment and society. The planetary boundaries framework echoes these approaches[13] and may inform other efforts to agree on a limit to acceptable environmental damage.

Arguably, the planetary boundaries framework is an idea whose time has come. With mounting evidence of global ecological crisis; an increasingly strong understanding in science, law and the humanities of the Earth as a single, interconnected system; globalised trade, communications and transport and a highly connected international society; and an increasingly pervasive idea of global responsibility for the Earth,[14] the planetary boundaries provide a potentially compelling conceptual framework that expresses the singularity, limits and interconnectedness of the Earth. Among many searching for solutions to address our global environmental predicament, there is a level of recognition that as the problems are global, so too must be the solutions. There is a desire to quantify the need for change in human societies and behaviour and to provide clear and tangible objectives for communities and policy-makers; and there is a quest for law and governance tools that can effectively orient, monitor and evaluate progress towards meaningful benchmarks. The planetary boundaries framework contains elements that may respond to these conditions and aspirations. It is partly for this reason that the planetary boundaries framework has begun to secure a toehold in the thinking and, to a lesser extent, the *practice* and *practise* of law and governance across the globe. Even so, the planetary boundaries concept has not materialised in a policy vacuum. Numerous targets, principles and conceptual frameworks currently orient local, regional, national and international legal systems involving multiple governance auspices, providers and tools.[15] It accordingly remains an open question as to how, and to what extent, policy-makers will supplant, synthesise or transmute the planetary boundaries framework with existing concepts and frameworks used in the governance of environmental issues.

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8 Gerald F Vaughn, ‘Siegfried Von Ciriacy-Wantrup and His Safe Minimum Standard of Conservation’ (1997) 12(4) Choices 30, 30.

9 Donella H Meadows et al, *The Limits to Growth* (Universe Books 1972).

10 James E Lovelock and Lynn Margulis, ‘Atmospheric Homeostasis by and for the Biosphere: The Gaia Hypothesis’ (1974) 26 (1–2) Tellus 2.

11 Gerhard Petschel-Held et al, ‘The Tolerable Windows Approach: Theoretical and Methodological Foundations’ (1999) 41(3–4) Climatic Change 303.

12 ‘Paris Agreement’, Draft decision -/CP.21 (12 December 2015) UN Doc FCCC/CP/2015/L.9/Rev.1, art 2(1)(a).

13 Rockström et al (n 2) 35–36.

14 See for example ‘Chile Madrid Time for Action’, Draft Decision -/CP.25 (15 December 2019) UN Doc FCCC/CP/2019/L.10; Fridays for Future <http://fridaysforfuture.org> accessed 6 June 2020.

15 See generally Neil Gunningham, Peter Grabosky and Darren Sinclair, *Smart Regulation: Designing Environmental Policy* (Clarendon Press 1998); Cameron Holley, ‘Linking Law and New Governance: Examining Gaps, Hybrids, and Integration in Water Policy’ (2016) 38(1) Law and Policy 24; Cameron Holley and Clifford Shearing, ‘A Nodal Perspective of Governance: Advances in Nodal Governance Thinking’ in Peter Drahos (ed), *Regulatory Theory: Foundations and Applications* (Australian National University Press 2017).

In an effort to respond to this question, this chapter critically examines the potential benefits and challenges of planetary boundaries as a conceptual framework to inform environmental law and governance responses and explores some possible synergies with other prominent framings. To do this, the chapter first discusses the evolution of the planetary boundaries framework, its integration into law and governance settings to date and its possible benefits as a guiding approach to developing legal and governance responses. It then addresses some of the challenges of the framework, both technical and conceptual. The chapter goes on to examine interactions of the planetary boundaries concept with three prominent and potentially synergistic conceptual approaches to environmental law and governance, namely sustainable development, the four-capital model and rights of nature.[16] Finally, we summarise implications of the planetary boundaries, concluding that the framework can usefully inform at least some existing conceptual approaches that may themselves help to evolve the planetary boundaries framework and respond to some of its limitations.

2. DEVELOPMENT, UPTAKE AND IMPACT OF THE PLANETARY BOUNDARIES FRAMEWORK

In its 2009 publication, the planetary boundaries framework represented a new approach to characterising global environmental sustainability, and research to explore its implications and address its uncertainties has continued. The evolution of the planetary boundaries is discussed in Section 2.1. There have also been many attempts to operationalise and downscale the planetary boundaries to regional, national and local levels to guide domestic environmental law and governance responses (Section 2.2). The relevance of the planetary boundaries concept is evidenced by the widespread uptake of the idea in diverse policy and governance contexts around the world (Section 2.3). The persistence of this idea over more than ten years, and the traction it continues to gain, suggests that certain beneficial attributes of the planetary boundaries framework have strengthened its impact, considered in Section 2.4.

2.1 Evolution of the Planetary Boundaries Framework

Although the idea of placing limits on human activity to protect the environment has a long history, the planetary boundaries framework offers a novel approach to addressing global ecological problems. Among other things,[17] the novelty of this framework includes its ability to bring multiple different critical systems (and therefore multiple environmental problems) into a single framework,[18] in contrast to law and governance instruments that tend to focus on a single system only.

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[16] Of course there are many other frameworks one could choose, such as ecological integrity, but in a chapter of this size we have necessarily limited our scope. There are also other potential interactions between the planetary boundaries framework and other policies, laws, governance and disciplinary fields. See for example Frank Biermann and Rakhyun E Kim, 'The Boundaries of the Planetary Boundary Framework: A Critical Appraisal of Approaches to Define a "Safe Operating Space" for Humanity' (2020) 45 Annual Review of Environment and Resources 1.

[17] See also the benefits we discuss further below in Section 2.4.

[18] Victor Galaz et al, 'Global Environmental Governance and Planetary Boundaries: An Introduction' (2012) 81 Ecological Economics 1, 1.

Within each of the nine planetary boundaries, the authors of the framework identified one or more control variables that was deemed to best reflect the status of the boundary process (recognising that great uncertainty remains about behaviour and interactions within each process and the exact point and nature of thresholds that may produce irreversible and/or catastrophic change). Drawing on a broad range of scientific study relevant to each boundary, they identified a zone of uncertainty around a threshold or dangerous level and, applying the precautionary principle, set the 'boundary' at the low end of the zone of uncertainty.[19] The boundaries for each process, then, are the limits which human activity must not exceed in order to remain a 'safe' distance away from the threshold over which each process 'could shift into a new state, often with deleterious or potentially even disastrous consequences for humans'.[20] With the exception of the two processes for which it has not yet been possible to determine a meaningful global boundary (chemical pollution and atmospheric aerosol loading),[21] the planetary boundaries represent quantified, measurable limits to the human impact that can be sustained by the Earth.

It is significant that the planetary boundaries framework rests on several important assumptions. First, it assumes that humanity desires to remain in the Holocene, the stable Earth system conditions which have allowed humans to flourish for more than 10,000 years. Although there is some contestation based on the possibility that altered conditions may improve human welfare,[22] the evidence of inhospitable conditions prior to the Holocene and the enormous uncertainty surrounding any alternative state[23] suggest this is a reasonable starting point. Second, the placement of each boundary is based on the assumption that all other boundaries remain within safe limits.[24] The nine planetary boundary processes are interdependent, and changes in one process may have significant implications for another.[25] Given that we have already crossed four of the nine boundaries (climate change, biodiversity, land system change and the nitrogen and phosphorus cycles),[26] this is something of a leap of faith; ultimately, it emphasises the importance of safeguarding all nine boundaries, as part of an interconnected Earth system. Interactions between the Earth's subsystems remain some of the most critical knowledge gaps in the framework.[27] Third, the designation of any specific boundary, while rooted in scientific understanding of the Earth's processes and function, is fundamentally a normative process because it is based on judgements about how much risk the human community is willing to assume, and the extent to which its component communities are capable of bouncing back from disaster (their level of resilience).[28] These considerations are difficult to determine with any certainty as they invoke moral, ethical, social, economic and political

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19 Rockström et al (n 2) 34, 35, 52.

20 Rockström et al (n 5) 472.

21 See, for a discussion, respectively Paloniitty, Nzegwu and French, Chapter 20, and Duvic-Paoli and Webster, Chapter 15, in this book.

22 Ted Nordhaus, Michael Shellenberger and Linus Blomqvist, *The Planetary Boundaries Hypothesis: A Review of the Evidence* (Technical Report, Breakthrough Institute 2012) 7–8.

23 Will Steffen et al, 'Planetary Boundaries: Guiding Human Development on a Changing Planet' (2015) 347 Science, 1259855–1.

24 Rockström et al (n 2) 35.

25 Johan Rockström, 'Planetary Boundaries' (2010) 27 New Perspectives Quarterly 72, 73.

26 Johan Rockström and Mattias Klum, 'Planetary Boundaries' in Johan Rockström and Peter Miller, *Big World, Small Planet: Abundance Within Planetary Boundaries* (Yale University Press 2015) 77–78.

27 Rockström et al (n 2) 51–52.

28 Ibid 36.

considerations that are likely to vary with context.[29] Deep inequalities exist between regions, nations, social groups and individuals in their contributions to land system change, climate change or changes to other planetary systems, as well as the extent to which they become victims of risks arising from crossing these boundaries.[30] Vulnerability to such risks will often intersect with social inequalities,[31] which is further complicated by an agreement on risks and the need for building resilience assuming away power, conflict and agency, and the potential politics of risk and resilience.[32] Olsson and colleagues succinctly illustrate this challenge when discussing the context of poverty and building system resilience: 'one person's resilience may be another person's vulnerability … emphasis on system-level resilience may work against the interest of people who are poor.'[33]

Notwithstanding these challenges, by demonstrating that we have already crossed four of the planetary boundaries and are close to transgressing several others, the framework makes a strong case for urgently reducing human impact on the Earth system.[34] In particular, its use of planetary boundaries to enclose a 'safe operating space for humanity' in which development can continue without compromising the Earth system retains a note of optimism that suggests the continuation of human prosperity and growth.[35]

An update to the framework was published in 2015, and introduced several modifications.[36] Steffen and colleagues designated the climate change and biosphere integrity (previously biodiversity loss) boundaries as 'core' boundaries that interact with all other planetary boundaries, but which also are the processes or systems within which all other planetary boundaries processes function. Effectively, these 'core' planetary boundaries are on the scale of the whole Earth system, whereas the remaining planetary boundaries are subsystems that feed into and influence the larger system. The critical finding emerging from this distinction is that 'large changes in the climate or in biosphere integrity would likely, on their own, push the Earth system out of the Holocene state', whereas '[t]he crossing of one or more of the other boundaries may seriously affect human well-being and may predispose the transgression of a core boundary(ies) but does not by itself lead to a new state of the Earth system'.[37] This elevates the criticality of the climate change and biosphere integrity boundaries, and downgrades the relative importance of the remaining boundaries, in that they are considered not likely to, on their own, cause the 'unacceptable environmental change' feared to be the result of transgressing any of the planetary boundaries in the original analysis.[38] However, this 'hierarchy of boundaries' clarifies an important quality of the Earth system by underlining the special significance of the core boundaries and arguably does not detract from a central argument of the planetary

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29 Bridget Hutter (ed), *Risk, Resilience, Inequality and Environmental Law* (Edward Elgar 2017).

30 Bridget Hutter, 'Risk, Resilience and Inequality: Current Dilemmas in Environmental Regulation' in ibid 14.

31 Ibid.

32 Lennart Olsson et al, 'Why Resilience is Unappealing to Social Science: Theoretical and Empirical Investigations of the Scientific Use of Resilience' (2015) 1(4) Science Advances 1.

33 Ibid; see also Jonathan Joseph, 'Governing through Failure and Denial: The New Resilience Agenda' (2016) 44(3) Millennium: Journal of International Studies 370.

34 Galaz et al (n 18) 1.

35 See for example Rockström and Klum (n 26) 59; see also the discussion in Adelman, Chapter 4 in this book.

36 Steffen et al (n 23).

37 Ibid 1259855–8.

38 Rockström et al (n 5) 472.

boundaries framework: that '[h]umanity … needs to become an active steward of all planetary boundaries – the nine identified … and others that may be identified in future – in order to avoid risk of disastrous long-term social and environmental disruption'.[39]

Further updates to the planetary boundaries framework consolidated in 2015 include the addition of sub-global control variables and boundaries for five planetary boundaries (biosphere integrity, biogeochemical flows, land system change, freshwater and atmospheric aerosol loading), where sub-global changes have the potential to influence the overall functioning of the relevant Earth system process. In addition to several name changes that reflect an evolving understanding of the planetary boundaries processes (most notably the shift from biodiversity loss to biosphere integrity and from chemical pollution to novel entities), each individual planetary boundary was re-examined and updated. For example, the biosphere integrity planetary boundary now reflects a 'two-component approach, addressing the two key roles of the biosphere in the Earth system'[40] and although the extinction rate control variable remains, it is acknowledged as weak and the desirability of alternatives (canvassed in the research of Mace et al[41]) is emphasised as well. The phosphorus cycle component of the biogeochemical flows planetary boundary was revised to incorporate freshwater systems in addition to flows to the ocean, drawing on the work of Carpenter and Bennett.[42] Although it is still not considered possible to determine a planetary boundary for novel entities, the 2015 update reflects the evolution of scientific thinking about this environmental problem, notably in the work of Persson et al[43] and MacLeod et al.[44]

2.2 Operationalising and Downscaling the Planetary Boundaries

A range of attempts have been made to operationalise the planetary boundaries framework by downscaling the planetary boundaries from global to national, regional and even local scales.[45] National parameters derived from the planetary boundaries have been developed for Sweden,[46]

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39 Rockström et al (n 2) 52.

40 Steffen et al (n 23) 1259855–5.

41 Georgina M Mace et al, 'Approaches to Defining a Planetary Boundary for Biodiversity' (2014) 28 Global Environmental Change 289.

42 Stephen R Carpenter and Elena M Bennett, 'Reconsideration of the Planetary Boundary for Phosphorus' (2011) 6 Environmental Research Letters 1.

43 Linn M Persson et al, 'Confronting Unknown Planetary Boundary Threats from Chemical Pollution' (2013) 47(22) Environmental Science and Technology 12619.

44 Matthew MacLeod et al, 'Identifying Chemicals That Are Planetary Boundary Threats' (2014) 48(19) Environmental Science and Technology 11057.

45 See also Kim and Kotzé, Chapter 3 in this book.

46 Björn Nykvist et al, *National Environmental Performance on Planetary Boundaries: A Study for the Swedish Environmental Protection Agency* (Report No 6576, Swedish Environmental Protection Agency 2013) <www.naturvardsverket.se/Documents/publikationer6400/978-91-620-6576-8.pdf> accessed 11 March 2020.

South Africa,[47] Switzerland[48] and the European Union (EU).[49] Regional applications, focusing primarily on regional sustainability challenges but drawing on the planetary boundaries framework, have been developed for the Bangladesh Delta[50] and the Heihe River in China.[51] Biophysical and socio-economic indicators derived from the planetary boundaries have also been developed to apply to cities or urban agglomerations.[52] Several downscaling methods draw on existing indicators and/or a footprint-approach to measuring environmental impact.[53] However, downscaling the planetary boundaries presents many methodological challenges. The authors of the framework have repeatedly stressed that '[t]he PB [planetary boundaries] framework is not designed to be "downscaled" or "disaggregated" to smaller levels, such as nations or local communities'.[54] Yet, even from the small range of studies discussed, it is clear that using different methods to downscale the boundaries in a national context can lead to very different estimates of each country's (or indeed other defined geographic unit's) objectives and responsibilities to contribute to the global effort to stay within the planetary boundaries.[55] As discussed further below, this may complicate the concept of a globally applicable, integrated framework and attempts to coordinate a sufficiently ambitious global response through a Westphalian-inspired global legal system.[56]

Perhaps partly because of this, others have focused on enlivening the social and ethical dimensions of the planetary boundaries – that is, examining the human rights, development and equity issues that will arise in any attempt to reposition human society within the planetary boundaries. Raworth's 'living within the doughnut' metaphor introduced a minimum social foundation mapped on to the planetary boundaries framework, arguing it was both necessary and possible for humanity to exist above the social foundation and below the 'environmental ceiling' created by the planetary boundaries – within the 'doughnut' of 'a safe *and just* space

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47 Megan J Cole, Richard M Bailey and Mark G New, 'Tracking Sustainable Development with a National Barometer for South Africa Using a Downscaled "Safe and Just Space" Framework' (2014) 111(42) Proceedings of the National Academy of Sciences of the United States of America E4399.

48 Hy Dao, Pascal Peduzzi and Damien Friot, 'National Environmental Limits and Footprints Based on the Planetary Boundaries Framework: The Case of Switzerland' (2018) 52 Global Environmental Change 49.

49 Holger Hoff et al, Bringing EU Policy into Line with the Planetary Boundaries (Discussion Brief, Stockholm Environment Institute 2017) <www.sei-international.org/publications?pid=3128> accessed 11 March 2020.

50 Md Sarwar Hossain et al, 'Operationalizing Safe Operating Space for Regional Social-Ecological Systems' (2017) 584–85 Science of the Total Environment 673.

51 Heng Yi Teah et al, 'Assessment of Downscaling Planetary Boundaries to Semi-Arid Ecosystems with a Local Perception: A Case Study in the Middle Reaches of Heihe River' (2016) 8(12) Sustainability 1233.

52 Daniel Hoornweg, Christopher Kennedy and Azin Behdadi, 'An Urban Approach to Planetary Boundaries' (2016) 45 Ambio 574. See, for an extensive discussion on cities, law, and the planetary boundaries, Aust and Nijman, Chapter 6 in this book.

53 See for example Kai Fang et al, 'The Environmental Sustainability of Nations: Benchmarking the Carbon, Water and Land Footprints against Allocated Planetary Boundaries' (2015) 7(8) Sustainability 11285.

54 Steffen et al (n 23) 1259855–8.

55 Cole, Bailey and New (n 47) 8; see also Tiina Häyhä et al, 'From Planetary Boundaries to National Fair Shares of the Global Safe Operating Space – How Can the Scales Be Bridged?' (2016) 40 Global Environmental Change 60, 66–68.

56 See Frisso and Kirk, Chapter 8, and Hey, Chapter 9, in this book.

for humanity'.[57] This idea has been extended by examining whether the biophysical resources required to meet the basic needs of all humanity are available within the planetary boundaries,[58] and integrating the planetary boundaries into scenario analysis to map ecological and social stresses.[59] Häyhä and colleagues argue that it is both possible and necessary to operationalise the planetary boundaries despite some 'blunt simplifications [that] need to be made to enable and mobilise societal action for global sustainability'.[60] They suggest that this can be achieved by explicitly translating the global-level planetary boundaries through three distinct steps, namely, addressing the biophysical, socio-economic and ethical dimensions of each planetary boundary. Even so, operationalising the planetary boundaries remains a challenge for law, policy and governance, particularly connecting the Earth system-level significance of diverse regional or location-specific environmental impacts.[61]

2.3 The Emergence of Planetary Boundaries in Policy and Governance

The planetary boundaries framework has only recently begun to gain a toehold in law and governance around the world. In the EU context, the 7th Environment Action Programme to 2020 – 'Living Well, Within the Limits of Our Planet' – refers multiple times to the planetary boundaries (in addition to implicitly invoking the planetary boundaries in the title of the document).[62] The concept has also been acknowledged in European Commission (EC) discussions about how to achieve a Sustainable Europe in 2030 and in the context of Europe meeting the SDGs (an issue to which we return below).[63] Several national governments, in Europe and elsewhere, have indicated interest in the planetary boundaries framework, including by commissioning reports (Sweden),[64] by making references in reports (United Kingdom),[65] in discussion papers (New Zealand)[66] and through facilitating international discussions (Germany).[67]

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57 Kate Raworth, 'A Safe and Just Space for Humanity: Can We Live Within the Doughnut?' (Discussion Paper, Oxfam International 2012) <www-cdn.oxfam.org/s3fs-public/file_attachments/dp-a-safe-and-just-space-for-humanity-130212-en_5.pdf> accessed 11 March 2020, emphasis added.

58 Daniel W O'Neill et al, 'A Good Life for All within Planetary Boundaries' (2018) 1 Nature Sustainability 88.

59 Michael D Gerst, Paul D Raskin and Johan Rockström, 'Contours of a Resilient Global Future' (2014) 6 Sustainability 132.

60 Häyhä et al (n 55) 68.

61 Ibid.

62 Parliament and Council Decision 1386/2013/EU of 20 November 2013 on a General Union Environment Action Programme to 2020 'Living well, within the limits of our planet' [2013] OJ L 354/171, paras 8, 71, 73, 106.

63 *Towards a Sustainable Europe by 2030* (Reflection Paper, European Commission, 30 January 2019) <https://ec.europa.eu/commission/sites/beta-political/files/rp_sustainable_europe_30-01_en_web.pdf> accessed 11 March 2020.

64 Nykvist et al (n 46).

65 Jonathan Wentworth, *Environmental Limits* (Report No 370, UK Parliamentary Office for Science and Technology 2011).

66 Margreet Frieling and Ken Warren, *Resilience and Future Wellbeing: The Start of a Conversation on Improving the Risk Management and Resilience of the Living Standards Capitals* (Discussion Paper No 18/05, New Zealand Treasury 2018) <https://treasury.govt.nz/sites/default/files/2018-07/dp18-05.pdf> accessed 11 March 2020.

67 Benno Keppner, *Outcomes of the International Conference: 'Making the Planetary Boundaries Work', 24–25 April 2017 Berlin* (Report, Adelphi 2017) <www.adelphi.de/en/system/files/mediathek/bilder/Outcomes_Planetary-Boundaries-Conference_Berlin-2017.pdf> accessed 11 March 2020.

The planetary boundaries framework has also received some acknowledgement within the United Nations (UN), including by the UN Secretary-General's High Level Panel on Global Sustainability,[68] and in the Global Environmental Outlook published by the UN Environment Program.[69] However, it was not included in 'The Future We Want', the outcome document of the 2012 Rio+20 UN Conference on Sustainable Development,[70] and does not appear in the 2015 General Assembly Resolution 'Transforming Our World: The 2030 Agenda for Sustainable Development', which adopts the SDGs as global objectives for sustainability.[71] Saunders suggests that this reflects a resistance on the part of the global south to the idea of limits (which was also reflected in the Limits to Growth debate that emerged in the 1970s).[72] This is based on the concern that embedding the planetary boundaries (or a similar set of global limits) in international decision-making would restrict the capacity of developing countries to achieve their goals for human development and higher living standards. It may also reflect a realpolitik anticipated by Rockström, Sachs and colleagues in the attitudes of developed countries: the global north is likely to reject the premise, posited as an alternative to ceasing growth and development in the global south, that '[r]ich countries need to substantially reduce their standard of living, and developing countries can grow until they converge at the lower income of high-income countries. At that point economic growth would need to stop.'[73]

Outside of nation states, several international non-government organisations (NGOs) have also promoted the concept in their policy advocacy. Raworth first developed the above-mentioned 'doughnut' approach as part of an Oxfam Discussion Paper in 2012.[74] The planetary boundaries are discussed in the World Wildlife Fund (WWF)'s *Living Planet Report 2018: Aiming Higher*,[75] and in the work of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES).[76] The International Union for Conservation of Nature (IUCN) also highlights the serious risks of transgressing the planetary boundaries in the *IUCN World Declaration on the Environmental Rule of Law*.[77] In short, the planetary boundaries are beginning to find traction in law and governance approaches, albeit more at the margins than is the case for other frameworks such as sustainable development.

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68 *Resilient People, Resilient Planet: A Future Worth Choosing* (United Nations Secretary-General's High-level Panel on Global Sustainability 2012).

69 *Global Environment Outlook GEO-6: Healthy Planet, Healthy People* (UN Environment 2019).

70 The Future We Want, GA Res 66/288 (27 July 2012) UN Doc A/RES/66/288.

71 Transforming Our World: the 2030 Agenda for Sustainable Development, GA Res 70/1 (25 September 2015) UN Doc A/RES/70/1.

72 Saunders (n 7) 827–30.

73 Johan Rockström et al, 'Sustainable Development and Planetary Boundaries' (Background Research Paper submitted to the High Level Panel on the Post-2015 Development Agenda, 2013) <www.eesc.europa.eu/resources/docs/sustainable-development-and-planetary-boundaries.pdf> accessed 11 March 2020, 5–6.

74 Raworth (n 57).

75 Monique Grooten and Rosamunde Almond, *Living Planet Report – 2018: Aiming Higher* (WWF 2018) <www.wwf.org.uk/sites/default/files/2018-10/wwfintl_livingplanet_full.pdf> accessed 11 March 2020.

76 *The Assessment Report on Land Degradation and Restoration* (Report, Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services 2018).

77 International Union for Conservation of Nature, 'World Declaration on the Environmental Rule of Law' (The IUCN World Congress on Environmental Law, Rio de Janeiro April 2016) <www.iucn.org/sites/dev/files/content/documents/world_declaration_on_the_environmental_rule_of_law_final_2017-3-17.pdf> accessed 11 March 2020.

2.4 Benefits of the Planetary Boundaries Concept and Framework

Global debate is crowded with ideas for responding to the global ecological crisis and suggested frameworks for mitigating and measuring environmental damage. The growing interest of academics, policy-makers, governments and advocates in the planetary boundaries concept suggests that the framework is perceived to have certain advantages by those seeking to address our planetary quandary.

The rhetorical force of the planetary boundaries, including the simplicity of the concept,[78] and the clear message it imparts about the danger of humanity stressing the Earth more than it can bear, is arguably a powerful advantage in a scientific and political environment clouded with uncertainty, scepticism and a cacophony of arguments about the right way to problematise, measure and solve global ecological problems. The concept of 'boundaries' is one that has resonated; after all, '[i]ntuitively, such an approach feels obvious to most people. We're accustomed to operating within the confines of safe boundaries in our own lives.'[79] It also conveys the urgency of responding to the planet's unfolding disasters, by showing that we have already exceeded safe levels and that the consequences of these excesses threaten life on Earth.

The planetary boundaries framework takes the familiar concept of limits to human impact on the environment, expressed in a range of international treaties, policy instruments and theoretical debates, and substantiates it with wide-ranging scientific evidence that puts a specific, measurable number on global ecological limits for the first time.[80] It also removes economic, technological and sovereign state politics from the determination of those limits, focusing exclusively on the biophysical realities of the Earth system.[81] Although admittedly based on a normative assessment of how much risk can be tolerated, the global scale and focus on critical Earth system processes of the planetary boundaries attempts to disarm the political contestability of defining 'safe operating spaces', allowing for a full range of policy choices with no pre-determined dependencies, other than the need to remain within biophysical planetary limits.[82] The result is a scientifically-based approach to establishing objectives for environmental protection and recovery (although, as discussed elsewhere in this chapter, the ways in which these objectives are implemented will likely be complex and contentious). Putting critiques of scientific objectivity to one side,[83] this suggests that the planetary boundaries can potentially act as an 'objective' starting point or common ground for international efforts to address environmental issues and could support international benchmarking and environmental monitoring efforts – for example as a reference point for the cumulative achievements of multilateral environmental agreements.

The global and holistic character of the planetary boundaries reflects what we now know about the interconnected and interdependent nature of the Earth system and meaningfully expresses the nature of the problem. The planetary boundaries framework explains the

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78 Sarah Cornell, 'On the System Properties of the Planetary Boundaries' (2012) 17(1) Ecology and Society 2.

79 Rockström and Klum (n 26) 64.

80 Rockström et al (n 5) 474.

81 Rockström et al (n 2) 36; See also Kim and Kotzé, Chapter 3 in this book.

82 Rockström and Klum (n 26) 64–67; ibid.

83 Bruno Latour and Steve Woolgar, *Laboratory Life: The Construction of Scientific Facts* (Princeton University Press 1986); Sheila Jasanoff, *The Ethics of Invention: Technology and the Human Future* (WW Norton 2016).

functioning of the Earth system in an accessible way by defining the nine key processes impacted by humans. However, by emphasising that the nine processes form part of one Earth system, the planetary boundaries framework militates against the siloing of responses into a system-by-system approach.[84] It is clear from the first articulation of the planetary boundaries framework that we need to maintain 'extreme caution in approaching or transgressing any individual planetary boundaries'.[85] Emphasis on the global nature of the problem may help foster a sense of shared global responsibility for responding. Ultimately, it could expand the interpretation of nation states' 'responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction',[86] a core principle of international environmental law.

It can also be argued that the planetary boundaries framework is beneficial because it clearly situates human responsibility for the ecological crisis at the heart of its illustration. The nine processes for which planetary boundaries are required are selected not only based on their criticality to the Earth system, but also because they are human-impacted.[87] In the context of the Anthropocene, which recognises that humans have become a significant force influencing the Earth system, it is critically important that humans see themselves as agents rather than passive observers. Kotzé argues: '[w]ith its predominant emphasis on humans and human-induced global ecological change, the Anthropocene neatly brings into focus the centrality of people as the primary cause of the global ecological crisis and, ironically, as the only victims of this crisis that could conceivably do anything about it.'[88] The planetary boundaries trope arguably fulfils a similar function.

These advantageous features of the planetary boundaries framework provide a strong rationale for pursuing the integration of planetary boundaries into law and governance mechanisms. However, the framework also engenders critiques and challenges that must inform this pursuit.

3. CHALLENGES OF THE PLANETARY BOUNDARIES FRAMEWORK

Within a lively debate engendered by the planetary boundaries, several critical challenges have emerged for their use in law and governance. These can be loosely grouped into technical challenges and conceptual critiques.

3.1 Technical Challenges

The planetary boundaries framework has attracted criticism because of how difficult it is to operationalise at a national, regional or global scale. It has been argued that without a feasible or consistent way of translating the planetary boundaries into meaningful targets at the level at

[84] See for example the discussion in Frank Biermann, 'Planetary Boundaries and Earth System Governance: Exploring the Links' (2012) 81 Ecological Economics 4, 7.
[85] Rockström et al (n 2) 51.
[86] Rio Declaration on Environment and Development (12 August 1992) UN Doc A/CONF.151/26 (Vol. I) Annex I, Principle 2.
[87] Rockström et al (n 2) 34.
[88] Louis J Kotzé, 'Rethinking Global Environmental Law and Governance in the Anthropocene' (2014) 32(2) Journal of Energy & Natural Resources Law 121, 134.

which law and governance decisions are made, they are effectively pointless and risk encouraging legal development that is not evidence-based.[89] Although the planetary boundaries were expressly designed to provide a global assessment of impacts on the Earth system and its processes, this approach poses a significant challenge for policy-makers operating within typically slow-moving, siloed national and regional legal systems seeking to turn the planetary boundaries into tangible objectives on the ground.

Even at a global scale the planetary boundaries present operational challenges. Suggestions that a strengthened UN Environment Programme or a new World Environment Organisation take on global oversight of the planetary boundaries[90] have not gained widespread support, at least in part because it is unclear what global oversight of planetary boundaries would entail. Myriad different approaches exist for setting environmental targets,[91] and it is not clear which, if any, should be applied to the planetary boundaries. International environmental law already suffers from fragmentation, so it could be expected that attempts to govern the planetary boundaries may be plagued by issues of incoherence and problem-shifting.[92] Concerns about representation in decision-making, equity and self-determination would persist in the context of planetary boundaries as much as in other areas of international law, and inevitably questions of national sovereignty would arise.[93] Saunders comments that '[h]ow to combine a steered (designed by experts) but de-centred approach (representing "the voice of the people") such as that advocated by many planetary boundaries proponents to bring about such transformation remains conceptually confusing and elusive in practice'.[94] While thoughtful and innovative responses are emerging,[95] more work will be needed to build on and connect planetary boundaries with existing frameworks, institutions and governance mechanisms to drive a global effort to remain within the planetary boundaries.

A further test for the planetary boundaries framework is the challenge of integrating fairly ossified and detailed legal instruments with scientific uncertainty.[96] The thresholds for each of the nine processes (with the boundaries themselves set a 'safe distance' away) are surrounded by a 'zone of uncertainty', in which it is not known whether catastrophic outcomes will

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[89] José M Montoya, Ian Donohue and Stuart L Pimm, 'Planetary Boundaries for Biodiversity: Implausible Science, Pernicious Policies' (2018) 33(2) Trends in Ecology and Evolution 71, 72; see also Steve Bass, 'Keep off the Grass' (2009) 3 Nature Reports Climate Change 113.

[90] Galaz et al (n 18) 2.

[91] Häyhä et al (n 55) 65.

[92] Rakhyun E Kim and Klaus Bosselmann, 'Operationalizing Sustainable Development: Ecological Integrity as a *Grundnorm* of International Law' (2015) 24(2) Review of European, Comparative & International Environmental Law 194, 200. For a somewhat contrasting view, see Rakhyun E Kim and Brendan Mackey, 'International Environmental Law as a Complex Adaptive System' (2014) 14(1) International Environmental Agreements: Politics, Law and Economics 5, arguing that international environmental law makes up a 'complex adaptative system' that could govern complex adaptive Earth systems, albeit the adequacy of the direction and rate of adaptation for the purpose of safeguarding the integrity of Earth's life-support system is questioned. See also Piselli and Van Asselt, Chapter 7 in this book.

[93] See discussion of sovereignty issues in Biermann (n 84) 7–8.

[94] Saunders (n 7) 833.

[95] Biermann (n 84) 7; Edgar Fernández Fernández and Claire Malwé, 'The Emergence of the "Planetary Boundaries" Concept in International Environmental Law: A Proposal for a Framework Convention' (2019) 28 Review of European, Comparative & International Environmental Law 48.

[96] See for a detailed discussion, Collins, Chapter 5 in this book.

occur. The boundaries themselves have been criticised for a lack of precision[97] – the authors explicitly indicate that some of the boundaries they denote are no more than a 'best guess' given the information available.[98] There is also a high degree of uncertainty that persists with regard to the interactions between the planetary boundaries processes and the consequences of change in one for another. Arguably, the boundaries for each process may be closer than we think if change is accelerated by cross-boundary interactions. However, the importance (and current unknowability) of the interactions between processes is emphasised by the authors, and the planetary boundaries framework is intended to be 'adaptive, continuously updated, and fine-tuned as new information is gathered, as things change'.[99] The authors also attempt to manage the uncertainty inherent in the framework by applying the precautionary principle,[100] a well-established concept in law and governance. Although scientific uncertainty requires us to proceed with caution in the application of the framework,

> [i]n a complex world we rarely if ever know things for certain. Instead we act on the best available knowledge to make a sober judgment of the risks. This is what planetary boundaries are all about, presenting the best possible scientific estimate of how we can avoid unacceptable risks of triggering catastrophic shifts in the Earth system.[101]

While such points are laudable, notions of adaptability and precaution have faced numerous implementation challenges and critiques within international and domestic legal systems.[102] This includes concerns about accountability deficits arising from flexible legal systems; inadequate resourcing to pursue requisite monitoring, learning and adaptive structures; and an absence of interest or capacity among governance auspices and providers to gather, analyse, share and collaboratively act on information.[103] While not insurmountable, these are as likely to challenge planetary boundary implementation as much as they have challenged earlier attempts to address and achieve complex environmental targets.[104]

The planetary boundaries framework has also been the subject of scientific debate and critique. For example, it has been argued that there is insufficient evidence to support a 'threshold' in some Earth system processes, which renders the planetary boundaries arbitrary;[105] that some control variables are unmeasurable at the global scale;[106] that the choice of control var-

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97 Biermann (n 84) 5–6.
98 Rockström et al (n 2) 52.
99 Rockström and Klum (n 26) 64.
100 Steffen et al (n 23) 736.
101 Rockström and Klum (n 26) 63–4.
102 See Jacqueline Peel, *The Precautionary Principle in Practice: Environmental Decision-Making and Scientific Uncertainty* (Federation Press 2005); Cameron Holley et al, 'Environmental Security and the Anthropocene: Law, Criminology, and International Relations' (2018) 14(1) Annual Review of Law and Social Science 185; Hutter (n 29).
103 Cameron Holley and Ekaterina Sofronova, 'New Environmental Governance: Adaptation, Resilience and Law', in Hutter (n 29).
104 Cameron Holley, Neil Gunningham and Clifford Shearing, *The New Environmental Governance* (Earthscan 2012). See also Ebbesson, Chapter 10 in this book.
105 Montoya, Donohue and Pimm (n 89) 71–72.
106 José M Montoya, Ian Donohue and Stuart L Pimm, 'Why a Planetary Boundary, If It Is Not Planetary, and the Boundary Is Undefined? A Reply to Rockström et al' (2018) 33(4) Trends in Ecology and Evolution 234, 234.

iables is inappropriate for establishing a planetary boundary;[107] that some boundaries are too generous, especially because they do not account for regional variation;[108] and that the 'planetary' nature of the boundaries risks compromising more nuanced conservation objectives, such as the preservation of landscape diversity.[109] An in-depth analysis of the scientific arguments is beyond the scope of this chapter, but it is clear that the purported clarity of the planetary boundaries is subject to challenge, albeit such challenges may help the framework to evolve over time. More generally, despite implicit and explicit claims of scientific neutrality and the vanquishing of economic, technological and political calculations, science by itself has rarely proven a sufficient justification for public policy decisions.[110] While regulators must rely on science to understand problems and predict the consequences of regulatory actions, effective and legitimate legal and policy decisions typically require social and economic considerations, reasoned decision-making by administrative agencies and 'buy in' from communities affected by proposed rules.[111]

3.2 Conceptual Challenges

Some critiques of the planetary boundaries go beyond contesting the implementation and science to challenge the framework at a conceptual level, bringing pivotal questions for environmental law and governance to the fore.

By proposing a cap on human impacts on the environment, the planetary boundaries framework has entered the enduring debate about whether enforcing global limits is an appropriate way to regulate human–environment interactions. As noted above, environmental regulation and policy goals are determined by reference to human factors[112] (such as development aspirations, tolerance levels of pollution or degradation and calculations of what is economically or politically realistic). Purely environmental-based limits are often challenged on the basis that human ingenuity will identify solutions to the problem, a position reflected in proposed geoengineering solutions to climate change, and by proponents of ecological modernisation.[113] Policy and legal solutions often avoid the controversy of focusing on ecological limits by setting aspirational goals ('improve' or 'increase' or 'restore' without a quantified target, or without a target that corresponds to global limits or thresholds). This approach is reflected in multilateral environmental agreements and the SDGs (discussed below).

The idea of ecological limits is closely associated with the idea of limits to (economic) growth. There are vociferous arguments about whether economic growth can be decoupled

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107 Cristián Samper, 'Rethinking Biodiversity' (2009) 3 Nature Reports Climate Change 118, 119; Mario J Molina, 'Identifying Abrupt Change' (2009) 3 Nature Reports Climate Change 115, 116.

108 David Molden, 'The Devil Is in the Detail' (2009) 3 Nature Reports Climate Change 116, 117.

109 Montoya, Donohue and Pimm (n 89) 72.

110 See for example the debates and social protests that arose throughout the setting of a sustainable diversion limit in Australia's Murray Darling Basin: Emma Carmody, 'The Unwinding of Water Reform in the Murray-Darling Basin: A Cautionary Tale for Transboundary River Systems' in Cameron Holley and Darren Sinclair (eds), *Reforming Water Law and Governance* (Springer 2018). For other examples see Cary Coglianese and Gary E Marchant, 'Shifting Sands: The Limits of Science in Setting Risk Standards' (2004) 152(4) University of Pennsylvania Law Review 1255, 1257–58.

111 Coglianese and Marchant (n 110) 1277. See also Kim and Kotzé, Chapter 3 in this book.

112 Rockström and Klum (n 26) 64.

113 See for example Nordhaus, Shellenberger and Blomqvist (n 22).

from environmental degradation. As discussed above, the idea of limits to growth is strongly resisted by developing countries, fearing that developed countries (that have benefited from unfettered opportunities for growth) seek to restrict their attainment of higher material living standards. There are genuine issues of equity at play, although research suggests that the planetary boundaries are not incompatible with raising standards of living for all people.[114] Conversely, it is argued that planetary boundaries do not place limits on economic growth; rather, they designate an environmental boundary within which economic growth can continue unrestrained.[115] This assumes compatibility between environmental sustainability and economic growth, although its proponents recognise the need to modify human approaches to using the resources of the planet.[116] This premise of compatibility is at the heart of the concept of sustainable development,[117] which remains a central, albeit contentious, theme in international environmental law.[118] A discussion of the debates about the suitability of sustainable development as the predominant approach to addressing the global ecological crisis is beyond the scope of this chapter, but it is worth noting that

> [s]ubstantial questions linger about whether a relatively minor tinkering of sustainable development as a deliverer of equitable, efficient and clean growth will be possible, and even if it is possible, will it be enough to avoid the dire social and ecological predictions of a BAU [business as usual] scenario where material flows and sinks push up against global ecological thresholds.[119]

The inverse argument opposes a thresholds- or limits-based approach because it allows pollution or degradation to continue up to the threshold, instead of requiring environmental damage to be reduced as much as possible. The planetary boundaries arguably create a ‘licence to pollute’, setting the bar too low for restraining human impact on the environment. It is argued that ‘[w]aiting to cross the threshold allows much needless environmental degradation’ and that ‘management based on thresholds, although attractive in its simplicity, allows pernicious, slow and diffuse degradation to persist nearly indefinitely’.[120] Montoya and colleagues have argued that thresholds create ‘an acute moral hazard’ by implying that ‘human actions were once environmentally benign or allowed recovery’ – that is, that environmental damage below the planetary boundaries is unproblematic.[121] It has also been suggested that a threshold implies a level of safety up to a point, which can reduce efforts to change, lead to complacency and make entrenched habits difficult to correct.[122]

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114 O’Neill et al (n 58).

115 ‘These boundaries won’t hinder growth or development, just as guardrails along a meandering road don’t slow down the progress of drivers. They’re there to prevent a catastrophe.’ Rockström and Klum (n 26) 59. This in turn raises issues related to anthropocentric ethics; see for example Louis J Kotzé and Duncan French, ‘The Anthropocentric Ontology of International Environmental Law and the Sustainable Development Goals: Towards an Ecocentric Rule of Law in the Anthropocene’ (2018) 7(1) Global Journal of Comparative Law 5.

116 Jeffrey D Sachs, *The Age of Sustainable Development* (Columbia University Press 2015) 199.

117 Ibid 182.

118 Philippe Sands, *Principles of International Environmental Law* (2nd edn, Cambridge University Press 2003) 290.

119 Saunders (n 7) 832. See also Adelman, Chapter 4 in this book.

120 William H Schlesinger, ‘Thresholds Risk Prolonged Degradation’ (2009) 3 Nature Reports Climate Change 112, 112–13.

121 Montoya, Donohue and Pimm (n 89) 72.

122 Schlesinger (n 120) 113.

All of these arguments feed a broader critique about the lack of normative force, at the conceptual (as well as the operational) level, of the planetary boundaries framework. Although normative judgements are implicit in the setting of the boundaries at a 'safe distance' from the identified threshold, the planetary boundaries framework deliberately 'does not offer a roadmap for sustainable development; it merely provides, in the context of the human predicament in the Anthropocene, the first step by identifying biophysical boundaries at the planetary scale within which humanity has the flexibility to choose a myriad of pathways for human well-being and development'.[123] The difficulties this presents for operationalising the planetary boundaries are discussed to an extent above. A fundamental conceptual concern is the lack of engagement with geographical variation, as well as socio-economic and ethical questions. Geopolitical dynamics and the lack of a consistent operational model also engender the confounding possibilities of differing and sometimes mutually exclusive approaches to using the planetary boundaries[124] for anything other than monitoring the Earth's condition on a global scale. The supporting analysis clearly declares that we have already crossed at least four of the planetary boundaries, but the framework provides no suggestions about how we should manage the consequences or find our way back within the boundaries we have exceeded. This calls into question the utility of the planetary boundaries, if they do not advance the critical debates about what must be done, and how, to avoid planetary collapse. Even so, it usefully highlights the potentially pivotal role of law and governance in establishing what must be done, and how.

One final concern with the planetary boundaries framework has received less attention but is nevertheless worth considering in the context of future directions for environmental law and governance. The planetary boundaries framework is explicitly anthropocentric – it is concerned with preserving the conditions that support *human* life on Earth.[125] Given that the Earth system is interconnected and human wellbeing is interdependent with the health of the biosphere, as demonstrated by the planetary boundaries framework, adhering to the boundaries will undoubtedly have some benefits for non-human species and may encourage more active conservation efforts. However, the centring of human interests in the framework leaves the interests of non-human species and elements of nature at risk of domination, exclusion or disposal in favour of humans.[126] It aggravates the possibility of unnecessary degradation permitted by thresholds because it suggests that as long as human interests are sufficiently met, no other interests are relevant. It is beyond the scope of this chapter, and possibly beyond the reach of current science, to estimate the interests and needs of non-human nature for remaining in an 'acceptable' state of the global environment. However, incorporating concern for non-human interests into the planetary boundaries framework may recalibrate the boundaries in favour of a higher standard of environmental protection and sustainability.

While the technical and operational challenges outlined above are significant, they do not render the planetary boundaries framework irrelevant or unworkable. One of the ways in

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[123] Rockström et al (n 2) 37–38.

[124] See for example Sachs (n 115) 215; Geoffrey Garver, 'Moving Forward with Planetary Boundaries and Degrowth' in Laura Westra, Prue Taylor and Agnès Michelot (eds), *Confronting Ecological and Economic Collapse: Ecological Integrity for Law, Policy and Human Rights* (Routledge 2013) 410.

[125] Cornell (n 78) 3. See also Adelman, Chapter 4 in this book.

[126] Laurence H Tribe, 'Ways Not to Think about Plastic Trees: New Foundations for Environmental Law' (1974) 83 Yale Law Journal 1315, 1331.

which the planetary boundaries can support policy, law and governance is as a complement to other frameworks already informing law and governance approaches.

4. COMPLEMENTARITY, CONCEPTUAL CLARIFICATION AND POINTS OF REFERENCE: INTERACTIONS OF PLANETARY BOUNDARIES WITH OTHER ENVIRONMENTAL LAW AND GOVERNANCE FRAMEWORKS

The global, quantifiable, systems-based approach embraced by the planetary boundaries can arguably add definition, clarity and robustness to existing frameworks in environmental law and governance, at the same time as these frameworks may help to address some of the limits the planetary boundaries face. Given that responding to our global ecological challenges embraces a multitude of targets and tools,[127] this section considers three prominent and diverse frameworks – sustainable development (Section 4.1), the related four-capital model (Section 4.2) and rights of nature (Section 4.3) – to illustrate potential interactions of other frameworks with the planetary boundaries.

4.1 Sustainable Development

The 1987 definition of sustainable development as development that 'meets the needs of the present without compromising the ability of future generations to meet their own needs'[128] has emerged as the major conceptual paradigm shaping current global environment and development approaches. The underlying idea behind sustainable development is that the objectives or goals of three pillars – environmental, economic and social – should be reconciled in human development.[129] Nothing in the planetary boundaries frameworks precludes compatibility of the three pillars of sustainable development, and the sustainable development framework may accordingly provide one means of integrating planetary boundaries into existing legal frames and goals. Indeed, as '[t]he PB [planetary boundaries] framework brings global-scale environmental dynamics firmly into this picture',[130] it is possible that sustainable development can be redefined as 'development that meets the needs of the present while safeguarding Earth's life-support system, on which the welfare of current and future generations depends', reflecting a global priority to protect the Earth system as a whole.[131] Although planetary boundaries are yet to be explicitly incorporated into the definition of sustainable development

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[127] Michelle Maloney, 'Ecological Limits, Planetary Boundaries and Earth Jurisprudence' in Michelle Maloney and Peter Burdon (eds), *Wild Law – In Practice* (Routledge 2014) 193, 205.

[128] Gro Harlem Brundtland, *Our Common Future – Report of the World Commission on Environment and Development* (United Nations 1987) 16.

[129] Ben Purvis, Yong Mao and Darren Robinson, 'Three Pillars of Sustainability: In Search of Conceptual Origins' (2019) 14 Sustainability Science 681, 681–82.

[130] Häyhä et al (n 55) 61.

[131] David Griggs et al, 'Sustainable Development Goals for People and Planet' (2013) 495 *Nature* 305, 305–06; see also Kim and Bosselmann (n 92); Michelle Lim, Peter Søgaard Jørgensen and Carina Wyborn, 'Reframing the Sustainable Development Goals to Achieve Sustainable Development in the Anthropocene – A Systems Approach' (2018) 23(3) Ecology and Society 22.

Table 2.1 Direct overlap of planetary boundaries and SDGs

Planetary Boundary	Relevant SDGs
Climate change	**Goal 13.** Take urgent action to combat climate change and its impacts
Biosphere integrity	**Goal 14.** Conserve and sustainably use the oceans, seas and marine resources for sustainable development **Goal 15.** Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification and halt and reverse land degradation and halt biodiversity loss
Ocean acidification	**Goal 14.** Conserve and sustainably use the oceans, seas and marine resources for sustainable development
Biogeochemical flows (phosphorus & nitrogen cycles)	**Goal 2.** End hunger, achieve food security and improved nutrition and promote sustainable agriculture
Land system change	**Goal 15.** Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification and halt and reverse land degradation and halt biodiversity loss
Freshwater use	**Goal 6.** Ensure availability and sustainable management of water and sanitation for all

by the global community, the concept can usefully illuminate the nature of the environmental pillar by contextualising environmental objectives within planetary limits. Planetary boundaries could bring an objective, science-based standard into what is otherwise a complex and often values-dependent process of determining what kind of environment is desirable, and what level of degradation can be tolerated. By connecting the environmental pillar to a global framework, it would also reinforce the idea that some environmental harms have global ramifications and strengthen the case for considering environmental trade-offs carefully.

The pre-eminent expression of global sustainable development objectives is currently the SDGs.[132] A total of 17 SDGs were agreed upon by the UN community in 2015 as part of the 2030 Agenda for Sustainable Development, and cover basic needs, human rights, economic growth and protection of the environment and natural resources. The goals encompass 169 'aspirational and global' targets, with each national government to establish national targets applicable to its own circumstances.[133] Several of the SDGs directly address the Earth system processes covered by the planetary boundaries framework (see Table 2.1), and there is further direct overlap in the targets.[134]

Several other goals of more general application, such as 'Ensure sustainable consumption and production patterns' (Goal 12) and 'Make cities and human settlements inclusive, safe, resilient and sustainable' (Goal 11), relate to all the planetary boundaries. Others, such as 'Ensure access to affordable, reliable, sustainable and modern energy for all' (Goal 6), address a particular component of what is required to stay within a planetary boundary, in this case for climate change. Arguably, the achievement of any and all of the SDGs is fundamentally dependent on remaining within the planetary boundaries; there are also risks in pursuing the

[132] See generally Duncan French and Louis J Kotzé (eds), *Sustainable Development Goals: Law, Theory and Implementation* (Edward Elgar 2018).

[133] GA Res 70/1 (n 71), para 55.

[134] See Holger Hoff and Ivonne Lobos Alva, *How the Planetary Boundaries Framework Can Support National Implementation of the 2030 Agenda* (Policy Brief, Stockholm Environment Institute 2017) 2. <https://mediamanager.sei.org/documents/Publications/SEI-2017-PB-Hoff-HowthePlanetary.pdf> accessed 11 March 2020.

SDGs without taking the planetary boundaries into account – not least de-prioritisation of environmental goals, and the challenges posed by competing objectives.[135] This suggests that the planetary boundaries could usefully complement efforts by both national governments and the international community as a point of reference for framing and even prioritising SDG targets.[136]

There are of course a myriad of other goal- and target-based approaches in environmental governance that could similarly draw on the planetary boundaries as a touchstone to contextualise their sustainable development ambitions at a global scale. One example is the 'science-based targets' used by businesses to quantify emissions reductions aligned with the Paris Agreement goal of keeping global temperature increase well below 2°C.[137] This is an explicit effort to connect operational (company-based) targets with a global goal – in this case, drawn from the Paris Agreement, but potentially analogous to the planetary boundaries. Further research (drawing, for example, on efforts to downscale the planetary boundaries described above) may provide opportunities to create similar methodologies for other planetary boundaries. Another pathway to operationalising the planetary boundaries may lie in economic modelling approaches,[138] one of which is explored in Section 4.2.

4.2 Four-Capitals Model

Various economic models have been developed to illustrate the environment's contribution to the economy and the risks of degrading environmental resources or 'natural capital'. These models operate consistently with the premise of sustainable development – that environmental, economic and social considerations can and should be holistically integrated – and propose an economic framing of the process to integrate them.

The four-capitals model is one example, based on an economic definition of sustainable development as 'the provision of services and benefits that increase human well-being without causing a decline in capital stocks per capita'.[139] The model elaborates on fundamental economic concepts of capital – that is, stocks of assets that can yield valuable flows of goods and services – to encompass various specific types, commonly: manufactured capital (such as machinery, buildings, equipment, urban land); human capital (such as the health, wellbeing and productive potential of individual people); social capital (such as social networks that support an efficient, cohesive society, and facilitate social and intellectual interactions among its members); and, most relevant to the planetary boundaries, natural capital (such as conventionally defined natural resources such as minerals and timber, and other natural assets, such as

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135 Jørgen Randers et al, *Transformation Is Feasible: How to Achieve the Sustainable Development Goals within Planetary Boundaries* (A Report to the Club of Rome, Stockholm Resilience Centre and BI Norwegian Business School 2018); see also Kim and Bosselmann (n 92) 198.

136 See Robin Kundis Craig and J B Ruhl, 'New Realities Require New Priorities: Rethinking Sustainable Development Goals in the Anthropocene' in Jessica Owley and Keith Hirokawa (eds), *Environmental Law Beyond 2020* (forthcoming, chapter published online 18 June 2019) <https://ssrn.com/abstract=3401301> accessed 11 March 2020.

137 'What Is a Science Based Target?' (*Science Based Targets*) <https://sciencebasedtargets.org/what-is-a-science-based-target/> accessed 11 March 2020.

138 Hoff and Alva (n 134) 2–3.

139 Paul Ekins and James Medhurst, 'The European Structural Funds and Sustainable Development: A Methodology and Indicator Framework for Evaluation' (2006) 12(4) Evaluation 474, 476.

biodiversity, endangered species and the ecosystems yielding flows of ecosystem services).[140] Explaining the Earth's contribution to the economy as 'natural capital' facilitates recognition of the diverse roles of the environment in language recognised in economic discourse and governance processes – for example, as 'products', 'goods', 'services' and 'flows'.[141]

Once natural capital is unpacked, there are many components that are part of or relevant to Earth system processes and planetary boundaries. Perhaps most obviously, the biosphere integrity boundary encompasses living natural resource stocks such as timber or fish stocks, but also ecosystem services (such as environmental features and species that absorb and process the economy's waste outputs) and even biodiversity and natural places valued for their cultural and spiritual significance.[142] Arguably, the concept of depleting the stock of natural capital is conceptually aligned with the planetary boundaries, based on the idea of exceeding sustainable limits with longer-term implications.

The four-capitals model reflects a fundamentally different approach to conceptualising environmental degradation – it focuses on fluctuations within a human-made economy, whereas the planetary boundaries describe the processes and interactions of the Earth system. However, introducing the planetary boundaries into the natural capital component of the four-capital model could help resolve a key debate in the model: the contest between 'weak' and 'strong' sustainability. This is at its heart a debate about substitutability – whether one form of natural capital can be substituted for another within the economic model.[143] From the four-capitals point of view, the 'strong' sustainability perspective elevates natural capital stocks above the others as the foundation of development – this has clear echoes in the preamble of the 2030 Agenda (which notes that development 'depends' on the environment and its resources).[144] The planetary boundaries framework complements this approach, and could support the adoption of a 'strong' version of sustainability in economic models, because the integrated nature of the planetary boundaries and their individual and collective criticality to the functioning of the Earth system arguably implies that Earth system processes are vital to global social systems and habitability. Even so, planetary boundaries in their present form remain arguably too crude in that there are some condition thresholds for natural capital that might be highly relevant to sustainability in practice (such as water quality/availability) at a certain level of scale (for example, national) that are not picked up within the planetary boundaries' global focus.

Natural capital as characterised in the four-capitals model is typically measured and monitored using environmental economic accounts. The UN System of Environmental-Economic Accounting (SEEA) is an internationally recognised accounting framework designed to provide consistent, comparable and regularly updated information about the status of the environment, in a format that is compatible with national economic accounting systems and therefore more amenable to consideration within economic policy- and decision-making pro-

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140 Ibid 477.

141 For a critique see Adelman, Chapter 4 in this book.

142 See for example discussion in Paul Ekins, 'Environmental Sustainability: From Environmental Valuation to the Sustainability Gap' (2011) 35(5) Progress in Physical Geography 629.

143 See discussion in Ekins and Medhurst (n 139) 478 referring to R Kerry Turner, 'Sustainability: Principles and Practice', in R Kerry Turner (ed), *Sustainable Environmental Economics and Management: Principles and Practice* (Belhaven Press 1993).

144 GA Res 70/1 (n 71), in particular SDG targets 15.9 and 17.19.

cesses.[145] It has been suggested that the planetary boundaries framework could be combined with SEEA, particularly that 'ecosystem accounting can be used to support the translation of planetary boundaries into indicators that can be monitored at the national level'.[146] Effectively, this is suggesting that SEEA could be used to downscale or interpolate the planetary boundaries to a national or other economically relevant scale. SEEA can also encompass processes to record and assign monetary values associated with environmental assets, goods and services – for example, monetary valuation of a coral reef in terms of the net present value of its contributions to tourism, fishing and shoreline protection. There is a wealth of discussion about monetary valuation of the environment that is beyond the scope of this chapter, but it is relevant to note for present purposes that use of monetary valuation in a manner that implies substitutability or interchangeability of certain critical environmental assets, goods and services would be contrary to the fundamental purpose of the planetary boundaries framework. Nevertheless, the exploration underway of how to integrate the planetary boundaries into SEEA suggests the possibility of fruitful interdisciplinary dialogue that could at least inform new approaches to environmental governance.

4.3 Rights of Nature

Recognising the rights of nature in law is an emerging alternative to traditional forms of environmental law and governance, with potential to incorporate the planetary boundaries and to overcome some of the conceptual critiques levelled at the framework. The concept of the rights of nature depends on a recognition that humans are part of nature, not separate to or masters of it, and that the Earth is one interconnected whole. It proposes that nature, either as a whole or as various component parts, should be the subject (holder) of legal rights including, for example, the right to exist, the right to flourish and regenerate and the right to be restored.[147] Indigenous laws and worldviews have long recognised such human interconnectedness with the natural world, while more recent theoretical expressions include the theory of Earth Jurisprudence that emphasises the importance of aligning human law with the laws of nature and the universe.[148] It is argued that the planetary boundaries are a useful framework to establish and quantify limits to human activity that are consistent with the laws of nature and implicit in this Earth-centred, often indigenously constructed, approach to law.[149]

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145 'What Is the SEEA?' (*System of Environmental Economic Accounting*) <seea.un.org> accessed 11 March 2020.

146 Leonardo Vargas, Louise Willemen and Lars Hein, 'Linking Planetary Boundaries and Ecosystem Accounting, with an Illustration for the Colombian Orinoco River Basin' (2018) 18 Regional Environmental Change 1521, 1532.

147 There are many diverse enumerations of the rights of nature, a detailed discussion of which is beyond the scope of this chapter. See for example the Constitucion de 2008 (Constitution of 2008) of the Republic of Ecuador, arts 71–73; Christopher D Stone, 'Should Trees Have Standing? Towards Legal Rights for Natural Objects' 45 Southern California Law Review 450; Thomas Berry, 'The Origin, Differentiation and Role of Rights' (*The Institute for Educational Studies (TIES)* 11 January 2001) <www.ties-edu.org/wp-content/uploads/2018/09/Thomas-Berry-rights.pdf> accessed 11 March 2020; Cormac Cullinan, 'A History of Wild Law' in Peter Burdon (ed), *Exploring Wild Law: The Philosophy of Earth Jurisprudence* (Wakefield Press 2011) 12, 13.

148 Cormac Cullinan, *Wild Law: A Manifesto for Earth Justice* (2nd edn, Green Books 2011) 78.

149 Maloney (n 127) 200.

Although the complementarity of planetary boundaries and rights of nature is yet to be fully developed, both the planetary boundaries and rights of nature adopt a worldview of the Earth as a single interconnected system (sometimes described as *Pacha Mama*[150] or Mother Earth) and emphasise the importance of respecting the integrity and functioning of the whole. As a consequence of this conceptual orientation, both frameworks explicitly address two major flaws identified in existing environmental law: the inability to account for cumulative impacts, and the failure to recognise effects of feedback loops in natural systems.[151] Both planetary boundaries and the rights of nature seek to make these qualities of the Earth system visible to policy-makers and to law and governance mechanisms. Further, it is possible that the planetary boundaries could provide more detailed scientific guidance about what nature's rights to function and to flourish mean, by offering robust analysis of the dependencies within the Earth system that enable flourishing, and an explanation of the consequences of infringing nature's rights on the whole Earth system. Most powerfully, perhaps, integrating the planetary boundaries into rights of nature frameworks would reinforce the concept that respecting the rights of nature means placing limits on human activity: 'Planetary Boundaries means for the first time that we have planetary-wide "targets" for reining in human activities, not just a continual process of improvement.'[152]

There are constraints on integrating the planetary boundaries into the rights of nature doctrine, first and foremost being the explicit anthropocentrism of the planetary boundaries framework. Rights of nature are premised on a non-anthropocentric, Earth-centred approach to nature. As discussed above, the planetary boundaries use the Holocene as their point of reference because it represents conditions that support human life (only). The implication is that if these conditions could be secured at the expense of other living things, the consequences for nature would not matter. In contrast, concepts like the Anthropocene position (some) humans as both the cause of the problem and the responsible agents for addressing it, and, for at least some scholars,[153] adopt a broadly Earth-centred approach and are more inclusive of the interests of non-humans.[154] Interaction with a doctrine such as the rights of nature creates a possible opportunity to expand the remit of the planetary boundaries, to examine the condition of the Earth system necessary to support the flourishing of all denizens of the Earth community. This seems unlikely to become a central preoccupation of the planetary boundaries framework any time soon, but dialogue between the two concepts may create opportunities to strengthen an ecocentric approach to the human–nature relationship and encourage more ambitious environmental protection, with potential benefits for both frameworks. Examining the interplay between the frameworks also raises some interesting questions: should Earth system processes (for which planetary boundaries have been set) have rights? If so, how could these be defined and operationalised, and what would the implications be? And where are the productive points

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150 See for example Constitucion de 2008 (Constitution of 2008) of the Republic of Ecuador, art 71: 'Nature, or Pacha Mama, where life is reproduced and occurs, has the right to integral respect for its existence…'.

151 See Maloney (n 127) 206.

152 Ibid 200.

153 See Andreas Malm and Alf Hornborg, 'The Geology of Mankind? A Critique of the Anthropocene Narrative' (2014) 1(1) The Anthropocene Review 62; for further debates see Cameron Holley et al (n 102).

154 Kotzé (n 88) 135–36; Anna Grear, 'Deconstructing Anthropos: A Critical Legal Reflection on "Anthropocentric" Law and Anthropocene "Humanity"' (2015) 26 Law and Critique 225.

of interaction between the western science-informed planetary boundaries and the various indigenous knowledges, worldviews and laws that increasingly drive and underpin rights of nature in practice? Many questions relating to scale, definition of rights-holders and rights and implementation persist within the rights of nature doctrine itself and may be made more complex by introducing the planetary boundaries framework. However, there is clearly scope for each framework to evolve and to inform the other.

5. CONCLUSION: IMPLICATIONS OF PLANETARY BOUNDARIES FOR ENVIRONMENTAL LAW AND GOVERNANCE

In a time of unprecedented ecological crisis, the international community, nations, governments, businesses and individuals are looking for ways to respond to and to repair the damage done by humanity to planet Earth. Scientific evidence is rapidly accumulating to suggest we are facing planetary ecological catastrophe, and a profound sense of urgency characterises the search for law and governance mechanisms that can pull us back from the brink of collapse.

The planetary boundaries framework has emerged in the context of this urgent debate. Although situated in the domain of Earth system science, it has implications for policy, law and governance around the globe. Scientists, economists, policy-makers, lawyers and theoreticians all seek compelling conceptual frameworks that can explain the nature of the crisis we face, including its causes, and inform a strategic plan of action to avoid the most serious risks. Beyond its scientific analysis, the planetary boundaries framework does most of this in a general way only. While it provides a clear and convincing explanation of the nature of the crisis as implicating the whole Earth system, it has little to say about the causes except that they are human-induced. While it generates nine or more global objectives to drive action, it very deliberately does not explain how those objectives should be reached or where responsibility lies for their achievement.

However, as discussed in this chapter, unique conceptual features of the planetary boundaries framework can usefully inform law and governance approaches. Arguably the most important of these features is the science-based argument it advances for a limits-based approach to environmental governance. As we have seen, the planetary boundaries can also provide useful guidance in terms of establishing environmental policy objectives connected to the Earth system. The illustration of how close we are to exceeding the boundaries creates a sense of urgency for those seeking ambitious reform. The recent update to the planetary boundaries framework to introduce a 'hierarchy' of boundaries, emphasising the fundamental importance of the 'core' climate change and biosphere integrity planetary boundaries, may also help policy-makers, nations and the international community to prioritise their actions. The global nature of the framework possibly enhances a sense of global responsibility for the outcomes for planet Earth and may provide a foundation for enhanced international collaboration.

Even so, there are difficulties in applying the planetary boundaries framework, not least of which is the scientific uncertainty that persists around the boundaries, thresholds and interactions between the planetary boundaries processes. However, all environmental law and governance must take account of uncertainty, and the precautionary principle clearly indicates that a lack of definitive answers is no reason for inaction.[155] More serious challenges arise in the operationalisation of the framework, where attempts to downscale or apply the planetary boundaries to national or regional levels of decision-making have proved difficult to rationalise and have produced conflicting approaches. It has also been argued that the planetary boundaries are insufficiently ambitious; certainly, it would be dangerous and inconsistent with the purpose of the planetary boundaries to use them as a justification for increasing humans' harmful impact on the Earth from current levels. However, in the immediate term, given the evidence suggesting that the world is extremely close to transgressing the planetary boundaries, and the continued inertia in our economic–industrial and political systems, it may be that simply trying to avoid that outcome will demand our most ambitious responses, as we have used up almost all the 'safe operating space' we have.

It has also been shown in this chapter that the planetary boundaries have entered the dynamic space of negotiation with different approaches to responding to the crisis. Beyond the planetary boundaries themselves, an enormous range of ethical, social, economic, political and operational choices will need to be made – and quickly – if we are to avoid ecological collapse and keep the Earth system within the safe operating space of the planetary boundaries. A diverse range of governance frameworks exist to shape these choices, which may be informed by the planetary boundaries and which may help to evolve the planetary boundaries framework in turn. The planetary boundaries could introduce specific, quantified limits into broader principles; provide a means of global benchmarking for progress towards sustainability; embed the importance of non-substitutability into environmental economic frameworks; and ensure the global implications of environmental harms are recognised and respected. Undoubtedly, there is great potential for productive exchange between the planetary boundaries and a plethora of different approaches to the law and governance challenges of the Anthropocene. Future work could explore to what extent the planetary boundaries can be integrated with existing mentalities, approaches and targets for environmental governance, and whether it is in fact more desirable and/or feasible to abandon such integration and instead create new legal and governance approaches that can directly pursue planetary boundaries.[156]

[155] Rio Declaration, annex I, Principle 15.

[156] Cameron Holley, 'Environmental Regulation and Governance' in Peter Drahos (ed), *Regulatory Theory: Foundations and Applications* (Australian National University Press 2017).

3. Governing the complexity of planetary boundaries: a state-of-the-art analysis of social science scholarship[1]

Rakhyun E. Kim and Louis J. Kotzé

1. INTRODUCTION

In a 2009 *Nature* article, a group of 29 environmental scientists led by Johan Rockström suggested an approach to define a 'safe operating space' for humanity.[2] The scientists argue that we can identify a set of nine 'planetary boundaries'. If crossed, the chance of maintaining the Holocene-like state for human development significantly diminishes as we step closer to 'dangerous levels', or, where applicable, 'tipping points' in Earth system processes.[3] The framework has since attracted significant interest in academic, policy and even social advocacy circles. In 2015, a partially overlapping group led by Will Steffen published an update of the initial research with some adjustments and elaborations.[4]

The increased popularity of the planetary boundaries theory is unsurprising. The boundaries manage to capture 'multiple global environmental stresses within one integrated framework', while this framework in turn foregrounds the 'urgency of political action through its emphasis on the risks associated with transgressing critical Earth system [limits]'.[5] For the purpose of governance, it also offers a crucial specification of environmental target indicators to support decision-making.[6] The planetary boundaries framework further points to the critical importance of a systems approach to governing global sustainability, as opposed to the hitherto fragmented approach that treats 'environmental' problems as distinct issues that are at best only implicitly interconnected.[7]

To this end, the planetary boundaries framework potentially has useful and far-reaching social–political–juridical implications for the governance of Earth system transformations in

[1] Research for this chapter by Louis J Kotzé was supported by the South African National Research Foundation (NRF) under grant agreement UID: 118746 and it was completed in April 2020. Opinions expressed and conclusions arrived at are those of the author and are not necessarily to be attributed to the NRF. This chapter is based in part on Rakhyun E Kim and Louis J Kotzé, 'Planetary Boundaries at the Intersection of Earth System Law, Science, and Governance: A State-of-the-Art Review' (2020) Review of European, Comparative and International Environmental Law 1.

[2] Johan Rockström et al, 'A Safe Operating Space for Humanity' (2009) 461 Nature 472.

[3] Ibid.

[4] Will Steffen et al, 'Planetary Boundaries: Guiding Human Development on a Changing Planet' (2015) 347 Science 1259855.

[5] Victor Galaz et al, 'Global Environmental Governance and Planetary Boundaries: An Introduction' (2012) 81 Ecological Economics 1, 1.

[6] Frank Biermann, 'Planetary Boundaries and Earth System Governance: Exploring the Links' (2012) 81 Ecological Economics 4, 5.

[7] See Piselli and Van Asselt, Chapter 7 in this book.

the Anthropocene. After all, we 'are faced with one of the largest political problems humankind has had to deal with … building stable institutions that guarantee a safe transition and a co-evolution of natural and social systems at planetary scale'.[8] The authors of the planetary boundaries framework themselves also state in the extended version of the 2009 article published in *Ecology & Society* that their framework suggests 'the need for novel and adaptive governance'.[9] In particular, they argue that we need to shift our approach to governance 'away from the essentially sectoral analyses of limits to growth aimed at minimizing negative externalities' towards 'the estimation of the safe space for human development'.[10] A critical question that consequently arises is how our social regulatory institutions (generally understood as *governance* of which *law* is an integral part) should respond to this existential challenge.

A sizeable body of literature has emerged since the planetary boundaries framework was first proposed, with numerous social science studies – law being as yet a somewhat notable exception – exploring the multifaceted challenge of governing planetary boundaries and the myriad processes, impacts and aspects related to these boundaries.[11] In this chapter, we present a systematic synthesis of this literature sitting at the interface of Earth system science,[12] law[13] and governance.[14] Our objective is to bring together emerging social science insights to offer a bird's-eye view of the implications of the planetary boundaries framework for law and governance. To that end, we conducted a survey of the state-of-the-art research that grapples with the challenge of navigating the complexity of planetary boundaries by means of law and governance interventions.

This chapter is organised as follows. We provide a brief overview of our method of the literature survey. We then present four key characteristics of the planetary boundaries framework that emerge from the literature, namely planetary boundaries: (i) as embodying environmental limits; (ii) as being interdependent and interacting phenomena; (iii) as being planetary in scale; and (iv) as being political constructs. We then discuss four key issues related to law and governance interventions that the social sciences are currently proposing as a response to the characteristics above, namely: (i) the institutionalisation of planetary boundaries; (ii) the coordination of planetary boundaries; (iii) the downscaling of planetary boundaries; and (iv) the democratisation of planetary boundaries. Where appropriate, we also underline issues related to the foregoing that have not received much attention in the literature. We conclude by highlighting future research directions.

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8 Biermann (n 6) 4.

9 Johan Rockström et al, 'Planetary Boundaries: Exploring the Safe Operating Space for Humanity' (2009) 14 Ecology & Society 1, 1.

10 Ibid 1.

11 Frank Biermann and Rakhyun E Kim, 'The Boundaries of the Planetary Boundary Framework: A Critical Appraisal of Approaches to Define a "Safe Operating Space" for Human Societies' (2020) 45 Annual Review of Environment and Resources 497. See also Bleby, Holley and Milligan, Chapter 2 in this book.

12 Will Steffen et al, 'The Emergence and Evolution of Earth System Science' (2020) 1 Nature Reviews Earth & Environment 1.

13 Louis J Kotzé and Rakhyun E Kim, 'Earth System Law: The Juridical Dimensions of Earth System Governance' (2019) 1 Earth System Governance 1.

14 Frank Biermann, *Earth System Governance: World Politics in the Anthropocene* (MIT Press 2014).

2. METHODOLOGY

We conducted a systematic literature survey by using Scopus and the Web of Science in order to find relevant peer-reviewed literature. We identified a set of publications published in English between 2009 and 2019 that include 'planetary boundar*' AND (law* OR institution* OR govern* OR polic*) in their title, abstract or keywords. The two databases offered broadly similar but also different results, which we merged. We ended up with about 250 papers after removing duplicates and clearly irrelevant ones. Among those, very relevant papers numbered 80. We took this approach with the assumption that it will capture most of the relevant literature that focuses on the law and governance implications of the planetary boundaries as their core concern. Where appropriate for the purpose of clarification and/or for the sake of further analysis, we also reference other sources outside the scope of these 80 papers that we found relevant for our discussion of the state-of-the-art analysis.

We consciously excluded the keyword 'Anthropocene' in our search with the view to specifically focusing on planetary boundaries (although we did include papers where 'Anthropocene' occurs in conjunction with the other keywords noted above). In doing so, we acknowledge that the relationship between planetary boundaries and the Anthropocene is a critically important, albeit often unclear one.[15] Most usually, the Anthropocene is employed, as it is in many other instances, as *context* within which to situate the discussion of the planetary boundaries.[16] By including the Anthropocene, we would only be adding another layer of complexity to the survey, instead of pursuing a more focused analysis of the role and place of law and governance in relation to the planetary boundaries. Our present pursuit obviously does not preclude future surveys from more fully embracing the added complexity that the notion of the Anthropocene might introduce to such a state-of-the-art literature survey.

The literature we covered are predominantly from a European (global North) perspective and turned out to be largely located in the political or governance research domain, especially research from the Earth System Governance Network, and to a lesser extent the related juridical domain. The research that is covered by the literature we have surveyed is generally normative in orientation towards protecting planetary boundaries and possible ways to keep humanity within the 'safe operating space'. However, this does not mean the literature is devoid of any critical appraisal of the *politics* of planetary boundaries.[17] In other words, the literature we surveyed predominantly examined how institutional interventions can govern the planetary boundaries, but part of this literature also engages in critically questioning, for example, the democratic legitimacy of the planetary boundaries framework.

We observe that the law, governance and planetary boundaries debate has mainly been driven by the original author group, namely Johan Rockström, Will Steffen and Brian Walker,

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[15] See, for example, Yadvinder Malhi, 'The Concept of the Anthropocene' (2017) 42 Annual Review of Environment and Resources 77.

[16] Sarah Burch et al, 'New Directions in Earth System Governance Research' (2019) 1 Earth System Governance.

[17] For example, Oran Young and Falk Schmidt, 'Protecting the Global Commons: The Politics of Planetary Boundaries' in Blake Hudson, Jonathan Rosenbloom and Dan Cole (eds), *Routledge Handbook of the Study of the Commons* (Routledge 2019) 412; Katrina Brown, 'Global Environmental Change II: Planetary Boundaries – A Safe Operating Space for Human Geographers?' (2016) 41 Progress in Human Geography 118; Anna Pegels et al, 'Politics of Green Energy Policy' (2018) 27 Journal of Environment & Development 26.

and especially by those who are interdisciplinary in their work, including Carl Folke, Åsa Persson and Robert Costanza. Other influential voices include those of scholars affiliated with the Stockholm Resilience Centre such as Victor Galaz and Sarah Cornell. Outside this core group of authors (mostly based in Sweden and Australia), influential authors based on citation impact include Frank Biermann, who founded the Earth System Governance Project.[18] Interestingly, very few legal scholars prominently figure in the literature we have surveyed, although this does not mean that law is entirely absent from the analysis, as we shall see below.

The most popular journals in which the research we surveyed has appeared are those in the field of sustainability, such as *Current Opinion in Environmental Sustainability*; *Ecological Economics*; *Ecology & Society*; *Global Environmental Change*; *Review of European, Comparative & International Environmental Law*; and *Sustainability*, with very few coming from outside this field (such as *Business and Society* and *Journal of Management Studies*).

2.1 Four Emerging Themes

In this section, we identify and discuss four emerging central themes and associated framings of planetary boundaries that social science studies have thus far highlighted. While we acknowledge the dangers of generalising, these four themes seem to constitute the principal emerging clusters around which social scientists frame their planetary boundaries-related research.

2.1.1 Planetary boundaries as limits

Social scientists consider a key function of the planetary boundaries framework – where this has been possible, as for some boundaries the available science still prevents this – as defining an upper limit to the total human impact on the Earth system in the long run. For example, atmospheric CO_2 concentrations of 350 ppm is the boundary limit for climate change, and the maximum amount of consumptive freshwater use is proposed at 4,000 km^3 per year globally.[19] It is argued that humanity should not cross these quantified limits, in order to have a reasonable chance at maintaining a stable Holocene-like state as the Earth transitions deeper into the Anthropocene. That is to say: if humanity fails to respect the climate change boundary, for example, we enter an unsafe operating space or zone of uncertainty where the Earth system may hit a tipping point and transform abruptly and irreversibly into a ‘hothouse’ as a result.[20] It should be noted that social scientists often conflate or fail to differentiate the notions of thresholds (used in relation to Earth system processes that show planetary-scale threshold behaviour); dangerous levels (used in relation to ‘slow’ Earth system processes that do not show such behaviour);[21] planetary boundaries, which are proposed at a safe distance from thresholds or dangerous levels; and the notion of ‘safe operating space’.

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[18] Frank Biermann et al, ‘Earth System Governance: A Research Framework’ (2010) 10 International Environmental Agreements: Politics, Law and Economics 277.

[19] Janos Bogardi, Balázs Fekete and Charles Vörösmarty, ‘Planetary Boundaries Revisited: A View through the “Water Lens”’ (2013) 5 Current Opinion in Environmental Sustainability 581.

[20] Will Steffen et al, ‘Trajectories of the Earth System in the Anthropocene’ (2018) 2 Proceedings of the National Academy of Sciences 8252.

[21] Biodiversity loss is such a process. See for example Barry Brook et al, ‘Does the Terrestrial Biosphere have Planetary Tipping Points?’ (2013) 28 Trends in Ecology & Evolution 396.

While the planetary boundaries framework essentially sets *environmental* limits that we must not overshoot, the literature we surveyed underlines several shortcomings of such a framing from a social science perspective. Key questions considered here are who sets the limits, on what basis and for whom.

Some critics argue, for example, that the framework does not pay due attention to the socially differentiated nature of global environmental change,[22] possibly because these environmental limits were decided and set through an expert review process involving 29 scientists with a predominantly natural science background. This was, however, not a concern in the eyes of the authors of the planetary boundaries framework, as the process merely sought to identify non-negotiable limits or planetary preconditions.[23] Their underlying assumption therefore is that value-neutral objective science exists, that the boundary-setting process was apolitical and that it was purely based on science. Consequently, the 'expert assessment and synthesis of the scientific knowledge'[24] was completed without any comprehensive consultation process involving key societal stakeholders. As a consequence, the framework is criticized for lacking legitimacy and for not being fully representative and differentiated, which in turn raises numerous additional, but related, political issues that we discuss below.

Furthermore, scholars argue that the planetary boundaries framework says little about drivers of change and how to govern these drivers.[25] This could possibly ignore or sideline the importance of identifying underlying socio-economic drivers of change that collectively push the Earth system towards the boundary limits.[26] To be fair, the framework does indicate that these drivers might be evident through the selection of certain control variables such as 'atmospheric carbon dioxide concentration' and 'change in radiative forcing' proposed for the climate change boundary. But what has caused some controversy is the fact that these control variables can be controlled in many different ways, including through controversial solar radiation management such as stratospheric aerosol injection. Indeed, the remarks by Johan Rockström at a climate conference alluding to the need for geoengineering measures demonstrate the wide range (and contested nature of some) of the interventions implied by planetary boundaries thinking.[27]

Some scholars also note that the planetary boundaries approach is inherently anthropocentric. After all, the scientists selectively identified key Earth system processes and subjectively quantified boundary levels with a view to avoiding 'unacceptable global environmental

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[22] Kate Raworth, *Doughnut Economics: Seven Ways to Think Like a 21st-Century Economist* (Random House 2017).

[23] Will Steffen, Johan Rockström and Robert Costanza, 'How Defining Planetary Boundaries Can Transform our Approach to Growth' (2011) 2 Solutions 59, 59.

[24] Rockström et al (n 2).

[25] Georgina Mace et al, 'Approaches to Defining a Planetary Boundary for Biodiversity' (2014) 28 Global Environmental Change 289.

[26] Brian Walker et al, 'Looming Global-scale Failures and Missing Institutions' (2009) 325 Science 1345.

[27] Fiona Harvey, 'UN Climate Talks Failing to Address Urgency of Crisis, Says Top Scientist' *The Guardian* (Madrid, 8 December 2019) <www.theguardian.com/environment/2019/dec/08/un-climate-talks-are-failing-to-see-urgency-of-crisis-says-scientist> accessed 19 April 2020. See also Victor Galaz, 'Geo-engineering, Governance, and Social-Ecological Systems: Critical Issues and Joint Research Needs' (2012) 17 Ecology & Society.

change' to humanity, not to ecosystems at large.[28] What is considered to be 'acceptable' to 'whom' remains an open and critically important question, and the underlying ontology of the planetary boundaries seems to be explicitly oriented towards maintaining a safe operating space for the exclusive benefit of *humanity*. While such a strong anthropocentric ontology shuts out the possibility of inviting non-humans within the boundaries' protective safe operating space, it also closes down innovative epistemic attempts to rethink issues such as interspecies justice. Moreover, it is unclear from the current planetary boundaries framework which segments of humanity should benefit from the treasured safe operating space. Presumably the implication is that all of humanity should, but the reality is that 'humanity' is used in a highly undifferentiated way in the standard framing of the planetary boundaries. Commentators point out that the 'we' at the heart of the planetary boundaries' universalised 'humanity' is, in reality, a small and particularised privileged subset of the global human population.[29] The argument, consequently, is that 'humanity' cannot and should not be universalised in an unqualified way. If an understanding of humanity is universalised, it runs the risk of being understood as only representing a small part of the human population that enjoys a disproportionate share of socio-economic and environmental benefits.

2.1.2 Planetary boundaries as interdependent and interacting phenomena

Despite the way in which the planetary boundaries are visualised as discrete slices of a pie, they are not independent, but instead are coupled in a hierarchical network of interacting Earth system processes.[30] Notably, this interdependency among Earth system processes is a feature unique to the planetary boundaries framework, which is not prominent in other similar frameworks such as 'planetary guard rails' and 'tolerable windows'.[31]

The coupling between the planetary boundaries implies that affecting one boundary might affect other boundaries – positively or negatively, depending on policy design and choice.[32] This implies, in turn, that the impact of crossing one boundary may cascade and become amplified and affect numerous other boundaries in doing so. Because (environmental) law and governance regimes are by their nature fragmented and therefore unable to holistically govern interactive, complex phenomena such as the Earth system, the planetary boundaries framework, by serving as a concrete manifestation of a coupled and complex Earth system, is understandably interesting to social scientists focusing on the development of complex adaptive social systems that must correspondingly govern a complex adaptive Earth system.

To this end, some commentators have paid attention to potential trade-offs between the boundaries to address environmental problem shifting that inevitably arises in a fragmented

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28 Andy Green et al, 'Creating a Safe Operating Space for Wetlands in a Changing Climate' (2017) 15 Frontiers in Ecology and the Environment 99. See, also Adelman, Chapter 4, and Bleby, Holley and Milligan, Chapter 2, in this book.

29 Louis J Kotzé, 'The Sustainable Development Goals: An Existential Critique alongside Three New-Millennial Analytical Paradigms' in Duncan French and Louis J Kotzé (eds), *Sustainable Development Goals: Law, Theory and Implementation* (Edward Elgar 2018) 41–65.

30 Rockström et al (n 9); Mace et al (n 25); Steffen et al (n 4). See also Steven Lade et al, 'Human Impacts on Planetary Boundaries Amplified by Earth System Interactions' (2020) 347 Nature Sustainability 119.

31 German Advisory Council on Global Change, *World in Transition: The Research Challenge* (Springer 1997).

32 Thomas Sterner et al, 'Policy Design for the Anthropocene' (2019) 2 Nature Sustainability 14.

setting.[33] One example is the case of increased ocean acidification by using the ocean as carbon sinks and reservoirs, or the case of exacerbating climate change by using certain substitutes with a high global warming potential for conventional ozone-depleting substances. Other commentators have pointed to the possibility of creating synergies by addressing the two core boundaries in a hierarchy of boundaries – climate change and biosphere integrity – that provide the planetary-level overarching systems within which the other boundary processes operate.[34]

It should also be noted that the interaction between planetary boundaries does not only amplify or dampen human impact, but also changes the boundary values themselves. Therefore, boundaries are not static but constantly shifting: crossing one boundary will also likely change the boundary values of the other boundaries. This would imply, in turn, that the size of the safe operating space as a whole is in constant flux. Difficulties arise in determining the impacts of such variability on social institutions and how social institutions should accommodate or compensate for this variability.

Some commentators also highlight a complicating factor that arises in the foregoing context, namely, time lags or feedback delays in the interaction between planetary boundaries.[35] Long feedback delays are common in Earth system processes. For example, many tipping elements in the climate system have a transition timescale of more than 100 years,[36] and feedback delays could easily lock the Earth system into certain trajectories. How should our current temporally dysfunctional law and governance arrangements deal with such time lags and feedback delays? The principal concern is that because social institutions are often oriented towards the here and now, despite the occurrence in global environmental policies of high rhetoric regarding sustainable development for future generations,[37] they are unable to effectively and comprehensively tackle critical existential global-scale challenges such as climate change – the full impacts of which will only become apparent well into the future. The inevitable result of such temporal dysfunctionality is simply to do nothing, which is clearly evident from the current inertia gripping global climate governance. A related concern is that social institutions become so preoccupied with a critical global challenge that upsets the current status quo that they tend to ignore other (often very much interrelated) global challenges. In 2020, for instance, the COVID-19 pandemic absorbed almost all the policy and governance bandwidth, with several other critical issues such as climate change and the European refugee crisis being pushed to the periphery of concern.

2.1.3 The planetary scale of the boundaries

Social scientists have also turned their attention to the planetary categorisation, or scale, of the boundaries, the totality of the human impact on the planet and the possible implications of such a vision for social institutions. The adoption of such a planetary lens is useful and nec-

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33 Rakhyun E Kim and Harro van Asselt, 'Global Governance: Problem Shifting in the Anthropocene and the Limits of International Law' in Elisa Morgera and Kati Kulovesi (eds), *Research Handbook on International Law and Natural Resources* (Edward Elgar 2016) 473.

34 Mace et al (n 25).

35 Arild Underdal, 'Complexity and Challenges of Long-term Environmental Governance' (2010) 20 Global Environmental Change 386.

36 Timothy Lenton et al, 'Tipping Elements in the Earth's Climate System' (2008) 105 Proceedings of the National Academy of Sciences 1786.

37 See, for example, World Commission on Environment and Development, *Report of the World Commission on Environment and Development: Our Common Future* (UN 1987).

essary at the global level because it reveals the importance and relevance of the Earth system perspective for law and governance. In stark contrast to earlier reductionist approaches to ensuring global sustainability, the significantly more all-embracing Earth system perspective instead shifts its holistic focus to the planetary scale. In doing so, it extends sustainability science's enquiry into new areas seeking to understand complex and dynamic Earth system relationships, complex self-organising systems, irreversible impacts of interacting stresses, multiple scales of organisation and the various actors and their agendas that influence Earth system change.[38]

In order to have significant practical application, however, planetary boundaries need to be translated to match the scale and levels at which governance decisions should be made. This includes not only national governments and other sub-national state agencies, but also non-state actors such as multinational corporations that make decisions with consequences for planetary boundaries.[39] These influential actors need to understand and accept their share of responsibility with respect to governing planetary boundaries. This means that planetary boundaries, although planetary in scale, need to become operationalised in the context of multi-level and multi-actor governance, rather than primarily taking a global-scale, top-down, state-driven approach.[40]

However, the type of downscaling that this inevitably implies is difficult to achieve through a purely scientific approach because, as the name itself suggests, *planetary* boundaries are not designed to be downscaled or 'disaggregated to smaller levels'.[41] That is because of the interdependent nature of Earth system processes, as well as nonlinear processes that display threshold behaviour as was mentioned earlier. The 2015 update introduces a two-tier approach for several of the boundaries that accounts for regional heterogeneity, but not for all of the boundaries.[42] The planetary scale of the boundaries therefore raises the difficult question of how to determine a fair share of the safe operating space among various state and non-state actors that are situated at various governance and geographic levels.

2.1.4 Planetary boundaries as political constructs

Earth system scientists quantified planetary boundaries at a 'safe' distance from dangerous levels or tipping points in Earth system processes. What exactly is considered to be 'safe' would presumably vary significantly. Therefore, although the concept of planetary boundaries was (at least initially) meant to be politically and normatively neutral and simply to be based on a pure scientific determination, its operationalisation and societal application, which depend on subjective risk perceptions, cannot be. Because of such highly differentiated risk

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38 Jill Jäger, 'Sustainability Science' in Eckart Ehlers and Thomas Krafft (eds), *Earth System Science in the Anthropocene: Emerging Issues and Problems* (Springer 2006).

39 Gail Whiteman, Brian Walker and Paolo Perego, 'Planetary Boundaries: Ecological Foundations for Corporate Sustainability' (2013) 50 Journal of Management Studies 307. See also Carl Folke et al, 'Transnational Corporations and the Challenge of Biosphere Stewardship' (2019) 3 Nature Ecology and Evolution 1396.

40 Galaz et al (n 5).

41 Steffen et al (n 4).

42 Ibid. See also Wim de Vries et al, 'Assessing Planetary and Regional Nitrogen Boundaries Related to Food Security and Adverse Environmental Impacts' (2013) 5 Current Opinion in Environmental Sustainability 392.

perceptions, the planetary boundaries are therefore embedded within a socio-political context, even if that is not always explicitly recognised.

It thus follows that the scientific determination of planetary boundaries, and their operationalisation and societal application, is necessarily also a political process,[43] while the boundaries themselves could also inform and shape sustainability policies and consequent governance actions.[44] What this implies is that 'these boundaries cannot be described exclusively by scientific knowledge-claims; they have to be identified by science-society and transdisciplinary deliberations'.[45] Yet the expert-driven approach to governing global sustainability risks questions the democratic legitimacy of the chosen planetary boundaries and their boundary values (see also the discussion above).[46] The inevitable result could be substantial: if scientific frameworks such as planetary boundaries are not perceived by people to be legitimate, they will have little value, if any, beyond the pure scientific confines of the discourse that invented them in the first place.

In fact, the limited political use of the planetary boundaries framework is, according to critics, largely due to its 'politically contentious nature sustained by global inequalities and conflicting perspectives on sustainable development'.[47] This is largely why the framework ended up having limited impact at the highly politicised Rio+20 global summit and on the equally politicised 2030 Agenda for Sustainable Development. Writing from the perspective of the developing world, D'Souza offers two key reasons why such an expert-driven process is not appealing to the global South:

> Firstly, a science that argues for planetary-scale interventions without being mindful of the long-term politics of injustice and histories of inequity between regions and countries will find it hard to sustain the claim that 'we' are all in this together. Secondly, shifting much of the burden of decision-making onto global technocratic elites, in which the ownership of the science might remain predominantly with the North, can easily breed anxieties within governments in the South about being disempowered. Nations without borders can become a palpable fear, if the rule of the expert overrides national self-determination.[48]

The challenge for social scientists is then to consider how the international community could establish science-based Earth system limits while at the same time ensuring their democratic legitimacy and social relevance and utility.[49] The historical trajectory of global climate change governance could provide some useful lessons. Initially perceived to be a pure scientific

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43 Biermann (n 6).

44 A prominent example is the European Commission, '7th General Union Environment Action Programme to 2020: Living Well, within the Limits of our Planet' (2013) <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013D1386&from=EN> accessed 19 April 2020.

45 Falk Schmidt, 'Governing Planetary Boundaries: Limiting or Enabling Conditions for Transitions towards Sustainability?' in Louis Meuleman (ed), *Transgovernance: Advancing Sustainability Governance* (Springer 2013) 215.

46 Fred Saunders, 'Planetary Boundaries: At the Threshold … Again: Sustainable Development Ideas and Politics' (2015) 17 Environment, Development and Sustainability 823.

47 Galaz et al (n 5).

48 Rohan D'Souza, 'Nations without Borders: Climate Security and the South in the Epoch of the Anthropocene' (2015) 39 Strategic Analysis 720.

49 Jonathan Pickering and Åsa Persson, 'Democratising Planetary Boundaries: Experts, Social Values and Deliberative Risk Evaluation in Earth System Governance' (2020) 2 Journal of Environmental Policy & Planning 59.

phenomenon discovered and propagated by scientists in the global North, climate change has since become a legitimate *global* governance (and an explicit political) concern. Under the prevailing global climate law and governance regime, countries from the global North and the global South have reached some form of political agreement on burden-sharing based on the principle of common but differentiated responsibilities (and respective capabilities).

This is arguably a step in the right direction, but important questions remain about global environmental governance, perceived as being biased towards promoting the interests of the global North at the expense of the global South. In light of ever-increasing global inequality, conceptual frameworks such as the planetary boundaries, that are seen by some to essentially whitewash the politics of global environmental governance, may not be all that helpful in addressing deeply divisive and pervasive political concerns that continue to pitch a rich, scientifically empowered and developed global North against a poor, ever-dependent, developing global South.

3. IMPLICATIONS FOR GOVERNANCE IN THE ANTHROPOCENE

The foregoing four characteristics and their associated framings have numerous and varied implications for the governance of planetary boundaries. While several of these implications are discussed in almost all of the chapters in the present book, we focus below on four issues that social scientists have identified, and that more or less correspond with one or more of the characteristics and their respective framings discussed above.

3.1 Institutionalising Planetary Boundaries

Respecting the environmental limits of the planetary boundaries requires strong institutions at all levels of governance, but arguably most prominently at the global level. Many scholars have individually considered the nine planetary boundaries and their corresponding potential institutional challenges.[50] The emerging consensus in the literature seems to be against establishing separate multilateral processes and institutions for each planetary boundary.[51] Authors believe such a sectoral governance approach would only increase governance fragmentation and 'spread political will thinly'.[52] Instead, there seems considerable support for building on, improving and better coordinating existing multilateral environmental treaty regimes.[53] In

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[50] See, for example, Miriam Diamond et al, 'Exploring the Planetary Boundary for Chemical Pollution' (2015) 78 Environ International 8; Vera Heck et al, 'Land Use Options for Staying within the Planetary Boundaries: Synergies and Trade-offs Between Global and Local Sustainability Goals' (2018) 49 Global Environmental Change 73.

[51] Victor Galaz, 'Planetary Boundaries Concept Is Valuable' (2012) 486 Nature 191.

[52] Simon Lewis, 'We Must Set Planetary Boundaries Wisely' (2012) 485 Nature 417.

[53] Jonas Ebbesson, 'Planetary Boundaries and the Matching of International Treaty Regimes' (2014) 59 Scandinavian Studies in Law 259. See also Piero Morseletto, 'Confronting the Nitrogen Challenge: Options for Governance and Target Setting' (2019) 54 Global Environmental Change 40; Matías Franchini, Eduardo Viola and Ana Flávia Barros-Platiau, 'The Challenges of the Anthropocene: From International Environmental Politics to Global Governance' (2017) 20 Ambiente Sociedade 177. But for the planetary boundary on ocean acidification, it is debatable whether a new multilateral environmental

essence, scholars urge the need to bolster those 'legal boundaries'[54] that correspond with the planetary boundaries, by strengthening and better coordinating existing legislation with a view to creating a 'safe policy space'.[55]

But the numerous and varied challenges that planetary boundaries present go far beyond simply strengthening existing institutions as a solution to these challenges. The challenges instead question some of the most fundamental ideas in contemporary law, politics and economics, among other social regulatory domains. The institutional challenges of the planetary boundaries for law are evident, for example, through environmental law's continued failure to fully hold corporations to account; its failure to reign in neoliberal corporate capitalist globalisation; its resistance to creating stringent standards to regulate the many ecological destructive activities of (especially transnational) corporations; and its structural promotion of corporations as 'private sector *quasi-states*'.[56] It is these failures that allow, and even facilitate, corporate exploitation that in turn contributes to moving us closer towards the upper limits of the planetary boundaries. After all, states as such are not principally responsible for causing global environmental destruction. Driven as they are by the many consumers they seek to satisfy in return for profit, it is often the corporations that operate within the jurisdictions of states and that engage in environmentally destructive processes that do so. Several commentators question if the current corporate-driven growth paradigm is compatible with planetary boundaries,[57] and they make a case for building 'biosphere economics' where 'growth in human well-being is the focus rather than growth in GDP [gross domestic product]'.[58]

Also related to institutional concerns is the challenge that the planetary boundaries approach presents to the idea of state sovereignty.[59] Concisely understood as 'supreme legitimate authority within a territory',[60] state sovereignty has since become an inextricable part of international

agreement is needed. See for example Rakhyun E Kim, 'Is a New Multilateral Environmental Agreement on Ocean Acidification Necessary?' (2012) 21 Review of European Community and International Environmental Law 243.

54 Guillaume Chapron et al, 'Bolster Legal Boundaries to Stay within Planetary Boundaries' (2017) 1 Nature Ecology and Evolution 1.

55 Lauriane Mouysset et al, 'Operationalizing Sustainability as a Safe Policy Space' (2018) 10 Sustainability 3682.

56 Anna Grear, 'Towards "Climate Justice"? A Critical Reflection on Legal Subjectivity and Climate Injustice: Warning Signals, Patterned Hierarchies, Directions for Future Law and Policy' (2014) 5 Journal of Human Rights and the Environment 103, 108. See also Beate Sjåfjell, 'Redefining the Corporation for a Sustainable New Economy' (2018) 45 Journal of Law and Society 29.

57 Jeroen van den Bergh and Giorgos Kallis, 'Growth, A-growth or Degrowth to Stay within Planetary Boundaries?' (2014) 46 Journal of Economic Issues 909; Cameron Hepburn et al, 'Resilient and Inclusive Prosperity within Planetary Boundaries' (2014) 22 China World Economy 76; Edward Barbier and Joanne Burgess, 'Natural Resource Economics, Planetary Boundaries and Strong Sustainability' (2017) 9 Sustainability 1; Per Espen Stoknes and Johan Rockström, 'Redefining Green Growth within Planetary Boundaries' (2018) 44 Energy Research & Social Science 41.

58 Anne-Sophie Crépin and Carl Folke, 'The Economy, the Biosphere and Planetary Boundaries: Towards Biosphere Economics' (2014) 8 International Review of Environmental and Resource Economics 57, 58. See also Joachim H Spangenberg, 'Institutional Change for Strong Sustainable Consumption: Sustainable Consumption and the Degrowth Economy' (2017) 10 Sustainability: Science, Practice and Policy 62.

59 Steffen, Rockström and Costanza (n 23); Franchini, Viola and Barros-Platiau (n 53).

60 Daniel Philpott, 'Sovereignty: An Introduction and Brief History' (1995) 48 Journal of International Affairs 353, 357.

law's canon and the associated 'colonial international law doctrines'[61] connected to it. Yet, it must be recognised that state sovereignty is not a socio-ecologically protective principle that is appropriate for keeping humanity within a safe operating space. Commentators point out that 'it appears questionable whether full national sovereignty can be upheld for the most essential environmental standards that are needed to protect the planetary boundaries'.[62] This has led some scholars to propose the idea of a 'common home of humanity', which sees Earth not as an amalgamation of independent separate states that must protect their sovereign integrity at all costs, but rather as an all-inclusive and accommodative home for all where it is possible to pursue 'a stable and accommodating state of the Earth System itself … as the intangible, natural heritage of all humanity'.[63] In the context of the planetary boundaries, such radical counter-narratives align with the suggestion that 'maintaining the type and level of activities within and beyond our jurisdictional boundaries … may become conditional upon respecting certain overall, planetary-scale boundaries'.[64]

Several commentators have begun calling for the creation of governance institutions for planetary boundaries, including a fundamental norm (or law in a broad sense) specifically dedicated to respecting planetary boundaries as limits to harmful activities, as well as a system of institutions that supports the administration of such a norm. Situated as it is within the emerging narrative of global environmental constitutionalism, one specific proposal is to constitutionalise international environmental law.[65] Constitutional international environmental law sits at the top of the international normative hierarchy,[66] and 'must be binding and supranational, with supremacy over sub-global legal regimes as necessary'.[67] While several scholars agree that 'some degree of constitutionalization is necessary to provide a rule of law framework in an increasingly globalized, networked, multilevel world',[68] the exact form of (a)

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61 M Rafiqul Islam, 'History of the North-South Divide in International Law: Colonial Discourses, Sovereignty, and Self-determination' in Shawkat Allam et al (eds), *International Environmental Law and the Global South* (Cambridge University Press 2015).

62 Biermann (n 6).

63 Steffen et al (n 12) at 62.

64 Davor Vidas, 'The Anthropocene and the International Law of the Sea' (2011) 369 Philosophical Transactions of the Royal Society A 909, 923–24.

65 Louis J Kotzé and Wendy Muzangaza, 'Constitutional International Environmental Law for the Anthropocene?' (2018) 27 Review of European, Comparative and International Environmental Law 278; Louis J Kotzé, *Global Environmental Constitutionalism in the Anthropocene* (Hart 2016); Louis J Kotzé, 'The Anthropocene's Global Environmental Constitutional Moment' (2014) 25 Yearbook of International Environmental Law 24; Louis J Kotzé, 'Arguing Global Environmental Constitutionalism' (2012) 1 Transnational Environmental Law 199. See also Norichika Kanie et al, 'A Charter Moment: Restructuring Governance for Sustainability' (2012) 32 Public Administration and Development 292; Frank Biermann et al, 'Navigating the Anthropocene: Improving Earth System Governance' (2012) 335 Science 1306.

66 Louis J Kotzé, 'Constitutional Conversations in the Anthropocene: In Search of Environmental *Jus Cogens* Norms' (2015) 46 Netherlands Yearbook of International Law 241.

67 Geoffrey Garver, 'The Rule of Ecological Law: The Legal Complement to Degrowth Economics' (2013) 5 Sustainability 316. See also Geoffrey Garver, 'Moving from Environmental Law to Ecological Law: Frameworks, Priorities and Strategies' in Laura Westra et al (eds), *Ecological Integrity, Law and Governance* (Routledge 2018) ch 14.

68 Joyeeta Gupta and Nadia Sanchez, 'Global Green Governance: Embedding the Green Economy in a Global Green and Equitable Rule of Law Polity' (2012) 21 Review of European, Comparative and International Environmental Law 12.

global environmental constitution(alism) is still being debated. The World Charter for Nature, the Earth Charter and the International Union for Conservation of Nature's Draft International Covenant on Environment and Development are some potential candidates.[69] Some also see potential in the Global Pact for the Environment currently under consideration as an overarching framework for bringing the fragmented sectoral and spatial multilateral environmental agreements together under a single higher order (or constitutional-like) global law;[70] yet others are more critical about its potential.[71] More radical proposals make a case for a new 'framework convention on planetary boundaries'[72] or a 'safe operating space treaty'[73] as a necessary means for integrating the planetary boundaries approach into higher order international law.

Steffen and Rockström, together with a prominent ecological economist, Costanza (also a co-author of the original 2009 article), propose 'an institution (or institutions) operating, with authority, above the level of individual countries to ensure that the planetary boundaries are respected'.[74] What precisely this institution might entail is not elaborated in their article, but the discussion clearly points to the need to create some sort of a supranational organisation that could respond to the global governance challenges envisioned by the planetary boundaries. Linked to this is the long-standing, but recently revitalised, debate around the need to upgrade the United Nations Environment Programme to a specialised agency such as a world environment organisation.[75] Proponents contend that such a full-fledged institution for global environmental governance would increase the likelihood of 'identifying and addressing social behavior that threatens to violate planetary boundaries'.[76]

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69 Rakhyun E Kim and Klaus Bosselmann, 'International Environmental Law in the Anthropocene: Towards a Purposive System of Multilateral Environmental Agreements' (2014) 2 Transnational Environmental Law 285; Louis J Kotzé, 'A Global Environmental Constitution for the Anthropocene?' (2019) 8 Transnational Environmental Law 11.

70 Christina Voigt, 'How a "Global Pact for the Environment" Could Add Value to International Environmental Law' (2019) 28 Review of European, Comparative and International Environmental Law 13.

71 Louis J Kotzé and Duncan French, 'A Critique of the Global Pact for the Environment: A Stillborn Initiative or the Foundation for Lex Anthropocenae?' (2018) 18 International Environmental Agreements: Politics, Law and Economics 811; Duncan French and Louis J Kotzé, '"Towards a Global Pact for the Environment": International Environmental Law's Factual, Technical and (Unmentionable) Normative Gaps' (2019) 28 Review of European, Comparative and International Environmental Law 25; Louis J Kotzé, 'International Environmental Law's Lack of Normative Ambition: An Opportunity for the Global Pact for the Environment?' (2019) 16 Journal for European Environmental and Planning Law 213.

72 Edgar Fernández Fernández and Claire Malwé, 'The Emergence of the "Planetary Boundaries" Concept in International Environmental Law: A Proposal for a Framework Convention' (2018) 28 Review of European, Comparative and International Environmental Law 48.

73 Paulo Magalhães et al (eds), *The Safe Operating Space Treaty: A New Approach to Managing Our Use of the Earth System* (Cambridge Scholars 2016).

74 Steffen, Rockström and Costanza (n 23).

75 Frank Biermann and Steffen Bauer (eds), *A World Environment Organization: Solution or Threat for Effective International Environmental Governance?* (Ashgate 2005).

76 Biermann (n 6).

3.2 Coordinating Planetary Boundaries

An issue that also emerges from the discussion immediately above is that the planetary boundaries framework clearly highlights the need to better coordinate international institutions and global governance to more effectively deal with interacting Earth system processes.[77] What the framework has highlighted in particular is the importance of creating coherence between different international environmental policies. This challenge is not entirely new to global environmental governance scholars; in fact, several lines of research centred on the notions of complexity and fragmentation aim to address these challenges.[78]

Drawing on the notion of polycentricity popularised by Ostrom around the same time as the planetary boundaries framework was developed,[79] governance scholars argue that polycentric coordination is an effective approach to governing interacting planetary boundaries.[80] Galaz and colleagues, for example, believe that a polycentric order provides certain useful functions such as information sharing to better coordinate governance actions and to facilitate conflict resolution.[81] Claims such as these have been tested through multiple empirical case studies. Examples include the Collaborative Partnership on Forests;[82] the Global Partnership on Climate, Fisheries and Aquaculture;[83] and the Global Partnership on Nutrient Management,[84] which all seek to address interaction between multiple planetary boundaries. But it has also been noted that polycentric coordination is 'vulnerable to internal tensions, unreliable external flows of funding, and negative institutional interactions', as well as to 'changes in the overarching institutional landscape'.[85] Therefore, continued support emanating from formal global governance institutions remains critically important.[86]

In particular, studies have emphasised the potentially significant role of a set of central principles and/or norms to facilitate coordination that could emanate from a central institution, and that could serve as 'the ultimate arbiter of the myriad trade-offs that need to be managed'.[87] To this end, Biermann argues that overarching principles are useful for, among others, governing the interaction, as well as regulating norm-conflicts, between different institutions.[88] In a similar vein (and harking back to the global environmental constitutionalism issue raised

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[77] Victor Galaz et al, 'Polycentric Systems and Interacting Planetary Boundaries: Emerging Governance of Climate Change – Ocean Acidification – Marine Biodiversity' (2012) 81 Ecological Economics 21.

[78] Fariborz Zelli and Harro van Asselt, 'The Institutional Fragmentation of Global Environmental Governance: Causes, Consequences, and Responses' (2013) 13 Global Environmental Politics 1.

[79] Elinor Ostrom, 'Polycentric Systems for Coping with Collective Action and Global Environmental Change' (2010) 20 Global Environmental Change 550.

[80] Galaz et al (n 5).

[81] Galaz et al (n 77). See also Victor Galaz et al, 'Global Networks and Global Change-induced Tipping Points' (2015) 16 International Environmental Agreements 189.

[82] Gunilla Reischl, 'Designing Institutions for Governing Planetary Boundaries: Lessons from Global Forest Governance' (2012) 81 Ecological Economics 33.

[83] Galaz et al (n 77).

[84] Hanna Ahlström and Sarah Cornell, 'Governance, Polycentricity and the Global Nitrogen and Phosphorus Cycles' (2018) 79 Environmental Science & Policy 54.

[85] Galaz et al (n 5).

[86] Carl Folke et al, 'Reconnecting to the Biosphere' (2011) 40 Ambio 719.

[87] Steffen, Rockström and Costanza (n 23).

[88] Biermann (n 6).

above), Kim and Bosselmann make a case for a single, legally binding, superior ecological norm (or *Grundnorm*) that provides all international regimes and organisations a shared purpose to which their specific objectives must collectively contribute.[89] They contend that such an overarching goal would provide a point of reference for legal reasoning and interpretation, thereby enhancing institutional coherence across the Earth's sub-systems.

Such hierarchical steering through a strong institutional core, or spine, will likely counterbalance the 'self-organising evasive possibilities' inherent in complex polycentric systems settings.[90] For example, a strong overarching norm could help address a normative conflict between planetary boundaries of equal priority or urgency, such as climate change and biosphere integrity.[91] What needs to be clarified in terms of such a central norm is to what extent, and which type of trade-offs, we should allow between planetary boundaries in order to optimise the effectiveness of securing the overall integrity of Earth's life-support systems.[92]

3.3 Downscaling Planetary Boundaries

Downscaling is a form of 'operationalising' planetary boundaries, which is critical to ultimately apply the theoretical framework *in practice*. Downscaling is mostly concerned with allocating the contribution of states and other major sub-national actors to global environmental change.[93] Examples of downscaling are found at regional,[94] national[95]

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89 Kim and Bosselmann (n 67). See also Oran Young et al, 'Goal Setting in the Anthropocene: The Ultimate Challenge of Planetary Stewardship' in Norichika Kanie and Frank Biermann (eds), *Governing through Goals: Sustainable Development Goals as Governance Innovation* (MIT Press 2017) ch 3; Arild Underdal and Rakhyun E Kim, 'The Sustainable Development Goals and Multilateral Agreements' in Norichika Kanie and Frank Biermann (eds), *Governing through Goals: Sustainable Development Goals as Governance Innovation* (MIT Press 2017) ch 10. For a critical reflection on this, see Jeremy J Schmidt, 'The Moral Geography of the Earth System' (2019) 44 Transactions of the Institute of British Geographers 721.

90 Donella Meadows, *Thinking in Systems: A Primer* (Earthscan 2008) 137.

91 Steffen et al (n 4).

92 Rakhyun E Kim, 'The Nexus Between International Law and the Sustainable Development Goals' (2016) 25 Review of European, Comparative and International Environmental Law 15.

93 John McLaughlin, 'Safe Operating Space for Humanity at a Regional Scale' (2018) 23 Ecology & Society; Md Sarwar Hossain and Chinwe Ifejika Speranza, 'Challenges and Opportunities for Operationalizing the Safe and Just Operating Space Concept at Regional Scale' (2020) 27 International Journal of Sustainable Development & World 40. See also Bleby, Holley and Milligan, Chapter 2 in this book.

94 John Dearing et al, 'Safe and Just Operating Spaces for Regional Social-Ecological Systems' (2014) 28 Global Environmental Change 227; Gregory Cooper and John Dearing, 'Modelling Future Safe and Just Operating Spaces in Regional Social-ecological Systems' (2019) 651 Science of the Total Environment 2105.

95 Megan Cole, Richard Bailey and Mark New, 'Tracking Sustainable Development with a National Barometer for South Africa Using a Downscaled "Safe and Just Space" Framework' (2014) 111 Proceedings of the National Academy of Sciences E4399; Hy Dao, Pascal Peduzzi and Damien Friot, 'National Environmental Limits and Footprints Based on the Planetary Boundaries Framework: The Case of Switzerland' (2018) 52 Global Environmental Change 49; Helena Kahiluoto et al, 'Local and Social Facets of Planetary Boundaries: Right to Nutrients' (2015) 10 Environmental Research Letters 104013. Paul Lucas et al, 'Allocating Planetary Boundaries to Large Economies: Distributional Consequences of Alternative Perspectives on Distributive Fairness' (2019) 60 Global Environmental Change 102017.

and local levels.[96] The rise and increased popularity of urban governance for planetary boundaries is a specific case in point.[97] Yet, downscaling is also now reaching into the non-state domain, to, for example, corporations and global civil society groups. Whereas downscaling to corporations is important considering the need to strengthen corporate social responsibility in the face of the severe impacts of multinational corporations and global supply chains on Earth system processes,[98] global civil society groups, such as the Fridays for Future climate movement, are having a greater than expected impact on climate politics, laws and governance.

So far, studies have used different approaches to downscaling, and a common conceptual framework is still lacking.[99] In addition to the need to develop such a framework, and possibly as a critical aspect of it, is the need for the framework to address not only the biophysical and socio-economic but also the ethical dimensions of bridging across scales.[100] This is so because the biophysical and socio-economic dimensions are inherently limited and often biased towards the type of anthropocentric growth and Northern biases explained earlier in this chapter. The inclusion of such ethical dimensions would arguably offer useful opportunities to re-orientate the anthropocentric, Northern ontology of the planetary boundaries, while also catering more fully for differentiation, global democracy and legitimacy not only of the boundaries themselves, but also of global environmental governance, *and* its various scales, more generally.

What would be critically important is to consider the ethical dimensions of downscaling in addition to the biophysical and socio-economic dimensions.[101] After all, downscaled 'shares' of the safe operating space will probably need to be allocated according to some ethical principles.[102] Nilsson and Persson ask,[103] for example: what is a fair share of the planetary boundaries for the European Union? To this end, some guidance could be obtained from the fairness and equity debates (or principles for allocation) that are to some extent already articulated

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[96] Leonardo Vargas, Louise Willemen and Lars Hein, 'Linking Planetary Boundaries and Ecosystem Accounting, with an Illustration for the Colombian Orinoco River Basin' (2018) 18 Regional Environmental Change 1521; Ville Uusitalo et al, 'Environmental Sustainability Assessment from Planetary Boundaries Perspective: A Case Study of an Organic Sheep Farm in Finland' (2019) 687 Science of the Total Environment 168.

[97] Daniel Hoornweg et al, 'An Urban Approach to Planetary Boundaries' (2016) 45 Ambio 567. See also Aust and Nijman, Chapter 6 in this book.

[98] Whiteman, Walker and Perego (n 39); Christoph Butz et al, 'Towards Defining an Environmental Investment Universe within Planetary Boundaries' (2018) 13 Sustainability Science 1031.

[99] Heng Teah et al, 'Assessment of Downscaling Planetary Boundaries to Semi-arid Ecosystems with a Local Perception: A Case Study in the Middle Reaches of Heihe River' (2016) 8 Sustainability 1.

[100] Tiina Häyhä et al, 'From Planetary Boundaries to National Fair Shares of the Global Safe Operating Space: How Can the Scales Be Bridged?' (2016) 40 Global Environmental Change 60.

[101] Sonja Klinsky et al, 'Why Equity is Fundamental in Climate Change Policy Research' (2017) 44 Global Environmental Change 170. See also Adelman, Chapter 4 in this book.

[102] Roland Clift et al, 'The Challenges of Applying Planetary Boundaries as a Basis for Strategic Decision-making in Companies with Global Supply Chains' (2017) 9 Sustainability 279.

[103] Måns Nilsson and Åsa Persson, 'Can Earth System Interactions Be Governed? Governance Functions for Linking Climate Change Mitigation with Land Use, Freshwater and Biodiversity Protection' (2012) 75 Ecological Economics 61. See also Meghan O'Brien et al, 'Living within the Safe Operating Space: A Vision for a Resource Efficient Europe' (2014) 2 European Journal of Futures Research 1.

for climate change and biodiversity loss.[104] These could usefully be extended to other issues covered by the planetary boundaries.

Downscaling is relatively straightforward for some planetary boundaries such as biosphere integrity that are based on aggregates of many sub-global actions.[105] However, the challenge of downscaling lies with planetary boundaries for spatially heterogeneous, systemically connected processes, such as climate change, ozone depletion and ocean acidification. More in-depth life cycle assessment may help to downscale planetary boundaries to sub-global levels,[106] including to specific industries,[107] but the applicability of life cycle assessment is inherently limited. This is because resilience thinking underlying the planetary boundaries framework is absent from life cycle assessment.[108] To be sure, we may never be able to fully refine the sciences of cross-scale dynamics and complex adaptive systems to downscale planetary boundaries through technical means that are squarely focused on biophysical aspects only.

3.4 Democratising Planetary Boundaries

Finally, commentators suggest that it is both necessary and possible to democratise planetary boundaries and their associated governance practices to help improve legitimacy, buy-in and support from all countries across the globe. We focus, for present purposes, on two popular dimensions to such a process of democratisation: (1) the global North–South divide; and (2) the perceived dominant role of experts in relation to citizens and policy-makers.

With respect to the first dimension, the planetary boundaries framework does not impose a specific decision and related outcome on global development trajectories within the safe operating space. It only defines the environmental target corridor within the larger context of sustainable development.[109] The pathway to sustainability is left open to be developed through a multi-scalar democratic political process. While such a process could be, and often is, plagued by democracy, participatory, legitimacy and representativity concerns, the concept of planetary boundaries does not in and of itself exclude marginalised stakeholders such as global

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[104] For example Edward Page, ‘Distributing the Burdens of Climate Change’ (2008) 17 Environmental Politics 556.

[105] Sarah Cornell, ‘On the System Properties of the Planetary Boundaries’ (2012) 17 Ecology & Society.

[106] Morten Ryberg et al, ‘Development of a Life-cycle Impact Assessment Methodology Linked to the Planetary Boundaries Framework’ (2018) 88 Ecological Indicators 250.

[107] E.g., Morten Ryberg et al, ‘How to Bring Absolute Sustainability into Decision-making: An Industry Case Study Using a Planetary Boundary-based Methodology’ (2018) 634 Science of the Total Environment 1406; Nicholas Bowles, Samuel Alexander and Michalis Hadjikakou, ‘The Livestock Sector and Planetary Boundaries: A “Limits to Growth” Perspective with Dietary Implications’ (2019) 160 Ecological Economics 128.

[108] Andrea Downing et al, ‘Matching Scope, Purpose and Uses of Planetary Boundaries Science’ (2019) 14 Environmental Research Letters 073005. But see Kai Fang, Reinout Heijungs and Geert de Snoo, ‘Understanding the Complementary Linkages between Environmental Footprints and Planetary Boundaries in a Footprint-boundary Environmental Sustainability Assessment Framework’ (2015) 114 Ecological Economics 218.

[109] Biermann (n 6).

South countries. On mere face value, then, the planetary boundaries framework is accordingly not undemocratic or exclusionary as such.[110]

Recognising the difficulties inherent to democratising global environmental governance, and everything that goes with that impulse, some commentators argue that it is necessary and possible to address the biophysical aspects of the boundaries in ways that are compatible with enhancing the many aspects of global social equity.[111] Such an effort would largely depend on what sort of shared development agenda the world has agreed on, which is currently most clearly embodied by the 2030 Agenda for Sustainable Development. Yet, scholars note that while the 2030 Agenda has successfully embraced some form of interdependent environmental limits as suggested by the planetary boundaries framework,[112] we still need to more explicitly prioritise safeguarding the Earth system within the Sustainable Development Goals (SDGs) framework.[113] Some believe it is still possible to have a good life for all within planetary boundaries (that is, satisfying the many needs explicated by the SDGs), but only at a much lower level of affluence than that which richer countries enjoy today.[114]

The second dimension relates to criticism that the planetary boundaries framework implies an expert-driven approach that essentially sidelines the participation of people. Drawing on deliberative democracy research and the role of science in democratic societies more generally, and as a response to such concerns, Pickering and Persson argue that planetary boundaries can in fact be interpreted in ways that largely remain consistent with democratic decision-making.[115] What would be required is 'an iterative, dialogical process to formulate planetary boundaries and negotiate planetary targets'.[116] In this view, the process of democratising planetary boundaries could form the basis for a 'democratically legitimate division of labour among experts, citizens and policy-makers in evaluating and responding to Earth-system risks'.[117] What would be crucial to such a division of labour is the need to open up space for 'deliberative contestation about the value judgments inherent in collective responses to Earth-system risks'.[118] If this could materialise, then the fact that experts are issuing warnings about what they consider to be unacceptable risks will not be a problem in

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[110] Rakhyun E Kim and Klaus Bosselmann, 'Operationalizing Sustainable Development: Ecological Integrity as a Grundnorm of International Law' (2015) 24 Review of European, Comparative and International Environmental Law 194.

[111] Will Steffen and Mark Stafford Smith, 'Planetary Boundaries, Equity and Global Sustainability: Why Wealthy Countries Could Benefit from More Equity' (2013) 5 Current Opinion in Environmental Sustainability 1.

[112] Jørgen Randers et al, 'Achieving the 17 Sustainable Development Goals within 9 Planetary Boundaries' (2019) 2 Global Sustainability 1.

[113] Maarten Hajer et al, 'Beyond Cockpit-ism: Four Insights to Enhance the Transformative Potential of the Sustainable Development Goals' (2015) 7 Sustainability 1651; Clara Brandi, 'Safeguarding the Earth System as a Priority for Sustainable Development and Global Ethics: The Need for an Earth System SDG' (2015) 11 Journal of Global Ethics 32; Kotzé (n 29).

[114] Daniel O'Neill et al, 'A Good Life for All within Planetary Boundaries' (2018) 1 Nature Sustainability 88; Jason Hickel, 'Is it Possible to Achieve a Good Life for All within Planetary Boundaries?' (2019) 40 Third World Quarterly 18; Kahiluoto et al (n 95).

[115] Pickering and Persson (n 49).

[116] Ibid 59.

[117] Ibid.

[118] Ibid.

and of itself, making it possible to allow the expert-driven assessments to continue alongside, and supported by, associated iterative and deliberative processes.

An ideal opportunity to test the foregoing hypothesis usefully presents itself in terms of the ongoing work of the Earth Commission, a group of 19 scientists mandated by Future Earth – a global network of sustainability scientists – to develop Earth system targets.[119] The Commission will build on 'analysis conducted by a series of international working groups of experts'.[120] This looks similar to the international panel of experts operating at the interface between science and policy for which some scholars are calling.[121] Will it, however, manage to provide to Earth system targets the democratic legitimacy that planetary boundaries seemingly have failed to secure? While only time will tell, some critics are already sceptical of the Earth Commission's perceived uncritical acceptance of, and reliance on, value-free global change science, as well as the inevitable marginalisation of the global South in the debate that this will entail.[122]

4. CONCLUSION

In this chapter we provided a systematic review of the literature at the intersection between Earth system science, law and governance in relation to the concept of planetary boundaries. The aim was to identify key framings of planetary boundaries found in the literature, as well as associated implications for the governance of planetary boundaries. The four framings we identified are: (1) planetary boundaries as environmental limits, with an emphasis on freedom within the safe operating space; (2) planetary boundaries as interdependent and interacting phenomena, which are at once in constant flux with synergies and trade-offs; (3) planetary boundaries as being planetary in scale, which in turn requires downscaling to sub-global levels in order to have an impact on decision-making; and (4) planetary boundaries as political constructs that challenge the democratic legitimacy of the framework and that complicate its widespread adoption and implementation in the overall global development and sustainability agendas.

Four key governance implications flow from these framings of planetary boundaries. First, scholars argue that we need to institutionalise planetary boundaries by means of constitutionalising (international environmental) law, possibly to the extent that planetary boundaries, as higher order constitutional limits, might temper state sovereignty. Second, we need to coordinate planetary boundaries by maximising the ability of existing decentralised institutional architectures to adapt, but at the same time we need to agree on a strong overarching norm to steer us into the right direction. Third, planetary boundaries must be operationalised through downscaling to sub-global levels by reaching global political agreement on key principles of allocation of benefits and responsibilities. Fourth, it is essential that we find ways to democratise planetary boundaries by opening up inclusive spaces for deliberative contestation between the global North and the global South and between scientific experts and non-experts.

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119 Future Earth 'Earth Commission' (2020) <https://futureearth.org/initiatives/earth-targets-initiatives/earth-commission/> accessed 23 June 2020.

120 The Earth Commission, 'Home' (2020) <https://earthcommission.org> accessed 19 April 2020.

121 Fernández and Malwé (n 72).

122 Biermann and Kim (n 11).

What our survey essentially reveals is that at the crux of this scholarly endeavour lies the challenging imperative for social scientists to navigate through the complexity of planetary boundaries. In order to build a system of effective planetary boundaries governance, more research is needed on the institutionalisation, coordination, operationalisation and democratisation of planetary boundaries. And we need to keep experimenting with various innovative solutions for transforming our societies and economies, while we must also scale up, and scale down, those solutions that seem to work.[123]

The planetary boundaries framework has proven useful and influential in driving academic debate and, at the very least, in initiating policy change discussions that could benefit global governance for sustainability.[124] However, the framework needs to be constantly updated and utilised to remain relevant; ideally, it should be considered as a living framework to which scientists and policy-makers add new boundaries or adjust existing boundaries.[125] While Earth system scientists have been leading the discussion,[126] social scientists should continue and even increase their engagement with the debate in order to more clearly reveal the regulatory implications of the planetary boundaries framework for law and governance, and to make the framework more effective and legitimate. After all, the planetary boundaries framework describes the problem, but it offers little as far as solutions are concerned. And it is exactly these solutions (especially the extent to which social institutions could facilitate such solutions) that social scientists can helpfully identify.

At the same time, however, it is important to be mindful of the fundamental assumption underlying the planetary boundaries approach to Earth system governance: that the Earth system has not (yet) passed critical tipping points. By symbolically acting as a safety net erected on the edge of a cliff, the planetary boundaries might lose much of their relevance and usefulness once we fall off the cliff, as it were. Considering the increasing probability of future tipping events occurring sooner than later,[127] more scholarly attention could be directed towards exploring novel governance challenges of navigating, and then surviving, the unknown and 'unsafe' space that lies far outside the planetary boundaries' safe operating space. Whether social science theorising should seek to prevent us arriving there, or should begin to sketch out what it might look like when we do, is a meta-conversation that, unfortunately, we have little time to have.

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[123] Melissa Leach et al, 'Transforming Innovation for Sustainability' (2012) 17 Ecology & Society; Klaus Jacob et al, 'Governance for the Sustainable Economy: Institutional Innovation from the Bottom Up?' (2019) 28 GAIA 204.

[124] European Commission (n 44).

[125] Patricia Villarrubia-Gómez, Sarah Cornell and Joan Fabres, 'Marine Plastic Pollution as a Planetary Boundary Threat: The Drifting Piece in the Sustainability Puzzle' (2018) 96 Marine Policy 213.

[126] Kirsty Nash et al, 'Planetary Boundaries for a Blue Planet' (2017) 1 Nature Ecology and Evolution 1625.

[127] Timothy O'Riordan and Timothy Lenton, 'Into a Precarious Future' in Timothy O'Riordan and Timothy Lenton (eds), *Addressing Tipping Points for a Precarious Future* (Oxford University Press 2013) 301; Yongyang Cai, Timothy Lenton and Thomas Lontzek, 'Risk of Multiple Interacting Tipping Points should Encourage Rapid CO_2 Emission Reduction' (2016) 6 Nature Climate Change 520; Joana Castro Pereira and Eduardo Viola, 'Catastrophic Climate Change and Forest Tipping Points: Blind Spots in International Politics and Policy' (2018) 9 Global Policy 513.

4. Planetary boundaries, planetary ethics and climate justice in the Anthropocene

Sam Adelman

1. INTRODUCTION

This chapter considers what is required for a planetary ethics that reflects the scale and urgency of climate breakdown and a foundation for climate justice in the Anthropocene. Its focus is specifically on the climate system and its attendant emergency, which is one of the nine planetary boundaries that has already been crossed.[1] Crossing the climate change boundary is intertwined with concerns centring on the Anthropocene's unfolding ecological cataclysm, which are, in turn, central components of a multi-layered crisis of capitalism and of the western model of development that cannot be solved through Holocene ethics and rationality.

The first section of the chapter examines the influence of the concept of the Anthropocene and the planetary boundaries framework to which it is linked. In the second section, I engage with the form and content of law in general, and international environmental law (IEL) in particular. I ask whether IEL can overcome its historical lack of normative ambition and the obstacles it places in the way of ecological sustainability. The final section discusses the legal paradigm shift needed to replace the current fragmented, polycentric environmental governance regime with one that is more responsive to the multiple challenges of the planetary boundaries framework.

2. PLANETARY ETHICS IN THE ANTHROPOCENE

The Anthropocene undermines Holocene ethics and epistemologies, forcing a radical reconsideration of conventional thinking about normative behaviour and its justifications.[2] An ethics that ignores the scale and urgency of climate breakdown, ecological collapse and the Sixth Mass Extinction is an ethics of extinction, particularly in a post-truth world in which science is called into question. In Houston's words, one of the 'key intellectual challenges of the Anthropocene epoch is to reimagine how humans make connections between planetary and everyday life in ethical, sustainable, and ecologically just ways'.[3] Planetary ethics must therefore be concerned with justice obligations to all species in current and future generations

1 See, for a detailed discussion of the climate change boundary and its legal framework, Verschuuren, Chapter 13 in this book.

2 Morals are guiding principles for individuals whereas ethics refer to collective rules and codes of behaviour. A moral precept is derived from the desire to be or do good whereas an ethical code is a set of rules that defines permissible action and correct behaviour.

3 Donna Houston, 'Crisis Is Where We Live: Environmental Justice for the Anthropocene' (2013) 10(3) Globalizations 439, 440.

and to the Earth as a living entity.[4] Planetary ethics provides a foundation for distributive, reparative and procedural justice, and it promotes ecological sustainability. It calls for remedial action to limit the impacts of global heating, safeguarding the capacity of all living beings to flourish, and bequeathing a habitable planet to future generations and an environmental equivalent of the Hippocratic oath that obliges precaution and the prevention of climatic and ecological harms.[5]

The Anthropocene – the age of humans – is widely ascribed to the acquisition by some *Homo sapiens* (for whom the term is an historical misnomer) of hyper-agency and telluric power. The Anthropocene is a problematic concept because it is often used to imply that all human beings are equally responsible for the climate crisis, contrary to the history of unequal carbon exchange.[6] The age of humans intersected with the age of rights and possessive individualism, but as Douzinas argues, if the twentieth century was the epoch of human rights:

> their triumph is, to say the least, something of a paradox … [because it] witnessed more violations of their principles than any previous, less 'enlightened' one … At no point in human history has there been a greater gap between the north and the south, between the poor and the rich in the developed world, or between the seduced and the excluded globally.[7]

The Anthropocene marks a new, existential, divide between those with rights and the rightless, and this requires ethics to address the harms of climate breakdown caused by the rupture to the Earth system from ecologically unsustainable models of development.[8] This rupture is reflected in the breaching of four of the nine planetary boundaries that demarcate a 'safe operating space' for humanity.[9] Nestled within the domain of Earth system science, the framework stresses the need for holistic, systemic thinking rarely found in modern western law.[10]

The spatialities and temporalities of the Anthropocene destabilise Eurocentric onto-epistemologies and disrupt environmental law and governance. Donna Haraway views

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4 As in indigenous onto-epistemologies (see below) and concepts such as Gaia: James Lovelock, *The Revenge of Gaia: Why the Earth Is Fighting Back – and How We Can Still Save Humanity* (Penguin 2007).

5 Joseph Rotblat, 'A Hippocratic Oath for Scientists' (1999) 286(5444) Science 1475.

6 J Timmons Roberts and Bradley C Parks, 'Ecologically Unequal Exchange, Ecological Debt, and Climate Justice: The History and Implications of Three Related Ideas for a New Social Movement' (2009) 50(3–4) International Journal of Comparative Sociology 385; Andreas Malm and Alf Hornborg, 'The Geology of Mankind? A Critique of the Anthropocene Narrative' (2014) 1(1) The Anthropocene Review 62. I prefer the idea of the Capitalocene because it highlights the capitalist growth imperative as the main driver of ecological destruction since the sixteenth century, but Anthropocene is a shorthand widely used in the academy that has entered public discourse. See Hans Baer, 'Anthropocene or Capitalocene? Two Political Ecological Perspectives' (2017) 45(3) Human Ecology 433.

7 Costas Douzinas, *The Radical Philosophy of Rights* (Routledge 2019) 89.

8 Clive Hamilton, 'The Anthropocene as Rupture' (2016) 3(2) The Anthropocene Review 93. On unsustainable development see Arturo Escobar, 'Sustainability: Design for the Pluriverse' (2011) 54(2) Development 137.

9 Will Steffen et al, 'Planetary Boundaries: Guiding Human Development on a Changing Planet' (2015) 347 Science 1259855; Johan Rockström et al, 'A Safe Operating Space for Humanity' (2009) 461 Nature 472.

10 Tim Stephens, 'What Is the Point of International Environmental Law Scholarship in the Anthropocene?' in Ole Pedersen (ed), *Perspectives on Environmental Law Scholarship: Essays on Purpose, Shape and Direction* (Cambridge University Press 2018). See also Collins, Chapter 5 in this book.

the Anthropocene as a liminal or threshold concept, as a boundary marking a rupture or severe discontinuity so that what comes after cannot be like what preceded it:

> The boundary that is the Anthropocene/Capitalocene means many things, including that immense irreversible destruction is really in train, not only for the 11 billion or so people who will be on earth near the end of the 21st century, but for myriads of other critters too … The edge of extinction is not just a metaphor; system collapse is not a thriller.[11]

This rupture of the Anthropocene has multiple, complex and urgent ethical implications at a planetary scale.

3. PLANETARY ETHICS AND PLANETARY BOUNDARIES

Any discussion of planetary ethics takes place against a background of boundaries, borders and limits. In this chapter, these are primarily planetary boundaries; bordered, xenophobic, sovereign-centric thinking; and the limits of economic growth. The planetary boundaries framework has gained increasing prominence since it was first introduced in 2009. It 'defines a safe operating space for humanity based on the intrinsic biophysical processes that regulate the stability of the Earth system'.[12] Four of these boundaries have been crossed: biosphere integrity, climate change, biogeochemical flows and land-system change.[13] The planetary boundaries have had a wide impact in many disciplines, reflected for example in the success of Kate Raworth's theory of doughnut economics that has been incorporated into Amsterdam's post-COVID-19 planning.[14] Kate Raworth adds an ethical element in arguing that socially just development must aim to achieve certain minimum thresholds while remaining within the 'safe *and just* space' of a doughnut whose outer border represents planetary thresholds and an inner core of minimum needs for a decent life.[15]

The planetary boundaries framework has the virtue of simplicity. It draws attention to the ecological consequences of growth-driven, carbon-based extractive development. But it is

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[11] Donna Haraway, 'Anthropocene, Capitalocene, Plantationocene, Chthulucene: Making Kin' (2015) 6(1) Environmental Humanities 159, 161. Haraway prefers the term Chthulucene, 'a name for the dynamic ongoing sym-chthonic forces and powers of which people are a part' (ibid.).

[12] See Bleby, Holley and Milligan, Chapter 2 in this book. The boundaries are climate change, biodiversity loss, ocean acidification, land-system change, nitrogen loading, phosphorous loading, freshwater use, atmospheric aerosol loading, chemical pollution and stratospheric ozone depletion. Ozone depletion is the only process that has been brought under control, thanks to a successful campaign in the 1980s. There are insufficient data for chemical pollution and aerosol loading. Rockström et al; and Steffen et al (n 9).

[13] See for a detailed discussion Somsen and Trouwborst, Chapter 12; Verschuuren, Chapter 13; Diz, Chapter 17; and Morrow, Chapter 19, in this book.

[14] Daniel Boffey, 'Amsterdam to Embrace "Doughnut" Model to Mend Post-coronavirus Economy', *The Guardian*, 8 April 2020 <www.theguardian.com/world/2020/apr/08/amsterdam-doughnut-model-mend-post-coronavirus-economy> accessed 8 April 2020. See Kate Raworth, *Doughnut Economics: Seven Ways to Think Like a 21st-Century Economist* (Chelsea Green Publishing 2017).

[15] Kate Raworth, *A Safe and Just Space for Humanity: Can We Live within the Doughnut?* (Oxfam Discussion Paper, February 2012) 1. These needs are related to the Sustainable Development Goals and include minimum levels of food, clean water, housing, sanitation, energy, education, healthcare, gender equality, income and political voice.

also open to several criticisms.[16] First, the planetary boundaries address the limits of growth implicitly instead of openly acknowledging that continued growth in the global south requires degrowth in the north and, in aggregate, across the planet. They have little to say about the underlying socio-economic structures that have brought the biosphere to the point of collapse. It is therefore difficult to envisage how the Sustainable Development Goals (SDGs), among other visions for future development, can be achieved within the planetary boundaries framework.[17] Montoya and colleagues maintain that:

> Because there is no operational definition of 'safe operating space', this not only encourages arguments that 'growth within limits' is acceptable but also the belief that human actions were once environmentally either benign or allowed recovery. Worse still, if the planet is not obviously collapsing around us, then surely we can continue to deplete it.[18]

Second, because they are designed to keep ecological degradation within a safe operating space for humanity, the planetary boundaries combine a paradoxical form of ecocentric-anthropocentrism that recognises that the needs and interests of humankind are contingent upon the well-being of the biosphere and other species. A key concern in this respect is that the planetary boundaries indicate thresholds but do not tell us how to avoid breaching them. This is problematic because evidence suggests that it has proved almost impossible to reconcile human welfare with the welfare of the planet under mainstream forms of development.[19] This is further complicated by the fact that the boundaries are dynamic and there is no consensus on how to measure ecological sustainability. A further complication is that the planetary boundaries are designed to preserve Holocene conditions as much as possible, but the framework does not interrogate the contributions of Holocene discourses of economics, ethics, law and politics to climate breakdown.[20]

Third, Montoya and colleagues contend that the framework 'lacks clear definitions, or it has too many conflicting definitions', and is 'ill-founded, inoperable, and can have unexpected detrimental effects on ecosystems'.[21] They argue that the idea of a safe operating space for biodiversity is incoherent because the planetary boundaries 'add no insight into our understanding of the threats to biodiversity and ecosystem functioning, have no evidence to support them, are too vague for use by those who manage biodiversity, and promote pernicious policies'.[22] They accordingly question the need and efficacy of boundaries and the idea of tipping points. The foremost proponents of the planetary boundaries framework acknowledge uncertainty due to

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[16] See further Kim and Kotzé, Chapter 3, and Bleby, Holley and Milligan, Chapter 2, in this book.

[17] Jorgen Randers et al, 'Achieving the 17 Sustainable Development Goals within 9 Planetary Boundaries', (2019) 2(e24) Global Sustainability 1.

[18] José M Montoya, Ian Donohue and Stuart L Pimm, 'Planetary Boundaries for Biodiversity: Implausible Science, Pernicious Policies' (2018) 33(2) Trends in Ecology & Evolution 71, 72.

[19] Daniel W O'Neill et al, 'A Good Life for All within Planetary Boundaries' (2018) 1(2) Nature Sustainability 88.

[20] See Kim and Kotzé, Chapter 3 in this book.

[21] Montoya, Donohue and Pimm (n 18) 72. See the response in Johan Rockström et al, 'Planetary Boundaries: Separating Fact from Fiction. A Response to Montoya et al' (2018) 33(4) Trends in Ecology & Evolution 233.

[22] Montoya, Donohue and Pimm (n 18) 71.

'our lack of scientific knowledge about the nature of the biophysical thresholds themselves, [and] the intrinsic uncertainty of how complex systems behave'.[23]

Fourth, the planetary boundaries are a manifestation of western science potentially at odds with the alternative epistemologies discussed below. As such, they promote a technocratic conception that underemphasises the political economy of carbon.[24]

Fifth, the planetary boundaries framework highlights the contradiction between thresholds and business-as-usual, without suggesting how the latter should be transformed. O'Neill and colleagues write: 'no country meets basic needs for its citizens at a globally sustainable level of resource use'; indeed, 'the more social thresholds a country achieves, the more biophysical boundaries it transgresses, and vice versa'.[25] As expected, wealthy countries which do well on social indicators significantly transgress biophysical boundaries, while the reverse is true for many poorer countries. The only countries that have achieved all of the social thresholds have transgressed at least five of the biophysical boundaries; those that remain entirely within all the biophysical boundaries have achieved at most three of the social targets.

Despite the cogency of much of this criticism, the planetary boundaries provide a framework for a planetary ethics in several ways. First, they link growth-driven, extractive development to comprehensible thresholds despite intrinsic scientific uncertainty. As such, they link agency and choices to ethics, and hence also to law, economics and public policy. And they feed into the social activism of the climate strikers and Extinction Rebellion, without which there will be no solution to climate breakdown. Second, they highlight the important role of Earth system scientists in 'democratic debate by warning citizens and policy-makers of global ecological risks, but that the value judgments underpinning these warnings need to be rendered transparent and open to public debate'.[26] Third, the planetary boundaries highlight the importance of planetary stewardship for current and future generations. They provide a basis for an ethics of sufficiency or ethics of enough,[27] for resistance to the abnormal world before the COVID-19 pandemic, and for solidarity in addressing the existential transboundary problem of climate breakdown.

4. TOWARDS A PLANETARY ETHICS?

Despite the term's widespread usage, there is disagreement about which geological spikes mark the onset of the Anthropocene.[28] The main contenders are the 1610 spike caused by the

[23] Johan Rockström et al, 'Planetary Boundaries: Exploring the Safe Operating Space for Humanity' (2009) 14(2) Ecology and Society 32, 37.

[24] See Kim and Kotzé, Chapter 3 in this book.

[25] O'Neill et al (n 19) 90.

[26] Jonathan Pickering, Karin Bäckstrand and David Schlosberg, 'Between Environmental and Ecological Democracy: Theory and Practice at the Democracy Environment Nexus' (2020) 22(1) Journal of Environmental Policy & Planning 1, 9.

[27] Alan Fricker, 'The Ethics of Enough' (2002) 34 Futures 427.

[28] According to an increasing number of geologists, the Holocene is the 11,700-year geological epoch that preceded the Anthropocene, during which favourable climatic conditions enabled human civilisation based upon agriculture.

genocide of the Columbian Exchange in 1610,[29] the invention of the steam engine at the start of the Industrial Revolution[30] and the Great Acceleration following the Second World War.[31]

Whichever point of transition is chosen, Holocene onto-epistemological and ethical 'survivals' perdure and perpetuate anachronistic, antithetical modes of thought that are at odds with contemporary ecological exigencies.[32] As we shall see below, anthropocentric Cartesian dualisms and mechanistic Baconian conceptions are deeply imbricated in modern western law and jurisprudence. The construction of a planetary ethics is thus a fitful process always vulnerable to resistance from libertarian ecological modernisers. Reflecting the increasingly acute dilemma about the political role of scientists, the planetary boundaries identify the thresholds of ecological sustainability but not the political or economic means to remain within them.

Nevertheless, I argue that a heuristic distinction between the Holocene and Anthropocene is justified because, in Santos's words, we are 'facing a modern problem that, nevertheless, cannot be solved in modern terms'.[33] The dominant ideologies of the Capitalocene are driving forces of ecological destruction as much as greenhouse gas emissions.[34] Liberal conceptions of freedom, autonomy and possessive individualism which entrench the division in modern western law between private action and public responsibility have proved to be an inadequate basis for dealing with the rupture to the Earth system. Binary, anthropocentric theories of justice (utilitarian, consequentialist, Kantian) that focus on individual autonomy have smoothly become 'green'. This was exemplified by the difficulties John Rawls encountered in seeking to extend his influential theory of justice from the domestic to the international sphere.[35] As Voigt observes:

> There have been attempts to extend the liberal theory of justice to humans' relationship with the inanimate world, even to the biosphere as such. But justice in this sense is generally not concerned about responsibility for – let alone the direct rights and interests of – the planet. Rather, the preservation of the earth in a healthy state is seen as primarily and instrumentally essential for the future life of humans. A duty towards the planet as such is, in this context, an indirect one; the direct duty being towards future people.[36]

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[29] Simon Lewis and Mark Maslin, *Human Planet: How We Created the Anthropocene* (Yale University Press 2018).

[30] Bruce D Smith and Melinda A Zeder, 'The Onset of the Anthropocene' (2013) 4 Anthropocene 8.

[31] Will Steffen et al, *Global Change and the Earth System: A Planet under Pressure* (Springer 2005) 131; Will Steffen et al, 'The Trajectory of the Anthropocene: The Great Acceleration' (2015) 2 The Anthropocene Review 1.

[32] Louis Althusser, *For Marx* (Verso 2005) 113ff.

[33] Boaventura de Sousa Santos, *Epistemologies of the South: Justice against Epistemicide* (Paradigm 2014) 72.

[34] Sam Adelman, 'The Sustainable Development Goals, Anthropocentrism and Neoliberalism' in Duncan French and Louis J Kotzé (eds), *Sustainable Development Goals: Law, Theory and Implementation* (Edward Elgar 2018). On the material power of ideologies, see Thomas Piketty, *Capital and Ideology* (Harvard University Press 2020), especially ch 13.

[35] John Rawls, *A Theory of Justice* (Oxford University Press 1983); *The Law of Peoples* (Harvard University Press 1999).

[36] Christina Voigt, 'From Climate Change to Sustainability: An Essay on Sustainable Development, Legal and Ethical Choices' (2005) 9(1) Worldviews: Global Religions, Culture, and Ecology 112, 123–124.

In retrospect, the onset of the Great Acceleration may be seen as a dividing line between a world defined by the expansionary logic of capital and the exclusionary logic of Westphalian sovereignty, and the slowly dawning realisation that this ecologically destructive model was intrinsically unsustainable – as Rachel Carson chronicled in *Silent Spring* in 1962. By the time that neoliberal globalisation began its seemingly uncontrollable expansion, the Intergovernmental Panel on Climate Change was clear about the growing threat of anthropogenic heating.[37] One of the most toxic aspects of neoliberalism is Hayek's insistence that markets are just, precisely because they are amoral.[38] The COVID-19 pandemic may finally sound the death knell of neoliberal globalisation, or lead to its continuation in a zombified form that indicates, in Antonio Gramsci's words, an ongoing crisis that 'consists precisely in the fact that the old is dying and the new is yet to be born. And in the interregnum, a great variety of morbid symptoms appear'.[39] The vigorous concerted global rush to push up the price of oil and rescue airlines during the pandemic suggests the old is not dying quickly enough.

Upendra Baxi argues that the Holocene produced weak 'world citizen loyalty' because 'utilitarian, global cosmopolitan, communitarian, civic and republican approaches and considerations of justice … do not encourage and sustain new planetary loyalty and the political urgency that global climate change, in its resilience, now summons'.[40] In his view, 'There is virtually no human rights law or jurisprudence commanding any *planetary loyalty* required to sustain this loyalty or even minimum human rights responsibilities in corporate governance or the ways of doing business that respect core human rights'.[41]

In a similar vein, Hamilton, Gemenne and Bonneuil argue that 'conventional ethics' seeking universal maxims grounded in Holocene deontologies or consequentialism resort to old normative categories at a time when new conceptual foundations are needed.[42] The conception of nature as an external backdrop upon which western epistemology has rested for more than two centuries is increasingly threadbare:

> It is not enough to describe as 'unethical' human actions that are causing the sixth mass extinction of species in the 3.7 billion-year history of life on the planet … Talk of ethics renders banal a transition that belongs to *deep time*, one that is literally Earth-shattering. In deep time, there are no ethics.[43]

Jeremy Baskin cogently argues that the Anthropocene:

> is not simply a neutral characterisation of a new geological epoch, but it is also a particular way of understanding the world and a *normative guide to action*. It is … more usefully understood as an

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[37] John Houghton, Geoff Jenkins and Jim Ephraums (eds), *Climate Change: The IPCC Scientific Assessment* (Cambridge University Press 1990).

[38] Friedrich A von Hayek, *The Road to Serfdom* (Routledge 1997); Friedrich A von Hayek, *Law, Legislation and Liberty, Volume 2: The Mirage of Social Justice* (University of Chicago Press 2012).

[39] Antonio Gramsci, Quinton Hoare and Geoffrey Nowell-Smith, *Selections from the Prison Notebooks of Antonio Gramsci* (International Publishers 1971), 276.

[40] Upendra Baxi, 'Towards a Climate Change Justice Theory?' (2016) 7(1) Journal of Human Rights and the Environment 7, 16, 21.

[41] Ibid at 22; emphasis in original.

[42] Clive Hamilton, François Gemenne and Christophe Bonneuil, 'Thinking the Anthropocene' in Clive Hamilton, François Gemenne and Christophe Bonneuil (eds), *The Anthropocene and the Global Environmental Crisis: Rethinking Modernity in a New Epoch* (Routledge 2015) 8.

[43] Ibid, emphasis in original.

> ideology – in that it provides the ideational underpinning for a particular view of the world, which it, in turn, helps to legitimate.[44]

The climate emergency challenges us to reject what Vandana Shiva calls modernity's 'monocultures of the mind' in favour of a radical ethics rooted in situated epistemologies that transcend anthropocentrism, Eurocentrism and methodological nationalism.[45] The Anthropocene subverts Holocene epistemologies and compels us to confront the consequences of hubristic human hyper-agency and the existential choice between sustained economic growth and ecological sustainability.[46] If it is futile to seek solutions to the climate emergency in binary, hierarchical thinking, it is proving difficult to construct widely accepted ecologically sound alternatives.[47] Just as the suddenness of the COVID-19 pandemic highlighted humanity's vulnerability to one invisible existential threat, so the slow '"arrival" of the Anthropocene has thrown us onto new terrain. Feminist critiques of hyper-separation are pushing us to move beyond the divisive binaries of human/nonhuman, subject/object, economy/ecology and thinking/acting'.[48] The origin and spread of COVID-19 is a stark example of threats caused by the breaching of the biodiversity loss planetary boundary.

Climate breakdown calls for an ethics of intragenerational, intergenerational and interspecies justice, and justice for the Earth itself. Whereas westerners typically consider the future needs of two generations, indigenous peoples commonly think in terms of seven generations.[49] Geohistory destabilises Holocene understandings of time by linking geological deep time, historical emissions and the fate of future generations.[50] Previous generations have not been confronted, as we are now, with the ethical imperative to bequeath a habitable planet to future generations on the same scale by mitigating climatic impacts that can no longer be halted, or the agonising moral choices of climate justice as triage.[51] Arguably, no comparable historical injustice is complicated by its entanglement with past and contemporary crimes and harms such as colonialism, patriarchy, genocide as global heating. Spatially, the breaching of plane-

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44 Jeremy Baskin, 'Paradigm Dressed as Epoch: The Ideology of the Anthropocene' (2015) 24(1) Environmental Values 9, 10–11; emphasis supplied.

45 Vandana Shiva, *Monocultures of the Mind: Perspectives on Biodiversity and Biotechnology* (Palgrave 1993); Ulrich Beck, 'The Cosmopolitan Condition: Why Methodological Nationalism Fails' (2007) 24(7–8) Theory, Culture and Society 286.

46 Sam Adelman, 'Modernity, Anthropocene, Capitalocene and the Climate Crisis' in David Bollier and Anna Grear (eds), *The Great Awakening: New Modes of Life amidst Capitalist Ruins* (Punctum Press 2020).

47 Anna Grear views the Anthropocene as a crisis of hierarchy. Anna Grear, '"Towards Climate Justice"? A Critical Reflection on Legal Subjectivity and Climate Injustice: Warning Signals, Patterned Hierarchies, Directions for Future Law and Policy' in Anna Grear and Conor Gearty (eds), *Choosing a Future: The Social and Legal Aspects of Climate Change* (Edward Elgar 2014).

48 Julie Kathy Gibson-Graham, 'A Feminist Project of Belonging for the Anthropocene' (2011) 18(1) Gender, Place and Culture 1, 1. See also Plumwood's contention that binary thought leads to hyper-separation in Val Plumwood, *Feminism and the Mastery of Nature* (Routledge 2002).

49 Laura Westra, *Environmental Justice and the Rights of Indigenous Peoples: International and Domestic Legal Perspectives* (Routledge 2012).

50 See, for a recent account, Frederic Hanusch and Frank Biermann, 'Deep-time Organizations: Learning Institutional Longevity from History' (2020) 7(1) Anthropocene Review 19.

51 Catriona McKinnon, *Climate Change and Future Justice: Precaution, Compensation and Triage* (Routledge 2012). On whether it is too late to stop dangerous anthropogenic heating, see the contributions to WIREs Climate Change 2020 11(1).

tary boundaries creates new geographies of suffering, under-development and conflict as the dead hand of carbon necropolitics falls on current and future generations.[52]

The planetary boundaries framework enables us to identify *who* is primarily responsible for breaching them, and *who* is obliged to do *what* and *why* through a fair allocation of burdens and responsibilities that goes beyond conventional consequentialist and deontological approaches.[53] Timothy Morton argues that ecological thought must proceed on the premise that 'everything is interconnected' and that the wellbeing of one species depends upon that of all species and the planet.[54] Planetary ethics must therefore be systemic and holistic, intersectional and relational, and address common but differentiated needs – especially those of the poor and vulnerable, who are least responsible for the multi-layered crisis but most vulnerable to its harms. It is a basic tenet of justice that equal treatment for people differently situated is unfair.

This raises the question of *whose* ethics should underpin climate justice and, indeed, whether a cosmopolitan planetary ethics is possible or desirable. In the Holocene, the nation state was viewed as the appropriate site of justice, as the place in which citizens with a common culture gave law to themselves through a social contract. Statist theories maintain that justice obligations arise almost exclusively within normative national, cultural, political and moral entities that justify the contemporary international system. Forst argues that global institutions violate domestic normative structures and *ipso facto* preclude global distributive justice.[55] In contrast, cosmopolitan, individual-centred approaches conceive moral obligations as global in scope.[56] Theories of global justice seek solutions to inequality and impoverishment through distributive justice and universal human rights, but the Anthropocene epoch is hardly characterised by a cosmopolitan ethic, particularly in the current period of xenophobic nationalism.[57] Harris argues that the virtue of cosmopolitan approaches to global heating is that they direct attention to the plight of individuals, but planetary ethics must confront the collective problem of climate breakdown.[58]

Sovereignty, the tenacious post-Westphalian organising principle of the international system, persistently undermines collective responses to planetary emergencies and inhibits the emergence of an ethic of ecological sustainability on which humanity's fate depends. Dealing with climate breakdown requires a reconfigured planetary environmental ethic based upon embeddedness, situated knowledge, neo-materialist posthuman agency and affect and intergenerational and interspecies obligations. Planetary ethics requires an understanding of

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52 Ewa Charkiewicz, 'A Feminist Critique of the Climate Change Discourse: From Biopolitics to Necropolitics' (2009) 6 Critical Currents 18.

53 Tim Hayward, 'Climate Change and Ethics' (2012) 2(12) Nature Climate Change 843; Steve Vanderheiden, 'Individual Moral Duties amidst Climate Injustice: Imagining a Sustainable Future' (2018) 37 University of Tasmania Law Review 116.

54 Timothy Morton, *The Ecological Thought* (Harvard University Press 2010) 1.

55 Rainer Forst, 'Towards a Critical Theory of Transnational Justice' (2001) 32(1–2) Metaphilosophy 160.

56 Charles Beitz, *Political Theory and International Relations* (Princeton University Press 1999); Thomas Pogge, *World Poverty and Human Rights* (Polity Press 2002).

57 Thomas Pogge, 'Cosmopolitanism and Sovereignty' (1992) 103(1) Ethics 48.

58 Paul G Harris, *World Ethics and Climate Change: From International to Global Justice* (Edinburgh University Press 2009) 2.

interconnectedness qualitatively different to the coerced interdependence of colonialism and neoliberal hyper-globalism.

Bruno Latour views the 'Global' as the discredited endpoint of modernity, and the 'Local' as the refuge for nationalist, xenophobic critics of globalism.[59] Those 'who continue to flee toward the Global and those who continue to take refuge in the Local' do not comprehend the scale of the upheaval of geo-human history.[60] Geohistory irreversibly changes our geographical and mental cartographies by creating new spatialities that call for planetary solutions, including obligations to the planet itself, through onto-epistemologies tied to the fate of the biosphere and biodiversity.[61] The 'Terrestrial', which signifies a new condition, is both a political actor and a site of law, governance and politics in the New Climatic Regime.[62] The 'Terrestrial' transcends all borders and identities and is therefore incompatible with sovereign-centric, territorialised logics that paradoxically refuses to acknowledge the existence of planetary boundaries. It is no longer merely a framework for human action 'because it *participates* in that action' as '*a way of worlding*'.[63]

Planetary ethics raises axiological and deontic questions about what 'we' value and why, and the scope of 'our' obligations to current and future generations; indeed, about who is included in the 'we' assumed by the Anthropocene. How much should we value species threatened by extinction and the lives of the unborn? In the desiccated jargon of economists, what discount rate should we apply to future generations?[64]

5. INTERNATIONAL ENVIRONMENTAL LAW'S ETHICAL VACUUM

Law facilitates ecological degradation in two ways. Law's *content* impedes ecological sustainability because it tends to favour the rich over the poor, private property over commons governance, polluters over nature and possessive individuals over communities; it privileges owners and shareholders over nature and indigenous peoples. Its *form* is problematic because it privileges abstractions over living beings and hides its biases behind veils of objectivity, neutrality and impartiality – powerful myths of liberal legality such as corporate legal personhood that disguise its role in reproducing unequal power relations and legitimising environmental destruction. *Anthropos* sits comfortably alongside abstract legal personhood apotheosised in corporate legal personality.[65] Law's anthropocentrism, hierarchies, instrumentalism, Cartesian binaries and mechanistic Baconian jurisprudence expedite the corporatisation, commodification and monetisation of nature.[66] In Fineman's view, the abstract, autonomous, mythical

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59 Bruno Latour, *Down to Earth: Politics in the New Climatic Regime* (Polity Press 2018).

60 Ibid at 51.

61 Ibid at 67, 72. I use planetary instead of global in an attempt, like Latour, to reach for terminology that is not mired in the negative associations and limitations of global and globalisation.

62 Ibid at 58.

63 Ibid at 42, 54, emphases in original.

64 Economistic thinking reveals the gulf between intrinsic and instrumental value and the limitations of mechanisms such as cost–benefit analysis – the closest neoclassical economics comes to ethics.

65 Elena Blanco and Anna Grear, 'Personhood, Jurisdiction and Injustice: Law, Colonialities and the Global Order' (2019) 10(1) Journal of Human Rights and the Environment 86.

66 Adelman (n 34).

figure at the centre of liberal legality and politics – the autonomous, invulnerable Kantian subject – is disengaged from the time and space.[67] Fineman accordingly argues that justice should instead be grounded in an understanding of universal vulnerability of individuals embedded in nature. Vulnerability provides 'an independent universal approach to justice, one that focuses on exploring the nature of the human, rather than the rights … parts of the human rights trope'.[68] This coheres with new materialist approaches to law that emphasise embeddedness and situatedness rather than separation. Davies argues that new materialist approaches:

> focus on situating the human, including human meaning and human subjectivity, in a material world where all matter, living and non-living, is related, where objects have their own vitality and resistance, and where agency emerges in relation rather than as an existing quality.[69]

Acknowledging the ethical and legal implications of the materiality and agency of living and non-living entities underpins Grear's contention that 'There is a need for law to face up to and embrace a certain non-negotiability of *ethical* demand emerging from the implications of living materiality itself, notwithstanding the fact that the precise implications of such ethical demand remain, in large part, undecided'.[70] Elsewhere, Grear calls for reconceptualised eco-human subjectivities and rights to overcome liberal law's contribution to the 'death of nature'.[71]

A legal paradigm shift is clearly required for law to facilitate a planetary ethic: from the sterility of formalism and positivism to relationality, vulnerability and intersectionality. As Voigt observes:

> Due to the long-standing tradition of the separation of law and ethics within the dominating jurisprudential theory of legal positivism, those norms which are valid as law are seen as distinct from those norms which are valid moral standards. As a result, the once well-established ethical basis for decision-making has been destroyed.[72]

The ethical vacuum in law manifests particularly starkly in IEL. Legal theorists have long debated whether justice is intrinsic to law, part of law, or simply a moral judgement about law.[73] IEL is ethically neutral at best and indifferent to ethics at worst, demonstrating that

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67 Martha Albertson Fineman, 'The Vulnerable Subject: Anchoring Equality in the Human Condition' (2008) 20 Yale Law Journal 1, 11–12.

68 Martha Albertson Fineman, 'Equality, Autonomy, and the Vulnerable Subject in Law and Politics' in Martha Albertson Fineman and Anna Grear (eds), *Vulnerability: Reflections on a New Ethical Foundation for Law and Politics* (Ashgate 2013) 13.

69 Margaret Davies, *Law Unlimited Materialism, Pluralism and Legal Theory* (Routledge 2017) 66.

70 Anna Grear, 'Vulnerability, Advanced Global Capitalism and Co-symptomatic Injustice: Locating the Vulnerable Subject' in Martha Albertson Fineman and Anna Grear (eds), *Vulnerability: Reflections on a New Ethical Foundation for Law and Politics* (Ashgate 2013) 41; emphasis in original.

71 Anna Grear, 'Human Rights and New Horizons? Thoughts toward a New Juridical Ontology' (2018) 43(1) Science, Technology, & Human Values 129; Carolyn Merchant, 'The Death of Nature' in Michael E Zimmerman et al (eds), *Environmental Philosophy: From Animal Rights to Ecology* (Prentice Hall 1998) 280.

72 Voigt (n 36) 126.

73 Anthony D'Amato, 'On the Connection between Law and Justice' (1992) 26 UC Davis Law Review, 527. See also the famous debate between HLA Hart and Lon Fuller on natural law, positivism

law may be normative but amoral.[74] To the extent that sustainable development is one of its principles (albeit unenforceable), IEL might be viewed as indirectly linked to the planetary boundaries framework. As Kim and Bosselmann argue, its plethora of principles (whose legal status is often uncertain) provide no guidance about how to stay within planetary boundaries.[75] IEL is therefore a body of law whose efficacy would be greatly enhanced if it reflected the complex functioning of the Earth system.[76]

Voigt argues that a significant reason why IEL is an ethical vacuum is that '*philosophical* ideas about sustainability have failed to inform *legal* approaches to the concept, and vice versa'.[77] The embrace of legal positivism has led to what Voigt describes as the 'moral vacuum of law'.[78] She justifiably argues that 'Linking the ethical concepts discussed by environmental ethicists to jurisprudence seems not only timely and promising, but also urgent'.[79]

IEL's efficacy would be further enhanced if it fully embraces an ethic or principle of ecological sustainability – which is not the same as sustainable development – something it currently lacks. Soft, non-binding rules and principles may eventually harden into binding obligations, but the climate emergency does not operate on the Holocene timescale of IEL and on the false promise of anthropocentric sustainable development for some privileged humans of the present generation.[80] Ecological destruction is unabated despite the inclusion of sustainable development in multilateral environmental agreements and regional and domestic legislation. To this end, Brandi points to the conspicuous absence of an Earth system SDG,[81] and the scale of the problem is further demonstrated by the oxymoron of sustained unsustainability in the call in SDG 8.1 for '*sustained*, inclusive and *sustainable* economic growth, full and productive employment and decent work for all'.[82] Sustainable development clearly promotes the delusion that endless growth is possible within planetary boundaries.[83] I have written elsewhere

and morality under Nazism discussed in Peter Cane (ed), *The Hart–Fuller Debate in the Twenty-first Century* (Bloomsbury Publishing 2010).

74 For a defence of the normativity of soft law see Dinah Shelton, 'Comments on the Normative Challenge of Environmental "Soft Law"' in Yann Kerbrat and Sandrine Malijean-Dubois (eds), *The Transformation of International Environmental Law* (Hart 2011).

75 Rakhyun E Kim and Klaus Bosselmann, 'International Environmental Law in the Anthropocene: Towards a Purposive System of Multilateral Environmental Agreements' (2013) 2 Transnational Environmental Law 285.

76 Rakhyun E Kim and Brendan Mackey, 'International Environmental Law as a Complex Adaptive System' (2014) 14(1) International Environmental Agreements: Politics, Law and Economics 5.

77 Voigt (n 36) 113; emphasis in original.

78 Voigt (n 36) 127 notes that natural law is not much better because 'Not only is it often unclear what the nature of claims about natural law are … arguments in favour of including environmental issues as ethical concerns are not yet strongly represented'.

79 Voigt (n 36) 127.

80 As Richardson observes, 'Mired in an overly contemporaneous time frame, preoccupied with the present, environmental law has failed to help human culture become attuned to Earth's timescales': Benjamin Richardson, *Time and Environmental Law: Telling Nature's Time* (Cambridge University Press 2017) 7.

81 Clara Brandi, 'Safeguarding the Earth System as a Priority for Sustainable Development and Global Ethics: the Need for an Earth System SDG' (2015) 11(1) Journal of Global Ethics 32.

82 Emphasis supplied.

83 The World Commission on Environment and Development (Brundtland Commission) was aware of warnings about the limits of growth issued in Denis L Meadows et al, *The Limits to Growth* (Universe Books 1972) 15 years before it published *Our Common Future* (Oxford University Press 1987).

about the gap between sustainable development and ecological sustainability, a cleavage that is irreconcilable under all forms of growth-driven extractive development driven by the expansionary logic of capitalism.[84] If ethics involves choices, the fundamental question of the Anthropocene is whether to gamble with ecological modernisers and green capitalists that technology will keep us within the planetary boundaries, or embrace an ethic of ecological sustainability that respects biophysical limits in pursuit of a safe and healthy biosphere upon which all life depends. We cannot have both, and the choice is now stark and existential.[85]As Rockström and colleagues argue:

> The ethical foundation of sustainable development is convergence: that all of the world should enjoy symmetrical benefits of human knowledge and technology, meaning that all countries should live in roughly comparable conditions over time. There should be a gradual convergence of living standards, technologies, and demographic patterns in the course of this century.[86]

For sustainable development to sustain the environment rather than profits, ecological integrity should be both a precondition and the ultimate objective of IEL in order to stay within the safe operating space of the planetary boundaries. Ethical principles of stewardship and trusteeship must extend beyond the public trust doctrine to every aspect of law, from company law to tort and trusts, and shape every law curriculum.

If it is over-optimistic to expect IEL to reflect biophysical limits, it might at least cease enabling ecological devastation through design or indifference. As French and Kotzé conclude, IEL lacks normative ambition and many of its core principles are not particularly ecological – and even these remain difficult to enforce.[87] The deeper problem identified by Bharat Desai is that:

> At the normative level, these so-called soft rules or principles generally lack the requisite characteristics of international legal norms proper. Hence, they are legally regarded as non-binding. It would be more appropriate to state that negotiating states design them in such a fashion that they remain uncertain in application, with 'calculated ambiguity', and generate conflicting signals.[88]

Injustice flows inexorably from liberal legality's lofty detachment from social relations and environmental realities and the rule of law's inability to resolve the tension between formal and substantive equality.[89] IEL's easily ignored hortatory principles undermine the environmental rule of law, most conspicuously in in Latin America. Despite a 38-fold increase in environ-

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84 Adelman (n 34).

85 'We are in the beginning of mass extinction, and all you can talk about is money and fairy tales of eternal economic growth': Greta Thunberg, speech to the UN Climate Action Summit, New York City, 23 September 2019 <www.npr.org/2019/09/23/763452863/transcript-greta-thunbergs-speech-at-the-u-n-climate-action-summit?t=1578937566418> accessed 4 January 2020.

86 Johan Rockström et al, *Sustainable Development and Planetary Boundaries* (Sustainable Development Solutions Network 2013), 19.

87 Duncan French and Louis J Kotzé, '"Towards a Global Pact for the Environment": International Environmental Law's Factual, Technical and (Unmentionable) Normative Gaps' (2019) 28(1) Review of European, Comparative & International Environmental Law 25. See also Louis J Kotzé, 'Earth System Law for the Anthropocene' (2019) 11(23) Sustainability 6796.

88 Bharat H Desai, 'Making Sense of the International Environmental Law-Making Process at a Time of Perplexity' (2018) 29 *Yearbook of International Environmental Law* 3.

89 Edward Palmer Thompson, *Whigs and Hunters: The Origin of the Black Act* (Penguin 1985).

mental laws since the 1972 United Nations (UN) Conference on the Human Environment in Stockholm, the power of capital, and its lobbyists, ensure they are seldom fully implemented or enforced.[90]

If the Anthropocene calls for a planetary ethics commensurate with the scale and urgency of climate breakdown, the planetary boundaries framework provides a means of linking law and ethics to specific boundaries. It does so by highlighting the connections between growth-driven development, impoverishment and ecological destruction, and the relationship between species and planetary wellbeing. If the ecological crisis is also fundamentally an ethical crisis, the planetary boundaries framework provides a scientific basis for a planetary ethics that values all biota. The planetary boundaries may not be definitive, but they provide the basis for an ethics defined by changing environmental conditions and ecological sustainability in ways that vague, self-serving interpretations of sustainable development do not. The planetary boundaries therefore helpfully point the way to the emergence of an ethic of sufficiency that respects biophysical limits and encourages circular economies and waste reduction.

This could guide efforts to formulate a clear vision of ecological sustainability for IEL. One option is ecological integrity, which should long have been a *Grundnorm* of IEL that takes precedence over free trade and gross domestic product (GDP) as yardsticks by which economic activity is measured.[91] By highlighting the limits to growth, the planetary boundaries point to the need for alternatives *to* development rather than different forms *of* development such as sustainable development.[92] These are alternatives to development that are no longer based upon unconstrained economic growth and consumption. How much growth, for whom and where, is now both an existential and an ethical matter. If Holocene ethics were rooted in individual control and appropriation of nature's plenitude, Anthropocene ethics are defined by limits and must prioritise solidarity. Inextricably linked to the distributive, reparative and procedural components of climate justice, planetary ethics must underpin a new conception of rights to and responsibilities for natural resources. As the global economy shut down in March 2020, the new world brought about by COVID-19 revealed the profound abnormality of what had been normalised and how many things deemed to be impossible suddenly became possible.

IEL fails in other ways. Principle 16 of the 1992 Rio Declaration states that 'the polluter should in principle bear the costs of pollution'.[93] But polluters seldom pay the full costs of the terrestrial destruction they cause, and none at all for atmospheric pollution, rendering the precautionary principle virtually redundant in relation to global heating. It is furthermore difficult to conceive an existential problem to which the precautionary principle is more applicable than global heating, but the silence of the Paris Agreement in this respect is deafening even though the climate change planetary boundary was crossed many years ago. In IEL, precaution is not prevention; in the climate regime it is a mirage.

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[90] Swatanter Kumar et al, *Environmental Rule of Law: First Global Report* (UN Environment Programme 2019).

[91] Rakhyun E Kim and Klaus Bosselmann, 'Operationalizing Sustainable Development: Ecological Integrity as a Grundnorm of International Law' (2015) 24(2) Review of European, Comparative & International Environmental Law 194; Klaus Bosselmann, *The Principle of Sustainability: Transforming Law and Governance* (Routledge 2016) 4, 93ff.

[92] Adelman (n 34).

[93] Report of the United Nations Conference on Environment and Development (Rio de Janeiro, 3–14 June 1992) UN Doc. A/CONF.151/26/Rev.1(Vol.1).

But the most conspicuous failing of IEL is the inadequacy of the principle with the greatest salience for ethics and justice in the climate regime: common but differentiated responsibility and respective capabilities in light of national circumstances (CBDR-RC). A core element of climate justice, the principle has been the most contentious issue in the UN Framework Convention on Climate Change (UNFCCC) since its inception in 1992. The principle acknowledges that countries in unequal circumstances have a common responsibility to protect life by staying within planetary boundaries. Much of the literature on climate justice focuses on distributive justice through a combination of the polluter pays principle as a means of discharging *historical responsibility*, the *benefits* accrued from carbon-based industrialisation and the *ability to pay* that ensued.[94] These criteria are open to a variety of objections, but they do provide an ethical basis for ascribing climate justice duties and obligations.[95] A common objection to historical responsibility is that it is backward-looking and therefore an inappropriate basis for assigning burdens for future climate-related loss and damage.[96] Assigning duties on the basis of historical responsibility is complicated by steeply rising emissions in rapidly industrialising southern countries – more greenhouse gases have been emitted since the adoption of the UNCCC in 1992 than prior to it[97] – but the CBDR-RC principle nonetheless serves as a coherent basis for addressing the legacies of carbon colonialism and contemporary structural and power imbalances that militate against climate justice. Although it is not an insuperable obstacle, another concern is whether it is acceptable to impose collective obligations on the descendants of early industrialisers who were ignorant of harms their emissions would cause. Shue argues that historical responsibility is important but not determinative because other considerations also matter, such as the benefits derived from fossil fuels, ability to pay, the no-harm principle and the duty to preserve the physical preconditions for human life.[98] He notes the false equivalence often made between punishment and responsibility.[99]

Historical responsibility is often linked to the *beneficiary pays* principle, which is used to argue that states which have benefited from sustained carbon-based economic growth in the form of sophisticated infrastructure, high standards of living and strong adaptive capacities have a duty to discharge their ecological debts by accepting steeper mitigation targets than less

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94 Jeremy Moss, 'Introduction: Climate Justice' in Jeremy Moss (ed), *Climate Change and Justice* (Cambridge University Press 2015). Göran Duus-Otterström and Sverker C Jagers, 'Identifying Burdens of Coping with Climate Change: A Typology of the Duties of Climate Justice' (2012) 22(3) Global Environmental Change 746.

95 Sam Adelman, 'Climate Justice, Loss and Damage and Compensation for Small Island Developing States' (2016) 7(1) Journal of Human Rights and the Environment 32.

96 Lauren Hartzell-Nichols, 'Responsibility for Meeting the Costs of Adaptation' (2011) 2(5) Wiley Interdisciplinary Reviews: Climate Change 687.

97 David Wallace-Wells, The Uninhabitable Earth: A Story of the Future (Tim Duggan Books 2019) 4.

98 Henry Shue, 'Historical Responsibility, Harm Prohibition, and Preservation Requirement: Core Practical Convergence on Climate Change' (2015) 2(1) Moral Philosophy and Politics 7, 7. See also Simon Caney, 'Cosmopolitan Justice, Responsibility and Global Climate Change' in Stephen M Gardiner et al (eds), *Climate Ethics: Essential Readings* (Oxford University Press 2010) and Henry Shue, *Climate Justice: Vulnerability and Protection* (Oxford University Press 2014).

99 Henry Shue, 'Global Environment and International Inequality' (1999) 75(3) International Affairs 531.

developed countries and to provide them with resources for adaptation and mitigation – and, I would argue, reparations for loss and damage.[100]

Caney argues that the polluter pays principle should be supplemented by a modified version of the *ability to pay* principle that is a core component of most theories of global justice.[101] The principle 'assumes that the main duty generating reason that people have to pay for climate change is that they can afford to pay for the costs of climate change and should do so in pursuit of the goal of, and equal enjoyment of, a healthy climate'.[102] Moss argues that since it is possible to benefit from an act even though you are unaware that it might be harmful, it 'is intuitively plausible to say that once the harm was discovered, it would be objectionable to continue to benefit and not share some responsibility for bearing current and future costs associated with climate change'.[103]

Common mitigation and adaptation obligations under the CBDR-RC principle must reflect significant differences in respective capabilities and national circumstances and be fulfilled in ways that reflect historical responsibility for emissions, the benefits accrued from carbon colonialism and the lower resilience and adaptive capacities of developing countries. The ethical dimension of the CBDR-RC principle is that it considers the differences between countries' and individuals' rights, abilities and responsibilities with respect to resource use and environmental impacts, and their respective capacities to contribute to solutions. It points to the need for gender, global and procedural justice, the discharge of ecological debts and reparations for climatic loss and damage. The dictum 'From each according to his ability, to each according to his needs!' presumably applies equally to all existential threats.[104] Article 3 recognises CBDR-RC as a guiding principle of the UNFCCC but developed countries most responsible for the climate crisis have resisted their obligations to discharge their ecological debts.

Generally, there is a close correlation between a country's historical responsibility for greenhouse gas emissions, the benefits and wealth it has accrued, its contribution to the breaching of planetary boundaries and its resistance to climate justice. After the top-down, binary nature of the Kyoto Protocol, under which Annex 1 countries had binding emissions reductions targets, in the Paris Agreement the CBDR-RC principle is more fluid, open-ended and voluntarist – and, as a result, perhaps less likely to produce climate justice. The divide between developed and developing countries in the Kyoto Protocol has given way to self-classification, with countries able to decide on obligations in successively more ambitious Nationally Determined Contributions (NDCs). Ahead of COP25 in Madrid in December 2019, the United Nations Environment Programme (UNEP) warned that submitted NDCs put the world on track for a catastrophic rise in global temperature up to 3.2°C by the end of the century.[105]

A core tenet of tort law is that those who harm others should make redress by restoring victims to the situation they were in prior to the harm, when possible, and paying compensa-

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[100] Margaretha Wewerinke-Singh and Diana Hinge Salili, 'Between Negotiations and Litigation: Vanuatu's Perspective on Loss and Damage from Climate Change' (2020) 20(6) *Climate Policy* 681.

[101] Simon Caney, 'Climate Change and the Duties of the Advantaged' (2010) 13(1) Critical Review of International Social and Political Philosophy 203.

[102] Jeremy Moss 'Climate Justice' in Jeremy Moss (ed), *Climate Change and Social Justice* (Melbourne University Press 2009) 58.

[103] Ibid at 56.

[104] Karl Marx, *Critique of the Gotha Programme* (Lawrence and Wishart [1875] 2013).

[105] United Nations Environment Programme, *Emissions Gap Report 2019* (UN Environment Programme 2019).

tion for loss and damage. The Paris Agreement does not provide redress. Restorative justice is impossible for irreversible climatic harms such as the inundation of small island developing countries and coastal communities where adaptation is not feasible, is too costly, or is both – but corrective and reparative justice are not. Shue argues that it is a basic principle of justice that those who have costs imposed upon them without consent, and are unilaterally disadvantaged, are entitled to demand 'that in the future the offending party shoulder burdens that are unequal at least to the extent of the unfair advantage previously taken, in order to restore equality'.[106]

Despite the foregoing critique, there are glimmers of hope in landmark climate litigation. For example, the Paris Agreement was an important factor in *Urgenda*, the Court of Appeal's ruling in January 2020 that plans for a third runway at Heathrow Airport are illegal, and in the *Thabametsi* case in South Africa.[107] There is a clear nexus between the breaching of planetary boundaries and the violation of human rights. Rights-based arguments succeeded in *Urgenda*, *Ashgar Leghari* and the 2017 Advisory Opinion in which the Inter-American Court of Human Rights decided that the right to a healthy environment is a right in itself, that a wide range of human rights are threatened by environmental degradation and that state parties have obligations to respect and guarantee the rights in the American Convention on Human Rights.[108] The Advisory Opinion has potentially significant implications for causation and the enforceability and extraterritoriality of human rights.

6. ALTERNATIVES: TOWARDS A DIFFERENT CONCLUSION

These landmark cases demonstrate that IEL can be effective, but favourable judgements do not disguise the need for a more fundamental paradigm shift. Kotzé raises the salient question not 'whether existing legal concepts can be extended and adjusted to reflect the new human condition but … whether new legal ontologies must be developed' that circumscribe human hyper-agency.[109] He calls for an Earth system law paradigm that embraces complexity, inclusivity and interdependencies to close the 'Anthropocene gap' that IEL has failed to fill.

The unfolding ecological catastrophe will not be averted by Holocene thinking, Eurocentric rationality and western models of development. Planetary ethics calls for epistemologies of

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[106] Henry Shue, 'Global Environment and International Inequality' (1999) 75(3) International Affairs 531, 534. Gosseries regards those who benefit from harm to others as free-riders who are liable to compensate the victims of the harms inflicted. Axel Gosseries, 'Historical Emissions and Free Riding' (2004) 11(1) Ethical Perspectives 36.

[107] *Urgenda Foundation v State of the Netherlands* ECLI:NL:HR:2019:2007 – Supreme Court, 20-12-2019/19/00135. *R (On The Application Of Plan B Earth) (Claimant) v Secretary Of State For Transport (Defendant) & (1) Heathrow Airport Ltd (2) Arora Holdings Ltd (Interested Parties) & WWF-UK (Intervener)*, Case Nos: C1/2019/1053, C1/2019/1056 and C1/2019/1145. *Earthlife Africa Johannesburg v Minister of Environmental Affairs & Others*, Case No. 65662/16, High Court, Order of 8 Mar. 2017. Ashgar Leghari v Federation of Pakistan (W.P. No. 25501/2015) Lahore High Court Green Bench. Inter-American Court of Human Rights, Environment and Human Rights, Advisory Opinion OC-23/17 of Nov. 15, 2017, Requested by the Republic of Colombia.

[108] Inter-American Court of Human Rights (15 November 2017), *Advisory Opinion* OC-23/17 Requested by the Republic of Colombia*:* Environment and Human Rights (15 November 2017).

[109] Kotzé (n 87) 6800 citing Jorge E Viñuales, 'The Organisation of the Anthropocene: In Our Hands?' (2018) 1(1) Brill Research Perspectives in International Legal Theory and Practice 1.

humility rather than domination and mastery; for Aidosian rather than Promethean postures, and a willingness to learn from other cultures instead of the hubristic techno-fetishism of ecological modernisers seeking to engineer the global climate.[110] Derived from Andean cosmovisions, *buen vivir* is the idea of a good life lived well rather than a life lived better than others. It is a way of being, knowing and living based not upon ontological separation, utility and exploitation, but on wellbeing that flows from complementarity, reciprocity, respect and collective living in harming with nature – all lessons taught by the COVID-19 pandemic. It eschews Eurocentric binaries, teleological conceptions of progress, possessive individualism, the superiority of human beings over nature and western ideas of development based upon the ceaseless exploitation of nature; it is an alternative to sustainable development that is ecologically sustainable. *Buen vivir* is an onto-epistemology about 'enough for all' within planetary boundaries and nature's limits, rather than endless, nihilistic accumulation and consumption. It suggests alternatives to development, based upon the recognition that human wellbeing depends upon the health of the planet.[111] *Buen vivir* and the rights of Pacha Mama (Mother Earth) are reflected in the ecocentric ethic in the 2010 People's Agreement adopted at Cochabamba:

> We propose to the peoples of the world the recovery, revalorization, and strengthening of the knowledge, wisdom, and ancestral practices of Indigenous Peoples, which are affirmed in the thought and practices of "Living Well," recognizing Mother Earth as a living being with which we have an indivisible, interdependent, complementary and spiritual relationship.

Buen vivir is based upon biocentrism and the subjectivity of nonhuman actors, considering that communality, affect, intuition and spirituality should guide ethics rather than individualism and commodification, and that there are many different ways of being, knowing, living and seeing rather than a hierarchy of epistemologies. The incorporation of *buen vivir* and the rights of Mother Earth, *Pacha Mama*, into the legal systems of Bolivia, Colombia and Ecuador has been contradictory but they are concepts that offer a glimpse of alternatives to business, development and law as usual and an ethics that corresponds to the existential, planetary nature of the climate emergency.[112]

The planetary boundaries denote a safe operating space that is rapidly closing. The planetary boundaries are scientific assessments about what is safe, and what is dangerous and unaccept-

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[110] There is no technological silver bullet and therefore no alternative to mitigation. Geoengineering raises significant issues of procedural justice and profound ethical questions that will soon confront us. See Sam Adelman, 'Geoengineering: Rights, Risks and Ethics' (2017) 8(1) Journal of Human Rights and the Environment 119. On epistemologies of humility and mastery, see Sam Adelman, 'Epistemologies of Mastery' in Anna Grear and Louis J Kotzé (eds), *Research Handbook on Human Rights and the Environment* (Edward Elgar 2015). I agree with Schneider that 'geoengineering will further deteriorate and undermine the natural resource base (i.e., oceans, forests, agricultural lands, water etc.) that serves as the foundation for adaptation and resilience for those who are, and will be, severely affected by the climate crisis': Linda Schneider, 'Fixing the Climate? How Geoengineering Threatens to Undermine the SDGs and Climate Justice' (2019) 62 Development 29, 35.

[111] Alberto Acosta, 'Buen Vivir: A Proposal with Global Potential' in Rosa Hartmut and Christoph Henning (eds), *The Good Life Beyond Growth: New Perspectives* (Routledge 2017).

[112] Catherine Walsh, 'Development as Buen Vivir: Institutional Arrangements and (de)Colonial Entanglements' (2010) 53(1) Development 15; Martin Calisto Friant and John Langmore, 'The Buen Vivir: A Policy to Survive the Anthropocene?' (2015) 6(1) Global Policy 64.

able; as such, they are also normative judgements with ethical implications. Lives of dignity for all within the planetary boundaries require reductions of 40–50 per cent in the biophysical footprints of most countries, which 'is highly unlikely to be possible without de-growth strategies' and rethinking the SDGs.[113] IEL does not reflect these realities and has therefore not succeeded in promoting ecological integrity. Requiring it to do so is perhaps asking law to do what politics and economics have not. But 'law grounded in the Earth, limited by planetary boundaries and shaped around ecological integrity' is long overdue.[114] Ethics involves choosing. It is time to choose.

[113] Jason Hickel, 'Is It Possible to Achieve a Good Life for All within Planetary Boundaries?' (2019) 40(1) Third World Quarterly 18.

[114] Klaus Bosselmann, 'The Rule of Law Grounded in the Earth: Ecological Integrity as a Grundnorm' in Laura Westra and Mirian Vilela (eds), *The Earth Charter, Ecological Integrity and Social Movements* (Routledge 2014).

5. Science, law and planetary uncertainty

Lynda Collins

1. INTRODUCTION

Scientific uncertainty has been a central challenge in all areas of domestic and international environmental law and policy, stemming in part from fundamental epistemological differences between law and science,[1] and in part from the inherent complexity of natural systems.[2]

> [C]lear-cut quantifiable boundaries do not exist in the earth system, or at least remain beyond human understanding. Yet such resignation does not help in shaping a normative vision for earth system governance and the concrete rules and standards that are needed to steer human behavior.[3]

Complexity and uncertainty go hand in hand, and it is hard to imagine a more complex subject of inquiry than that of the Earth system – 'the interacting physical, chemical and biological processes that cycle materials and energy throughout the [Earth] at the planetary level'.[4] In this arena, scientific certainty is unattainable. While the Earth system has been immensely complex since the beginning of time, the problem is heightened in the current Anthropocene era,[5] in which 'humans have added their footprint to nature's complexity',[6] disturbing Earth system functioning to an unprecedented degree. In the Anthropocene, we can no longer speak of a natural world separate from human influence;[7] the Earth system (or 'system of systems', as Erdelman and Richardson put it),[8] must now be understood as an eco-social phenomenon.[9]

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1 See generally Erica Beecher-Monas, *Evaluating Scientific Evidence: An Interdisciplinary Framework for Intellectual Due Process* (Cambridge University Press 2006); Sheila Jasanoff, *Science at the Bar* (Harvard University Press 1995).

2 Paulo Magalhães et al (eds), *The Safe Operating Space Treaty: A New Approach to Managing Our Use of the Earth System* (Cambridge Scholars 2016).

3 Frank Biermann, *Earth System Governance: World Politics in the Anthropocene* (MIT Press 2014) 34.

4 Magalhães et al (n 2) 24.

5 Whether or not the Anthropocene merits recognition as a new geological era, it has become a powerful metaphor for this unique moment in the history of the human–nature relationship, in which anthropogenic disruptions have become a defining force in Earth system functioning. See eg Louis J Kotzé, 'Rethinking Global Environmental Governance in the Anthropocene' (2014) 32 Journal of Energy and Natural Resources Law 121; Louis J Kotzé and Rakhyun E Kim, 'Earth System Law: The Juridical Dimensions of Earth System Governance' (2019) 1 Earth System Governance 100003.

6 Walter R Erdelen and Jacques G Richardson, *Managing Complexity: Earth Systems and Strategies for the Future: Earth Systems and Strategies for the Future* (Routledge 2018) 16.

7 Kotzé and Kim (n 5) 3; Tim Stephens, 'Reimagining International Environmental Law in the Anthropocene' in Louis J Kotzé (ed), *Environmental Law and Governance for the Anthropocene* (Hart 2017) 32 ('As humanity is now transforming the planet's biophysical systems and imperiling their functioning, the Anthropocene entails the collapse of the human/nature distinction').

8 Erdelen and Richardson (n 6).

9 Kotzé and Kim (n 5) 3.

Moreover, as scientists attempt to understand the 'new Earth' that has emerged as a result of human activities, those activities continue to change and evolve.[10] Thus, predicting the probable trajectories of the Earth system involves overlaying multiple, complex and ever-changing human and natural phenomena. The project of *governing* human impacts on the Earth system is even more challenging as it requires us to translate the relevant science into workable legal (and social) norms. Our current eco-social predicament involves

> several different types of complexity, including the natural complexity of the planet's ecology, the psycho-social complexity of humans and their institutions, and the political or moral complexity of bringing both together in a meaningful way. This multi-faceted view of the earth system as a complex, interconnected system places considerable importance on understanding and governing key processes that regulate the system, including the climate, biodiversity, land use and global chemical flows.[11]

The emergence of the planetary boundaries concept would appear to be a major step forward in this respect. Planetary boundaries may be viewed as a distillation of key findings from the broader field of Earth system science – the study of the interrelated biogeochemical processes that regulate life on Earth. The planetary boundaries framework describes nine global pillars of Earth system functioning, identifies specific parameters for evaluating threats to these subsystems (for seven of the nine planetary boundaries) and specifies numerical limits wherever possible.[12] By applying a precautionary approach to the best available science, planetary boundaries seek to delineate a '"safe operating space" for global societal development'.[13] The planetary boundaries approach marries rigorous scientific inquiry with clear, actionable guidance. It is probably the most comprehensive, accessible and 'policy-ready' articulation of Earth system science yet to emerge from the discipline.[14]

However, despite the reassuring solidity of clear parameters and real numbers, planetary boundaries are steeped in uncertainty in almost every imaginable dimension. Sceptics may question the scientific appropriateness/validity of the Earth system processes selected as planetary boundaries and the accuracy of their associated 'control variables'. Further, there are profound socio-political and ethical uncertainties that flow from the normative dimension of planetary boundaries. Even if one accepts the validity and value of the planetary boundaries concept at face value, there are also profound juridical, ethical and governance problems associated with their implementation.[15] Finally, we are still at the early stages of learning how to communicate complex and emotionally charged information about global environmental

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[10] See eg Sarah Burch et al, 'New Directions in Earth System Governance Research' (2019) 1 Earth System Governance 100006, 3: 'The next couple of decades is likely to see, a tremendous wave of global infrastructure investment … which will have profound impacts on the biosphere … Migration and mobility, shifting geopolitics and trade patterns, rapid and sometimes disruptive technological change … also signify the changing circumstances within which earth system governance is embedded.'

[11] Ibid at 5, citing 'The Anthropocene and the Body Ecologic' in Philipp Pattberg and Fariborz Zelli (eds), *Environmental Politics and Governance in the Anthropocene: Institutions and Legitimacy in a Complex World* (Routledge 2017) 15–30.

[12] Johan Rockström et al, 'A Safe Operating Space for Humanity' (2009) 461 Nature 472; Johan Rockström et al, 'Planetary Boundaries: Exploring the Safe Operating Space for Humanity' (2009) 14 Ecology & Society 32, 1.

[13] Will Steffen et al, 'Planetary Boundaries: Guiding Human Development on a Changing Planet' (2015) 347 Science 1259855, 1259855-1.

[14] See also Kim and Kotzé, Chapter 3; and Bleby, Holley and Milligan, Chapter 2, in this book.

[15] See Adelman, Chapter 4 in this book.

threats to relevant audiences. Confronted with this vast sea of uncertainty surrounding planetary boundaries, citizens and decision-makers might be tempted to dismiss the concept. That would be a mistake.

This chapter will argue that, despite the inevitable and enormous scientific uncertainty surrounding them, planetary boundaries capture insights and information that are both knowable and crucially important for humanity and the other living beings with whom we share the Earth. Furthermore, the planetary boundaries framework provides meaningful guidance to decision-makers, and could help strengthen their resolve to implement the many pragmatic and legal strategies that *are* known to increase ecological sustainability and decrease environmental hazards.[16] The author concludes that the planetary boundary concept, despite its shortcomings – which are all more fully explored elsewhere in this book – is a key conceptual and technical tool to spur our transition to sustainable human systems and societies.[17]

2. PLANETARY BOUNDARIES – THE BASICS

Developed by a group of leading scientists, the planetary boundaries framework maps out specific biophysical limits within which the Earth system is likely to continue functioning in ways that support human flourishing.[18] If we transgress one or more of the planetary boundaries, we risk transitioning 'to a very different state of the Earth system, one that is likely to be much less hospitable to the development of human societies'.[19] Planetary boundaries have been identified for nine critical threats to Earth system processes: stratospheric ozone depletion; loss of biosphere integrity (including declining biodiversity and increasing extinctions); chemical pollution and introduction of novel entities; climate change; ocean acidification; freshwater over-consumption and human pressure on the global hydrological cycle; land system change; disruptions to biogeochemical flows (particularly nitrogen and phosphorous flows); and atmospheric aerosol loading.[20]

Wherever possible, planetary boundaries researchers have selected and quantified one or more metrics or 'control variables' for each boundary. For example, a control variable for climate change is the concentration of carbon dioxide in the atmosphere and the boundary for this control variable is 350 parts per million.[21] In some cases, such as climate change and ocean acidification, planetary boundaries anticipate a likely 'tipping point' or threshold beyond which rapid and drastic system change is probable.[22] Where thresholds are believed to exist, planetary boundaries have been placed 'upstream' of them, both as a precautionary response to scientific uncertainty, and in order to provide societies enough time to avoid the

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16 See eg Paul Hawken, *Drawdown: The Most Comprehensive Plan Ever Proposed to Reverse Global Warming* (Penguin Books 2017); David R Boyd, *The Optimistic Environmentalist* (University of British Columbia Press 2015); Chris Turner, *The Geography of Hope: A Tour of the World We Need* (Vintage Canada, 2008).

17 See Part III of this book, examining pertinent law in relation to all nine planetary boundaries.

18 Steffen et al (n 13) 1259855-1.

19 Ibid at 1.

20 Ibid.

21 Steffen et al (n 13) 1259855-3.

22 Ibid at 1259855-1; Johan Rockström et al, 'Planetary Boundaries: Separating Fact from Fiction; a Response to Montoya et al' (2018) 33 Trends in Ecology & Evolution 233, 233–34.

impending tipping point.[23] Other boundaries are, however, not believed to have a tipping point at the global level (an example is land system change), though there may be regional or local threshold effects.[24] Climate change and biosphere integrity have now been identified as 'core' boundaries; a sustained transgression of either of these could, by itself, cause profound changes in the state of the Earth system, with sobering consequences for human beings (and countless other Earth-dwellers).[25]

Humanity has in fact already crossed core planetary boundaries for both climate change and loss of biosphere integrity.[26] We have also transgressed the planetary boundaries for land system change and altered biogeochemical cycles.[27] The planetary boundary for stratospheric ozone depletion is transgressed over Antarctica during the austral spring, but the integrity of the ozone layer has been stable over the past 15 years and is expected to improve in future as a result of the phase-out of ozone-depleting substances:[28] 'This is an example in which, after a boundary has been transgressed regionally, humanity has taken effective action to return the process back to within the boundary.'[29] The vision of those who support a planetary boundaries approach to global environmental governance would be to replicate this process for the remaining eight planetary boundaries.

It should be noted at the outset that the planetary boundaries concept is not without its critics. Schlesinger expresses the concern that 'management based on thresholds, although attractive in its simplicity, allows pernicious, slow and diffuse degradation to persist [within the boundaries]'.[30] Montoya contends that the planetary boundaries framework 'encourages arguments that "growth within limits" is acceptable'.[31] For his part, Lewis suggests that a focus on planetary boundaries obscures the distinction between porous thresholds (that is, those that can be crossed and then complied with, as in the case of stratospheric ozone) and fixed limits on the depletion of non-renewable resources.[32] However, he concedes that 'the concept of planetary boundaries and avoiding dangerous thresholds is important'.[33]

In fact, there is nothing in the planetary boundaries framework that encourages 'growth within limits' or discourages the conservation of non-renewable resources. It is neutral on

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23 Steffen et al (n 13) 1259855-1.

24 Ibid at 1259855-2.

25 Ibid at 1259855-8. See, specifically, Verschuuren, Chapter 13, and Somsen and Trouwborst, Chapter 12, in this book.

26 Ibid at 1259855-4.

27 Ibid at 1259855-4-5.

28 Ibid at 1259855-6. See Du Toit, Chapter 14 in this book.

29 Steffen et al (n 13) 1259855-6.

30 William H Schlesinger, 'Planetary Boundaries: Thresholds Risk Prolonged Degradation' (2009) 3 Nature Climate Change 112, 113.

31 José Montoya et al, 'Planetary Boundaries for Biodiversity: Implausible Science, Pernicious Policies' (2018) 33 Trends in Ecology & Evolution 71, 72.

32 Simon Lewis, 'We Must Set Planetary Boundaries Wisely' (2012) 485 Nature 417. Lewis observes that the distinction between porous thresholds and fixed depletion limits is not merely academic: 'To highlight a boundary on phosphate pollution, for example, would drive investment in technology to combat the impact on marine environments, but do nothing to stop the running down of rock-phosphate supplies [which are used in fertiliser and therefore important to food security]. To emphasize the depletion limit would shift the focus to technology to use and re-use phosphorus to safeguard stocks.' Ibid.

33 Ibid.

the former[34] and silent on the latter,[35] which is understandable since it is explicitly focused on factors that bear directly on Earth system functioning.[36] The planetary boundaries concept – while comprehensive in scope – does not purport to be a complete formula for global ecological salvation. Rather, it 'is complementary to the myriad methods and policies for [ecological] management at subglobal levels, and is not meant to either replace or override these necessary and important approaches'.[37] However, the planetary boundaries framework does attempt to set out measurable and manageable parameters for key biogeochemical processes necessary to maintain the Earth system in a state that is compatible with human flourishing. By far the greatest challenge to this unprecedented project is the problem of uncertainty, in its myriad scientific and socio-political dimensions.

3. PLANETARY BOUNDARIES AND THE CERTAINTY OF UNCERTAINTY

The planetary boundaries framework explicitly acknowledges and addresses the problem of scientific uncertainty as follows:

> A zone of uncertainty, sometimes large, is associated with each of the boundaries … This zone encapsulates both gaps and weaknesses in the scientific knowledge base and intrinsic uncertainties in the functioning of the Earth system. At the 'safe' end of the zone of uncertainty, current scientific knowledge suggests that there is very low probability of crossing a critical threshold or substantially eroding the resilience of the Earth system. Beyond the 'danger' end of the zone of uncertainty, current knowledge suggests a much higher probability of a change to the functioning of the Earth system that could potentially be devastating for human societies. Application of the precautionary principle dictates that the planetary boundary is set at the 'safe' end of the zone of uncertainty.[38]

In some cases, the level of uncertainty is so great as to preclude identification or quantification of a control variable. For example, the 2015 scientific update to the planetary boundaries framework notes that there is currently no global-level analysis on which to base a control variable for the chemical pollution boundary, and further that it may 'serve little purpose to define boundary values and control variables for a planetary boundary of this complexity'.[39] For the biosphere integrity boundary, researchers have selected an interim control variable (the Biodiversity Intactness Index) that will be used until further data emerge; Steffen and colleagues acknowledge major gaps in this area.[40] For atmospheric aerosol loading, a control

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34 See Biermann (n 3) 33–35, 146.

35 Although the planetary boundaries framework explicitly leaves the question of development trajectories to decision-makers, and therefore cannot be seen to have taken a position on growth, an important qualification should be noted. For those boundaries that have already been crossed, the planetary boundaries paradigm would not sanction any further growth *in environmental degradation.* Since it is not an economic model, it reasonably refrains from commenting upon whether economic growth could continue to occur without further incursions into the territory beyond the boundaries that have been transgressed.

36 Rockström et al (n 12). See also Kim and Kotzé, Chapter 3 in this book.

37 Ibid at 233.

38 Steffen et al (n 13) 1259855-2.

39 Ibid at 1259855-8.

40 Ibid at 1259855-6.

variable has been chosen (Aerosol Optical Depth (AOD)), but it has not been quantified at the global level.[41] Even where control variables can be identified and quantified, significant uncertainties remain in the scientific, socio-political and juridical/governance dimensions of planetary boundaries.

While it is virtually impossible to disentangle these interrelated threads, the following sections will attempt a categorical analysis of the various overlapping uncertainties and potential solutions.

3.1 Uncertainty in the Natural Sciences

A preliminary observation should be made regarding the ever-evolving nature of Earth system science. As with any field of scientific inquiry, the scientific research reflected in planetary boundaries is necessarily a 'moving target'.[42] Although it is likely that the planetary boundaries framework as a whole will remain stable over time, we have already seen an evolution in the taxonomy of planetary boundaries, the content of several categories and the selection and quantification of control variables.[43] This reality does not in any way undermine the scientific validity of the planetary boundaries framework – indeed, it is the sign of a flourishing field of scientific research (though it does challenge environmental governance processes to evolve beyond existing models and embrace a nimble, adaptive management approach).[44] The key question is not whether our current scientific understanding of planetary boundaries will evolve over time – it will – but rather whether the current science of planetary boundaries is *adequate* to inform policy. Is the scientific uncertainty surrounding planetary boundaries so great as to negate their utility?

As Rockström and colleagues noted in their original articulation of the planetary boundaries concept:

> Much of the uncertainty in quantifying planetary boundaries is due to our lack of scientific knowledge about the nature of the biophysical thresholds themselves … the intrinsic uncertainty of how complex systems behave, the ways in which other biophysical processes such as feedback mechanisms interact with the primary control variable, and uncertainty regarding the allowed time of overshoot of a critical control variable in the Earth System before a threshold is crossed.[45]

Thus, for planetary boundaries that do have thresholds or 'tipping points', we cannot be certain when the threshold will be crossed, or what the world will look like on the other side. For those that are not believed to have tipping points, it is difficult to specify the boundary

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41 Ibid at 1259855-7.

42 Bierman (n 3) 34.

43 For example, the original planetary boundaries concerning phosphorous and nitrogen flows now encompasses 'bigeochemical flows' generally, noting that concentrations and ratios of other elements (such as silicon) may also have significance for earth system functioning; the land system change planetary boundaries is now more closely focused on phenomena that affect climate regulation, and the control variable has been changed from the amount of cropland (an ecological negative) to the amount of forest cover (an ecological positive); the planetary boundaries originally termed 'rate of biodiversity loss' is now known as 'change in biosphere integrity'. Steffen et al (n 13) at 1259855-4 to 1259855-6.

44 See Victor Galaz et al, 'Planetary Boundaries: Exploring the Challenges for Global Environmental Governance' (2012) 4 Current Opinion in Environmental Sustainability 80, 81.

45 Rockström et al (n 12) 34.

with any precision, and this invariably involves expert judgement about when Earth system degradation becomes critical. In addition to the varying levels of uncertainty surrounding each planetary boundary individually, there is the enormously complex question of how the various Earth system components and processes interact. Indeed, 'a systematic, quantitative analysis of interactions among all of the processes for which boundaries are proposed remains beyond the scope of current modeling and observational capacity'.[46] There are also highly complex questions of scale. The planetary boundaries framework is explicitly global in nature,[47] yet it must be scaled down in order to inform policy at subglobal levels, which is where regulation primarily occurs.[48] Again, faced with this ferociously complex landscape, it may be tempting to simply throw up one's hands and abandon the planetary boundaries concept.[49]

However, pessimism about planetary uncertainty is probably unhelpful and perhaps unnecessary. Re-framing the question to focus on whether the science is *adequate* rather than *certain* potentially leads to a more encouraging answer. With respect to planetary boundary interactions, for example, while the problem of a deeply intertwined Earth system is extremely complex, the science has already revealed some crucially important insights. Most notably, we know that increasing concentrations of CO_2 in the atmosphere exacerbate both climate change and ocean acidification.[50] Both of these, in turn, combine to threaten marine biodiversity, with negative implications for the biosphere integrity boundary. Thus, from the jungle of millions of interacting data points, a very simple policy directive emerges: keep atmospheric CO_2 below 350 ppm. Similarly, we know that forests preserve biodiversity, capture carbon and help human societies adapt to the effects of climate change (for example, by reducing temperatures and improving air quality locally).[51] Again, from the crucible of complexity comes a simple imperative: preserve forests.

More broadly, planetary boundaries research can help to inform a governance approach aimed at increasing resilience, or the ability of ecosystems to 'retain their structures and functions in the face of disturbance'.[52] Since the interacting social and ecological processes that shape Earth system functioning are complex and dynamic, it makes sense to focus on knowable strategies for increasing resilience rather than to agonise about inevitable uncertain-

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46 Steffen et al (n 13) 1259855-8.

47 Ibid at 1259855-8-1259855-9.

48 Note, however, that a growing body of scholarship has mapped out how planetary boundaries science and policy can be scaled down to regional and local levels. Barbara Norman, *Sustainable Pathways for Our Cities and Regions: Planning within Planetary Boundaries* (Routledge 2018); see also Chapter 11 herein. Moreover, some of the planetary boundaries already include regional metrics (eg regional forest cover for the biosphere boundary and regional AOD for the atmospheric aerosol loading planetary boundaries).

49 Taking aim at the biosphere integrity boundary, for example, Montoya argues that '[t]he notion of a "safe operating space for biodiversity" is vague [and] [a]ttempts to fix it strip it of all meaningful content'. Montoya et al (n 31) 71.

50 See eg, Long Cao et al, 'Effects of Carbon Dioxide and Climate Change on Ocean Acidification and Carbonate Mineral Saturation' (2007) 34(5) Geophysical Research Letters 1.

51 Michael Jenkins and Brian Schaap, *Forest Ecosystem Services* (Background study prepared for the thirteenth session of the United Nations Forum on Forests April 2018) <www.un.org/esa/forests/wp-content/uploads/2018/05/UNFF13_BkgdStudy_ForestsEcoServices.pdf> accessed 9 June 2020.

52 Olivia Woolley, *Ecological Governance: Reappraising Law's Role in Protecting Ecosystem Functionality* (Cambridge University Press 2014) 16.

ties.[53] Indeed, Woolley convincingly argues that 'the goal of ecological governance should be to reduce human pressures on resilience … in order to enhance the ability of ecosystems to withstand whatever future disturbances confront them'.[54] If we inquire whether the planetary boundaries approach would improve Earth system resilience, the problem of scientific uncertainty virtually disappears. There seems little room for doubt that a world in which we complied with planetary boundaries (even in their current, imperfect, ever-evolving state) would be far more resilient than the one in which we find ourselves today.

Thus, it becomes clear that the significance of scientific uncertainty depends upon the lens through which we view the project of defining planetary boundaries. If the goal is to discover *the* ultimate scientific 'Truth', then the planetary boundaries approach is probably unworkable. However, if the goal is to better inform environmental policy and increase our chances of sustaining thriving human communities on Earth, then scientific uncertainty should not be viewed as a fatal flaw in the planetary boundaries framework. As Biermann has argued,

> [w]hat counts for governance is not absolute precision on boundaries but broad agreement among scientists and policy networks about the goals we should strive for. And these goals will likely be more powerful if they are clear and convincingly quantified. Thus, even though quantification of earth system boundaries will always be based on scientific research that may become more certain but never fully certain, quantification of earth system boundaries has the potential of creating powerful political narratives.[55]

The following section considers some of the ethical and socio-political ground that would need to be covered in order to move from planetary boundary science to planetary boundary law and governance.

3.2 Planetary Boundaries and Justice

In any environmental dialogue, the successful transition from scientific recommendation to legal enactment depends to a significant degree on ethical and socio-political considerations. If the planetary boundaries framework is to fulfil its promising potential, it will need to be translated into laws and policies that are ethically and politically defensible in the very diverse array of societies that make up the human community on Earth.[56] While planetary boundaries are inherently normative (in that they explicitly counsel us to shape our behaviour in such a way as to preserve a safe operating space for humanity),[57] they are ethically thin. As a result, there is great uncertainty as to the justice/fairness of a system of global (or local) environmental governance informed by planetary boundaries.

The normative direction of the planetary boundaries concept is limited to promoting anthropocentric environmental protection at a global scale; it does not even go as far as Aldo

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53 See Kotzé (n 5) 154.
54 Woolley (n 52) 16–17.
55 Biermann (n 3) 34. As examples, Biermann points to campaigns built around the idea of limiting warming to below 2 degrees C (now 1.5 degrees) and those centred on keystone saving species such as salmon and turtles. Ibid.
56 See Adelman, Chapter 4 in this book.
57 See Galaz (n 44) 81.

Leopold's famous ecological definition of morality.[58] As noted above, some scholars also assert that the very notion of a threshold (embodied in both core planetary boundaries) is harmful in that it allows humans to indulge in ongoing environmental depredations within the boundary, to the detriment of other living beings.[59] It is quite possible that the anthropocentrism of planetary boundaries will sit poorly with some cultures and communities, notably indigenous peoples.[60] While this concern should not be dismissed lightly, it is worth noting that since our fellow Earth-dwellers have also evolved to suit the conditions of the Holocene era, it seems likely that stabilising the Earth system within a Holocene-like state will improve the lot of millions of other species with whom we share the planet.

In addition to the question of interspecies justice, planetary boundaries will need to be assessed from the perspective of intra-generational environmental justice, defined here as the just allocation of environmental benefits and burdens among existing humans.[61] In particular, as Biermann notes, any policy responses to planetary boundaries will need to be attentive to the needs of the world's poorest people and the interests of developing countries more generally.[62] The principle of 'common but differentiated responsibilities' is particularly apt here.[63] All of the peoples of Earth are threatened by Earth system degradation, but developed countries both contributed more to the problem and have reaped an immensely greater share of the benefits accruing from ecologically harmful economic activity.[64] Even at regional and local levels, ethically defensible policies to protect planetary boundaries must be sensitive to distributive fairness and the unique vulnerabilities of particular communities.[65] Above all, countries must resist the temptation to suppress human rights (for example, through mandatory fertility control) in an attempt to comply with planetary boundaries.[66]

Finally as with any environmental policy tools, planetary boundaries should also be evaluated from the perspective of intergenerational equity, defined as a just balancing of the envi-

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[58] 'A thing is right when it tends to preserve the integrity, stability and beauty of the biotic community. It is wrong when it tends otherwise.' Aldo Leopold, *A Sand County Almanac and Sketches Here and There* (Oxford University Press 1949) 224–25.

[59] Schlesinger (n 30).

[60] See eg John Borrows, 'Living between Water and Rocks: First Nations, Environmental Planning and Democracy' (1997) 47 The University of Toronto Law Journal 417; John Borrows, *Law's Indigenous Ethics* (University of Toronto Press 2019) 43–47; Catherine Iorns Magallanes, 'Maori Cultural Rights in Aotearoa New Zealand: Protecting the Cosmology that Protects the Environment' (2015) 21(2) Widener Law Review 273.

[61] See, generally Paul Martin et al (eds), *The Search for Environmental Justice* (Edward Elgar 2015).

[62] Biermann (n 3) 35, 146.

[63] Tuula Honkonen, 'Development of the Principle of Common but Differentiated Responsibilities and Its Place in International Environmental Regimes' in Tuomas Kuokkanen et al (ed), *International Environmental Law-making and Diplomacy: Insights and Overviews* (Taylor & Francis 2016) 160–84.

[64] See, for a discussion of (in)global justice concerns in relation to the stratospheric ozone boundary specifically, Du Toit, Chapter 14 in this book.

[65] See eg Jean Leclair, 'Invisibility, Wilful Blindness and Impending Doom: The Future (If Any) of Canadian Federalism' in Carolyn Hughes Tuohy et al (eds), *Policy Transformation in Canada: Is the Past Prologue?* (University of Toronto Press 2019) 112 ('Indigenous peoples have borne the brunt of the distributive inequities of economic development (shouldering the costs without gaining much of the benefits), they should not now bear the burden of saving us from the abyss'); David J Doorey, 'Just Transition: Putting Labour Law to Work on Climate Change' (2017) 30(2) Journal of Environmental Law and Practice 201.

[66] See Biermann (n 3) 33.

ronmental rights and obligations of present and future human generations.[67] Intergenerational equity has legal and cultural roots in a very broad swathe of human societies around the world, and neatly marries the dominant western ideal of rights with the concept of duty, which is much more central in many non-western societies.[68] In this area the planetary boundaries framework is possibly superior to existing paradigms both in its specificity and in the level of intergenerational ambition it reflects. Unlike the vague, aspirational rhetoric of sustainable development,[69] for example, planetary boundaries could inform a system of measurable, outcome-based obligations to protect the ecological rights and interests of future generations.[70]

To summarise, we cannot be certain that societies will apply planetary boundaries in a just manner, but there is nothing about the framework that renders it incompatible with interspecies, intra-generational, or intergenerational justice.

3.3 Uncertainty in Law and Governance

Even if the planetary boundaries framework is scientifically valid, ethically viable and politically persuasive, it is not – as lawyers would say – 'self-executing'. In a hypothetical world in which all governments and international organisations were united in their commitment to comply with planetary boundaries, there would still be major challenges in translating planetary boundaries science into effective law and governance. However, 'Earth system governance' has emerged as a growing new field of scholarship, offering many theoretical insights and practical solutions that are described in more detail elsewhere.[71] The legal dimension of Earth system governance is less well defined – both generally and specifically with respect to planetary boundaries – but recent work by Rakhyun Kim, Louis Kotzé and Alexandra Aragão (among others)[72] has laid crucial foundations for reimagining law in a way that could lead human societies back into the safe operating space within planetary boundaries. While this brief section will not attempt to summarise the body of scholarship in these fields, a few points should be made regarding the law and governance dimension of planetary uncertainty.

First, there are basic questions about how to conceptualise planetary boundaries in the legal universe. While the notion of a 'planetary boundary' may make sense to natural scientists, what does it mean to social scientists or legal scholars more specifically? Is the planetary boundary framework just a marketing tool? Is it essentially a re-branding and unification of long-standing environmental campaigns? Or could the concept acquire some form of legal status that is recognisable to decision-makers in international, regional and/or domestic legal

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67 Edith Brown Weiss, *In Fairness to Future Generations: International Law, Common Patrimony, and Intergenerational Equity* (United Nations University 1989).

68 Ibid; Lynda Collins, 'Revisiting the Doctrine of Intergenerational Equity in Global Environmental Governance' (2007) 30 The Dalhousie Law Journal 79.

69 Klaus Bosselmann, *The Principle of Sustainability: Transforming Law and Governance* (2nd edn, Routledge, 2017) 1 ('The concept of "sustainable development" lost its core meaning somewhere between the 1980s and today'); Collins, ibid at 87 ('The sustainable development paradigm eschews the language of both rights and responsibility, lacks any mechanism for effective implementation, and is highly ambiguous as a policy framework'). See also Adelman, Chapter 4 in this book.

70 Alexandra Aragão, 'Legal Tools to Operationalize Anthropocene Environmental Law' in Magalhães et al (n 2) 172–80.

71 Sarah Burch et al, 'New Directions in Earth System Governance', Earth System Governance 1 (2019) 100006; and Kim and Kotzé, Chapter 3 in this book.

72 Aragão (n 70) 172–80; See Kotzé and Kim (n 5).

systems? At the level of legal theory, planetary boundaries may be situated in the broader discourses of ecological law[73] and governance,[74] strong sustainability,[75] ecological integrity,[76] Anthropocene environmental law,[77] common heritage of humankind,[78] global environmental constitutionalism,[79] Earth system governance[80] and the exciting new theory of Earth system law proposed by Kotzé and Kim.[81]

On the more prosaic level of legal taxonomy, planetary boundaries are probably best viewed as constitutional principles. The message 'legislate as you wish within these non-derogable boundaries' is a quintessentially constitutional idea.[82] Moreover, constitutional principles tend to suffuse entire legal systems and influence thought and conduct throughout societies.[83] On the domestic level, the obligation to stay within planetary boundaries could be viewed as inherent in all other constitutional environmental rights and duties (embodied in the constitutional law of at least 147 nations).[84] At the international level, planetary boundaries could function as a *Grundnorm* for all international law, including international environmental law.[85] Thus, uncertainties regarding the legal conceptualisation of planetary boundaries are significant but not insurmountable.

Another crucial area of uncertainty concerns the practical imperative of *effectuating* planetary boundaries (however viewed) in law and governance around the globe.[86] As Bosselmann has noted, '[t]here is as yet nothing in the law responding to the Earth's wholeness and complexity'.[87] If we succeed in translating the planetary boundaries framework into a legally recognisable tool to fill this crucial gap, there remain profound uncertainties as to *how* it could be used to achieve real change in ecological outcomes. At the domestic level, recognition of

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73 Kotzé and Kim (n 5); see also Klaus Bosselmann and Prue Taylor, *Ecological Approaches to Environmental Law* (Edward Elgar 2017).

74 Woolley (n 52).

75 David R Boyd, 'Sustainability Law: (R)evolutionary Directions for the Future of Environmental Law' (2004) 14 Journal of Environmental Law and Practice 357; Kotzé (n 5) 152; Bosselmann (n 69).

76 Rakhyun E Kim and Klaus Bosselmann, 'Operationalizing Sustainable Development: Ecological Integrity as a Grundnorm of International Law' (2015) 24(2) Review of European, Comparative & International Environmental Law 194.

77 Aragão (n 70).

78 Prue Taylor, 'The Common Heritage: Constructive Utopianism' in Magalhães (n 70) 104–31.

79 Louis J Kotzé, *Global Environmental Constitutionalism in the Anthropocene* (Hart Publishing 2016); Klaus Bosselmann, 'Global Environmental Constitutionalism: Mapping the Terrain' (2015) 21 Widener Law Review 171, 180.

80 Klaus Bosselmann, 'Shifting the Legal Paradigm: Earth-Centred Law & Governance' in Magalhães et al (n 2).

81 See Kotzé and Kim (n 5); see also Planetary Boundaries Initiative <https://planetaryboundariesinitiative.org> accessed 9 June 2020.

82 See Kotzé (n 5) 62–63; Louis J Kotzé and Wendy Muzangaza, 'Constitutional International Law for the Anthropocene?' (2018) 27(3) Review of European, Comparative and International Environmental Law at 14; Louis J Kotzé, 'The Conceptual Contours of Environmental Constitutionalism' (2015) 21 Widener Law Review 187; Louis J Kotzé, 'Arguing Global Environmental Constitutionalism' (2012) 1 Transnational Environmental Law 199.

83 David R Boyd, *The Environmental Rights Revolution: A Global Study of Constitutions, Human Rights, and the Environment* (University of British Columbia Press, 2012) at 4–7; Kotzé (n 79).

84 Ibid at 47.

85 Bosselmann (n 80) 68.

86 See specifically Ebbesson, Chapter 10 in this book.

87 Bosselmann (n 80) 65.

planetary boundaries would not lead inexorably to any one approach to governance or politics more broadly. Rather, 'socioeconomic development trajectories – within the safe operating space set by the earth system boundaries – are not defined by scientists. They are left open to the … political process.'[88] While planetary boundaries could in theory be enforced by a scientific oligarchy (or another anti-democratic system), they are equally amenable to implementation in liberal democracies.[89]

At the international level, perhaps the most glaring area of uncertainty is how to create effective institutions for policing planetary boundaries.[90] Stephens has shown that the current international environmental law regime does not regulate effectively for planetary boundaries.[91] Our existing governance infrastructure is similarly ill-prepared to protect the safe operating space. Galaz et al argue that '[g]overnance failure is imminent when the information needed to monitor "planetary boundary" processes and their interactions, is dispersed amongst a wide set of agencies and scientific communities'.[92] However, Biermann and others have suggested pragmatic pathways for building the necessary architecture to create, police and evaluate international law and governance initiatives aimed at achieving compliance with planetary boundaries.

Whatever institutional architecture is chosen, a major challenge to the law and governance of planetary boundaries at all levels is the reality of ongoing scientific discovery – 'a fact that seriously complicates attempts to reach political agreements through scientific consensus'.[93] As noted above, in the six years between Rockström's original planetary boundary publication and the 2015 update by Steffen and colleagues, three of the nine planetary boundaries underwent substantial revision, affecting scope, conceptualisation and/or quantification. Any system of law or governance structured around planetary boundaries will thus need to be adaptive in nature. Fortunately, scholars have turned their attention to the difficult question of how to integrate adaptiveness into both local and international environmental law and governance regimes.[94] Burch and colleagues observe that '[a]daptiveness (particularly adaptive governance) has been extensively studied over the last decade, and continues to be at the forefront of environmental governance theory and practice'.[95]

Ultimately, it seems likely that there are many viable options for effectuating planetary boundaries in law and governance. However, the extent to which such solutions will be adopted and implemented depends largely on the public and political appetite for planetary boundaries thinking. Thus, a final important question must be addressed: how can scientists

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88 Biermann (n 3) 33.

89 Indeed, Biermann suggests that planetary boundaries should be viewed as embedded in the sustainable development paradigm, which includes 'other important policy goals such as democracy, human rights, and freedom'. Ibid at 33–34.

90 See Ebbesson, Chapter 10 in this book.

91 Tim Stephens, 'Reimagining International Environmental Law in the Anthropocene' in Louis J Kotzé (ed) *Environmental Law and Governance for the Anthropocene* (Hart Publishing 2017) 31.

92 Galaz et al (n 44) at 81.

93 Ibid.

94 See eg Woolley (n 52) 54–64; Lance Gunderson et al, 'Practising Adaptive Management in Complex Eco-social Systems' in Jon Norberg and Graeme Cumming (eds), *Complexity Theory for a Sustainable Future* (Columbia University Press 2008) 223–45.

95 Burch (n 71) 12.

and advocates mobilise public attention and political will to take the necessary actions to remain within the safe operating space mapped out by the planetary boundaries?

3.4 Communicating Planetary Boundaries

First, in communicating planetary boundaries to the public and to decision-makers, it is crucial to convey accurately what the framework does and does not capture. As noted above, the planetary boundaries framework does not claim to be an ecological panacea. Messaging should note that governance measures based on planetary boundaries will need to be complemented by effective policies to address ecological concerns outside the planetary boundary framework (for example, conservation of non-renewable resources). Moreover, planetary boundary advocates will need to make clear that this approach should not be taken as a 'licence to pollute' up to the edge of the relevant boundary. In particular, it will be crucial to emphasise that we have already crossed four boundaries; hence urgent, effective action is required in order to bring humanity back into the safe operating space.

Explaining threshold effects to non-experts is particularly difficult since, by definition, the severity of anticipated changes does not become apparent until the threshold has been crossed. (Recall that for planetary boundaries that are believed to have thresholds, the boundary has been drawn well before the anticipated tipping point). Thus, it can be difficult for people to reconcile the evidence of their own senses with scientific forecasts of future doom.[96] However, with the growing incidence of extreme weather events, planetary boundary advocates are probably in a stronger position than ever before to impress upon humans the need to make deep changes in order to preserve a livable home for humanity.[97]

In some cases, planetary boundaries may offer an opportunity to breathe new life into existing environmental dialogues.[98] In the climate context, for example, there is already considerable momentum around the imperative of keeping carbon dioxide concentrations below 350 parts per million, but it may well be that some people will understand this idea better if it is framed in the language of 'boundaries'. The planetary boundary concept might encapsulate the risk of climate catastrophe in a way that is more digestible to the average citizen. We have all become accustomed to living within the constraints of various rules or 'boundaries' in our public and private lives, and it may be very salutary to encourage people to think about planetary constraints in a similar way. Further, the conceptualisation of climate change as just one of nine planetary boundaries[99] may lead climate-concerned citizens (people who have already accepted the need to live within at least one planetary boundary) to broaden their focus

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[96] Montoya captures this concern when he asks: 'if we suggest that a catastrophe has taken place and the consequences are not evident, then how will managers and policy makers trust the science we do?' Montoya et al (n 31).

[97] See Christopher Borick and Barry G Rabe, 'Personal Experience, Extreme Weather Events, and Perceptions of Climate Change' (Oxford Research Encyclopedias, March 2017) <https://oxfordre.com/climatescience/view/10.1093/acrefore/9780190228620.001.0001/acrefore-9780190228620-e-311> accessed 9 June 2020.

[98] See generally Dan M Kahan, 'Making Climate-Science Communication *Evidence*-based: All the Way Down' in Deseria A Crow and Maxwell T Boykoff (eds), *Culture, Politics and Climate Change: How Information Shapes Our Common Future* (Routledge 2014) 203–20.

[99] See Verschuuren, Chapter 13 in this book.

to include all aspects and processes of the Earth system that are necessary to ensure human flourishing.

However, planetary boundaries messaging will only be effective if scientists and advocates are sensitive to the ordinary human sensibilities of the relevant audiences. Whether they be legislators, diplomats, judges or members of the general public, when people are asked to contemplate serious threats to the Earth system there is a real danger of psychological overwhelm. As Koger and colleagues explain, '[i]t is well known that depressive symptoms including feelings of anxiety, paralysis, and lack of motivation occur when the causes of events are seen as unchangeable and global; this is particularly relevant to issues of environmental degradation'.[100] (The related phenomenon of 'burnout' is well known in the environmental community).[101] While some become depressed, many others simply ignore messages that are viewed as apocalyptic or alarmist. When confronted with a dystopic vision of the future, '[t]he effect on the public is about what you would expect: people avoid thinking about the unthinkable, get on with their lives, and hope the experts are wrong'.[102] On the other hand, it is possible to motivate and even inspire environmental commitments by emphasising the possibility of sustainable societies and the solubility of environmental problems:[103]

> It seems crucial to build motivation from a positive, rather than a negative, source. Consider the civil rights movement: 'Martin Luther King Jr.'s "I have a dream" speech is famous because it put forward an inspiring, positive vision that carried a critique of the current moment within it … [H]ad King given an "I have a nightmare" speech instead' the movement might have turned out differently. Comparably, Roszak, the [founder] of Ecopsychology, warned about the 'green guilt and ecological overload' conveyed by many environmental initiatives.[104]

In this respect, it will be crucial to communicate the message that we *know* we can reverse course to achieve compliance with a planetary boundary, since we have already done so with respect to ozone depletion.[105] The importance of telling and re-telling this planetary success story cannot be overstated. Success stories boost optimism[106] and can buffer decision-makers against the inevitable mental health challenges that will beset any mere mortal who seriously contemplates our planetary predicament.

In addition to focusing on solutions and positive possibilities, dialogue on planetary boundaries should be de-politicized to the greatest extent possible. A convincing body of research has shown that political partisanship leads to ideological rather than evidence-based reason-

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[100] Susan M Koger et al, 'Climate Change: Psychological Solutions and Strategies for Change' (2011) 3(4) Ecopsychology 227 at 228.

[101] See Jeff Warren, 'Environmentalist and the Mind' (*Psychology Tomorrow*, 7 March 2013) <http://psychologytomorrowmagazine.com/environmentalism-and-the-mind> accessed 9 June 2020.

[102] Steven Pinker, *Enlightenment Now: The Case for Reason, Science, Humanism and Progress* (Penguin Books 2018) 310.

[103] Koger et al (n 100) 227; Boyd (n 16).

[104] Koger et al (n 100) 228 (internal citations omitted); Molly S Casstelloe, 'Coming to Terms with Ecoanxiety' (2018) Psychology Today <www.psychologytoday.com/gb/blog/the-me-in-we/201801/coming-terms-ecoanxiety> accessed 9 June 2020.

[105] See Du Toit, Chapter 14 in this book.

[106] See eg, Boyd (n 16); Madelon L Peters et al, 'Manipulating Optimism: Can Imagining a Best Possible Self Be Used to Increase Positive Future Expectancies?' (2010) 5(3) Journal of Positive Psychology 204.

ing.[107] Around the world, advocates of planetary boundaries should do their best to ensure that the concept does not become identified with a particular political party or identity. One way to expand the reach of planetary boundaries discourse is to enlist 'champions' from a broad range of political communities. Research strongly suggests that rather than presenting more scientific 'talking heads' to explain planetary boundaries and evidence-based solutions, it may be more effective to focus efforts on convincing influential leaders across the political spectrum and asking them to communicate it to their constituencies.[108]

To summarise, those who wish to see planetary boundary science translated into sound environmental policy will need the support of an informed, motivated and (as much as possible) unified public. Advocates and decision-makers seeking to implement measures to comply with planetary boundaries may also have recourse to a powerful recognised norm of global environmental governance – the precautionary principle.

4. BOUNDARY PATROL: PLANETARY BOUNDARIES AND THE PRECAUTIONARY PRINCIPLE

The precautionary principle has become a key guiding concept in environmental governance at all levels around the globe and has likely emerged as a norm of customary international law.[109] Despite some controversy regarding the merits (or demerits) of the precautionary approach to environmental regulation,[110] many governments have agreed, at least in principle, that precaution is central to sustainability. Summarising the various existing formulations of the precautionary principle, the Fourth Ministerial Conference on Environment and Health observes as follows:

> According to most interpretations of the principle, precautionary decisions are those that prevent damage to health or ecosystems in the face of uncertainty, stimulate the development of more health-protective technologies and activities, and place greater responsibility on proponents of potentially damaging activities.[111]

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[107] See eg Pinker (n 102) 360–62; Keith E Stanovich and Richard F West, 'Natural Myside Bias Is Independent of Cognitive Ability' (2007) 13(3) Thinking & Reasoning 225.

[108] See eg Blake Hudson and Evan Spencer, 'Denying Disaster: A Modest Proposal for Transitioning from Climate Change Denial Culture in the Southeastern United States' (2018) 40 University of Arkansas at Little Rock Law Review 545.

[109] See Arie Trouwborst, *Evolution and Status of the Precautionary Principle in International Law* (Kluwer Law 2002) 117–20; Owen McIntyre and Thomas Mosedale, 'The Precautionary Principle as a Norm of Customary International Law' (1997) 9 Journal of Environmental Law 221, 241 ('the precautionary principle has indeed crystallized into a norm of customary international law'); David Freestone and Ellen Hey, 'Origins and Development of the Precautionary Principle,' in David Freestone and Ellen Hey (eds) *The Precautionary Principle and International Law* (Kluwer Law International 1996) 41 (the precautionary principle has been included 'in virtually every recently adopted treaty and policy document related to the protection and preservation of the environment').

[110] Noah M Sachs, 'Rescuing the Strong Precautionary Principle from Its Critics' (2011) 2011 University of Illinois Law Review 1285.

[111] World Health Organization, Europe, *Dealing with Uncertainty – How Can the Precautionary Principle Help Protect the Future of our Children?* EUR/04/5046267/11.

In his outstanding exposition of the precautionary principle, Trouwborst characterizes it as a conceptual 'tripod', including (i) a threat of environmental harm, (ii) uncertainty and (iii) precautionary action.[112] The so-called weaker interpretations of the precautionary principle view it as a permissive concept, allowing, but not requiring, governments to take protective action even in the face of scientific uncertainty.[113] Stronger versions of precaution shift the burden of scientific uncertainty to the proponents of environmental harmful activities, requiring producers, emitters and developers to prove the sustainability or safety of their activities in order to justify regulatory approval.[114]

As explained above, the planetary boundaries framework is inherently precautionary, since the authors have attempted to draw boundaries at the '"safe" end of the zone of uncertainty'.[115] While planetary boundaries may thus be seen as an instantiation of the precautionary principle, that principle also has much to say about *how we respond* to the persistent uncertainty surrounding planetary boundaries. What if scientists have selected the wrong control variable or made errors in its quantification? What if they have underestimated the Earth's adaptive capabilities or overestimated synergistic interactions between multiple Earth system stressors (for example, climate change and ocean acidification)? The precautionary principle strongly suggests that legal decision-makers should in fact set aside these important scientific questions and regulate now in accordance with the planetary boundary framework as it is. Although planetary boundaries remain uncertain, the data underlying each quantified metric is more than adequate to meet the risk threshold necessary to justify action under the precautionary principle. Perhaps, like sausages and legislation,[116] it is better to simply use planetary boundaries constructively than to agonise over how they were produced.

While the planetary boundaries framework does not always point to specific precautionary action, in some cases the relevant boundary provides clear guidance in this respect. The biosphere integrity boundary, for example, is immensely helpful in clarifying priorities for biodiversity law and governance.[117] With the enormous number of issues that bear on biodiversity, it is undoubtedly helpful to zero in on forest cover, particularly since the control variables for this boundary are both precise and regionally disaggregated. The direction to preserve 80 per cent of tropical forest cover and 50 per cent of temperate forest cover is both clear and compelling. At the international level, this planetary boundary provides a strong argument for global protection of, and investment in, forests – particularly tropical forests in developing

112 Trouwborst (n 109) 11–12.

113 Principle 15 of the Rio Declaration has been cited as an example of a weak articulation of Precaution. See Sachs (n 110) 1292–93. Some have even argued that the use of the term 'approach' rather than 'principle' suggests a further dilution of the concept. See Miguel A Recuerda, 'Dangerous Interpretations of the Precautionary Principle and the Foundational Values of the European Union Food Law: Risk versus Risk' (2008) 4 Journal of Food Law and Policy 1. However, as Trouwborst has observed, the second clause in Principle 15, providing that 'lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation', strongly suggests a corollary obligation to take such action in advance of scientific certainty.

114 See Sachs (n 110).

115 Steffen et al (n 13) 1259855-2.

116 Robert Pear, 'If Only Laws Were Like Sausages' (*New York Times*, 4 December 2010) <www.nytimes.com/2010/12/05/weekinreview/05pear.html> accessed 10 June 2020.

117 See Somsen and Trouwborst, Chapter 12 in this book.

countries that need financial help to achieve conservation.[118] At the domestic level, nations with significant forests could consider embodying these targets in statutes or even constitutional provisions.[119] Similar proposals can be made with respect to other planetary boundaries, and many of these are canvassed in the boundary-specific chapters in this book.

A final observation should be made regarding the relationship between precaution and planetary uncertainty. While uncertainty is a constant, unavoidable reality within planetary boundaries science, law and policy, that is not to say that we should simply surrender to it. Just as Earth system scientists work tirelessly to close data gaps and increase our scientific understanding of the planetary boundaries, law and governance must strive to create incentives to reduce uncertainty regarding threats to Earth system functioning.[120] In sum, if any doubt remains regarding the need to take action in response to uncertain planetary boundaries, it should be resolved by application of the precautionary principle.

5. CONCLUSION: PLANETARY BOUNDARIES AND THE CLEAR PATH HOME

In a celebrated series of mystery novels by Canadian writer Louise Penny, the protagonist begins every investigation with a simple request to his officers: ‘Tell me what you know.’[121] In a sea of unknowns, the heroes ultimately find truth by laying down a path of known facts, ‘brick by brick’, as it were. Our collective socio-ecological journey from crisis to sustainabi lity,[122] arguably requires a similar approach. Though it is a daunting task, decision-makers in the Anthropocene need to find ways to ensure a sustainable future for humanity in the presence of intractable uncertainties. Since a perfect understanding of the science of the Earth system is unattainable, and uncertainty regarding planetary boundaries inevitable, it may be more constructive to ask what we *do* know, rather than lament the depth of our ignorance.

On the scientific level, we understand the general scope of key threats to Earth system functioning and viable ways of measuring many of them. We know that ‘wild’ spaces (especially forests) should be conserved to the greatest extent possible in order to protect biodiversity and mitigate climate change.[123] We even know how to bring species back from the brink of extinction.[124] We know that atmospheric carbon dioxide levels should be kept under 350 ppm, and myriad technical and policy solutions have been developed to arrive at this goal.[125] We know that agriculture in the developed world needs to transition away from its overdependence on chemical inputs that disrupt nitrogen and phosphorous flows, and that the transition

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[118] See Pedro Pablo Kuczynski, ‘Climate Talks: Rich Countries Should Pay to Keep Tropical Forests Standing’ (*The Guardian*, 2 December 2015) <www.theguardian.com/global-development/2015/dec/02/climate-talks-rich-countries-should-pay-to-keep-tropical-forests-standing> accessed 10 June 2020.

[119] See eg *Constitution of Bhutan,* art 5(3) (stating that ‘a minimum of sixty percent of Bhutan’s total land shall be maintained under forest cover for all time’).

[120] See Aragão (n 70) 91–93; Biermann (n 3) 72–74.

[121] See eg Louis Penny, *Still Life* (HarperCollins 2005).

[122] See, James Gustave Speth, *The Bridge at the Edge of the World: Capitalism, the Environment, and Crossing from Crisis to Sustainability* (Yale University Press 2008).

[123] See eg Edward O Wilson, *Half Earth* (Liveright Publishing Corporation 2016).

[124] Boyd (n 103) 3–25.

[125] See eg Paul Dawken, *Drawdown* (Penguin 2017).

to sustainable agriculture is technically possible.[126] Perhaps most inspiringly, we know how to tackle an impending global atmospheric crisis; we have already done so with respect to stratospheric ozone.

On the ethical level, we know that any law or policy enacted based on planetary boundaries must be attentive to non-human interests, and to distributive fairness and justice globally, regionally and locally. On the socio-political level, we know that the planetary boundaries framework will only make a difference if it is taken up by governmental decision-makers, civil society and members of the general public. Planetary boundaries leave plenty of room for democratic choices between available development paths, but such choices can only be rationally made by an informed (and inspired) public. We are learning how to better communicate the crucial insights of planetary boundary science, and this will be a crucial step towards effective precautionary action.

On the level of law and governance, we know that existing international infrastructure and domestic laws are probably inadequate to the task of policing planetary boundaries and ensuring Earth system integrity. Happily, scholars have proposed a number of achievable reforms to governance models and legal regimes that could remedy this problem. Thought leaders such as Edith Brown Weiss, Louis Kotzé, Olivia Woolley and Klaus Bosselmann (among others) have given us 'big ideas' necessary to inspire scholars and decision-makers alike and guide our thinking as we navigate the many challenges and opportunities that await us. And around the world, millions of committed individuals and communities are taking steps, small and large, towards a sustainable future. All of this is cause for optimism.

Thus, what may at first seem like an insurmountable mountain of uncertainty is not in fact fatal to the implementation of a planetary boundary approach to environmental governance. Importantly, the planetary boundaries framework may actually *decrease* uncertainty (or at least ambiguity) in global environmental governance by clarifying the meaning of sustainable development generally,[127] and contextualising the Sustainable Development Goals (SDGs) specifically.[128] Planetary boundaries replace the vague and internally conflicted language of sustainable development with specific biogeochemical parameters and metrics for evaluating them, and they provide an important context for and complement to the SDGs. As a starting point for environmental governance (at global, regional or even local levels) this must be viewed as a major step forward.

To summarise, the scientific, ethical, socio-political and juridical uncertainty surrounding the planetary boundaries concept should not distract us from its very promising potential. Among the other defining principles of the emerging global environmental constitution,[129] planetary boundaries serve a crucial function, marrying normative force with technical utility. While great uncertainties remain, it seems quite certain that law and policy based on the planetary boundaries framework have the real potential to translate Earth system science

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126 See eg Mark Shepherd, *Restoration Agriculture: Real World Permaculture for Farmers* (Acres USA 2013).

127 See Jeffrey D Sachs, *The Age of Sustainable Development* (Columbia University Press 2015) 181.

128 Victor Galaz, *Global Environmental Governance, Technology and Politics* (Edward Elgar 2015) 138; David Griggs et al, 'Policy: Sustainable Development Goals for People and Planet' (2013) 495 Nature 305.

129 See Kotzé (n 82); Bosselmann (n 80).

into effective governance to preserve the safe operating space for humans and the many other beings with whom we share our planetary home.

6. Planetary boundaries *intra muros*: cities and the Anthropocene

Helmut Philipp Aust and Janne E. Nijman

1. INTRODUCTION

It is a bleak vision that is evoked by Brendan Gleeson in his rumination about the role of cities for the future of the world, after the – nota bene – exit from the Anthropocene.

> Cities, the new human homelands, will carry our species through the 'terminal crisis' transition to what must succeed to an entangled, failing modernity. It may indeed mark our exit from the Anthropocene to a world less tolerant of human existence.[1]

Whereas geological scholars might still debate the time at which the world will or did enter the Anthropocene, the concept itself has taken firm hold across the natural and social sciences.[2] Among the various contributions to the debate, a stream of literature has emerged about the appropriate scale to use in dealing with the challenges of the Anthropocene. The Anthropocene confronts us with the boundaries of planet Earth and with the fact that humanity's 'safe operating space' is under threat.[3]

The question of scale has led to innovative research in Earth system law and governance, which recognises on the one hand the relevance and importance of the planetary scale, while on the other hand pointing to a clear need to reflect on what is called 'downscaling'.[4] Can planetary boundaries be translated to non-global scales of law and governance? Or, as some have suggested, can't the city take up its share of responsibility and enrol as a decisive actor in the governance of planetary boundaries?

This turn to the city is as inevitable as it is puzzling. It is inevitable to the extent that the Anthropocene as an all-encompassing reality will have repercussions at every governance level; the same is true for the various planetary boundaries. Yet, there is a puzzle here, or some might even say a paradox: why turn to the city to address a phenomenon as macro-level as the Anthropocene? Should solutions not emanate from higher-level echelons of global governance? At first sight, the turn to the city as a promising level for governance in the face of the planetary boundaries that are triggered by the Anthropocene is counterintuitive. The Anthropocene, as explained elsewhere in this book,[5] stands for a possible new geological epoch into which the world has entered. The transition from one geological epoch to the next is perceived to occur at an extraordinarily macro or global level. After all, the discourse on

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1 Brendan Gleeson, *The Urban Condition* (Routledge 2014) 100.

2 Ayşem Mert, 'Democracy in the Anthropocene' in Agni Kalfagianni, Doris Fuchs and Anders Hayden (eds), *Routledge Handbook of Global Sustainability Governance* (Routledge 2019) 282, 282–83.

3 See Kim and Kotzé, Chapter 3 in this book.

4 Ibid.

5 See Blebly, Holley and Milligan, Chapter 2, and Kim and Kotzé, Chapter 3, in this book.

the Anthropocene is about the general impact that humanity has on Earth – not in the hitherto superficial assumed sense, but in a more fundamental one, leaving an imprint on the hard rocks of planet Earth and through various other geological and natural markers.[6] If the combined effects of human behaviour push against planetary boundaries, as the other chapters in this book show, any governance-related responses would presumably need to take place at the planetary level itself.

In the following reflections, we will not be able to solve this paradox. Instead, this contribution sets forth a dual argument. First, we reveal that the primary contribution that can be made by the turn to the city in debates on law and governance in the face of planetary boundaries lies in unsettling established categories of law and governance which are tied up with the inter-state system that has an important role to play in the current conditions of the Anthropocene. Second, however, the city itself is inextricably bound up with the same conditions of the current sovereignty-driven and capitalist-oriented governance system. This inescapable paradox calls for renewed attention to the planetary boundaries within the city, to be found literally '*intra muros*': the city and its governance is not a level external to the planetary boundaries. Rather, it is deeply implicated in these planetary processes, and without the city's involvement, it may be hard for humanity to stay within a safe operating space.

Our approach can be understood as a variation of what urban scholars have called 'planetary urbanisation'. The social practice of urbanisation has reached a point at which there currently are no places that are *not* part of the planetary urban fabric. This scale contributes to cities' geological agency. We build on the work of Henri Lefebvre, Neil Brenner and Christian Schmid, who, among others, have pointed to the various contingencies of the 'urban age' in which we are said to live.[7] As Brenner observes, 'the world's oceans, alpine regions, the equatorial rainforests, major deserts, the arctic and polar zones, and even the earth's atmosphere itself are increasingly interconnected with the metabolic circuitry and spatiotemporal rhythms of planetary urbanisation'.[8] At the same time, there are limits to the theory of planetary urbanisation from a legal perspective: while this theory offers a conceptual lens through which to appraise the embeddedness of cities in bigger planetary conditions, it has limited traction in legal terms. This is because law as a discipline and field of practice depends on formal categories which identify actors, and which are bestowed with certain competences by public law. Public international law translates these competences and powers into the category of personality and subjecthood.[9] Accordingly, if we think about cities as actors in a global setting *from a legal perspective*, we will to some extent remain bound by formal categories and distinctions which might be unsatisfactory from the perspective of an approach of planetary urbanisation. This sensitivity speaks to the necessity to 'downscale' governance approaches to the planetary boundaries.[10] At the same time, the theory of planetary urbanisation points to the fact that

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[6] Jorge Viñuales, 'The Organisation of the Anthropocene: In Our Hands?' (2018) 1 International Legal Theory and Practice 1, 4.

[7] See the contributions in Neil Brenner (ed), *Implosions/Explosions: Towards a Study of Planetary Urbanization* (Jovis 2014).

[8] Neil Brenner, *New Urban Spaces: Urban Theory and the Scale Question* (Oxford University Press 2019) 306–307.

[9] On the notion of legal personality in international law see eg Catherine Brölmann and Janne E Nijman, 'Personality' in Jean d'Aspremont and Sahib Singh (eds), *Concepts for International Law* (Edward Elgar 2019) 678.

[10] See again Kim and Kotzé, Chapter 3 in this book.

cities occupy different scales simultaneously: they are local, yet their urbanisation patterns are deeply interwoven with the very processes which have pushed us towards the outer limits of the planetary boundaries.

Insights from the planetary urbanisation approach might then help us better understand the limits of what cities can do. And yet, when aiming to bring interdisciplinarity to fruition, the formal side of law may also have something to offer. Simply rehearsing the theory of planetary urbanisation from a legal perspective, by replacing the State with the city, might lead to offering just another variation of 'law is politics'. In this perspective, the city is inevitably bound up in broader networks and conditions whose forces it cannot control. While this is undoubtedly correct to a certain point, we wish to interrogate also whether there is something positive and concrete that the formal perspective of the law can offer to questions of cities in the Anthropocene. Rather than merely pointing to the embeddedness of the city in these planetary considerations, we aspire to bring the planetary boundaries home, as it were, to show how they are connected with the conditions in the city – *intra muros* – and how this affects the promise that cities hold for dealing with the planetary boundaries in the context of the Anthropocene.

In order to substantiate our two claims, the contribution will first turn to the governance challenges behind a demand for the urban turn for the governance of the Anthropocene and its fast approaching planetary boundaries (Section 2). Building on this analysis, we will examine in some detail the solutions which are on offer and which make a claim for the potential of innovative planetary boundaries governance that lies with cities (Section 3). Because these promises are rather vague, however, we seek to reveal some of the limits of the urban turn, in particular the prevailing impact of 'the private city', as well as the many unsettled questions about democratic participation at the local level (Section 4). We conclude with the observation that the main benefit of an urban focus in dealing with the Anthropocene lies with a shift towards 'seeing like a city' rather than 'seeing like a state', and we offer suggestions for future research (Section 5).

2. CITIES AND THE ANTHROPOCENE – THE GOVERNANCE CHALLENGES

It is not without reason that cities have recently received significant attention as a seemingly more appropriate level of governance for dealing with the manifold planetary boundaries-related governance challenges that are triggered in the Anthropocene.[11] These reasons relate to the particular connection between the nation state and sovereignty and the role that this combination has played with respect to the emergence of the capitalist world system (see Section 2.1). It is also debatable whether the interstate system and the law it has brought about leads to methodological shortcomings which stand in the way of effective governance for the Anthropocene (Section 2.2).

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[11] See Sybil P Seitzinger et al, 'Planetary Stewardship in an Urbanizing World: Beyond City Limits' (2012) 41 Ambio 787; Daniel Hoornweg et al, 'An Urban Approach to Planetary Boundaries' (2016) 45 Ambio 567.

2.1 State Sovereignty and the Capitalist System

The Anthropocene emerged from a particular combination of capitalism and the interstate system which became the dominant paradigm for world order from late modernity.[12] Capitalism and the current interstate system are deeply imbricated in that they form two sides of the same coin: the international legal order facilitates (unregulated) corporate-driven capitalism.[13] Some go so far as to argue that the precarious situation of our planet can only be explained by the toxic combination of a capitalist mindset and the vicissitudes of sovereignty, a system based on (the consideration of) 'privatising' benefits and socialising costs.[14] This combination of factors arguably has played (and continues to play) a major role in pushing us towards planetary boundaries, if only for the reason that the principle of state consent, as the most direct consequence of sovereignty, allows States to choose not to commit to effective regulation to push back against current unsustainable practices with respect to energy consumption, waste production, ocean acidification and other developments.

While the Earth system has existed for well over four billion years, human life has only been an integral part of this system for the past 200,000 years. With human life, human society and its processes, human practices and products came to interact with the Earth system. While humans relate to Earth differently in different cultures, the idea of humans having *dominium*, that is, ownership and sovereignty over nature – deeply rooted in haughty interpretations of the biblical book of Genesis – has been at the core of western thinking about law and governance ever since early modernity.[15] Colonial and post-colonial capitalism has further contributed to a form of international law that has been complicit in exploiting Earth's natural resources and producing global inequality.[16]

In *The History Manifesto*, Jo Guldi and David Armitage observe: 'the West has been on a long path to environmental exhaustion, moving from one energy source to another, generation by generation, a process that helped to give rise to the modern nation-state, at the time a form of "international government" of unprecedented size and strength.'[17] They further point out that 'capitalism, the nation-state, and rule by landlords are directly related to the environmental destruction that characterises the last two hundred years of the Anthropocene'.[18] History of the *longue durée* enables us to see these relations, to reveal more sharply the shortcomings of the old 'modern' governance models. It also helps us to realise that the intricate relation of the modern State and its international governance system with capitalism has

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12 See Adelman, Chapter 4 in this book.

13 See Kim and Kotzé, Chapter 3 in this book.

14 Viñuales (n 6) 10–11.

15 On the relationship between sovereignty and property see, for instance, Martti Koskenniemi, 'Sovereignty, Property and Empire: Early Modern English Contexts' (2017) 18 Theoretical Inquiries in Law 355. See on *dominium* as given with human nature, Janne E Nijman, Grotius' *Imago Dei Anthropology*: Grounding *Ius Naturae et Gentium* in Martti Koskenniemi, Monica García-Salmones Rovira and Paolo Amoroso (eds), *International Law and Religion: Historical and Contemporary Perspectives* (Oxford University Press 2017) 87.

16 For a vivid account see Sundhya Pahuja, 'Conserving the World's Resources?' in James Crawford and Martti Koskenniemi (eds), *The Cambridge Companion to International Law* (Cambridge University Press 2012) 398, especially at 401–09.

17 Jo Guldi and David Armitage, *The History Manifesto* (Cambridge University Press 2014) 66.

18 Ibid 70.

produced the multiple intertwined crises of climate change, global governance and inequality, which have exclusively been caused by humans.

If indeed the interstate system and its focus on sovereignty is the problem, why not then pursue cities as alternatives to States? This rather bold type of 'downscaling', turning the governance of planetary boundaries upside-down, may for example be found in the work of the late Benjamin Barber. He has built the main argument of his essay on the rising power of cities in today's world around this central consideration: 'let cities, the most networked and interconnected of our political associations, defined above all by collaboration and pragmatism, by creativity and multiculture, do what states cannot.'[19] Barber has a clear view of general State failure: 'The nation-state once did the job, but recently it has become too large to allow meaningful participation even as it remains too small to address centralised global power.'[20] Cities, in comparison, 'lack an appetite for sovereignty and jurisdictional exclusivity', which 'enable[s] them as agents of cross-border collaboration'.[21] In solving contemporary challenges of global governance, Barber hence sees basically no role for States: 'Never before has sovereign power been used so effectively to impede and thwart collective action.'[22]

This is certainly an interesting argument, and one with merit, if only through its invitation to rethink the international system from the bottom upwards. It is, however, an altogether different question whether this fascination with cities rests on a solid empirical basis. Can the proposition be generalised that cities are indeed the more effective and responsible citizens of planet Earth, as compared to States? What is their share in the creation of the current conditions in which we live? Which ideological, political and economic factors drive their policies, also when they partner and network in the name of sustainability? We will return to these questions below.

2.2 Methodological Implications: The Strictures of the Interstate System and Its Law

A second and less obvious reason for the greater attention received by cities in the Anthropocene discourse is that a turn to the city might also facilitate responses to the challenge of interdisciplinarity. The ongoing anthropocenic crisis does not question only the current international institutions of law and governance. Guldi and Armitage argue that long-term thinking has to be given prevalence over short-termism, and call on all disciplines, including historians, to zoom out again to study the big picture and turn to what they call '*the public future*'.[23] With the existential implications of the Anthropocene's imagery gradually sinking in, all disciplines need to confront the urgent questions of the crises of climate change, global governance and inequality. This challenge to rethink global governance and its anchor-pin, the modern State, for an anthropocenic future that will be *urban* takes (international) lawyers out of their comfort zone.[24] As observed by Viñuales, the Anthropocene 'calls upon all disciplines,

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19 Benjamin R Barber, *If Mayors Ruled the World: Dysfunctional Nations, Rising Cities* (Yale University Press 2013) 4; this account of Barber's work is adapted from Helmut Philipp Aust, 'Shining Cities on the Hill: The Global City, Climate Change and International Law' (2015) 26 European Journal of International Law 255, 265–66.

20 Barber (n 19) 5.

21 Ibid 71.

22 Ibid 147.

23 Guldi and Armitage (n 17) 13.

24 See also Hey, Chapter 9 in this book.

the entire body of human knowledge about the world, to analyse what is happening and how to face it'.[25]

While interdisciplinarity is not a strength typically associated with legal academics, this might not be equally true for urban law scholarship. The genre of urban law has developed in close connection with other disciplines, ranging from sociology, to urban geography, to political science. So maybe 'seeing like a city'[26] is in and of itself more prone to the complexities of the Anthropocene than 'seeing like a state',[27] where a focus on the positivist legal framework necessarily entails a reduction of the complexities of real life that makes such a positivist legal framework unsuitable for the Anthropocene.

In any case, 'seeing like a city' might help us to develop a different understanding of the Anthropocene and might hence also contribute to downscaling governance approaches to the planetary boundaries. It could help us move away from generalising macro considerations and help us build a more sensitive, context-based and indeed localised language to deal with the Anthropocene and the planetary boundaries we are facing.[28] As formulated by Dahlia Simangan in a related move towards a more regional approach: 'Regional investigations can unpack the universalizing discourse on the Anthropocene and expose the differentiated impact of global environmental concerns […] A regional level of analysis can also assist in bridging global action and local capacity.'[29]

Simangan is not pursuing a specific focus on cities and urban questions in her work. Yet, her plea against the universal perspective on the Anthropocene resonates with those scholars who wish to turn the focus instead on what cities and their institutions can do to accommodate the many governance challenges of the Anthropocene and its planetary boundaries. In particular, highlighting the universalizing traits of both the prevailing Anthropocene discourse and the literature on planetary boundaries[30] has the potential to show that 'western paradigms continue to dominate the discussions about the Anthropocene, while global South perspectives remain under-represented'.[31] Simangan rightfully points to the fact that it 'remains difficult […] for vulnerable populations to exercise their agency within the prevailing anthropocentric, western-based and modernist practices and institutions of governance'.[32]

At the same time, a note of caution should be heard as the city might not be the ultimate, or even most appropriate, locus for solutions to the manifold challenges of the Anthropocene. Kate Driscoll Derickson has put it quite provocatively: 'The city emerges as the *deus ex machina* of the Anthropocene.'[33] A similar observation could be made with respect to urban governance responses to planetary boundaries. Indeed, many hopes and aspirations formulated

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[25] Viñuales (n 6) 7.

[26] Proposed by Mariana Valverde, 'Seeing Like a City: The Dialectic of Modern and Premodern Ways of Seeing in Urban Governance' (2011) 45 Law & Society Review 277.

[27] As coined by James C Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed* (Yale University Press 1999).

[28] For a similar point see Kim and Kotzé, Chapter 3 in this book.

[29] Dahlia Simangan, 'Where Is the Anthropocene? IR in a New Geological Epoch' (2020) 96 International Affairs 211, 212.

[30] See the literature overview by Kim and Kotzé, Chapter 3 in this book.

[31] Simangan (n 29) 212.

[32] Ibid 222.

[33] Kate Driscoll Derickson, 'Urban Geography III: Anthropocene Urbanism' (2018) 42 Progress in Human Geography 425, 426.

by and for cities share the same underlying assumptions as the supposedly debunked nation state and the global economic order it has created. Helga Leitner and Eric Sheppard have pointed out in this regard what 'mainstream global urbanism' consists of: 'a set of ideas and practices rooted in the belief that free markets and neoliberal "good" governance policies will enable mega-cities in the postcolony to transform themselves into global cities.'[34] This is a subtle reference to a fact that is difficult to ignore: cities are in and of themselves the most visible contributors to and expression of the Anthropocene,[35] while the planetary boundaries run right through them.

3. INNOVATIVE URBAN GOVERNANCE AS AN ANSWER?

If States and law's State-centrism are part of the problem, and if urbanisation is one of the main drivers of the disruption of the inner balance of the Earth system, should cities and urban governance then take the lead in confronting the governance challenges of the Anthropocene? Surely, replacing mainstream interstate-based thinking with mainstream (neoliberal) global urbanism will not do much good in seeking to overcome the dark sides of the Anthropocene. Yet, for the urban promise to take hold, an innovative approach to urban governance is arguably worth examining. And this raises a key question: if current (neoliberal) international institutions are not the ones we *necessarily* have to work with, could a turn to the city then fit the needs of the human species in the Anthropocene? After all, as James Lovelock has stated recently: 'Cities have been the most spectacular development of the Anthropocene.'[36] And if this is true, could cities play a role in facilitating alternative systems of law and governance to respond to the challenges posed by the Anthropocene's planetary boundaries?

In this section, we will take a closer look at what the urban promise may hold for some of the governance challenges of the Anthropocene and its planetary boundaries. We do so by first exploring the context in which this call for innovative governance has been developed. This context relates to the transformation of a narrative of urban crisis into one of urban resurgence (Section 3.1). We will then focus on a contribution by one of the most prominent scholars working on the relationship between law and planetary boundaries, Louis Kotzé, who has recently examined the potential of a turn to the city in this context (see Section 3.2).

3.1 The Context: from Urban Crisis to Urban Resurgence?

The increased prominence of urban governance in the Anthropocene is situated in a broader narrative of how cities have managed to transform themselves and their perception from the strictures of 'urban crisis'. Philippopoulos-Mihalopoulos has pointed to such an 'urban crisis' that exists in the spheres of ecology, housing, health, population, economy and climate change.[37] This diagnosis chimes with the widespread underfunding of cities and local govern-

[34] Helga Leitner and Eric Sheppard, 'Provincializing Critical Urban Theory: Extending the Ecosystem of Possibilities' (2015) 40 International Journal of Urban and Regional Research 228.

[35] Gleeson (n 1) 10, 27 goes so far as to hold that 'the urban age defines … the Anthropocene'.

[36] James Lovelock, *Novacene: The Coming Age of Hyperintelligence* (MIT Press 2019) 50.

[37] Andreas Philippopoulos-Mihalopoulos, 'Introduction: In the Lawscape' in Philoppopoulos-Mihalopoulos (ed), *Law and the City* (Routledge 2007) 1, 2.

ments throughout the world. This lack of resources is exacerbated by a simultaneous trend of decentralisation which leads to an increasing number of obligations being devolved to the local level of government.[38] Cities are then approached as 'a remedy to the regional and global crisis', since they can 'ac[t] as flexible and creative platforms that can develop responses in a pragmatic and efficient manner'.[39] They are 'the engine-rooms of human development as a whole'.[40]

The turn to international law and governance can also be read as an attempt to respond to that *global* 'urban crisis'. The fact that the globe is speedily urbanising, with an estimated 60 per cent of the world population expected to live in urban areas by 2040, increases this sense of urgency.[41] The planetary boundaries are manifest in cities. An international legal system that is responsive to the challenge of avoiding humanity crossing the planetary boundaries has to do justice to the city and urban attempts to push back against these symptoms of crisis. Sustainable Development Goal (SDG) 11, as adopted by the United Nations (UN) General Assembly in 2015, may be read as an instigation of urban response to this crash in slow motion. The SDGs and Agenda 2030 are global governance initiatives, but through SDG 11 and its incumbent New Urban Agenda (NUA) the international community specifically (re-) affirms the role of cities as governance actors in sustainable development, and emphasises that urban law and governance should make cities inclusive, safe, resilient and sustainable.[42] SDG 11 and the NUA are currently the most visible expressions of a broader trend towards the globalisation of urban governance.[43]

This normative call to interrelate global and urban governance has triggered a rich stream of literature.[44] Oomen and Baumgärtel examine the rising role of cities and local governments in the implementation of international (human rights) law and governance against what they argue to be a situation of 'state failure' and 'political deadlock' at the level of national government around the globe.[45] They argue that 'th[e] entry [of local governments] onto the [international] stage ought to be welcomed from the perspective of the effectiveness and legitimacy of human rights'.[46] This is so because human rights law and governance could become more 'multi-layered' and less formal, and could more effectively challenge the classical understand-

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[38] The World Bank, *Entering the Twenty-first Century*, *World Development Report 1999–2000* (Oxford University Press 2000). See also, the Advisory Group on Decentralisation of UN Habitat, 'Guidelines on Decentralisation and the Strengthening of Local Authorities', which has been approved by the UN Habitat Governing Council UN Doc. A/62/8, Resolution 21/3, 20 April 2007.

[39] UN Habitat 2012/13 *State of the World's Cities Report: Prosperity of Cities* at xi.

[40] Ibid at v, x–xi.

[41] See Philippopoulos-Mihalopoulos (n 37); Doug Saunders, *Arrival City* (Heinemann 2010); Janne E Nijman, 'Renaissance of the City as a Global Actor' in Andreas Fahrmeir, Gunther Hellmann and Milos Vec (eds), The Transformation of Foreign Policy: Drawing and Managing Boundaries from Antiquity to the Present (Oxford University Press 2016) 209, 216–21.

[42] UN Doc. A/RES/71/256, 'New Urban Agenda', 2017, available at http://habitat3.org/wp-content/uploads/NUA-English.pdf.

[43] See the contributions in Helmut Philipp Aust and Anél du Plessis (eds), *The Globalisation of Urban Governance: Legal Perspectives on Sustainable Development Goal 11* (Routledge 2019).

[44] See also the contributions in Helmut Philipp Aust and Janne E Nijman (eds), *Research Handbook on International Law and Cities* (Edward Elgar, forthcoming).

[45] Barbara Oomen and Moritz Baumgärtel, 'Frontier Cities: The Rise of Local Authorities as an Opportunity for International Human Rights Law' (2018) 29 European Journal of International Law 607.

[46] Ibid 629.

ing of legal subjecthood.[47] Ileana Porras similarly points to the changing role of the city in and through the move from 'government' to 'governance' as captured in UN-HABITAT's concept paper *The Global Campaign on Urban Governance*, and as propagated by international organisations such as the UN and the World Bank.[48] She believes '[i]t is beyond doubt that cities – with their economies of scale, relative concentration of wealth, people, businesses, and educational institutions – have much to contribute to the pursuit of sustainable development and to the response to climate change. Less clear is whether cities alone can deliver.'[49] Be this as it may, the city clearly holds out particular promise to deal with planetary boundaries.[50] This promise is reflected in cities' own ambitions as articulated poignantly – and by now famously – by former New York City mayor Bloomberg at the launch of the C40 Cities Climate Leadership Group in 2012: 'We're the level of government closest to the majority of the world's people. We're directly responsible for their well-being and their futures. So, while nations talk, but too often drag their heels, cities act.'[51]

In more recent international legal scholarship, the initial high expectations of cities for planetary boundaries law and governance have sobered. Still there is a clear interest in harvesting the energy that mayors and local governments generate, for example, around fighting the climate crisis through initiatives that hope to play a significant role in the prevention of humanity's crash into atmospheric CO_2 concentrations of 350ppm, and for confronting other planetary boundaries rapidly coming into sight.

The initiatives of local governments are manifold. They seek collaboration across borders and continents, broker networks and organise around questions of climate change, housing and the right to the city, mobility, smart tech in the urban space, health and jobs for urbanites. They have turned 'international', not least because urban problems often have global origins and impacts, and are (expected to be) some of the main drivers of the implementation of Agenda 2030 and its SDGs. The initiatives around climate vary from networks, to exchanges of best practices of climate action, such as the C40 Climate network or Local Governments for Sustainability (ICLEI), to Carbon*n*, a shared and unified system of reporting climate data. Local governments have assembled in organisations such as United Cities and Local Governments (UCLG), which then enables them to participate in international organisations, such as the UN, the World Bank or the European Union. In turn, they have become recognised by, for example, the UN Human Rights Council for their role in the promotion and protection of human rights. Other initiatives relate to the limits of consumptive freshwater use. We all remember Cape Town being the first global city to run out of drinking water, in 2018, but shortages characterise many of the world's major cities. The European Environmental Agency runs a programme called 'Water in the City' and UCLG is active on the localisation of SDG 6. With respect to wetland conservation, cities have been accredited by the Conference of the Parties (COP) of the Ramsar Convention for particular activities in safeguarding urban

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47 Ibid 629–30.

48 Ileana Porras, 'The City and International Law: In Pursuit of Sustainable Development' (2009) 36 Fordham Urban Law Journal 537, 540.

49 Ibid 543.

50 See further Aust (n 19).

51 Cited in Michele Acuto, 'An Urban Affair: How Mayors Shape Cities for World Politics' in Simon Curtis (ed), *The Power of Cities in International Relations* (Routledge 2014) 69, 77.

wetlands.[52] While cities develop transnational governance initiatives to respond to the local manifestations of global challenges, and to confront the many governance challenges of the Anthropocene and its fast approaching planetary boundaries, we concur with Kotzé and Viñuales that the governance of the Anthropocene requires even more innovative governance, possibly also of cities.

3.2 A Proposal on Urban Governance in Focus

Rakhyun Kim and Louis Kotzé have conceptualised a new legal paradigm for the Anthropocene, called Earth system law (ESL).[53] Proceeding from this paradigm, Kotzé assigns a critical role to cities in confronting the Anthropocene's socio-ecological crises.[54] In an admittedly optimistic vein, Kotzé suggests cities could be 'sites of regulatory innovation' to experiment and reimagine how we govern our world.[55] His is among a growing number of voices that envisage cities to be 'laboratories'[56] for experimenting with innovative law and governance arrangements.

Kotzé's intriguing argument unfolds in the following manner. With their potential for regulatory innovation, cities should lead in shaping ESL to end the complicity of (international) law and governance in the anthropocenic crises and to move it beyond neoliberalism, anthropocentricism, neocolonialism and the sanctity of property rights. Law itself then should 'be oriented by and based on an Earth system approach'. Reimagining an international law and governance system that departs from the notion of a complex Earth system (articulated as this also is by the planetary boundaries),[57] Kotzé argues, has to account for the significant role of the city in destabilising the complex Earth system. It is in cities that the Anthropocene and its socio-ecological crises 'concretise, particularise and localise'. While the anthropocenic crises become tangible in the city, 'the city' in turn may offer a scale of governance that makes action to confront human exploitive domination of nature feasible.[58] The city then is not one universal actor, but rather a multitude of laboratories 'foregrounding a critical awareness of unevenness that is necessary in relation to how Anthropocene [human and non-human] vulnerability should be understood and responded to'.[59] Through cities, ESL would be 'sensitive to *differentiated* vulnerabilities'. This reimagination involves a decentring of the State and the national level of government and a recognition of the city and the local level of government as 'influential governance actors' in a polycentric governance system.[60] Judging from cities'

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52 See <www.ramsar.org/news/18-cities-recognized-for-safeguarding-urban-wetlands> accessed 6 June 2020.

53 Louis J Kotzé and Rakhyun E Kim, 'Earth System Law: The Juridical Dimensions of Earth System Governance' (2019) 1 Earth System Governance 100003.

54 Louis J Kotzé, 'Cities, the Anthropocene and Earth System Law' in Helmut Philipp Aust and Janne E Nijman (eds), *Research Handbook on International Law and Cities* (Edward Elgar, forthcoming).

55 Ibid.

56 Shanna Singh, 'Brandeis's Happy Incident Revisited: Cities and the New Laboratories of International Law' (2005) 37 George Washington International Law Review 537.

57 Kotzé (n 54).

58 Ibid.

59 Ibid.

60 On polycentricity see Victor Galaz et al, 'Polycentric Systems and Interacting Planetary Boundaries – Emerging Governance of Climate Change – Ocean Acidification – Marine Biodiversity' (2012) 81 Ecological Economics 21.

(transnational) initiatives to fight climate change, cities are increasingly expected to respond in a more receptive way to these vulnerabilities and to be able to formulate a kind of governance that embraces 'notions of care such as resilience and vulnerability'. Innovative urban governance is thus understood to produce regulatory innovations drawing on values such as care, humility, integrity, context-sensitivity and inter-generational solidarity.[61] Cities and local governments then bring a scale, focus and value-orientation to polycentric governance, and the innovative, more responsive norms it produces, that makes them potentially more effective and legitimate actors in the Anthropocene.[62] Globalising these innovative urban initiatives would give them the clout necessary to prevent crossing the planetary boundaries. To this end, a polycentric model of governance system may assist in conceiving ways of meeting the complexity of Earth system challenges that enrol the city.

Like Barber, Kotzé and others turn to cities as 'ideal laboratories' out of a disappointment in the top-down, State sovereignty-based approaches currently in place. Cities then become the scale of governance to which to turn for those trying not to despair over the Earth system's disintegration and the 'dysfunctional' State-centric international law and global governance institutions that fail to live up to the existential threat to the human species. In this sceptical approach to States and international law and governance, the emphasis is on how sovereignty and geopolitical power games undermine good governance in and of the Anthropocene. While this approach importantly helps to draw out the implications of the Anthropocene for an alternative perspective on (international) law and cities, ultimately one cannot help but think that rather than a turn to the city, the involvement of all levels of government is needed and the limits of the globalisation of urban governance need to be taken into account.

4. INHERENT LIMITATIONS OF CITY GOVERNANCE

As sympathetic as we are towards this city-oriented approach, we wonder whether 'seeing like a city' could indeed automatically bring an end to exploitative hierarchies in law and governance. Moreover, while writing this chapter in 'intelligent lockdowns' in Amsterdam and Berlin due to the COVID-19 pandemic, we think that a challenge like a global pandemic requires an intricate interplay between the global, European, national and urban levels of governance.

More specifically, however, we see two main limitations for the promise that cities can deliver. The first one pertains to the prevalence of what one of us has in previous work called 'the private city' (Section 4.1). This refers to the dominance that private actors often have in defining what modern cities stand for. Second, we see an inherent tension between parts of the lofty rhetoric on the urban promise, especially with respect to their supposedly superior democratic legitimacy, and the actual practices by which participation in decision-making processes is realised (Section 4.2).

[61] Kotzé (n 54), beginning of section 4.1.

[62] See also Jeroen van der Heijden, 'City and Subnational Governance: High Ambitions, Innovative Instruments and Polycentric Collaborations' in Andrew Jordan et al (eds), *Governing Climate Change: Polycentricity in Action?* (Cambridge University Press 2018) 81.

4.1 The Private City

While we value the growing optimism around the role of the cities in global governance, we hesitate to declare the city to be the new 'foundation' of global governance replacing the State in the system altogether,[63] or indeed localism, 'as a philosophy and a way of doing things', as a 'revolutionary' alternative to liberalism and conservatism.[64] There seems considerable merit in the view that '(w)e should not romanticize localism'.[65] Urban diversity and density may not by definition be productive of tolerant, inclusive and resilient cities. Yet, local government and local democracy may play a role in facing current crises, even though we have to acknowledge their limitations with regard to addressing and standing in for, or rectifying, failings on national government level. Cities and local government have a very important role to play in keeping diverse societies united and peaceful: harvesting the strength and clout that comes with just and inclusive cities may empower them to counter growing inequality and to act in the face of planetary boundaries.[66] Apart from examining the city's claim to democratic legitimacy and thus legitimate representation at the global level, here we wish also to raise a few more critical points about the contribution of cities to global governance with respect to the social-economic dimension of planetary boundary challenges. Our central questions are varied but straightforward: can functional cities replace dysfunctional States? Is innovative urban governance of resilient cities an alternative for confronting the complex, global governance challenges of the Anthropocene as reflected by the complex and deeply intertwined planetary boundaries? If the socio-ecological crises of the Anthropocene are (in part) attributed to an intricate web of relations between the modern nation state and its 'ungovernance' of the global economy, can cities escape this and *faire face* at the financial and economic forces of brutish capitalism?

The eminent work of Saskia Sassen in the past 30 years has shown how important it is to analyse what lies behind the internationalisation of the city. With her seminal book 'The Global City', an important realisation began to penetrate broader consciousness; namely, that 'the global city' is a product of late-modern capitalism.[67] Global cities are by definition the nodes from which the global economy is controlled and commanded; these are cities defined by corporate actors, which play with their 'multinationality' – drawing fiscal and other legal and financial benefits from this – and with their powerful significance for the urban labour market and urban consumerism.[68] The 'blood circulation', as it were, of these cities is then to a significant extent determined by the beating heart of these corporate actors, which is in turn facilitated by States and their 'ungovernance' of the global economy. These corporate actors are often considered to be too big to fail in a city. With their influence on the job market and

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63 Barber (n 19) 78.

64 David Brooks 'The Localist Revolution', *New York Times* (New York, 19 July 2018).

65 As president and director-counsel of NAACP's Legal Defense and Educational Fund, Sherrilyn Ifill, wrote in a tweet in response to David Brooks: 'The Localist Revolution', *New York Times* (New York, 19 July 2018).

66 See further on some of these issues Francois Venter, 'The Challenges of Cultural Diversity for Safe and Sustainable Cities' in Aust and Du Plessis (n 43) 151.

67 Saskia Sassen, *The Global City: New York, London, Tokyo* (2nd edn, Princeton University Press 2001).

68 On some of the challenges involved here see Anna Grear, *Redirecting Human Rights: Facing the Challenge of Corporate Legal Humanity* (Palgrave Macmillan 2010).

the wealth in the city, they may exert an undue influence on the definition of urban needs and interests. Examples of mayors and local governors travelling the world on trade missions with a view to luring big corporations to their cities are by now legendary. Once the corporations' headquarters are in place, cities will go to extra lengths in servicing them in order to keep them in the city. Sassen's work has contributed to what is today a vast body of literature on the effects of being a node in the global economy for urban life and citizens.[69] The global city then is in fact the corporate or 'private city', in contrast to the global 'public city', that is, the city as local government and local *demos*, which begins to step up to confront glocal challenges and work internationally and transnationally to keep a position in relation to the global 'private city'.[70] If the state and state-centric international law and governance do not regulate the private or corporate actors in the hubs of the global economy – that is, the global city – then who will? This is again where the city as the scale of governance with potentially regulatory power emerges.

The global private city, then, is not merely one of the drivers of the Anthropocene. The global private city is not just the *site* of the global economy, but also potentially the level of governance that could remedy the global ungovernance of the global economy. Cities all over the world are warned by the International Monetary Fund – a not entirely uninvolved actor in this context of global neoliberalism – about how local real estate markets are falling prey to global investors.[71] Housing is crucial to urban issues such as health, mobility, inclusiveness, greenhouse gas emissions, biodiversity, and is still one of the major challenges of planetary urbanisation. The homes people inhabit are, after all, related to planetary boundary issues such as biosphere integrity, the production of waste, the use of water and energy, the risks to health issues or more general wellbeing needed for urbanites to participate in the transition towards sustainable urban life. A global city defined by its corporate citizens may actually be less responsive and responsible to the commons, and challenge local authorities, as the 'public' face of the city, to unite globally to generate a regulatory force.

So, while there is an inextricable link between cities and urban agglomerations and the current economic world order, the question emerges whether, and if so how, innovative urban governance or 'the public city' could do what States do not do – namely, to break through the current laws of neoliberalism and regulate the global economy to halt humanity's encroachment on planetary boundaries.[72] If cities are among the most visible signs of contemporary capitalism (or its 'visual imprint', so to speak), is it there that the Anthropocene's social-ecological crisis can be curbed effectively? And is there a role for international law to play in guiding and constraining local governments?

Frug and Barron, the early identifiers of this emerging field of 'international local government law' – that is, the set of international norms which speak to the level of local government

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[69] See only the contributions assembled in Neil Brenner and Roger Keil (eds), *The Global Cities Reader* (Routledge 2006).

[70] Janne E Nijman, 'The Future of the City and the International Law of the Future' in Sam Muller (ed), *The Law of the Future and the Future of Law* (Opsahl 2011) 213, at 217 *et seq*.

[71] International Monetary Fund, *Global Financial Stability Report: A Bumpy Road Ahead* (IMF 2018). The situation on the ground in many cities around the world has triggered a conjoint response by local governments to the neoliberal global economy: the Municipalist Declaration of Local Governments for the Right to Housing and the Right to the City.

[72] See eg John Linarelli, Margot E Salomon and Muthucumaraswamy Sornarajah, *The Misery of International Law* (Oxford University Press 2018).

and to issues of urban governance – warned how cities are currently being understood and approached by international law and organisations.[73] They explained, at least in part, the emergence of cities and their transnational networks as international actors by developments in the global economy. In the early 2000s one finds managerial and technical-economic language to discuss urban development, for example, in an annual report by Cities Alliance. This includes the language of 'efficiency', private investment and, to illustrate this 'private' identity, the much-cited 'cities and towns are essentially markets'.[74] This tendency in international law and governance to approach cities as sites of consumption and production may have negative implications for cities as agents involved in the governance of planetary boundaries.

Yishai Blank and Ileana Porras were among the first in international legal scholarship to ask critical questions about this approach. Blank points to the past and how cities in, for example, the Anglo-Saxon legal world were private corporations: 'The privatized conception of localities views them first and foremost as financially self-sufficient entities, whose main goal is to advance private economic development, and efficiently manage local services to their residents.'[75] In other words, he underscores the private economic DNA of cities. So, while representative of the local *demos*, currently cities are constituted to a large extent by economic globalisation. In the neoliberal world, moreover, they are approached often as private corporations concerned about their branding and market value, that is, the local investment climate. This focus on local (short-term) economic interests is difficult to reconcile with urban governance that is enrolled in planetary stewardship.[76] The 'public-oriented' conception of local governments came under severe pressure in the past few decades when the city became entangled in international institutional relations and policies through organisations such as the World Bank and international financial institutions. They propagate, for example, 'governance' over 'government', therewith accommodating and engaging the private sector in governance.[77] These international organisations, often with a developmental mandate, approach the city mostly as an economic puzzle, as a space where public welfare is promoted by stimulating and accommodating the localisation of capitalism, with all its (unintended) consequences.[78]

While authors such as Frug and Barron and Blank explicate the 'private corporation' origins of cities, Porras, points to how the internationalisation of the city is also to a large extent pushed by late-modern capitalism and the privatisation that comes with it, while explaining the problematic side of these trends.[79] In several of our own publications, we have expressed

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73 Gerald Frug and David J Barron, 'International Local Government Law' (2006) 38 The Urban Lawyer 1.

74 Cities Alliance, Annual Report 2004 <www.citiesalliance.org/resources/knowledge/cities-alliance-knowledge/annual-report-2004> accessed 24 May 2020.

75 Yishai Blank, 'The City and the World' (2006) 44 Columbia Journal of Transnational Law 868, 874 and 872: 'a conception of local governments as private corporations whose main goal is to be financially viable and selfsupporting, provide good services to their consumer-residents, and "foster" democracy (rather than manifest it) is emerging, replacing the more public-oriented one.'

76 Seitzinger et al (n 11). Planetary stewardship is defined 'as the active shaping of trajectories of change on the planet, that integrates across scales from local to global, to enhance the combined sustainability of human well-being and the planet's ecosystems and non-living resources'.

77 See eg Helmut Philipp Aust, *Das Recht der globalen Stadt – Grenzüberschreitende Dimensionen kommunaler Selbstverwaltung* (Mohr Siebeck 2017) 56.

78 See further Michael Riegner, 'International Institutions and the City: Towards a Comparative Law of Global Governance' in Aust and Du Plessis (n 43) 47–50.

79 Porras (n 48) 563–66.

concerns about an uncritical understanding of the global city and the internationalisation of the city. We have taken the view that the global city by itself does not guarantee a concern for the urban *bonum commune*, and this may explain why the global (private) city has triggered the rise of the global public city.[80] That said, this public city, including local governments and their networks such as C40, is supported by private actors (such as the Ford Foundation) and international funding mechanisms such as World Bank programmes.[81] Oomen and Baumgärtel also argue that cities are easy targets for big money and neoliberal policies giving way to the privatisation of urban public services and public goods.[82] In our view, human rights and other open-textured norms such as 'inclusivity' or 'sustainability' do not automatically lead to improvements for urbanites as they provide space for politics; to the localisation of globalisation; and to a reproduction of pre-legal or pre-policy power dynamics and interests. If the private city is actually so much in charge of the governance of the city, how then may urban governance mitigate the urban impact of globalisation and neoliberal capitalism on the Earth system?

First, the 'innovative urban governance' discourse needs to pay attention to which version of the city is in the driver's seat. It is like with any actor or field of law – power relations are crucial, and they illuminate the struggles between urban identities and between the private and the public city. In an attempt to confront the effects of today's capitalism on their cities and housing markets, urban governments have united transnationally, and with their 'Municipalist Declaration of Local Governments for the Right to Housing and the Right to the City', called upon the UN for support in their attempts to resist global investors that try to remodel their cities into exclusive markets and commodities. However innovative this attempt is, and however well in tune with social movements such as 'the right to the city' alliance these may be,[83] they are not sufficient when aiming for a 'just city'.[84]

As Jorge Viñuales points out, to truly fight rising inequality globally, within and without cities, and planetary destruction, governance of the Anthropocene requires a fundamental reorganisation of our production and consumption processes.[85] And this is where international law and governance could play a critical role in tandem with cities to address the following questions: how can cities, especially global and mega-cities, play a more prominent role in the international – or multi-level – legal reorganisation of the aforementioned processes? Is it sufficient to conclude a bilateral memorandum of understanding at the level of cities, for example, between Chicago and Mexico City to counter negative effects of unsustainable trade, or is that effort merely the product of neoliberalism, which means that we would need more

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80 Nijman (n 70) 217–18.

81 Aust (n 19) 263.

82 Oomen and Baumgärtel (n 45) 613.

83 See the website of the Right for the City alliance: <https://righttothecity.org/> as well as various takes from the literature: Barbara Oomen, Martha F David and Michele Grigolo (eds), *Global Urban Justice* (Cambridge University Press 2016); Barbara Oomen and Esther van den Berg, 'Human Rights Cities: Urban Actors as Pragmatic Idealistic Human Rights Users' (2014) 8 Human Rights & International Legal Discourse 160; Michele Grigolo, *The Human Rights City: New York, San Francisco, Barcelona* (Routledge 2019) 54–56.

84 See further Heather Campbell and Susan S Fainstein, 'Justice, Urban Politics, and Policy' in Karen Mossberger, Susan E Clarke and Peter John (eds), *The Oxford Handbook of Urban Politics* (Oxford University Press 2012) 545; Margaret Kohn, *The Death and Life of the Urban Commonwealth* (Oxford University Press 2016) 6; Grigolo (n 83) 19–21.

85 See, in general, Viñuales (n 6).

fundamental measures to redirect the processes that led us to the current anthropocenic crises in the first place?[86] If Viñuales is right when he says that '[w]e need to go beyond addressing externalities and concentrate on addressing the transactions themselves', this means rethinking and changing our defining legal categories.[87] Second, and consequently, we tend to think that effective regulation of the Anthropocene to curb and prevent further degradation of the Earth system requires cities to step up, but only in the context of a mutually reinforcing relationship between cities and States. If cities are indeed drivers of the Anthropocene and thus have geological agency, are there ways to flip this into a constructive, more far-reaching role in Anthropocene governance? Is it possible to water down the role of sovereignty, by strengthening the role of city governments? The Paris Agreement and the negotiations leading to it may have been an attempt in this direction[88] – but one which has so far not proven to be successful, as the States have reasserted themselves as central actors in the global climate change regime.[89]

Finally, we are also critical about decentralisation – indeed one of the trends relevant to the internationalisation of cities – exactly because it also allows for certain (power) dynamics to flourish. One of us has earlier expressed our concerns about the ongoing promotion of decentralisation. Often decentralisation promotes a particular vision of the city, with decentralisation and an emphasis on neoliberalism going seemingly hand in hand.[90] With the decentralisation of policies, we see a risk of privatisation of governmental tasks that are supported by smart tech. So-called 'smart city' solutions have to be critically considered as possible power grabs, instead of a reorganisation of production and consumption processes.

4.2 Local Democracy and Its Limits

As we have seen above, part of the fascination with the city in the Anthropocene discourse lies in the fact that it seemingly offers the promise to address the shortcomings of the nation state by embracing a different form of governance at the local level; a form of governance which is devoid of the nation state's proverbial desire to protect State sovereignty and to put its own interests first. This governance is arguably experimentally driven and bottom-up; it values scientific expertise and pays close attention to the needs of the citizenry and the inhabitants of cities more generally. Yet, much of the innovative governance promise has the imprimatur of privatisation and is smitten with the technological fix, through a fixation on resilient and smart cities. Here lies an inherent tension for the urban promise in the Anthropocene: much of the fascination for what cities can offer to tackle pressing global problems lies in their alleged greater democratic legitimacy, their sensitivity to local needs and conditions – in other words,

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86 See for example the memorandum of understanding to establish the 'Chicago – Mexico City Global Cities Economic Partnership' to '[f]oster trade in goods and services in key sectors, as included in Annex A, compliant with the rules of NAFTA': <www.brookings.edu/wp-content/uploads/2016/07/GCEP-CHI-MEX-MOU_FINAL.pdf> accessed 23 June 2020.

87 Viñuales (n 6) 9.

88 At some point prior to the final negotiations, the idea was ventilated that cities could self-report contributions to cut greenhouse gas emissions on a par with states: see further Helmut Philipp Aust, 'The Shifting Role of Cities in the Global Climate Change Regime: From Paris to Pittsburgh and Back?' (2019) 28 Review of European, Comparative and International Environmental Law 57, 62. See also Verschuuren, Chapter 13 in this book.

89 Ibid.

90 Nijman (n 41) 216–21.

their closeness to the proverbial grassroots. At the outset it should be noted that democracy can take many forms, also at the local level. It can comprise elements of representative as well as deliberative democracy, and may also include elements of the direct consultation/participation of citizens and non-citizens in decision-making processes.[91] This relationship between cities and democracy is crucial for the governance discourse concerning planetary boundaries. As Kim and Kotzé argue in this book, it is not just an important imperative to downscale governance approaches to planetary boundaries, but also to democratise them.[92] Their notion of democracy is ambitious insofar as it transcends established political categories like the people of a given State. In this respect, the urban level might indeed be a useful laboratory for experimenting with different forms of democratisation.

Arguably one benefit of the city level is indeed that it *can* be closer to people. Individuals might find it easier to relate to a city with a sense of belonging than to the abstract notion of a nation state. This, however, is not a given – the resurgent waves of nationalism and populism throughout the world can be understood as a counter-argument, pointing to the need for some parts of the population to express their sense of belonging not through allegiance to a (supposedly liberal and cosmopolitan) city and its governance, but rather to the level of politics which might be more attuned to practices of exclusion.[93]

Here could indeed lie a certain promise with regard to urban approaches to the global governance challenges of the planetary boundaries. If the challenge is to rethink 'political agency in a democratic Anthropocene' by building on the 'complex interconnectedness between human/non-human, self/other and nature/society',[94] the scale of the city might prove to be more hopeful than the level of the nation state. This assumption can build on insights into democratic experimentation at the local level and there are already some examples of this happening across the globe. One example is the possibility for European Union (EU) citizens to vote at the local level also in EU member states whose citizenship they do not hold (Article 22 Treaty on the Functioning of the European Union (TFEU)). Another example of innovative inclusionary practices at the local level pertains to the concept of so-called participatory budgets, which are now used by several cities worldwide. Based on an initiative in the Brazilian city of Porto Alegre, this involves the administration of part of the public budget by the city's inhabitants.[95] Also here, participation is not subject to the condition of citizenship. Porto Alegre has also made judicious use of this form of public administration to create an image of itself as a 'global solidarity city', for example by hosting the World Social Forum,

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[91] For a controversial proposal see David van Reybrouck, *Against Elections: The Case for Democracy* (Bodley Head 2016); on the relationship between citizenship, democracy and cities see also Maarten Prak, *Citizens without Nations: Urban Citizenship in Europe and the World c. 1000–1789* (Cambridge University Press 2018).

[92] Kim and Kotzé, Chapter 3 in this book.

[93] From the burgeoning literature on populism see Jan-Werner Müller, *What Is Populism?* (Princeton University Press 2016); Janne E Nijman and Wouter Werner, 'Populism and International Law: What Backlash and Which Rubicon?' (2018) 48 Netherlands Yearbook of International Law 3; Heike Krieger, 'Populist Governments and International Law' (2019) 30 European Journal of International Law 971; Helmut Philipp Aust, 'The Democratic Challenge to Foreign Relations Law in Transatlantic Perspective' in Jacco Bomhoff, David Dyzenhaus and Thomas Poole (eds), *The Double-Facing Constitution* (Cambridge University Press 2020) 345, 347–52.

[94] Mert (n 2) 286.

[95] Monica Salomon, 'Paradiplomacy in the Developing World' in Mark Amen et al (eds), *Cities and Global Governance: New Sites for International Relations* (Ashgate 2011) 45, 53.

understood to be the counterpart to the (neoliberal and capitalist-oriented) World Economic Forum in Davos. These are examples of attempts to propagate the idea of participatory budgeting and for cities to assume the role of ’norm entrepreneur’.[96] Both examples also illustrate the potential for political participation among non-citizens at the local level. At the same time, the examples underline the transnational dimension of such forms of experimentation: in the case of voting rights for EU foreigners at local level, purely national notions of the legitimacy subject are partially dissolved. This leads to the formation of multi-layered loyalties, namely to more than just one nation state and to the community in which the EU citizens in question live. By contrast, participatory budgets are an example of a transnational idea originating at the municipal level before being disseminated through a specific understanding of alternative forms of politics. Thinking about democracy in the Anthropocene in city terms might present a chance to unlearn parts of what has come to be known as the ‘state-level bias’ of democracy.[97] This might arguably also help to think further about the necessary democratisation of governance approaches to planetary boundaries as advocated by Kim and Kotzé.[98]

Obviously, these findings cannot and should not be easily generalised. Many cities around the globe are not primarily sites of experimentation for new forms of democratic governance. Exposed to severe financial constraints, persistent conditions of urban poverty and marginalisation of large parts of the population as they are, many cities struggle to provide basic services to their citizens while being confronted with a plethora of responsibilities decided upon at the higher level of the State apparatus. There is accordingly the lingering real risk of focusing too much on the exotic flowers of successful and fascinating urban experiments while overlooking the day-to-day conditions in which many cities, their local governments and citizens have to slog away. What is more, it is not self-evident that what is perceived first as progressive experimentation at the local level is necessarily beneficial to the greater good. Think of the current hype for the sustainable and green city – all these places cannot exist independently of their respective *Hinterland*, not to mention the bigger global supply chains in which they remain embedded even if they have successfully deindustrialised and reconverted wastelands into hipster-compatible urban waterfronts. There is a ‘local trap’ in city thinking about the Anthropocene: ‘small is not always beautiful or intrinsically “good”; small-scale, or “bottom-up”, direct democracy practices – often executed at a neighbourhood level – can bring about consequences that are negative at a larger scale, especially if decisions are inconsiderate toward other neighbouring communities.’[99]

Eventually, the Anthropocene and its planetary boundaries evoke the big question: whether all these considerations will be moot anyway. Does the Anthropocene not eventually call for some kind of ecological state of necessity? Will the challenges for survival on planet Earth become of such magnitude that considerations of democratic legitimacy will ultimately become less important? The various global responses to the COVID-19 pandemic may have given us some first glimpses of that unwieldy future. Whereas there have been sound and scientifically valid reasons for the various forms of lockdown with which States and cities around the world have tried so far to get the spread of COVID-19 under control, there has been

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96 Salomon (n 95) 58.
97 Mert (n 2) 288.
98 Kim and Kotzé, Chapter 3 in this book.
99 Ihnji Jon, ‘Scales of Political Action in the Anthropocene: Gaia, Networks, and Cities as Frontiers of Doing Earthly Politics’ (2020) 34 Global Society 163, 172.

a sense of inevitability: nothing else was imaginable, 'there is no alternative'. The space for politics seems to have been considerably reduced, which is of course not the outcome of an apolitical process. For cities and their authorities, the order of the day seems to be no longer experimentation for a shiny future urban age, but simply ensuring the survival of their population. It is too early to tell, but it seems not entirely unrealistic that as a result, we might also see a re-emergence of the strong, prominent, centralised State.[100]

This survivalist turn of urban governance can build on previous and much-hyped discourses on sustainable cities, resilient cities, smart cities and the like. It is particularly the ideal of the smart city which exposes the weak foundations of current hopes for rescuing democracy at the local level. Parts of the planetary boundaries literature seem to embrace a similar belief in the objective and indisputable nature of scientific research that animates smart city ideals. The approach is comparable to the extent that it assumes that there can be an easy way towards the 'right' solution, which just needs to be implemented.

The vision of a smart city promises interconnection through data networks of various infrastructure devices.[101] If these devices interact directly, it is assumed, the provision of public services can be much more efficient. Interventions into the working of the system take place on a real time basis. Ultimately, the city would become a space in which the real world and the virtual world meet.[102] Ecosystems of sensors would 'collect information from urban space, and an array of network-enabled actuators can subsequently transform that space. Data-driven feedback loops turn the city into a reflexive test-bed and workshop for connected habitation in enmeshed digital and physical space.'[103] Consequently, what we would see would amount to a merger between social reality and digital technology.[104] This need not be the end: in future, digitally integrated transplants into humans could take this even further, thereby tearing down boundaries between human agency and machine-driven processes.[105]

It is with respect to the ideal of the smart city that many of the themes of this chapter intersect: this ideal holds the promise of innovative governance which can be put to test in a local laboratory. Smart city technologies will arguably contribute to better management of resources, waste and emissions and might hence contribute to pushing back against crossing the planetary boundaries. On a superficial level, smart city solutions foster participation, as public preferences are supposedly generated by a form of collective ('swarm') intelligence, based on real-life preferences of individuals engaging with such systems. And smart city schemes are often implemented by corporate actors.

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[100] Related to this concern is the question of how urban density will be regarded in a post-COVID-19 world. First reflections on this question can be found in Ian Klaus, 'Pandemics Are Also an Urban Planning Problem' (Bloomerg CityLab 6 March 2020) <www.citylab.com/design/2020/03/coronavirus-urban-planning-global-cities-infectious-disease/607603/> accessed 23 June 2020; and Michele Acuto, 'Will Covid-19 Make Us Think Differently of Cities?' (New Cities Blog 20 March 2020) <https://newcities.org/the-big-picture-will-covid-19-make-us-think-cities-differently/> accessed 23 June 2020.

[101] This paragraph is adapted from Helmut Philipp Aust, 'The System Only Dreams in Total Darkness: The Future of Human Rights Law in the Light of Algorithmic Authority' (2017) 60 German Yearbook of International Law 71, 77.

[102] Carlo Ratti and Matthew Claudel, *The City of Tomorrow: Sensors, Networks, Hackers, and the Future of Urban Life* (Yale University Press 2016) 20.

[103] Ibid 23.

[104] Steffen Mau, *Das metrische Wir: Über die Quantifizierung des Sozialen* (Suhrkamp 2017) 41.

[105] Ratti and Claudel (n 102) 68; Lovelock (n 36).

The ideal of the smart city not only stands for a deeply ingrained belief in technocratic solutions; it also triggers important questions on the future of democratic legitimacy of urban governance in the Anthropocene. These concerns derive from the impetus to favour output over input legitimacy in the face of the magnitude of the crisis of the Anthropocene.[106] Whereas the two need not be diametrically opposed concepts relating to each other in a zero-sum manner, output legitimacy has a certain propensity to justify ends over means. If the survival of mankind as such is at stake, who can argue against the allegedly best technological fix? However, the smart city might usher in a 'post-political' phase of urban governance.[107]

At the same time, the fixation on smart and resilient cities as innovative forms of urban governance suffers from the very same attachment to the technocratic fix that has characterised the conditions which have brought us closer to reaching the outer limits of the planetary boundaries, while exiting the safe operating space in doing so. As Ayşem Mert has argued, something different is needed: 'The first step towards democratic governance in the Anthropocene is, then, to step back from quick fixes, which promise unrealistically easy and efficient solutions to difficult problems without deep alterations in contemporary socio-economic structures.'[108]

5. CONCLUSION

It is hence with a good degree of ambivalence that we conclude this chapter. While we are sympathetic to the 'urban promise' for governing the Anthropocene, we also see many inherent limitations. In particular, powerful cities are emanations of the same interstate system which supposedly needs to be overcome in order not to cross the planetary boundaries. And urban governance is faced with manifold challenges itself, stretching from housing crises, to underfunding, to the new realities of the COVID-19 pandemic.

At the same time, we think that 'seeing like a city' is at least a useful heuristic paradigm change insofar as it unsettles established categories of the State and its law. It can have a useful and much-needed destabilising effect which also forces international lawyers out of their comfort zone. However, as Mariana Valverde has remarked, '[s]eeing like a city is not the polar opposite of "seeing like a state" […] as cities in all parts of the word do indeed often see "like a state"'.[109] It is rather that '[t]he phrase is meant to indicate the pragmatic approach that uses both old and new gazes, premodern and modern knowledge formats, in a nonzero-sum manner and in unpredictable and shifting combinations'.[110]

If one of the findings of the present chapter is the need to unsettle established categories of law and governance and to start thinking of different categories that may serve the transition from our current unsustainable way of living to a future sustainable one, what are we thinking of? We see a vast array of open research questions for the future. A most important question, especially for the safeguarding of democratic legitimacy in the Anthropocene in a world which

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106 See, for instance, Benjamin Franklen Gussen, 'On the Hypotactic Imperative for a Transition from the Anthropocene to the Sustainocene' in Michelle Lim (ed), *Charting Environmental Law Futures in the Anthropocene* (Springer Nature 2019) 181, 184.
107 Derickson (n 33) 431.
108 Mert (n 2) 284–85.
109 Valverde (n 26) 281.
110 Ibid.

is at once also fighting against crossing planetary boundaries, concerns the representation of both urbanites and people living in the proverbial *Hinterland*. What does the growing focus on an urbanising planet mean for the representation of the non-urban? In a way, the emergence of the modern State was an answer to that problem. It solved a power struggle between cities and their surrounding territories. If cities become more powerful again, this may not necessarily bring us back into a new Middle Age, but it may be another sign that at least a particular era of the nation state is coming to an end. We are not arguing that States will disappear any time soon, or that they will no longer be the most important actors at the international level. But with the growing realisation that the interstate system may fail us in the struggle to keep a safe distance from the planetary boundaries, the need to find alternative governance models is more acute than ever. Cities may offer some promise in this regard, in particular when powerful cities form coalitions and exert pressure on States, and the international (economic) law and governance they uphold, to get their act together.

But too often, we fear, there is not enough substance behind the façade of the current hype for all things urban. Preventing humanity crossing the planetary boundaries, and the potential contribution of cities in this respect, will hence require even more out-of-the-box thinking. It will require a reflection on the outgrowth of capitalism and the role that both States and cities play in this regard. Some might want to go even further, and this would be another research field for the future: namely, how to form a symbiosis between a growing role of cities for planetary governance and attempts at personification of the non-human. We are not sure ourselves whether the move towards granting legal personality to non-humans (such as a river or the biosphere) will make for palpable change in the real world.[111] But what we do know, given the inescapability of the planetary boundaries' limits, is that we need all the legal imagination and creativity we can get.

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[111] Gunter Teubner, 'Rights of Non-Humans? Electronic Agents and Animals as New Actors in Law and Politics' (2006) 33 Journal of Law and Society 497, 515; Marina Brilman 'Environmental Rights and the Legal Personality of the Amazon Region' (2018) *EJIL Talk!* <https://www.ejiltalk.org/environmental-rights-and-the-legal-personality-of-the-amazon-region/> accessed 23 June 2020.

PART II

INTERNATIONAL LAW AND THE PLANETARY BOUNDARIES

7. Planetary boundaries and regime interaction in international law

Dario Piselli and Harro van Asselt

1. INTRODUCTION

The concept of planetary boundaries has directed scholarly and political attention to the influence exerted by humans on the Earth system.[1] By seeking to identify and quantify a 'safe operating space' for nine complex and non-linear Earth system processes, the proponents of the concept aim to specify 'the non-negotiable planetary preconditions that humanity needs to respect in order to avoid the risk of deleterious or even catastrophic environmental change at continental to global scales'.[2] The Earth system perspective called for by the concept of planetary boundaries poses daunting challenges for international law and governance.[3] One of these challenges is related to the fact that several of the boundaries are closely intertwined and interact in ways that are not yet fully understood.[4]

As almost all of the chapters in this book testify, there is no international legal regime that neatly matches each of the boundaries, let alone any of their possible interactions. Indeed, with the possible exception of the boundary related to stratospheric ozone layer depletion, it is hard to identify any boundary that is governed by a single regime.[5] This is not necessarily problematic:[6] many international problems are governed by a host of regimes, at times referred to as 'regime complexes',[7] and the fragmentation of international law can be said to be an inevitable

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1 Johan Rockström et al, 'A Safe Operating Space for Humanity' (2009) 461 Nature 472; Johan Rockström et al, 'Planetary Boundaries: Exploring the Safe Operating Space for Humanity' (2009) 14 Ecology & Society 32; Will Steffen et al, 'Planetary Boundaries: Guiding Human Development on a Changing Planet' (2015) 347 Science 1259855.

2 Rockström et al, 'Planetary Boundaries: Exploring the Safe Operating Space for Humanity' (n 1).

3 Frank Biermann, 'Planetary Boundaries and Earth System Governance: Exploring the Links' (2012) 81 Ecological Economics 4; Victor Galaz et al, '"Planetary Boundaries": Exploring the Challenges for Global Environmental Governance' (2012) 4 Current Opinion in Environmental Sustainability 80.

4 Victor Galaz et al, 'Polycentric Systems and Interacting Planetary Boundaries: Emerging Governance of Climate Change – Ocean Acidification – Marine Biodiversity' (2012) 81 Ecological Economics 21; Kirsty Nash et al, 'Planetary Boundaries for a Blue Planet' (2017) 1 Nature Ecology & Evolution 1625.

5 See also Jonas Ebbesson, 'Planetary Boundaries and the Matching of International Treaty Regimes' (2014) 59 Scandinavian Studies in Law 259; and Du Toit, Chapter 14 in this book.

6 Biermann (n 3) 7.

7 On regime complexity see, eg, Kal Raustiala and David Victor, 'The Regime Complex for Plant Genetic Resources' (2004) 58 International Organization 277; Robert Keohane and David Victor, 'The Regime Complex for Climate Change' (2011) 9 Perspectives on Politics 7; Karen Alter and Kal Raustiala, 'The Rise of International Regime Complexity' (2018) 14 Annual Review of Law and Social Science 329. Others have chosen to refer to 'institutional fragmentation'. See Frank Biermann et al, 'The Fragmentation of Global Governance Architectures: A Framework for Analysis' (2009) 9 Global Environmental Politics 14; Fariborz Zelli and Harro van Asselt, 'The Institutional Fragmentation

'feature of the social complexity of a globalizing world'.[8] Nevertheless, the interdependence of the various planetary boundaries raises several questions concerning the parallel interaction of different international legal regimes: How do relevant regimes interact with each other, and what effect does this have on avoiding negative feedbacks between planetary boundaries? How can different regimes work in conjunction to address complex Earth system interactions and prevent 'problem-shifting' between one boundary and the next?[9] What tools does international law offer to ensure that different legal regimes work in harmony? Linking the literature on planetary boundaries to that of regime interaction in international law, this chapter offers preliminary answers to these questions.

The remainder of the chapter proceeds as follows. Section 2 surveys the state of knowledge on interactions between individual planetary boundaries, highlighting in particular the challenge of environmental problem-shifting. Section 3 then discusses how – and with what effects – international legal regimes interact, with a focus on regime interaction in international environmental law. Section 4 zooms in on two case studies of planetary boundary interactions to illustrate the extent to which relevant legal regimes interact with each other, and with what consequences. Section 5 discusses ways in which such interactions can be managed so as to achieve synergistic outcomes. Section 6 concludes the discussion.

2. INTERACTIONS BETWEEN PLANETARY BOUNDARIES

The primary purpose of the concept of planetary boundaries is to help identify 'safe levels' of anthropogenic pressure on critical components of the Earth system, thus preventing humanity from crossing social-ecological thresholds that could increase the risk of abrupt (and catastrophic) global environmental change. In the planetary boundaries framework, this is done by choosing one or more control variables for every boundary and then determining 'limit' values for each variable that are either set below the related threshold (if known), or within a wide margin of a level that is otherwise considered dangerous (if there is no known threshold at the global or regional scale).[10] The relevant biophysical processes, according to this approach, are those that contribute to the regulation of Earth system functioning, including those affecting global circulation systems (such as climate change, ocean acidification and stratospheric ozone depletion), the major biogeochemical cycles (such as global freshwater use and phosphorus and nitrogen flows) and the integrity of the biosphere (such as land-system change and loss of genetic and functional diversity).[11]

When the concept of planetary boundaries was first introduced, the notion that the Earth's sub-systems are tightly coupled and operate through complex feedbacks loops and linkages

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of Global Environmental Governance: Causes, Consequences and Responses' (2013) 13 Global Environmental Politics 1.

8 International Law Commission (ILC), 'Fragmentation of International Law: Difficulties Arising from the Diversification and Expansion of International Law. Report of the Study Group of the International Law Commission' UN Doc A/CN.4/L.682 (13 April 2006) para 222.

9 Rakhyun E Kim and Harro van Asselt, 'Global Governance: Problem-shifting in the Anthropocene and the Limits of International Law' in Elisa Morgera and Kati Kulovesi (eds), *Research Handbook on International Law and Natural Resources* (Edward Elgar 2016) 473.

10 Rockström et al, 'Planetary Boundaries: Exploring the Safe Operating Space for Humanity' (n 1).

11 Steffen et al (n 1).

was already well established among Earth system scientists.[12] Interacting planetary-level processes had been increasingly studied through observational data and model simulations, ranging from the relationship between climate variability and oceanic carbon dioxide (CO_2) uptake[13] to the effects of land-use changes on biological diversity,[14] freshwater availability[15] and carbon storage.[16] Although they did not initially explore this aspect of the framework in a systematic way, its proponents were building on a substantial body of knowledge when they declared that the destabilisation of individual planetary boundaries had the potential to shrink the 'safe operating space' for one or more of the others.[17] In practice, even though planetary boundaries are usually described as static limits, the Earth system processes to which they refer are constantly interacting in a dynamic way, and modifications in one would normally act as slow variables influencing the resilience of the sub-systems that are coupled to it.[18] Crossing the planetary boundary for climate change would mean, for example, consequences for the freshwater boundary due to the loss of glacial reservoirs, but it would also threaten biosphere integrity through its effects on species distribution, population size and loss of genetic diversity.[19] In turn, the accelerating loss of biosphere integrity would carry profound implications for the global carbon cycle, and could affect several other boundaries as well (such as freshwater use and nitrogen and phosphorus cycles), owing to the fundamental role that biodiversity plays in underpinning ecosystem functioning.[20]

Unfortunately, notwithstanding the necessity of sustainably managing these (and other) planetary-level linkages, the conceptual understanding of boundary interactions has not yet been translated into a comprehensive quantification of their impacts. Despite notable advancements over the past decade,[21] current modelling and observational capabilities remain unable to fully analyse the incredibly dense network of feedback loops and social-ecological cascades that characterise the Earth system, thereby adding an additional margin of uncertainty to the definition of 'safe levels' of human development.[22] At the same time, however, the original framework has since been expanded and enriched by new insights that contribute to shedding

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12 See eg John Lawton, 'Earth System Science' (2001) 292 Science 1965; Michael Jacobson et al (eds), *Earth System Science: From Biogeochemical Cycles to Global Change* (Elsevier 2000); and Will Steffen et al, *Global Change and the Earth System: A Planet under Pressure* (Springer 2004).

13 Graham Farquhar et al, 'The Carbon Cycle and Atmospheric Carbon Dioxide' in John Houghton et al (eds), *Climate Change 2001: The Scientific Basis* (Cambridge University Press 2001); Corinne Le Quéré et al, 'Impact of Climate Change and Variability on the Global Oceanic Sink of CO_2' (2010) 24 Global Biogeochemical Cycles 1.

14 Millennium Ecosystem Assessment, *Ecosystems and Human Well-Being: Current State and Trends* (Island Press 2005) 75–76.

15 See eg Peter Snyder et al, 'Analyzing the Effects of Complete Tropical Forest Removal on the Regional Climate Using a Detailed Three-Dimensional Energy Budget: An Application to Africa' (2004) 109 Journal of Geophysical Research Atmospheres D21102.

16 See eg Rattan Lal, 'Forest Soils and Carbon Sequestration' (2005) 220 Forest Ecology and Management 242.

17 Rockström et al, 'Planetary Boundaries: Exploring the Safe Operating Space for Humanity' (n 1).

18 John Anderies et al, 'The Topology of Non-linear Global Carbon Dynamics: From Tipping Points to Planetary Boundaries' (2013) 8 Environmental Research Letters 044048.

19 Rockström et al, 'Planetary Boundaries: Exploring the Safe Operating Space for Humanity' (n 1).

20 Ibid.

21 Anderies et al (n 18); and Steven Lade et al, 'Human Impacts on Planetary Boundaries Amplified by Earth System Interactions' (2020) 3 Nature Sustainability 119.

22 Steffen et al (n 1). See also Collins, Chapter 5 in this book.

light on different aspects of interacting boundary processes. First, it has recently been suggested that a 'hierarchy' can be identified among the different planetary boundaries. More specifically, the framework's 2015 update explicitly described climate change and biosphere integrity as 'core' boundaries by virtue of their highly integrated nature, strong connection to all the other Earth sub-systems and capacity to drive, on their own, the planet out of its Holocene state.[23] Second, it has been highlighted that the boundaries may interact with each other not only through biophysical mechanisms, but also through mediation of the societal and policy responses that are enacted to respond to anthropogenic environmental change.[24] Third, awareness has grown about the importance of seeing planetary boundaries in the wider social context of the Anthropocene, in order to avoid the risk of addressing biophysical boundary processes and interactions in a way that undermines the societal foundations of human rights and wellbeing (that is, the so-called social boundaries).[25] Lastly, the proponents of the planetary boundary framework have emphasised how interaction between boundaries does not happen solely at the planetary level, but can often operate across scales. This may occur when the accumulation of sub-global impacts under one boundary (especially in processes that are known to have local and regional thresholds, such as loss of biomes or eutrophication of freshwater bodies) ultimately impinges on the global or sub-global thresholds associated with another boundary (such as climate regulation or global freshwater use).[26]

From a governance perspective, the idea that planetary boundaries are closely interrelated, including through policy responses, has highlighted the need to update existing discussions around the challenges of international law and global governance in the Anthropocene. Inevitably, this idea builds upon a series of broader debates that predate the notion of planetary boundaries, from the issue of fragmentation in the institutional architecture of global environmental governance[27] to questions of conflicting norms and environmental policy integration;[28] however, it also pushes them forward significantly. In particular, the assumption is that the planetary boundary framework could have new and powerful implications for the reform of international legal regimes, because our increased understanding of the complexity of Earth

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[23] Ibid 1259855-8 and Table S3.

[24] Måns Nilsson and Åsa Persson, 'Can Earth System Interactions be Governed? Governance Functions for Linking Climate Change Mitigation with Land Use, Freshwater and Biodiversity Protection' (2012) 75 Ecological Economics 61, 62–63.

[25] Melissa Leach, Kate Raworth and Johan Rockström, 'Between Social and Planetary Boundaries: Navigating Pathways in the Safe and Just Space for Humanity' in International Social Science Council (ISSC) and UNESCO (eds), *World Social Science Report 2013: Changing Global Environments* (OECD Publishing and UNESCO Publishing 2013); Daniel O'Neill et al, 'A Good Life for All Within Planetary Boundaries' (2018) 1 Nature Sustainability 88.

[26] Steffen et al (n 1) Table S1.

[27] See eg Harro van Asselt, *The Fragmentation of Global Climate Governance: Consequences and Management of Regime Interactions* (Edward Elgar 2014); and Steinar Andresen, 'The Effectiveness of UN Environmental Institutions' (2007) 7 International Environmental Agreements: Politics, Law and Economics 317.

[28] See eg Frank Biermann, Olwen Davies and Nicolien van der Grijp, 'Environmental Policy Integration and the Architecture of Global Environmental Governance' (2009) 9 International Environmental Agreements 351; Sebastian Oberthür, 'Interplay Management: Enhancing Environmental Policy Integration among International Institutions' (2009) 9 International Environmental Agreements: Politics, Law and Economics 371.

system interactions would require a parallel effort to strengthen normative and institutional interactions at different scales and levels.[29]

As suggested by several authors, it is both unrealistic and probably undesirable to expect the international legal response to coupled planetary boundaries to exactly match each relevant Earth sub-system as well as its intricate web of feedbacks and interactions.[30] However, the fact that these interactions are critical to the functioning and resilience of the Earth system itself calls for a better understanding of how different types of conflicts within (and across) environmental regimes can be reconciled. Owing to their multi-level nature, the area of scientific uncertainty surrounding them and the plurality of their drivers of change, boundary interactions have been associated with the necessity of privileging polycentric approaches to governance over the creation of new institutions or overarching treaty-based regimes.[31] At the same time, the sound management of regime interactions in international law (such as through shared legal principles and concepts, conflict clauses or coordination policies) remains a prerequisite for avoiding the possibility of degrading one of the Earth's sub-systems while trying to reduce anthropogenic pressures on one of the others – a phenomenon known as problem-shifting.[32] In fact, even though problem-shifting has long been a concern in environmental and natural resource management, its occurrence at the planetary scale (for example, as a consequence of humanity's attempts to confront climate change through geoengineering techniques that increase ocean acidification or reduce global freshwater availability)[33] has been flagged as posing an unacceptable risk to the very survival of human civilisation, owing to the large knowledge gaps involved and the likely magnitude of the resulting impacts.[34]

3. REGIME INTERACTIONS IN INTERNATIONAL LAW

Acknowledging that planetary boundaries and their interactions may be governed by multiple international legal regimes, questions arise concerning the ways in which these regimes themselves may interact, the effects of such interactions and efforts to ensure that interactions contribute to solving several problems or, at the very least, do not lead to problem-shifting. Such questions are beginning to be addressed by a growing body of literature on regime interactions.[35]

The study of regime interactions in international law is by no means new. As early as 1953, Sir Wilfred Jenks discussed different types of conflicts between 'law-making treaties' as

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29 Victor Galaz, 'Planetary Boundaries Concept Is Valuable' (2012) 486 Nature 191. See also Biermann (n 3) 2.

30 Biermann (n 3) 7; Galaz et al (n 4); and Ebbesson (n 5).

31 Galaz et al (n 4) 21–22.

32 Kim and Van Asselt (n 9); Nilsson and Persson (n 24).

33 See eg Long Cao and Ken Caldeira, 'Can Ocean Iron Fertilization Mitigate Ocean Acidification?' (2010) 99 Climatic Change 303; and Jim Haywood et al, 'Asymmetric Forcing from Stratospheric Aerosols Impacts Sahelian Rainfall' (2013) 3 Nature Climate Change 660.

34 Kim and Van Asselt (n 9) 477–79.

35 See eg Margaret Young, *Trading Fish, Saving Fish: The Interaction between Regimes in International Law* (Cambridge University Press 2011); Margaret Young (ed), *Regime Interaction in International Law: Facing Fragmentation* (Cambridge University Press 2012); Van Asselt (n 27); Jeffrey Dunoff, 'How to Avoid Regime Collisions' in Kerstin Blome et al (eds), *Contested Regime Collisions: Norm Fragmentation in World Society* (Cambridge University Press 2016) 49.

well as the means to resolve them.[36] The question of how different 'self-contained regimes'[37] interact began to draw significant attention at the turn of the century, when the International Law Commission (ILC) launched a study group on the nature and consequences of the fragmentation of international law.[38] The 2006 report by the ILC on the topic,[39] as well as much of the ensuing debate, has been primarily concerned with the nature and underlying drivers of fragmentation,[40] the consequences in terms of conflicts between norms emanating from various regimes[41] and legal techniques to address such conflicts.[42]

The notion of regime interaction, by contrast, is much broader, and encompasses various ways in which international institutions cooperate and coordinate. In the context of the present chapter, this concept offers several advantages. First, regime interaction involves actors beyond the States participating in two regimes or international adjudicators, including international organisations, non-governmental organisations, companies, standard-setting bodies and international bureaucracies.[43] Second, the concept of regime interaction shifts the focus away from legalistic approaches that could come into play when norms collide in the context of individual disputes, such as applying the interpretive 'principle of systemic integration' of Article 31(3)(c) of the Vienna Convention on the Law of Treaties,[44] or the principle of *lex specialis*.[45] Such approaches can help determine how the norms emanating from two regimes can be interpreted in a mutually supportive fashion, or can identify which norm prevails. However, disputes often only involve two States, are backward-looking and aim to offer a resolution for a specific instance of (potential) conflict. By contrast, the notion of regime interaction adopts

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36 Wilfred Jenks, 'The Conflict of Law-making Treaties' (1953) 30 British Year Book of International Law 401. Jenks (ibid 405) traces scholarship back to the earliest leading thinkers in international law, including Grotius, Pufendorf and Vattel.

37 Bruno Simma, 'Self-Contained Regimes' (1985) 16 Netherlands Yearbook of International Law 111.

38 ILC, 'Report of the International Law Commission on the Work of its Fifty-Second Session, 1 May–9 June and 10 July–18 August 2000' UN Doc A/55/10 (2000) para 729.

39 ILC (n 8).

40 See eg Martti Koskenniemi and Päivi Leino, 'Fragmentation of International Law? Postmodern Anxieties' (2002) 15 Leiden Journal of International Law 553; Anne-Charlotte Martineau, 'The Rhetoric of Fragmentation: Fear and Faith in International Law' (2009) 22 Leiden Journal of International Law 1.

41 See eg Joost Pauwelyn, *Conflict of Norms in Public International Law: How WTO Law Relates to other Rules of International Law* (Cambridge University Press 2003); Erich Vranes, 'The Definition of "Norm Conflict" in International Law and Legal Theory' (2006) 17 European Journal of International Law 395; Valentin Jeutner, *Irresolvable Norm Conflicts in International Law: The Concept of a Legal Dilemma* (Oxford University Press 2017).

42 See eg Anja Lindroos, 'Addressing Norm Conflicts in a Fragmented Legal System: The Doctrine of *Lex Specialis*' (2005) 74 Nordic Journal of International Law 27; Campbell McLachlan, 'The Principle of Systemic Integration and Article 31(3)(c) of the Vienna Convention' (2005) 54 International and Comparative Law Quarterly 279.

43 Young, *Trading Fish, Saving Fish* (n 35) 28.

44 Art 31(3)(c) guides the interpreter to take into account 'any relevant rules of international law applicable in the relations between the parties'; Vienna Convention on the Law of Treaties (concluded 23 May 1969, entered into force 27 January 1980) 1155 UNTS 331, art 31(3)(c). See in detail McLachlan (n 42).

45 Lindroos (n 42).

a more systemic, dynamic and forward-looking perspective on how different international legal regimes relate to each other.[46]

Regime interaction thus covers the law-making, implementation and enforcement (that is, dispute settlement) stages.[47] Dunoff usefully distinguishes between several types of regime interaction. 'Operational interactions' involve practical arrangements – such as partnerships, consortia, memoranda of understanding – between relevant international organisations affecting the operational activities of individual regimes.[48] The category of 'regulatory interactions' includes iterative exchanges between bodies of different regimes with a view to producing regulatory guidance on issues of overlapping interest.[49] 'Conceptual interactions' cover efforts to transfer social knowledge between different regimes.[50] These types of 'relational' interactions between regimes – as opposed to the 'transactional' interactions that have drawn most attention in the debate on the fragmentation of international law – show that regimes influence each other in a variety of ways.[51]

The preceding discussion suggests that to understand the interactions between regimes governing planetary boundaries, we need to extend our gaze beyond conflicting norms. Shifting away from blackletter interpretations of treaty texts, we should scrutinise the activities and decisions by constituted treaty bodies such as the Conferences (or Meetings) of the Parties (COPs/MOPs)[52] and secretariats,[53] inter-organisational platforms such as the Collaborative Partnership on Forests or the Strategic Approach to International Chemicals Management, scientific collaborations between experts or other actors involved in different regimes, and so on.[54]

Before exploring two case studies of regime interaction in the context of planetary boundary interactions, it is perhaps useful to note that no conceptual model can, by itself, describe the

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[46] Dunoff (n 35) 56–58. For international relations scholars, this broader focus conceptualisation of interactions between regimes has been a longer focus. See eg Oran Young, 'Institutional Linkages in International Society: Polar Perspectives' (1996) 2 Global Governance 1; Olav Schram Stokke, 'The Interplay of International Regimes: Putting Effectiveness Theory to Work?' FNI Report 14/2001 (Fridtjof Nansen Institute 2001); Sebastian Oberthür and Thomas Gehring (eds), *Institutional Interaction in Global Environmental Governance: Synergy and Conflict among International and EU Policies* (MIT Press 2006).

[47] Margaret Young, 'Regime Interaction in Creating, Implementing and Enforcing International Law' in Young (2012) (n 35) 85.

[48] Dunoff (n 35) 59–64. See also Jeffrey Dunoff, 'A New Approach to Regime Interaction' in Young (2012) (n 35) 136, 163–66.

[49] Dunoff (n 35) 64–70; Dunoff (n 48) 158–63.

[50] Dunoff (n 35) 70–74; Dunoff (n 48) 166–73. Here, Dunoff's work can be linked to Stokke's (n 46) category of 'cognitive interplay'.

[51] Dunoff (n 35) 55.

[52] See also Robin Churchill and Geir Ulfstein, 'Autonomous Institutional Arrangements in Multilateral Environmental Agreements: A Little-Noticed Phenomenon in International Law' (2000) 94(4) American Journal of International Law 623; Jutta Brunnée, 'COPing with Consent: Law Making under Multilateral Environmental Agreements' (2002) 15(1) Leiden Journal of International Law 1; Annecoos Wiersema, 'The New International Law-makers? Conferences of the Parties to Multilateral Environmental Agreements' (2009) 31(1) Michigan Journal of International Law 231.

[53] See Sikina Jinnah, *Post-Treaty Politics: Secretariat Influence in Global Environmental Governance* (MIT Press 2014).

[54] On regime interaction in international environmental law more generally, see Karen Scott, 'International Environmental Governance: Managing Fragmentation through Institutional Connection' (2011) 12 Melbourne Journal of International Law 177; Young, *Trading Fish, Saving Fish* (n 35); Van Asselt (n 27).

variety of situations that may occur in practice. We can, however, distinguish among two broad dynamics of interaction, which are captured by the two simplified models presented in Figure 7.1. The first model assumes that one specific planetary boundary (PB) is governed by a single legal regime (R), which then interacts with another regime governing another boundary. As several chapters in this book underscore, many boundaries are governed by a variety of regimes, with the possible exception of the boundary for stratospheric ozone depletion (which is primarily governed by the ozone regime including the 1985 Vienna Convention and its 1987 Montreal Protocol). In addition, even for those boundaries where there is arguably one 'core' regime – such as climate change and the United Nations Framework Convention on Climate Change (UNFCCC) – it can be argued that rather than focusing on a single regime, one should focus on the broader 'regime complex'.[55] In any event, this model represents an intuitive way of conceptualising possible interactions between regimes and Earth system processes that are associated with well-established global-level boundaries – one relevant example being the role of the Montreal Protocol in influencing the use of chemicals that contribute to global heating. This is due to the fact that both greenhouse gases and ozone-depleting substances are well mixed in the atmosphere, and their aggregate impact does not depend on where the respective emissions are generated.[56] As a result, even when the complexities of the respective regimes are taken into account, it can be argued that multilateral instruments such as the UNFCCC and the Montreal Protocol, which enjoy universal (or near-universal) participation, continue to play a leading role in the management of the relevant boundary interactions.

In the second model, the assumption is that several interacting planetary boundaries are themselves governed by a host of interacting regimes. This often appears to be the case for biophysical processes that are not (or not yet) known to exhibit threshold behaviour at the global scale, such as loss of biosphere integrity, land-use change, freshwater use and alteration of biogeochemical flows. For these processes, the transgression of the related planetary boundaries is usually linked to the dynamics of environmental change at regional or local levels (such as land-based biomes, river basins, marine ecosystems), which can cascade through the Earth system via their impact on ecological functions and biogeochemical feedbacks.[57] From a governance perspective, the absence of clear global-level boundaries can prevent the emergence of universally accepted regimes, leading to a fragmented landscape of overlapping agreements with a narrower geographic or thematic focus.[58] In a similar context, interaction management is a matter not only of creating synergies and interlinkages across planetary boundaries, but also of achieving a degree of internal coherence across the multiple regimes that target each individual boundary.

Other constellations of interactions are conceivable. First, a slight variation of the second one may be used to capture those situations in which a regime covering one planetary boundary interacts with a variety of other regimes addressing another boundary. For example, the rules of the UNFCCC and its Paris Agreement applying to forest carbon sinks interact with the

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55 Keohane and Victor (n 7); see also Biermann et al (n 7).

56 Rockström et al, 'Planetary Boundaries: Exploring the Safe Operating Space for Humanity' (n 1); Steffen et al (n 1).

57 Steffen et al (n 1) 1259855-2; Tiina Häyhä et al, 'From Planetary Boundaries to National Fair Shares of the Global Safe Operating Space: How Can the Scales Be Bridged?' (2016) 40 Global Environmental Change 60, 62.

58 Galaz et al (n 3); Häyhä et al (n 57).

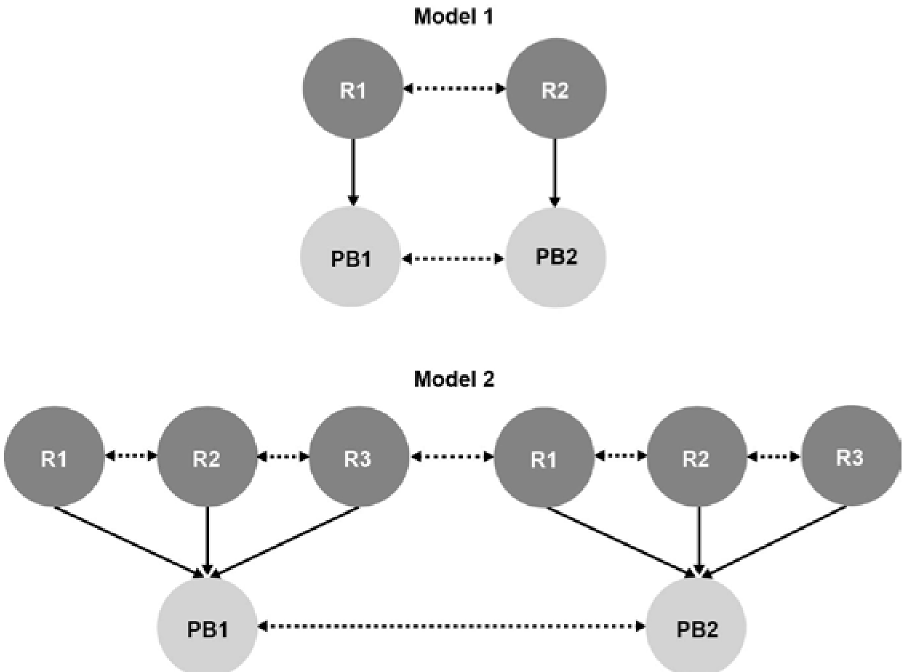

Figure 7.1 Models of regime interactions in the context of planetary boundaries

biosphere integrity boundary, which is governed by a multitude of international and regional regimes that in turn determine the ability of ecosystems to mitigate, and adapt to, climate change. Second, it is possible that one single regime presents direct implications for several interacting boundaries regardless of its interplay with other regimes (for example, the norms of the UNFCCC impinge on the interface between climate change and ocean acidification). Finally, a single planetary boundary can be governed by several interacting regimes: a situation that represents a case of regime interaction but does not influence (at least directly) the potential interplay between different social-ecological processes.

Importantly, these variations are mostly a matter of perspective, a consequence of different framings of the issues at hand. International regimes and planetary boundaries, in other words, can both be described as complex systems, simultaneously interacting among themselves and with each other in a myriad of ways that cannot be fully captured by a static model. By shedding light on two practical cases in which these dynamics occur, however, we hope to illustrate the importance of targeting regime interactions as a critical means for avoiding problem-shifting and preserving the safe operating space for humanity.

4. REGIME INTERACTION IN PRACTICE

4.1 Stratospheric Ozone Depletion and Climate Change

Several planetary boundaries have threshold effects at the global scale,[59] including the 'global public bads' of stratospheric ozone depletion and climate change.[60] The hole in the ozone layer that appeared above Antarctica in the 1980s was a prime example of a threshold being crossed regionally, although, through the implementation of measures to reduce the use and production of ozone-depleting substances, we have since returned to safe levels.[61] For climate change, the story is a different one: we have by now well passed the boundary of atmospheric CO_2 concentration of 350 parts per million (ppm), with the Mauna Loa Observatory in Hawaii measuring concentrations of 416 ppm in April 2020.[62] This still falls within the range of uncertainty of the planetary boundaries framework (which extends up to 450 ppm),[63] but projections towards the end of the century significantly exceed even this higher-level threshold.[64] The current value of the other relevant planetary boundary for climate change, concerning the energy balance at the Earth's surface (or radiative forcing), likewise has been exceeded (2.3 W m^{-2} compared to 1.0 W m^{-2}).[65]

The two planetary boundaries, as well as their governance responses, interact in various ways. Although ozone depletion itself contributes to negative radiative forcing, the main chemical substances initially identified as driving ozone depletion – chlorofluorocarbons (CFCs) – are also a potent greenhouse gas, with the global warming potential of some CFCs thousands times greater than that of CO_2.[66] As a consequence, the consumption of ozone-depleting substances such as CFCs has significantly contributed to global and regional warming.[67] The flipside is that actions taken under the Montreal Protocol have made a major contribution to tackling climate change, with studies suggesting that the emission reductions

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59 Gail Whiteman, Brian Walker and Paolo Perego, 'Planetary Boundaries: Ecological Foundations for Corporate Sustainability' (2012) 50 Journal of Management Studies 307, 313–14.

60 Scott Barrett, 'Montreal versus Kyoto: International Cooperation and the Global Environment' in Inge Kaul, Isabelle Grunberg and Marc Stern (eds), *Global Public Goods: International Cooperation in the 21st Century* (Oxford University Press 1999) 192, 192. See also Verschuuren, Chapter 13, and Du Toit, Chapter 14 in this book.

61 Rockström et al, 'Planetary Boundaries: Exploring the Safe Operating Space for Humanity' (n 1); Steffen et al (n 1).

62 National Oceanic and Atmospheric Administration, 'Trends in Atmospheric Carbon Dioxide' <www.esrl.noaa.gov/gmd/ccgg/trends/monthly.html> accessed 29 May 2020.

63 Steffen et al (n 1).

64 See eg Gerald Meehl et al, 'Global Climate Projections' in Susan Solomon et al (eds), *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge University Press 2007) 747, 750.

65 Steffen et al (n 1).

66 World Meteorological Organization (WMO) and United Nations Environment Programme (UNEP), *Scientific Assessment of Ozone Depletion 2018* (WMO and UNEP 2019) A.2–A.5.

67 Intergovernmental Panel on Climate Change (IPCC) and Technological and Economic Assessment Panel (TEAP), *Safeguarding the Ozone Layer and the Global Climate System: Issues Related to Hydrofluorocarbons and Perfluorocarbons* (Cambridge University Press 2005) 5; Lorenzo Polvani et al, 'Substantial Twentieth-Century Arctic Warming Caused by Ozone-Depleting Substances' (2020) 10 Nature Climate Change 130.

achieved through the Montreal Protocol's phaseout of ozone-depleting substances surpass those of the 1997 Kyoto Protocol.[68]

Some of these benefits were initially negated, however, by a typical case of problem-shifting:[69] some of the substitutes for CFCs promoted by the Montreal Protocol, while not contributing to ozone depletion, are also greenhouse gases. At first, the concern was about hydrochlorofluorocarbons (HCFCs), which were used as transitional chemicals to help phase out CFCs and were supported as such through the Montreal Protocol's Multilateral Fund.[70] With HCFCs also being phased out under the Montreal Protocol,[71] attention shifted to the use of hydrofluorocarbons (HFCs), another potent greenhouse gas used as a substitute.[72] With the use of CFCs and HCFC being curtailed, the use of HFCs was projected to grow significantly, with associated greenhouse gas emissions estimated somewhere between 3.5 and 8.8 gigatonnes of CO_2-equivalent in 2050.[73]

The question of where and how to develop international regulation for HFCs set the stage for regulatory interaction between the two regimes. At first blush, the jurisdictional scope of the two regimes governing ozone depletion and climate change may seem clearly delimited, with the UNFCCC (as well as the Kyoto Protocol) referring multiple times to 'greenhouse gases not controlled by the Montreal Protocol'.[74] HFCs are further included in reporting guidelines developed under the UNFCCC,[75] and listed as a greenhouse gas for the purposes of the Kyoto Protocol.[76] In addition, many Parties to the Paris Agreement cover HFCs in their nationally determined contributions.[77] HFCs, therefore, clearly fall within the scope of the international climate regime.

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68 Guus Velders et al, 'The Importance of the Montreal Protocol in Protecting Climate' (2007) 104 Proceedings of the National Academy of Sciences 4814.

69 See also Kim and Van Asselt (n 9) 488–92.

70 Sebastian Oberthür, 'Linkages between the Montreal and Kyoto Protocols: Enhancing Synergies between Protecting the Ozone Layer and the Global Climate' (2001) 1 International Environmental Agreements: Politics, Law and Economics 357, 367.

71 Montreal Protocol on Substances that Deplete the Ozone Layer (adopted 16 September 1987, entered into force 1 January 1989) 1522 UNTS 3 (Montreal Protocol), art 2(f); and Montreal Protocol Decision XIX/6 'Adjustments to the Montreal Protocol with Regard to Annex C, Group I, Substances (Hydrochlorofluorocarbons)' UN Doc UNEP/OzL.Pro.19/7 (21 September 2007).

72 Guus Velders et al, 'The Large Contribution of Projected HFC Emissions to Future Climate Forcing' (2009) 106 Proceedings of the National Academy of Sciences 10949; Veerabhadran Ramanathan and Yangyang Xu, 'The Copenhagen Accord for Limiting Global Warming: Criteria, Constraints, and Available Avenues' (2010) 107 Proceedings of the National Academy of Sciences 8055; Guus Velders et al, 'Preserving Montreal Protocol Climate Benefits by Limiting HFCs' (2012) 335 Science 922; Yangyang Xu et al, 'The Role of HFCs in Mitigating 21st Century Climate Change' (2013) 13 Atmospheric Chemistry and Physics 6083; Guus Velders et al, 'Future Atmospheric Abundances and Climate Forcings from Scenarios of Global and Regional Hydrofluorocarbon (HFC) Emissions' (2015) 123 Atmospheric Environment 200.

73 UNEP, *HFCs: A Critical Link in Protecting Climate and the Ozone Layer* (UNEP 2011) 22.

74 See eg United Nations Framework Convention on Climate Change (adopted 29 May 1992, entered into force 21 March 1994) 1771 UNTS 107, arts 4(1)(b) and 12(1)(a).

75 UNFCCC, 'UNFCCC Guidelines on Reporting and Review' UN Doc FCCC/CP/1999/7 (16 February 2000).

76 Kyoto Protocol to the United Nations Framework Convention on Climate Change (adopted 11 December 1997, entered into force 16 February 2005) 2303 UNTS 162, Annex A.

77 Katherine Ross et al, 'Strengthening Nationally Determined Contributions to Catalyze Actions that Reduce Short-Lived Climate Pollutants' (World Resources Institute 2018) 12.

At the same time, the Vienna Convention and Montreal Protocol do not preclude their parties from taking action on HFCs. The Vienna Convention aims, among others, to 'protect human health and the environment against adverse effects resulting from modifications of the ozone layer'.[78] The Convention further obliges Parties to adopt measures 'to control, limit, reduce or prevent human activities under their jurisdiction or control should it be found that these activities have or are likely to have adverse effects resulting from modification or likely modification of the ozone layer'.[79] Such activities include the regulation of ozone-depleting substances, which has led to the increased production and consumption of HFCs.[80] The Conference of the Parties to the Vienna Convention is further mandated to '[c]onsider amendments to any protocol' and to 'consider and undertake any additional action that may be required for the achievement of the purpose of [the] Convention'.[81] In short, an amendment of the Montreal Protocol to address HFCs was on the cards.

Indeed, in October 2016, less than a year after the Paris Agreement was adopted, Parties to the Montreal Protocol adopted the Kigali Amendment to phase down HFCs.[82] The amendment generally follows the regulatory model of the Montreal Protocol, specifying phase-down schedules that are differentiated between developed ('non-Article 5') and developing ('Article 5') countries, with a 'grace period' for the latter group.[83] However, in a sign that the 'subtle differentiation' of the Paris Agreement[84] spilled over to negotiations under the Montreal Protocol (in Dunoff's terms, a 'conceptual interaction'), distinctions are made within both groups of countries. In the non-Article 5 group, selected countries (including Russia and four other former Soviet countries) can use a different baseline and are granted more time to implement the HFC phase-down.[85] Likewise, those on a specific list of Article 5 countries (including India

[78] Vienna Convention for the Protection of the Ozone Layer (adopted 22 March 1985, entered into force 22 September 1988) 1513 UNTS 293 (Vienna Convention), preamble. Adverse effects are defined as 'changes in the physical environment or biota, *including changes in climate*, which have significant deleterious effects on human health or on the composition, resilience and productivity of natural and managed ecosystems, or on materials useful to mankind'; ibid art 1(2) (emphasis added).

[79] Ibid art 2(2)(b).

[80] Mark Roberts and Peter Grabiel, 'A Window of Opportunity: Combating Climate Change by Amending the Montreal Protocol to Regulate the Production and Consumption of HFCs and ODS Banks' (2009) 22 Georgetown International Environmental Law Review 99, 121–25; and Ozone Secretariat, 'Briefing Note on Legal Aspects in the Context of HFC Management under the Montreal Protocol' (2016) 4–5 <http://conf.montreal-protocol.org/meeting/oewg/oewg-37/presession/Background_documents/Briefing_note_on_legal_synergies.pdf> accessed 29 May 2020. But see Tomilola Akanle, 'Impact of Ozone Layer Protection on the Avoidance of Climate Change: Legal Issues and Proposals to Address the Problem' (2010) 19 Review of European, Comparative and International Environmental Law 239, 243–44.

[81] Vienna Convention (n 78) arts 6(4)(f) and (k). See also Montreal Protocol (n 71) arts 11(4)(h) and (j).

[82] Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer (adopted 15 October 2016, entered into force 1 January 2019) (Kigali Amendment) <http://conf.montreal-protocol.org/meeting/mop/mop-28/final-report/English/Kigali_Amendment-English.pdf> accessed 29 May 2020.

[83] Ibid art I (in particular the amendments of arts 2 and 5 of the Montreal Protocol).

[84] Sandrine Maljean-Dubois, 'The Paris Agreement: A New Step in the Gradual Evolution of Differential Treatment in the Climate Regime?' (2016) 25 Review of European, Comparative and International Environmental Law 151, 154.

[85] Kigali Amendment (n 82) art I (amending art 2 of the Montreal Protocol); and 'Decision XXVIII/2: Decision Related to the Amendment Phasing Down Hydrofluorocarbons' UN Doc UNEP/OzL.Pro.28/12 (15 November 2016) para 1.

and Saudi Arabia) are given a more relaxed schedule,[86] while a partially overlapping group of 'high-ambient-temperature parties' can choose to temporarily exempt certain sectors from the phase-down.[87]

Though HFC regulation was ultimately developed under the Montreal Protocol, this does not mean that HFCs are outside the scope of the UNFCCC or the Paris Agreement.[88] Instead, the amendment offers a significant boost for climate protection, projected to result in 0.2–0.4°C of avoided warming.[89] But the ozone regime still has other important roles to play, notably in the area of enforcement. For instance, a study demonstrated that illegal production and use of CFC-11 in China accounted for a 40–60 per cent increase of emissions of the substance since 2012.[90] This event is related to the fact that Parties to the Protocol have yet to adopt regulation targeting 'banks' (that is, the substances in existing equipment, chemical stockpiles, foams and other products[91]) of ozone-depleting substances and HFCs. Emissions from such banks can be substantial. For example, CFC-11 and CFC-12 banks could lead to further emissions of nine billion metric tonnes CO_2-equivalent between 2020 and 2100.[92] Likewise, HFC banks built up before the substances are phased down can lead to significant greenhouse gas emissions.[93] Addressing these emissions could lead to further climate benefits, as could coordinating the HFC phase-down with efforts to improve energy efficiency in refrigeration and air-conditioning.[94]

In what can be viewed as an operational interaction, scientific communities played a key role in underscoring the biophysical linkages between climate change and ozone depletion, and helping to put these on the political agendas in both the climate and ozone regimes. Notably, the Intergovernmental Panel on Climate Change and the Montreal Protocol's Technological and Economic Assessment Panel prepared a joint assessment on ozone depletion and climate change.[95] Regular scientific assessments carried out under the Montreal Protocol continue to set the agenda, with a 2019 synthesis pointing out that '[f]uture geoengineering efforts to mitigate climate change by generating stratospheric aerosols to reflect sunlight have the potential to alter stratospheric ozone in ways that we do not yet fully understand'.[96] This shows that although interactions thus far have primarily led to synergies between the regimes governing the two planetary boundaries, problem-shifting remains a distinct possibility in the future.

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86 Kigali Amendment (n 82); and Decision XXVIII/2 ibid para 2.

87 Kigali Amendment (n 82); and Decision XXVIII/2 (n 85) para 29 and Appendix II. As a result, however, they would not be eligible for funding through the Protocol's Multilateral Fund; ibid para 35.

88 As confirmed by Kigali Amendment (n 82) art III.

89 World Meteorological Organization (WMO) et al, *Scientific Assessment of Ozone Depletion: 2018* (WMO 2019) ES.22.

90 Matt Rigby et al, 'Increase in CFC-11 Emissions from Eastern China Based on Atmospheric Observations' (2019) 569 Nature 546.

91 IPCC and TEAP (n 67) 450.

92 Megan Lickley et al, 'Quantifying Contributions of Chlorofluorocarbon Banks to Emissions and Impacts on the Ozone Layer and Climate' (2020) 11 Nature Communications 1, 7.

93 Guus Velders et al, 'Growth of Climate Change Commitments from HFC Banks and Emissions' (2014) 14 Atmospheric Chemistry and Physics 4563.

94 UNEP, 'Synthesis of the 2018 Assessment Reports of the Scientific Assessment Panel, the Environmental Effects Assessment Panel and the Technology and Economic Assessment Panel' UN Doc UNEP/OzL.Pro.31/8 (29 August 2019) paras 20–22.

95 IPCC and TEAP (n 67).

96 UNEP (n 94) para 38. See also WMO et al (n 89) Appendix 6.A.

4.2 Biogeochemical Flows and Global Freshwater Use

When compared to climate change and stratospheric ozone depletion, the planetary boundaries for global freshwater use and biogeochemical flows represent a case in point for discussing regime interaction in a context characterised by (i) absence of known global-level thresholds and (ii) a fragmented landscape of regional and thematic legal instruments (a situation that broadly covers our second explanatory model). The complex dynamics linking these two Earth sub-systems have been extensively studied and were even described in the first iteration of the planetary boundary framework. On the one hand, nutrient runoff and atmospheric inputs from agricultural and industrial applications, particularly as they relate to phosphorus (P) and nitrogen (N) flows, are a major contributor to freshwater eutrophication and drinking water contamination. As a result, the anthropogenic perturbation of P and N cycles directly impinges on the amount of blue water (that is, from lakes, rivers, reservoirs and groundwater stores) that is available for human consumptive uses at both global and river-basin levels.[97] On the other hand, excessive freshwater withdrawals can reduce river flows and thereby affect productivity in agricultural lands, potentially feeding back into the biogeochemical flows boundary by stimulating increased use of fertilisers.[98] Problem-shifting between these boundaries is also possible; for example, the setting of strict boundaries for global freshwater availability could itself be dangerous if it disregarded spatial variability in agricultural applications of P of N, because it would constrain fertiliser use in developing countries and thereby have an impact on soil fertility and food security.[99]

At present, the specific control variables proposed for freshwater use and biogeochemical flows have attracted a certain amount of criticism, including for their failure to capture water functions beyond human consumptive use and elements other than P and N, respectively.[100] Importantly, however, the study of the interactions between these two boundaries demonstrates the centrality of the hydrological and nutrient cycles to most other Earth system processes, and the difficulty for international legal regimes to adequately align with their strong cross-sectoral and multi-scalar dimensions.

With respect to the freshwater use boundary, international law is notoriously characterised by hundreds of bilateral and basin-level agreements that have been stipulated since the late nineteenth century in order to ensure cooperation between riparian States in the management of shared water resources. The 1997 UN Convention on the Law of the Non-Navigational Uses of International Watercourses (UN Watercourses Convention) attempted to define a broad set of framework principles that could be applicable to the conservation and sustainable use of all transboundary systems of surface waters and connected groundwaters, while leaving ample scope for countries to maintain these pre-existing agreements or enter new ones to adjust its

97 Steffen et al (n 1); Stephen Carpenter and Elena Bennett, 'Reconsideration of the Planetary Boundary for Phosphorus' (2011) 6 Environmental Research Letters 014009; Wim de Vries et al, 'Nitrogen Boundaries Related to Food Security and Adverse Environmental Impacts' (2013) 5 Current Opinion in Environmental Sustainability 392. See also Cooper, Chapter 18, and Diz, Chapter 17 in this book.

98 Lade et al (n 21) Supplementary Information.

99 De Vries et al (n 97).

100 Tom Gleeson et al, 'The Water Planetary Boundary: Interrogation and Revision' (2020) 2 One Earth 223; and Steffen et al (n 1) 1259855–6.

general provisions to specific watercourses.[101] Even though the UN Watercourses Convention can in many ways be considered a codification of norms of customary international law, its recent entry into force, lack of an institutional machinery to support implementation and small number of ratifications make it difficult to evaluate its present impact on such a fragmented landscape of water governance. Moreover, the UN Economic Commission for Europe (UNECE) Convention on the Protection and Use of Transboundary Watercourses and International Lakes (UNECE Water Convention)[102] has also recently been opened for accession for countries outside the pan-European region, thereby creating a potential situation of regime interaction at the global level as well.[103]

For the purpose of the present chapter, it should be noted that the UNECE Water Convention contains more detailed provisions concerning the prevention, control and reduction of freshwater pollution likely to cause transboundary impacts, including an obligation for Parties to take measures at source, when possible, and the obligation not to transfer pollution to other parts of the environment when doing so.[104] Article 3 particularly clarifies that in order to address these impacts, countries shall ensure that, *inter alia*, appropriate measures are taken, best environmental practices developed and best available technologies applied for the reduction of inputs of nutrients from both point sources (such as industrial sites) and diffuse ones (such as agriculture).[105] As such, the UNECE Water Convention directly targets the transboundary impacts on freshwater availability of the most important P and N applications, not only identifying a positive duty for countries to set emission limits and water quality objectives,[106] but also obliging riparian Parties to develop concerted action programmes through the joint bodies that they are required to establish under Article 9.[107] For those Parties to the Convention that ratified its Protocol on Water and Health, the above-mentioned provisions are reinforced by Article 4(2)(c) of the Protocol, which specifically applies to waters used as sources of drinking water (that is, including *internal* waters) and mandates the adoption of appropriate measures to ensure their *effective* protection from pollution linked to agriculture and industrial activities.[108]

Insofar as they relate to nutrient inputs, the obligations contained in international water law are therefore crucial in addressing the effects of altered biogeochemical flows on freshwater availability. At the same time, while no global instrument applies directly to the entirety of P and N cycles, there are several regimes that target other specific steps within those cycles. First, P and N runoff to sea can be considered to be generally covered under the norms of the

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[101] United Nations Convention on the Law of the Non-Navigational Uses of International Watercourses (adopted 21 May 1997, entered into force 17 August 2014) 36 ILM 700, arts 1 and 3.

[102] Convention on the Protection and Use of Transboundary Watercourses and International Lakes (adopted 17 March 1992, entered into force 6 October 1996) 1936 UNTS 269 (UNECE Water Convention).

[103] A full discussion of the interaction between the two conventions falls outside of the scope of this chapter. See eg Attila Tanzi, *The Economic Commission for Europe Water Convention and the United Nations Watercourses Convention. An Analysis of their Harmonized Contribution to International Water Law* (United Nations 2015).

[104] UNECE Water Convention (n 102) arts 2(3)–(4).

[105] Ibid art 3(1)(g).

[106] Ibid arts 3(2)–(3).

[107] Ibid art 9(2)(f).

[108] Protocol on Water and Health to the 1992 Convention on the Protection and Use of Transboundary Watercourses and International Lakes (adopted 17 June 1999, entered into force 4 August 2005) 2331 UNTS 202, art 4(2)(c).

UN Convention on the Law of the Sea relating to pollution from land-based sources,[109] as well as under regional seas agreements such as the 1992 Helsinki Convention, which explicitly targets P and N compounds as priority 'harmful substances' whose negative impact on the marine environment should be prevented.[110] Interestingly, this particular treaty lays out a series of detailed provisions applying to pollution from agriculture, including limits on the use of nutrients such as P and N in agricultural lands and livestock manure,[111] but its geographical application remains confined to the countries of the Baltic Sea area. Second, atmospheric emissions of N compounds from agriculture, industry and transport, which also contribute to eutrophication, generally fall under the scope of regional air pollution regimes. For example, the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP Convention) and its Gothenburg Protocol oblige Parties to reduce their annual emissions of nitrogen oxides and ammonia in accordance with emission ceilings that are determined through the integrated assessment modelling of critical loads of N in ecosystems.[112] Third, the regulation of excess nutrient use can be seen as central to the mandates of several transnational partnerships, including the UN Environment Programme (UNEP)-led Global Partnership on Nutrient Management and the Global Soil Partnership, which is hosted by the Food and Agriculture Organization of the United Nations (FAO). In recent years, these actors have been instrumental in increasing information sharing and promoting regulatory interactions. For example, the Global Soil Partnership has been leading the development of the Voluntary Guidelines for Sustainable Soil Management[113] and the subsequent International Code of Conduct for the Sustainable Use and Management of Fertilizers,[114] which, in spite of their non-binding nature, provide a set of standards of practice that should prevent misuse and excessive use of nutrients in the agricultural sector.[115]

When trying to make sense of such a multi-layered governance landscape, it is evident that the possibility of norm conflicts is just a secondary aspect within a more complex web of regime interactions that often play out in the activities of governing and scientific bodies, rather than in treaty texts. As a matter of fact, obligations to prevent nutrient pollution are formulated in vague and broadly compatible terms, and the regional character of many of the relevant instruments also means that the Parties to which they are applicable do not necessarily overlap. By contrast, owing to the interconnected nature of hydrological and biogeochemical cycles, significant synergies and trade-offs are likely to emerge in implementation activities, monitoring and reporting efforts and use of scientific assessments for decision-making (for example, integrated assessment models of P and N flows). It is therefore not surprising that,

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[109] United Nations Convention on the Law of the Sea (adopted 10 December 1982, entered into force 16 November 1994) 1833 UNTS 397, arts 194–195 and 207. See, specifically, Diz, Chapter 17 in this book.

[110] Convention on the Protection of the Marine Environment of the Baltic Sea Area, (adopted 21 April 1992, entered into force 25 March 1998) 32 ILM 1068 (Helsinki Convention), arts 5–6 and Annex 1.

[111] Ibid Annex III, Part II, Regulation 2.

[112] Protocol to Abate Acidification, Eutrophication and Ground-level Ozone to the Convention on Long-Range Transboundary Air Pollution (adopted 30 November 1999, entered into force 15 May 2005) 2319 UNTS 81 art 3(1), Annex I.II and Annex II, Tables 2 and 3.

[113] FAO, *Voluntary Guidelines for Sustainable Soil Management* (FAO 2017).

[114] FAO, *The International Code of Conduct for the Sustainable Use and Management of Fertilizers* (FAO 2019).

[115] See eg Ibid art 4.

with the exception of the Watercourses Convention, the agreements discussed above usually assign their governing bodies (such as MOPs and executive bodies) a duty to seek advice from, or pursue cooperation with, other relevant bodies or international organisations.[116]

In practice, however, the extent to which this happens is influenced by the different priorities and approaches that must guide the respective treaties' implementation. On the one hand, the UNECE Water Convention has traditionally been focused on supporting and monitoring the implementation of legislative frameworks for shared freshwater resources, rather than assessing the effects of pollutants on watercourses per se. As a result, outside of ensuring that the measures taken to mitigate runoff from the agricultural or industrial sectors are reported by the Parties,[117] the Convention has not organically engaged in the forms of 'relational' regime interactions discussed in the previous section. At the opposite end of the spectrum, the obligations to reduce nutrient emissions under the LRTAP and Helsinki Conventions are based on the fixation of critical pollution loads, which in turn requires the integrated modelling of the effects of these substances on the relevant ecosystems. This means that data collection and knowledge-sharing across different regimes constitute important activities for the subsidiary bodies that have been created under both instruments to support implementation. For example, the Helsinki Convention's Working Group on Pressures is explicitly tasked with seeking synergies with the LRTAP's Gothenburg Protocol[118] in order to meet the nutrient reduction targets contained in the 2013 HELCOM Copenhagen Ministerial Declaration,[119] particularly as they relate to P and N runoff to sea from non-contracting Parties. Similarly, bodies such as the Task Force on Reactive Nitrogen and the International Cooperative Programme on Waters (ICP Waters), which were established under the LRTAP Convention, are encouraged to collaborate with external partners so as to make scientific and technical information on N flows widely available for decision-making beyond the Convention's immediate areas of work.[120] As a result, the Task Force on Reactive Nitrogen has assumed an important role in those transnational science–policy interfaces that have been developed to promote synergies in global nitrogen management, including the International Nitrogen Initiative[121] and the more recent project 'Towards an International Nitrogen Management System'.[122]

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116 See eg UNECE Water Convention (n 102) art 17(2)(c); Helsinki Convention (n 110) art 20(1)(f); Convention on Long-Range Transboundary Air Pollution (adopted 13 November 1979, entered into force 16 March 1983) 1302 UNTS 217 art 10(4).

117 'Meeting of the Parties to the Water Convention, Decision VIII/I' UN Doc ECE/MP.WAT/54/Add.2 (30 January 2019).

118 HELCOM, 'Outcome of the 46th Meeting of the Heads of Delegation' Doc HOD 46-2014 (16–17 September 2014) 19–21.

119 HELCOM, 'Copenhagen Ministerial Declaration – Taking Further Action to Implement the Baltic Sea Action Plan' (adopted 3 October 2013) <https://helcom.fi/media/documents/2013-Copenhagen-Ministerial-Declaration-w-cover-1.pdf> accessed 29 May 2020.

120 See eg Executive Body of the LRTAP Convention, 'Decision 2007/1, Establishment of a Task Force on Reactive Nitrogen' UN Doc ECE/EB.AIR/91/Add.1 (27 February 2008); and 'Decision 2019/15, Revised Mandate for the International Cooperative Programme on Assessment and Monitoring of the Effects of Air Pollution on Rivers and Lakes' UN Doc ECE/EB.AIR/144/Add.1 (3 February 2020).

121 See International Nitrogen Initiative, 'About INI' <https://initrogen.org/content/about-ini> accessed 29 May 2020.

122 See International Nitrogen Management System, 'About' <http://www.inms.international/about_INMS> accessed 29 May 2020.

5. MANAGING REGIME INTERACTION

Understanding the ways in which specific regimes interact in the governance of interconnected planetary boundaries, as well as the subsequent outcomes of such interactions, can be considered a starting point for efforts to develop mutually supportive regimes, which at once seek to avoid the risk of problem-shifting between boundaries. Here, we will discuss several conceivable forms such 'interplay management' could take,[123] while simultaneously noting the unique challenges that the planetary boundaries framework brings to our understanding of possible solutions.

For international lawyers, an intuitive response to addressing relationships between different international legal regimes may be to search for a normative hierarchy, with a view to determining which treaty or norm will prevail.[124] A normative hierarchy refers to 'the relationship between and ordering of legal norms according to their superiority in terms of their objectives, importance of their content, as well as the universal acceptance of their superiority'.[125] This could entail a quest to identify which norm prevails based on conflict resolution techniques such as *lex specialis* (the more specific norm prevails) or *lex posterior* (the later norm prevails). However, in the context of international environmental law in general, and planetary boundary interactions specifically, the usefulness of these techniques is limited, for instance because it is not possible to determine which norm is the more specific one or because relevant international agreements should rather be viewed as 'living treaties' rather than blackletter texts.[126]

Establishing a normative hierarchy could also involve a search for *jus cogens* norms (that is, peremptory norms from which no derogation is possible). Much ink has been spilled on identifying such norms, including in the international environmental law context.[127] Aside from the general challenge of proving that such norms actually exist,[128] it remains unclear which norms would actually lead to mutually supportive regimes and avoid problem-shifting.[129] One candidate put forward in this regard is the notion of 'ecological integrity', which Kim and

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[123] See Oberthür (n 28). Stokke defines 'interplay management' as 'any deliberate efforts to improve the interaction of two or more institutions that are distinct in terms of membership and decision-making but that deal with the same issue, usually in a non-hierarchical manner': Olav Schram Stokke, 'Interplay Management' in Frank Biermann and Rakhyun E Kim (eds), *Architectures of Earth System Governance: Institutional Complexity and Structural Transformation* (Cambridge University Press 2020) 207, 208.

[124] Rakhyun E Kim et al, 'Hierarchization' in Biermann and Kim, ibid, 275.

[125] Louis J Kotzé and Wendy Muzangaza, 'Constitutional International Environmental Law for the Anthropocene?' (2018) 27 Review of European, Comparative and International Environmental Law 278, 282–83. See also Dinah Shelton, 'Normative Hierarchy in International Law' (2006) 100 American Journal of International Law 291.

[126] See eg Van Asselt (n 27) 69–71; Pauwelyn (n 41) 361ff; Rüdiger Wolfrum and Nele Matz, *Conflicts in International Environmental Law* (Springer 2003) 152–58.

[127] On *jus cogens* generally, see ILC (n 39) paras 361–379. On *jus cogens* and international environmental law, see Louis J Kotzé, 'Constitutional Conversations in the Anthropocene: In Search of Environmental Jus Cogens Norms' (2015) 46 Netherlands Yearbook of International Law 241.

[128] See Alan Boyle, 'Relationship between International Environmental Law and Other Branches of International Law' in Daniel Bodansky, Jutta Brunnée and Ellen Hey (eds), *The Oxford Handbook of International Environmental Law* (Oxford University Press 2007) 125, 136.

[129] See Rakhyun E Kim, Klaus Bosselmann and Volker Mauerhofer, 'Planetary Boundaries in Post-2015 Sustainable Development Goals: Safeguarding Ecological Integrity as a Priority Goal and a *Grundnorm* of International Law' (Planetary Boundaries Initiative, 2013) 21 <http://planetary

Bosselmann suggest should be considered a *Grundnorm* in international environmental law.[130] Their proposal, which is explicitly connected to the planetary boundaries framework, could certainly make the risk of problem-shifting more visible in the development, application and interpretation of legal norms. For example, it could help to clarify the meaning of those treaty clauses that set forth a duty for countries not to transfer pollution or hazards from one part of the environment to another, when taking action on a particular environmental problem (such as so-called no transfer clauses).[131] In addition, it would probably promote policy synergies by supporting a more coherent framing of the concepts and approaches adopted across different interacting instruments. However, it would arguably be insufficient for addressing the myriad of other forms of regime interaction that also have a bearing on how planetary boundaries are governed. As the two case studies discussed in this chapter demonstrate, these interactions are often 'relational' (rather than strictly normative) in nature, and a broader approach to institutional reform and coordination would thus be required in order to address them.

A primary form of institutional response to interacting legal regimes – one that could itself be associated with establishing a normative hierarchy – may be centralisation, which would essentially entail 'promoting one decision-making authority over other authorities'.[132] As a number of authors have argued over the years, this could happen, for instance, through strengthening existing international organisations such as UNEP or creating a new World Environment Organization.[133] While the latter course of action has by and large remained a pipe dream, the former has been possible in the past, as illustrated by the replacement of the UNEP Governing Council with a UN Environment Assembly enjoying universal membership of UN member states.

In a similar vein, Fernández and Malwé recently proposed a radical restructuring of the global architecture of multilateral environmental agreements under the umbrella of a new 'Framework Convention on Planetary Boundaries'.[134] In these scholars' vision, the use of such a legal tool could help systematise the plethora of sectoral instruments that already exist, making it possible to define overarching principles that would be applicable to all interactions between regimes targeting different boundary processes. Moreover, especially if compared to the centralisation of decision-making under a single institution, a Framework Convention would provide for greater flexibility and adaptability in the governance of planetary boundaries themselves, in order to cope with a rapidly evolving scientific understanding of Earth system dynamics.

Despite suggesting an institutional rather than strictly normative response, these options would also turn to 'hierarchisation' to address the deeply interconnected nature of planetary

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boundariesinitiative.org/wp-content/uploads/2013/07/The-Kim-Report-September-2013.pdf> accessed 29 May 2020.

[130] Ibid; Rakhyun E Kim and Klaus Bosselmann, 'Operationalizing Sustainable Development: Ecological Integrity as a *Grundnorm* of International Law' (2014) 24 Review of European, Comparative and International Environmental Law 194. See also Kim and Kotzé, Chapter 3 in this book.

[131] Kim and Van Asselt (n 9) 480–83.

[132] Kim et al (n 124) 280.

[133] See Frank Biermann, *Earth System Governance: World Politics in the Anthropocene* (MIT Press 2014) 97ff.

[134] Edgar Fernández Fernández and Claire Malwé, 'The Emergence of the "Planetary Boundaries" Concept in International Environmental Law: A Proposal for a Framework Convention' (2019) 28 Review of European, Comparative and International Environmental Law 48.

boundaries. However, other forms of interplay management exist that may help bridge institutions in a non-hierarchical way, through joint efforts or unilateral attempts at improving coordination.[135] Such categories of interventions have indeed been discussed in the context of planetary boundaries for some time, and studies have been conducted to explore their dynamics in areas such as forest governance,[136] nutrient cycles[137] and the climate–ocean acidification–marine biodiversity nexus.[138] This emerging body of research shows that the degree of institutional coordination that results from non-hierarchical interplay management may vary, ranging from informal arrangements for information- and knowledge-sharing to more structured partnerships and inter-organisational platforms, and even including (although this is less common) some form of shared decision-making.[139] At the same time, a similar approach does not appear to be exclusive to one category of institutions, as it can occur both among and between States, international organisations (including their secretariats) and non-state actors such as private actors, subnational governments and civil society groups.[140]

Regardless of the shape that it may take in practice, non-hierarchical interplay management is therefore likely to be of particular relevance in the context of planetary boundary interactions. We have already mentioned how establishing hierarchies in the international governance of boundary processes could be seen as intrinsically difficult and perhaps even undesirable,[141] despite the fact that there may well be a hierarchy among the boundaries themselves.[142] The same arguments would *a fortiori* apply to planetary boundary interactions, which are similarly driven by a complex set of causes that play out at different temporal and spatial scales, are often surrounded by varying degrees of uncertainty, and concern different sectors of human activity. As a result, we would expect the regimes targeting them to operate in a nested and partially overlapping manner, giving rise to highly polycentric governance systems in which the management of relational interactions (that is, conceptual, regulatory, operational) arguably matters more (and is perhaps more feasible) than the resolution of possible normative or institutional conflicts.[143]

The two case studies discussed in this chapter seem to provide support to this theory. With regard to the boundaries for climate and stratospheric ozone depletion, synergies between the respective regimes have been developed without a centralised institution or legal framework, but rather owing to the progressive spill-over of conceptual framings and regulatory

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[135] Oberthür (n 28) 375–77; Stokke (n 123) 208–9.

[136] Gunilla Reischl, 'Designing Institutions for Governing Planetary Boundaries: Lessons from Global Forest Governance' (2012) 81 Ecological Economics 33, 36.

[137] Hanna Ahlström and Sarah Cornell, 'Governance, Polycentricity and the Global Nitrogen and Phosphorus Cycles' (2018) 79 Environmental Science & Policy 54.

[138] Galaz et al (n 4).

[139] Ibid.

[140] See eg Stokke (n 123) 212–16.

[141] See text accompanying n 30. See also Frank Biermann and Rakhyun E Kim, 'The Boundaries of the Planetary Boundary Framework: A Critical Appraisal of Approaches to Define a "Safe Operating Space" for Humanity' (2020) 45 Annual Review of Environment and Resources 497.

[142] Steffen et al (n 1).

[143] For a discussion of polycentric governance systems in the context of planetary boundaries, see Galaz et al (n 4); Ahlström and Cornell (n 137). See also Elinor Ostrom, 'Polycentric Systems for Coping with Collective Action and Global Environmental Change' (2010) 20 Global Environmental Change 550; and Andrew Jordan et al (eds), *Governing Climate Change: Polycentricity in Action?* (Cambridge University Press 2018).

approaches as well as through the emergence of operational interactions between epistemic communities. In our second case, where the inherent complexities of the hydrological and nutrient cycles are compounded by the cross-scale nature of their boundary processes, hierarchical forms of interplay management have been even less viable, leaving space for a network of partnership initiatives, overlapping guidelines and regulations and mandates to engage in scientific cooperation and knowledge-sharing.

This obviously does not imply that planetary boundary interactions can only be governed through non-hierarchical, *ad hoc* forms of interplay management. First, the fact itself that these arrangements exist does not say anything about the extent to which they actually improve coherence and coordination, including by influencing subsequent legal developments within different regimes. Second, it is also possible that the choice of specific interplay management techniques merely reflects the progressive strengthening of the political and/or scientific consensus around the relevant Earth system interactions. As this consensus evolves, governance arrangements that were meant to be informal or temporary may become institutionalised, and opportunities may emerge for the definition of overarching legal principles and norms or the clarification of existing ones (for example, the duty not to transfer pollution discussed above). What is clear, however, is that norm conflicts and institutional development only constitute one component of a broader governance dilemma. Managing planetary boundary interactions requires the same amount of attention to be devoted to questions of mutual supportiveness, knowledge diffusion and inter-organisational coordination, and in doing so challenges our traditional understanding of how international law can contribute to these goals.

6. CONCLUSIONS

The holistic perspective inherent in the planetary boundaries framework is pushing scholars and practitioners to look beyond the perimeters of individual legal regimes. In particular, the idea that Earth system processes are constantly interacting in ways that are dynamic and not fully understood poses new challenges to the study of regime interactions, underscoring the importance of considering how different international legal regimes are interrelated across, and not just within, discrete sectors and issue areas. Though initially focused on the narrower legalistic question of norm conflicts, studies in this field have started to reveal other channels through which different regimes can influence each other.

This chapter sought to further probe the debate on regime interactions in the context of interconnected Earth system processes, as reflected by the intertwined planetary boundaries. It did so by analysing two instances in which these interfaces – the biophysical one and the governance one – come together in different fashions. In one case, represented by the management of chemical substances with global warming potential through the ozone regime, the relevant governance interactions impinge more directly on the respect of global-level boundaries for climate change and stratospheric ozone depletion. In the other case study, the complex cross-scale dimensions of freshwater use and nutrient flows are mirrored by the fragmented nature of the applicable regimes, thus complicating the bridging of institutions and the development of a common knowledge base.

Overall, the chapter's findings lend support to the notion that managing regime interactions cannot be limited to the solution of norm conflicts or the creation of overarching legal frameworks, but must also emphasise the promotion of conceptual, regulatory and operational synergies between the different types of actors and institutions involved in the relevant legal response.

It is clear, however, that more research is needed to illuminate the multi-faceted implications of interconnected Earth system processes for international law and governance. First, it would be important to conduct additional, in-depth case studies targeting other areas of the planetary boundaries framework. Such studies would have to devote particular attention to those boundary interactions that have strong sub-global operating scales, as these are more likely to be characterised by high levels of institutional fragmentation and lack of overarching governance processes. For example, the interface between the biosphere integrity and land-system change boundaries remains poorly understood from a governance perspective, despite the growing use of integrated assessment models that seek to describe the relationships between the respective social-ecological dynamics.

Second, in line with our argument on the importance of 'relational' interactions beyond conflicting norms, research on international environmental legal regimes could broaden its scope from both a methodological and thematical perspective. On the one hand, this would mean incorporating the interactive exchanges that occur among and between different COPs/MOPs, secretariats, subsidiary bodies and wider epistemic communities more centrally into the analysis, even when such an approach challenges existing perceptions of what exactly constitutes 'international law'. On the other hand, and as a consequence, it would require greater attention to be paid to the role of non-environmental institutions in the management of planetary boundary interactions. Beyond the 'usual suspects' of international economic organisations and trade and investment agreements, it could for example be useful to focus on the interface between international environmental law and all those transnational forms of decision-making that also concur to shape human influence on planetary-level processes, from the industry standards of large producer organisations to regional economic development strategies and their impacts on land-use patterns.

8. Changing role of law-making in responding to planetary boundaries?

Giovanna M. Frisso and Elizabeth A. Kirk

1. INTRODUCTION

Legal discourse on the potential of law to help ensure that human behaviour does not breach the planetary boundaries tends to focus on areas in which the law can be improved to prevent further reductions in the carrying capacity of the Earth caused by human actions. New measures are proposed to give the Earth time to recover from human activities. This discourse rests on the assumption that it is possible to tweak existing international and national laws, and through that to nudge States and individuals into behaving in ways that do not threaten the Earth system's planetary boundaries. The result is that laws are adopted, for example, to reduce the use of certain single-use plastics,[1] but no laws are adopted to stop the use of oil-based plastics completely.[2] Similarly, while treaties exist to place limits on certain activities, they appear ineffective. For example, while the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) exists to limit trade in endangered species,[3] more and more species are added to the list of those that are endangered, either in treaty agreements or in scientific papers.[4]

In examining these discourses, we highlight their limits as a framework for safeguarding the Earth's planetary boundaries and explore possible alternatives. In particular, we focus on the need to embrace an understanding of the relationship between humans and our environment that is found in a variety of cultures which are often overlooked at present. Such a move risks being undermined by the autopoietic nature of law and so we propose that, in order to minimise this risk, the focus of legal discourse must move from rights to responsibilities.

2. THE ROOTS OF CURRENT APPROACHES

A number of international treaties have been adopted which are directly relevant to preventing breaches of the planetary boundaries. For instance, threats to stratospheric ozone are addressed

1 See for example the Single Use Carrier Bags Charges (England) Order 2015.

2 Elizabeth A Kirk and Naporn Popattanachai, 'Marine Plastics: Fragmentation, Effectiveness and Legitimacy in International Law-making' (2018) 27 Review of European, Comparative and International Environmental Law 222.

3 Convention on International Trade in Endangered Species of Wild Fauna and Flora (adopted 3 March 1973, entered into force 1 July 1975) 993 UNTS 243.

4 Justin Worland, 'There Are More Endangered Species than Ever: Here's What to Know on Endangered Species Day' *Time* (18 May 2017).

most clearly through the Ozone Convention,[5] and climate change is addressed through the United Nations Framework Convention on Climate Change (UNFCCC).[6] Both conventions are also relevant to addressing aerosol loading, which is also governed by agreements such as the Convention on Long-range Transboundary Air Pollution.[7] Threats to the biosphere and ecosystems are addressed primarily through the Convention on Biological Diversity (CBD),[8] and through treaties which focus on particular ecosystems (such as the 1980 Convention for the Conservation of Antarctic Marine Living Resources)[9] or on particular aspects of ecosystem management (such as the 1995 Fish Stocks Agreement).[10] Chemical pollution is addressed through a series of treaties focused on particular types of pollutant, such as the Stockholm Convention on Persistent Organic Pollutants[11] and the Minamata Convention[12] addressing pollution from mercury, and treaties addressing pollutants in particular regions, such as the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention),[13] which tackles marine pollution in the North-East Atlantic. Certain planetary boundaries are less obviously addressed by international agreements. Ocean acidification is, for example, indirectly addressed through the United Nations Convention on the Law of the Sea (UNCLOS),[14] the UNFCCC and the CBD. Nitrogen and phosphorous flows are also addressed indirectly through UNCLOS, but more directly through regional seas agreements such as the OSPAR Convention.[15] Land system change is addressed through the Convention

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5 Vienna Convention for the Protection of the Ozone Layer (adopted 22 March 1985, entered into force 22 September 1988) 1513 UNTS 293.

6 United Nations Framework Convention on Climate Change (adopted 9 May 1992, entered into force 21 March 1994) 1771 UNTS 107 4. See, respectively, Du Toit, Chapter 14, and Verschuuren, Chapter 13, in this book.

7 Convention on Long-range Transboundary Air Pollution (adopted 13 November 1979, entered into force 16 March 1983) 1302 UNTS 217.

8 Convention on Biological Diversity (adopted 5 June 1992, entered into force 29 December 1993) 1760 UNTS 79.

9 Convention on the Conservation of Antarctic Marine Living Resources (adopted 5 May 1980, entered into force 7 April 1982) 1329 UNTS 47.

10 Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (adopted 4 August 1995, entered into force 11 December 2001) 2167 UNTS 3. See also Somsen and Trouwborst, Chapter 12 in this book.

11 Stockholm Convention on Persistent Organic Pollutants (adopted 22 May 2001, entered into force 17 May 2004) 2256 UNTS 119.

12 Minamata Convention on Mercury (adopted 10 October 2013, entered into force 16 August 2017) UNTS treaty number No. 54669 (no volume number has yet been allocated).

13 Convention for the Protection of the Marine Environment of the North-East Atlantic (adopted 22 September 1992, entered into force 25 March 1998) 1992 2354 UNTS 67. See also Paloniitty, Nzegwu and French, Chapter 20 in this book.

14 United Nations Framework Convention on Climate Change (adopted 9 May 1992, entered into force 21 March 1994) 1992 1771 UNTS 107.

15 Convention on the Protection of the Marine Environment of the Baltic Sea 1992 (adopted 9 April 1992, entered into force 17 January 2000) 2009 UNTS 195. See also Diz, Chapter 17 in this book.

on Desertification[16] and through soft law instruments on forest management,[17] but there is little directly addressing issues such as increasing urbanisation.[18]

Besides the obvious gaps in coverage, in terms of preventing breaches of the planetary boundaries, four key issues arise with these treaties. The first relates to the monitoring and enforcement of State obligations and the second to the nature of the obligations found within treaties. Both issues arise because each treaty is developed from the assumption that States have sovereignty over their territory and thus have the right to use that territory and the resources in it as they wish, provided they do not cause harm to the territory, interests or rights of other States.[19] The third issue is that our laws and legal systems are largely based on the idea(l)s of (economic) development and commodification of nature as a means to achieve that development.[20] One final issue, evident in treaties and international law more generally, is that international law is directed mainly to States as the primary actors in international law and this, in combination with the primacy of sovereignty, prevents it from really addressing the problematic behaviours and actions ascribed to certain non-State actors, particularly multinational companies (MNCs), despite the fact that these companies benefit from the ideological and practical advantages related to their corporate juridical subjectivity.[21]

2.1 Monitoring, Enforcement and the Nature of Treaty Obligations

While some of the treaties contain monitoring provisions, with States required to report on the actions they have taken, enforcement action against States that fail to meet agreed targets are often weak or non-existent.[22] To those new to international law, this construction of a legal system appears odd. Those subject to the law both make it and enforce it, and in practice there is little enforcement action unless one State believes that it has been or will be harmed by the actions of another, or by their failure to act. For example, Ireland pursued the United Kingdom (UK) over potential radioactive pollution release from the MOX plant because it foresaw a direct threat to its fisheries activities in the Irish Sea, and consequently to its economy,[23] but without such direct links any attempts at enforcement of obligations by individual States are

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[16] United Nations Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa 1994 (adopted 14 October 1994, entered into force 26 December 1996) 1954 UNTS 3. See Morrow, Chapter 19 in this book.

[17] See for example the Non-Legally Binding Authoritative Statement of Principles for a Global Consensus on the Management, Conservation and Sustainable Development of all Types of Forests (13 June 1992) UN Doc A/CONF.151/6/Rev.1.

[18] See Aust and Nijman, Chapter 6 in this book.

[19] *Canada v United States* [1938, 1941] 3 RIAA 1905.

[20] See Sam Adelman, 'Rio+20: Sustainable Injustice in a Time of Crises' (2013) 4(1) Journal of Human Rights and the Environment, 6; Sam Adelman, 'Between the Scylla of Sovereignty and the Charybdis of Human Rights: The Pitfalls of Development in Pursuit of Justice' (2008) 2 Human Rights and International Legal Discourse 17; and Adelman, Chapter 4 in this book.

[21] Anna Grear, *Redirecting Human Rights: Facing the Challenge of Corporate Legal Humanity* (Palgrave Macmillan 2010); Anna M Grear, 'Towards a New Horizon: In Search of a Renewing Socio-Juridical Imaginary' (2013) 3(5) Oñati Socio-Legal Series, 980. See also Kim and Kotzé, Chapter 3 in this book.

[22] See, for a detailed discussion, Ebbesson, Chapter 10 in this book.

[23] *Ireland v United Kingdom* [2001] *ITLOS* 10 95. The provisional measure order required the UK and Ireland to 'exchange further information with regard to possible consequences for the Irish Sea arising out of the commissioning of the MOX plant, monitor risks or the effects of the MOX plant for

unlikely. Thus, for example, the UNFCCC and related agreements provide for reporting by parties of compliance with their targets to reduce greenhouse gas emissions, but there is no real enforcement action where States fail to meet their targets. Under the Paris Agreement, for example, the model adopted focuses on facilitation and support, rather than the adoption of punitive measures.[24]

Distinctions in existing enforcement mechanisms partly rest upon the ease or difficulty of demonstrating causation. Whereas it is challenging in the extreme to demonstrate that a particular harm, such as the loss of crops caused by increased drought, is directly linked to greenhouse gas emissions from any given State, it is relatively straightforward to demonstrate that radioactive pollution has emanated from a particular State. In part the general lack of enforcement, particularly in relation to global problems such as climate change, can be traced to the primacy of the concept of sovereignty within the Westphalian system of international law, which is designed to prevent the universal hegemony of any given State or ruling party,[25] and to protect States from external interference.[26]

From the clear enunciation of the rule that sovereignty over a territory prevents interference by other States in the Island of Palmas Case,[27] to its repetition in the United Nations (UN) Charter,[28] sovereignty underpins our modern international legal system. The principle of non-interference which is integral to it serves as a limit to the possibility of interference in activities that are seen as internal to States. This presents a challenge in terms of preventing breaches of the planetary boundaries, as enforcement of obligations rests upon an identifiable harm traceable to an identifiable cause within a State or States' territory/ies. The problem here is that the nature of the planetary boundaries is such that the chain of causation is not always easily established.[29] For example, ocean acidification is caused by increased absorption of carbon dioxide and, as with climate change, it is not easy to link the specific increases in acidification to any one State's emissions. Similarly, aerosol loading is affected by myriad emissions of different types from different States. While some, such as chlorofluorocarbons (CFCs), may be traceable,[30] others may not be so easily traced to their source. In addition, some of the planetary boundaries may be breached without harm actually occurring for the purpose of international environmental law. For example, the biosphere may be severely

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the Irish Sea and devise, as appropriate, measures to prevent pollution of the marine environment which might result from the operation of the MOX plant'.

[24] On compliance and enforcement models see Jutta Brunnée, 'Multilateral Environmental Agreements and the Compliance Continuum' in Gerd Winter (ed), *Transnational Governance of Environmental Change* (Cambridge University Press 2005).

[25] Hedley Bull, *The Anarchical Society: A Study of Order in World Politics* (Macmillan 1977).

[26] But see Andreas Osiander, 'Sovereignty, International Relations, and the Westphalian Myth' (2001) 55(2) International Organization 251, where Osiander argues that the Peace of Westphalia was not designed to codify the concepts of sovereignty and non-interference in the affairs of other States.

[27] *Netherlands v United States* [1928] 2 RIAA 829.

[28] Charter of the United Nations 1945 (adopted 26 June 1945, entered into force 24 October 1945), art 2(7) provides: 'Nothing contained in the present Charter shall authorize the United Nations to intervene in matters which are essentially within the domestic jurisdiction of any state or shall require the Members to submit such matters to settlement under the present Charter'.

[29] See, for example, the discussion in Bleby, Holley and Milligan, Chapter 2 in this book, on the difficulty/inappropriateness of downscaling the planetary boundaries.

[30] Matt Rigby et al, 'Increase in CFC-11 Emissions from Eastern China based on Atmospheric Observations' (2019) 569 Nature 546.

harmed through degradation of ecosystems which lie wholly within the jurisdiction of individual States. Removal of forest cover is not ostensibly an issue in international law if the forest is found wholly within the jurisdiction of a single State, as there is no obvious harm to another State; so too with eradication of non-migratory species within a single State (such as beavers in the UK). Nonetheless, these actions may in combination lead to a breach of the biosphere's integrity, or harm to the other planetary boundaries, or may undermine measures to mitigate climate change. The management of wetlands, for example, can play a key role in the treatment of landfill leachate[31] and in managing nitrogen flows,[32] but it will most often be undertaken by a single State without any (legal) need to address a potential harm to other States, as there is no perceived potential transboundary harm. While States may be subject to obligations under global or regional treaties relevant to their management, such as the Ramsar Convention,[33] or provisions, such as Article 3 of the OSPAR Convention, they have considerable discretion as to how to meet these obligations. In addition, policing breaches can be problematic as the inviolability of sovereignty prevents independent inspections being carried out.

Enforcement problems also arise where a harm occurs to or in an area beyond national jurisdiction, such as the overfishing of fish stocks in the high seas, or degradation of the high seas' ecosystem from pollution. If no State can show its interests have been harmed by such acts, then the chances of any form of enforcement being taken are slim.

2.2 The Nature of Obligations

The concept of sovereignty also lies at the root of the second issue with international treaty obligations relevant to preventing breaches of the planetary boundaries. While it would be ideal to take precautionary action to protect the world from reaching or breaching the planetary boundaries,[34] there is some debate over the extent to which such an approach is required.[35] Moreover, such action is not easily taken in international law. In treaty practice, for example, the 'precautionary approach' has tended only to be embraced in relation to highly risky activities such as dumping at sea.[36] In such cases, while the language used in treaty texts may point to the use of a precautionary approach, the degree of risk attached to the activity is so high that the measures may more accurately be characterised as preventive in nature. Equally, preventive action is only taken where there is both strong scientific agreement as to the impacts of a particular activity or product (such as depletion of the ozone layer by CFCs,

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31 Margit Kõiv et al, 'The Performance of Peat-filled Subsurface Flow Filters Treating Landfill Leachate and Municipal Wastewater' (2009) 35(2) Ecological Engineering 204.

32 Sheng Zhou, Yutaka Nakashimada, and Masaaki Hosomi 'Nitrogen Transformations in Vertical Flow Systems With and Without Rice (Oryza sativa) Studied with a High-resolution Soil–Water Profiler' (2009) 35 (2) Ecological Engineering 213.

33 Convention on Wetlands of International Importance Especially as Waterfowl Habitat 1971 (adopted 2 February 1971, entered into force 21 December 1975) 995 UNTS 245.

34 On the concept of precaution in law see, for example, Arie Trouwbost, 'The Precautionary Principle in General International Law: Combating the Babylonian Confusion' (2007) 16 Review of European, Comparative and International Environmental Law 185; Arie Trouwborst, *Precautionary Rights and Duties of States* (Martinus Nijhoff Publishers 2006).

35 See Bleby, Holley and Milligan, Chapter 2 in this book.

36 See, for example, the Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wates and Other Matter, London, (adopted 7 November 1996, entered into force 24 March 2006) 36 ILM 1.

mercury poisoning and pollution from persistent organic pollutants) and broad political will among States to act. For example, plastics were until relatively recently not perceived of as a problematic material. It has only been as plastic accumulation in the oceans and on land has increased (oceans plastics have increased from around 5 million tonnes in the 1950s to more than 300 million tonnes today)[37] that plastics have been recognised as problematic materials requiring a legal response. Now States are beginning to adopt measures to tackle plastics pollution, but the political will is not yet present to adopt a treaty that severely restricts plastics pollution, and there is no strong consensus as to the measures to adopt globally to tackle this problem.[38] Similarly, while the scientific consensus on the causes of the climate emergency are clear, political will and agreement on how to address it is limited. But lack of political will is not confined to highly complex problems such as climate change and plastics pollution; it is also evident in much more straightforward problems such as overfishing. The high financial rewards from overfishing, combined with the fact that ever-declining fish stocks remain a concern, mean that even where scientific evidence points to the need to reduce or even ban fishing of certain stocks, it can prove extremely difficult to adopt measures to effectively manage fish stocks.[39]

The primacy of the notion of sovereignty in the international system, when combined with the primacy of the liberal market economy and conceptions of 'development' within the global community, make generating the political will to act to address potential and even recognised threats problematic.[40] In this context, the determinative and structural role of State consent in international law-making further challenges the achievement of an effective international regime.[41] It might either prevent any agreement being reached or weaken the content of an agreement where attempts to achieve a common agreement or to reconcile different views lead to the adoption of weak or ambiguous provisions. And even when an agreement is reached, it might not enter into force for several years, especially when controversial or ambiguous measures cause States to withhold ratification of the treaty.[42] Sovereignty, and its expression in the form of consent, also limits the ability of individual States to take action – for example, in the form of trade sanctions – to persuade/force others to adopt particular behaviours.

2.3 The Idea(l) of Development

Perhaps the key stumbling block to adopting effective measures for global environmental protection and for preventing breaches of the planetary boundaries is that any negotiation or

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37 Richard C Thomson, 'Future of the Sea: Plastic Pollution' (Foresight, Government Office for Science, 2017) 5.

38 See, for example, Kirk and Popattanachai (n 2); Ina Tessnow-von Wysocki and Philippe Le Billion, 'Plastics at Sea: Treaty Design for a Global Solution to Marine Plastic Pollution' (2019) 100 Environmental Science and Policy 94.

39 Seth Korman, 'International Management of a High Sea Fishery: Political and Property-Rights Solutions and the Atlantic Bluefin' (2011) 51 Virginia Journal of International Law 697.

40 See Adelman, Chapter 4 in this book.

41 Similarly, issues of consent can stand in the way of effective enforcement or dispute settlement: Duncan French, 'Compulsory Inter-State Adjudication in the Anthropocene: Achieving the Paradoxical?' in Jacques Hartmann and Urfan Khaliq (eds), *The Achievements of International Law: Essays in Honour of Robin Churchill* (Hart Publishing 2020).

42 Geoffrey Palmer, 'New Ways to Make International Environmental Law' (1992) 86 American Journal of International Law 259.

implementation of international agreements takes place in the context of a system which continues to posit the idea(l) of development as the norm to which to aspire. Thus

> [d]eveloping countries rightly yearn to catch up with the living standards enjoyed in developed countries … If the Earth's natural resource base were infinite, catching up by developing countries, continued growth in high-income countries, and further global population growth, would all be relatively straightforward. To catch up with the rich countries, the developing countries would invest in technology, infrastructure, and human capital (especially health and education), and step by step, would narrow the income gap with today's high-income countries … That, after all, is the current trajectory of Brazil, China, and India. It is also the preceding path of Japan and Korea. It is the hoped-for path of Africa as well.[43]

In this system, the developed world continues to be presented as the future of the developing world, and the present of the developing world as the past of the developed world.[44] Thus, although alternative visions exist in theory at least,[45] the generally accepted view is that some countries have attained a state of 'development' towards which the others are striving, and which can only be reached through the increasing commodification of nature. In this conception of development, the focus is on the efficient appropriation of nature and the dream of material comfort.

This view of development – which reduces nature to 'a mere appendage',[46] to be managed through law, science and technology[47] – has been evident in international law since the first major UN conference on natural resources, the 1949 UN Scientific Conference on Conservation and Utilization of Natural Resources. States that took part in the conference discussed how economic utilisation could be combined with ecologically sound management of natural resources. This view of environment as an appendage to be managed is still obvious in provisions relating to the management of shared resources such as fish stocks[48] and shared watercourses,[49] where provision is made for economic interests to be considered in setting optimum or equitable utilisation alongside, or in priority to, environmental issues.[50] More than this, however, this view of the environment as something for humans to use or manage as they wish underpins the approach to environmental issues in international law in general. Thus, treaties focused on conservation of biodiversity still recognise the use of resources as

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43 Johan Rockström et al, 'Sustainable Development and Planetary Boundaries' (2013) Background research paper for the UN High-Level Panel of Eminent Persons on the Post-2015 Development Agenda 2 <www.eesc.europa.eu/resources/docs/sustainable-development-and-planetary-boundaries.pdf> accessed 1 April 2020.

44 Sundhya Pahuja, 'Changing the World: The Ethical Impulse and International Law' in Raimond Gaita and Gerry Simpson (eds), *Who's Afraid of International Law*? (Monash University Press 2017).

45 See, for example, Eduardo Gudynas, 'Value, Growth, Development: South American Lessons for a New Ecopolitics' (2019) 30(2) Capitalism Nature Socialism 234–43; Adelman, Chapter 4 in this book.

46 Arturo Escobar, *Encountering Development: The Making and Unmaking of the Third World* (Princeton University Press 1995) 37.

47 Björn-Ola Linnér, 'The Cocoyoc Declaration: How It All Began: Global Efforts on Sustainable Development from Stockholm to Rio' (6th Nordic Conference on Environmental Social Sciences, 2003).

48 United Nations Convention on the Law of the Sea (adopted 10 December 1982, entered into force 16 November 1994) 1833 UNTS 3 (UNCLOS) part V.

49 Convention on the Law of the Non-Navigational Uses of International Watercourses 1997 (adopted 21 May 1997, entered into force 17 August 2004) 2999 UNTS Document I-52106 (Watercourses Convention).

50 See the Watercourses Convention arts 5 and 6 and UNCLOS art 61.

a legitimate and allowable activity. Treaties addressing pollution both depart from and fully embrace the assumption that pollution is an inevitable by-product of resource use. States are most usually merely enjoined to prevent, reduce or control pollution, with the emphasis generally on the reduction or control of pollution in all but the most hazardous of cases. As Porto-Goncalves and Leff note, the environment 'has been captured by the logics of the market and its financial strategies, as well as by normal science, ignoring the power relations that cut across the geopolitics of biodiversity and sustainable development that extends, intensifies and complexifies previous processes of destructive appropriation of natural resources'.[51] In terms of such a framing, our understanding of nature has been relegated to its being an asset, its value equated to its usefulness to human beings. Such a notion of human development at the expense of nature has now become central to environmental debates,[52] including those concerning planetary boundaries. It also underpins, in part at least, the hostility of some States in the global south to the imposition of limits to growth inherent in concepts such as the planetary boundaries.[53]

These views of development and of the environment disregard different forms of relating to nature – forms that require not only the technical thematisation of nature, but also the ability to experience it. In particular, the views of those who are 'beyond development', that is, those who are usually viewed as underdeveloped, tend to be disregarded. As explained by Mignolo, to be considered '"underdeveloped" in a highly industrialized world also implies being "behind" in spirit and knowledge'.[54]

While there are some attempts now to draw in other understandings and other voices to the development or implementation of international law, for example through measures for public participation in international decision-making, these measures tend to be rather limited. They are largely functional in nature, designed to draw in additional information to be used in decision-making that fits within these conceptions of development and of the environment, rather than to challenge existing conceptions.[55] As Zhouri, for example, notes in relation to environmental impact assessment procedures,

> The language of impact, hegemonic within the sustainable environment discourse, presupposes the environment as an objective reality independent and separated from society. As an object, the environment is to be analyzed in the light of scientific knowledge and technical assessment. As a consequence, other epistemologies and knowledges are disregarded as legitimate environmental

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[51] Carlos Walter Porto-Gonçalves and Enrique Leff, 'Political Ecology in Latin America: the Social Re-Appropriation of Nature, the Reinvention of Territories and the Construction of an Environmental Rationality' (2015) 35 Desenvolvimento e Meio Ambiente 65, 70.

[52] It is interesting to note that continued development, even at the cost of some environmental degradation, was believed not only to be good for the environment in the long run, but also to be 'the only answer to many of the environmental problems' of developing countries. Ibid; see also Picard and Barsalou, Chapter 11 in this book.

[53] See Kim and Kotzé, Chapter 3 in this book.

[54] Walter Mignolo, 'Delinking: The Rhetoric of Modernity, the Logic of Coloniality and the Grammar of De-coloniality' (2007) 21 Cultural Studies, 449, 473.

[55] Elizabeth A Kirk, 'The Role of Non-State Actors in Treaty Regimes for the Protection of Marine Biodiversity' in Michael Bowman and Edward Goodwin (eds), *Research Handbook on Biodiversity and Law* (Edward Elgar 2016) 95; Pia Marchegiani, Elisa Morgera and Louisa Parks, 'Indigenous Peoples' Rights to Natural Resources in Argentina: The Challenges of Impact Assessment, Consent and Fair and Equitable Benefit-sharing in Cases of Lithium Mining' (2020) 24 The International Journal of Human Rights 224.

> perceptions and discourses within the environmental field, a fact that contributes to the increase of inequalities and the perpetuation of the coloniality of knowledge and power.[56]

Thus, procedural arrangements such as environment impact assessments that enable public participation simply become costly legitimation tools for the dominant world view. They do not provide an institutional space in which the meaning of development, sustainability, boundaries and a safe operating space can be contested. Nor do they provide an opportunity to really learn the true extent and scope of potential environmental and human impacts associated with development. The experience of the Krenak indigenous communities affected by the Samarco dam disaster in Brazil illustrates this issue rather clearly. As the 13-year-old Krenak activist Kathy Krenak explained: 'The name "Krenak" means "People of the River". Basically, it's our life. [The flood] ends up killing the Krenak people.'[57]

Even where this reductive relationship with nature is challenged on the international stage, those challenges often fail to change the path of commodification. For example, the indigenous peoples represented in the First International Forum of Indigenous Peoples on Climate Change, held in Lyon, France in September 2000, rejected the inclusion of carbon sinks under the Clean Development Mechanism (CDM) because:

> it reduces our sacred land and territories to mere carbon sequestration which is contrary to our worldviews and philosophy of life. Sinks in the CDM would constitute a worldwide strategy for expropriating our lands and territories and violating our fundamental rights that would culminate in a new form of colonialism. Sinks in the CDM would not help to reduce GHG [greenhouse gas] emissions; rather it would provide industrialized countries with a ploy to avoid reducing their emissions at source ... the CDM pose the threat of invasion and loss of our land and territories by establishing new regimes for protected areas and privatization. We emphatically oppose the inclusion of sinks, plantations, nuclear power, mega-hydroelectric and coal. Furthermore, we oppose the development of a carbon market that would broaden the scope of globalization.[58]

Nevertheless, a carbon market has been created and the use of technical and market-oriented solutions not only for (under)development, but also for environmental problems, has been reinforced. As such, the international debate, including our responsibility towards the environment, is monetised. Thus the climate change regime 'does not seek to fundamentally change consumption and/or carbon-intensive lifestyles, rather allowing for a continuation of existing practices until ecological thresholds are reached'.[59] The consequence is that the development of a 'throw-away society' was and remains inevitable. Valuable resources such as rare earth

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56 Andreá Zhouri, Working Paper 75 'Mapping Environmental Inequalities in Brazil' (2014), desiguALdades.net International Research Network on Interdependent Inequalities in Latin America <www.desigualdades.net/Working_Papers/Search-Working-Papers/working-paper-75-_mapping-environmental-inequalities-in-brazil_/index.html> accessed 2 April 2020.

57 Jonathan G Wald, 'Feral Disasters, Feral Recovery: Ecosystem-based Disaster Risk Reduction and the Governance of Nature' (Feral: A Nearly Carbon-neutral Conference, 2018) 1.

58 Porto-Gonçalves and Leff (n 51) 70.

59 Rowena Maguire, 'Gender, Climate Change and the United Nations Framework Convention on Climate Change' in Susan H Rimmer and Kate Ogg (eds), *Research Handbook on Feminist Engagement with International Law* (Edward Elgar 2019) 76.

minerals, phosphorous[60] and even the (apparently plentiful) hydrocarbons used in the production of plastics and in transport and heating are simply used and discarded as waste.

Such a monetised and development-focused vision of environmental protection also leads to tensions between developed and developing States that play out in the negotiation and creation of treaty regimes. In some contexts, this tension manifests in the actions taken by those States which already have access to a particular market or resource (such as States which fish a particular fish stock) to exclude other States from the market and from the opportunity to use the resource. Such practices can also occur when creating new treaty regimes, such as in the development of regimes to address tuna fishing.[61]

In other contexts, the tension is played out through negotiations on questions of access and benefit sharing. We see this in numerous regimes, ranging from the CBD, to management and use of the deep seabed under the UN Convention on the Law of the Sea,[62] to the control of global diseases.[63] These debates centre on questions of equity with regard to who has the capacity to access resources and who gains benefits from their exploitation. The key issue for our present purposes is that these debates largely centre on use and commodification of nature,[64] even when they arise in the context of regimes, such as the CBD, which have apparently been designed with conservation as their main aim. As a result, the dominant liberal market discourse remains largely unchallenged.

2.4 States as Primary Actors

The final factor we consider is the focus of international law, which primarily remains directed at States. While non-State actors have (increasing) rights to participate in international law, whether in the policy-making process[65] or in enforcement of their own rights,[66] holding non-State actors, and in particular corporate actors, to account for environmental harms in international law is problematic. Many of the activities that threaten the planetary boundaries

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[60] Martin Blackwell, Tegan Darch and Richard Haslam, 'Phosphorus Use Efficiency and Fertilizers: Future Opportunities for Improvements' (2019) 6(4) Frontiers of Agricultural Science and Engineering 332.

[61] Organisation for Economic Cooperation and Development (OECD) *Strengthening Regional Fisheries Management Organisations* (OECD Publishing 2009) 53.

[62] See generally Elisa Morgera, 'The Need for an International Legal Concept of Fair and Equitable Benefit-sharing' (2016) 27 European Journal of International Law 353.

[63] Stephanie Switzer et al, 'Biodiversity, Pathogen Sharing and International Law' in Stephania Negri (ed), *Environmental Health in International and EU Law: Current Challenges and Legal Responses* (Routledge 2019) 253.

[64] But see Elisa Morgera, 'Under the radar: The Role of Fair and Equitable Benefit-Sharing in Protecting and Realising Human Rights Connected to Natural Resources' (2019) 23 (7) International Journal of Hospital Research 1098.

[65] See, for example, Steve Charnovitz, 'Two Centuries of Participation: NGOs and International Governance' (1996–97) 18 Michigan Journal of International Law 183.

[66] As well as rights under various human rights treaties to bring legal actions in court or raise complaints at compliance commissions against States, individuals have rights of petition to the compliance commission under the 1998 Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (Aarhus Convention) (adopted 25 June 1998, entered into force 30 October 2001) 2161 UNTS 447. These latter rights are interesting in that they focus on access to information, and so on, in relation to the environment rather than the direct protection of individual human rights seen within human rights treaties.

are undertaken by corporations, often multinational ones; the rights and duties of these are primarily governed by the laws of the States in which they are registered or operate.[67] Holding such actors to account is problematic, particularly where low-value subsidiary companies are established to undertake risky activities such as extraction of oil and gas. Problems are most obvious where large MNCs extract minerals, oil or gas in countries in the global south, particularly when these countries have rather weak environmental regulations in order to stimulate economic growth and investment. Here the disparities in the financial, technical and human resources between corporations and States can be significant. The MNCs, which may have resources many times the size of the resources of the State in question, will often be able to negotiate agreements in their favour,[68] or simply to walk away when damage, liability and costs arise. The assignment of responsibility to MNCs also presents legal challenges as the host State might fail to exercise its regulatory obligations.[69]

Even though company law and tort law can be used to hold a parent company liable, they set demanding thresholds which make holding companies to account difficult.[70] In addition, most domestic systems seem to require a territorial nexus for the exercise of jurisdiction, imposing further challenges to the judicial determination of parent companies' liability for the harm caused by their subsidiary(ies).[71] Without an international court with jurisdiction over corporate abuses, international law also fails to offer a relevant framework to deal with the accountability of MNCs.[72]

While cases such as *Vedanta*[73] suggest that instances of parent companies avoiding liability may be reducing, at present, most corporate actors still do not incur sufficient liability for their socio-ecological destructive activities. At the same time, other types of non-State actors, such as those operating in organised crime, exploit gaps in enforcement by States to illegally

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67 *Belgium v Spain* [1970] ICJ Reports 3. See also Kim and Kotzé, Chapter 3 in this book.

68 See, for example, Thomas W. Wälde, 'Renegotiating Acquired Rights in the Oil and Gas Industries: Industry and Political Cycles Meet the Rule of Law' (2009) 1 Journal of World Energy Law & Business 55.

69 As happened, for example, when Trafigura dumped toxic waste in Cote d'Ivoire. Côte d'Ivoire chose to give the company immunity from prosecution. See Amnesty International and Greenpeace Netherlands, *The Toxic Truth: About a Company Called Trafigura, a Ship Called the Probo Koala, and the Dumping of Toxic Waste in Côte d'Ivoire* (Amnesty International/Greenpeace Netherlands 2012).

70 Radu Mares, 'Liability within Corporate Groups: Parent Company's Accountability for Subsidiary Human Rights Abuses' in Surya Deba and David Birchall (eds), *Research Handbook on Human Rights and Businesses* (Edward Elgar 2020).

71 Chilenye Nwapi, 'Jurisdiction by Necessity and the Regulation of Transnational Corporations' (2014) 30(78) Utrecht Journal of International and European Law 24.

72 Olivier de Schutter, 'Regulating Transnational Corporations: A Duty under International Human Rights Law' (2014) Contribution of the Special Rapporteur on the right to food, Mr Olivier De Schutter, to the workshop 'Human Rights and Transnational Corporations: Paving the way for a legally binding instrument' convened by Ecuador, 11–12 March 2014, during the 25th session of the Human Rights Council <www.ohchr.org/Documents/Issues/Food/EcuadorMtgBusinessAndHR.pdf> accessed 2 April 2020.

73 *Vedanta Resources PLC and another (Appellants) v Lungowe and others (Respondents)* [2019] UKSC 20. In this case, the UK Supreme Court decided that the claim brought by 1826 Zambian villagers in 2015 against the UK-based Vedanta and its subsidiary KCM could proceed to trial on the substantive issues in English courts. The claimants alleged that they had suffered personal injury, damage to property and loss of income, amenity and enjoyment of land as a result of the alleged pollution and environmental damage caused by discharges of harmful substances from the Nchanga copper mine into local waterways since 2005.

trade species, or to sell illegally captured animal products across borders.[74] The international legal system based on the primacy of State sovereignty prevents us from comprehensively and effectively tackling deeply persistent problems such as these.

3. PREVENTING OR ADAPTING TO BREACHES OF THE PLANETARY BOUNDARIES

There are two directions in which international law-making could travel to address the multiple and varied concerns discussed above. The first would be to undertake a fundamental review of existing legal provisions and their relationship to commodification, including a review of the ethics underpinning these laws. This might see land rights, fishing rights, drilling rights, shareholder rights, intellectual property rights and State sovereignty, for example, all being reconsidered in a critical way. A second option could be to focus on how we respond to the socio-ecological constraints placed upon our society in light of the fact that we have already crossed several planetary boundaries and threaten to cross others. On balance, it seems as if the international community has chosen to focus most of its attention on the second option. For example, climate change is increasingly considered through the lens of adaptation, be that how to manage retreating coastlines as a result of sea-level rise,[75] or how to manage extreme weather events such as flooding,[76] or how to address the movements of fish stocks,[77] or through consideration of the systems needed to manage disease vectors modified by climate change.[78] In the majority of instances, however, we neither consciously adapt to the fact that we are hurtling towards breach of the planetary boundaries, nor take measures that are adequate to slow or stop our encroachment onto the boundaries. We 'adapt' to the growing waste produced by our throw-away society through improved collection and recycling,[79] and better commu-

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74 See, for example, Daan van Uhm and Dina Siegel, 'The Illegal Trade in Black Caviar' (2016) 19 Trends in Organized Crime 67.

75 Vera Köpsel and Cormac Walsh, 'Coastal Landscapes for Whom? Adaptation Challenges and Landscape Management in Cornwall' (2018) 97 Marine Policy 278.

76 See, for example, Ruth Dittrich et al, 'Making Real Options Analysis More Accessible for Climate Change Adaptation: An Application to Afforestation as a Flood Management Measure in the Scottish Borders' (2019) 245 Journal of Environmental Management 338; Tahmina Akter et al, 'Impacts of Climate and Land Use Changes on Flood Risk Management for the Schijn River, Belgium' (2018) 89 Environmental Science and Policy 163.

77 Manuel Barange et al (eds), *Impacts of Climate Change on Fisheries and Aquaculture: Synthesis of Current Knowledge, Adaptation and Mitigation Options* (FAO Fisheries and Aquaculture Technical Paper 2018) 627.

78 Victor Galaz, *Global Environmental Governance, Technology and Politics: The Anthropocene Gap* (Edward Elgar 2014).

79 See Rafia Afroz et al, 'The Knowledge, Awareness, Attitude and Motivational Analysis of Plastic Waste and Household Perspective in Malaysia' (2017) 24 Journal of Environmental Science and Pollution Research 2304; Josh Gabbatiss, 'Plastic-eating Enzyme Accidentally Created by Scientists Could Help Solve Pollution Crisis' *The Independent* (16 April 2018); Melissae Fellett, 'Improving a Plastic-degrading Enzyme for Better PET Recycling: Adding Sugars to A Cutinase Enzyme Makes It More Effective at Breaking Down Polyethylene Terephthalate', *Chemical and Engineering News* 28 February 2018.

nication between importers and exporters,[80] rather than modification of consumption patterns to produce less waste. Energy efficiency measures are encouraged[81] while new frontiers are opened up to enable further exploitation of hydrocarbons and minerals in the deep seabed,[82] ignoring the fact that in opening these areas to exploitation we risk further reductions in biodiversity, and further pollution by chemicals, thus continuing our journey towards breaches of the planetary boundaries.

We suggest there is a further problem should we choose to make adaptation the primary norm of law as its role changes in light of breaches or threatened breaches of the planetary boundaries. That problem is that there are some environmental changes (such as the loss of pollinators) to which we may never be able to adapt. We therefore turn to focus our discussion on the first route – addressing the relationship between rights and commodification.

3.1 Law, Rights and Commodification

Law has played two roles in relation to commodification: both granting exclusive access to resources and providing routes to control activities. Although the right to property has 'played a crucial role […] in turning interconnected ecosystems into realms of infinite commodification and exchange, and in extracting and conceptually separating an atomized human individual from the intertwined mesh of life',[83] at the same time it is one of the oldest means of legally protecting the environment, with landowners or right holders able to protect the land and environment within their control from further degradation.[84] At the same time, property rights enable a clear link between certain forms of pollution and a responsible individual. The 'landowner', for example, retains responsibility for ensuring that nothing is introduced to their land or takes place on it which will harm their neighbours. This has extended both to the international obligation of States not to harm their neighbours and areas beyond their jurisdiction, and to the granting of rights to use particular resources, or to pollute in particular ways to those with an identifiable interest in an activity or area of land.

Perhaps because of the perceived ability of property owners to protect property and thus the environment, a solution to perceived problems, such as Hardin's tragedy of the commons,[85] has been to extend the notion of property and grant rights to those agents deemed to have an interest in the area and/or activity. For example, property rights have for some time been used to control access to fisheries and as a response to the threats to vulnerable/indigenous com-

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[80] Basel Convention Decision BC-14/13: Further actions to address plastic waste under the Basel Convention.

[81] See, for example, The Energy Efficiency (Private Rented Property) (England and Wales) Regulations 2015 UKSI 962; *Commission Regulation (EC) 244/2009* of 18 March 2009, OJL 76/3, 24 March 2009.

[82] Marc-Andrej Felix Mallin, 'From Sea-level Rise to Seabed Grabbing: The Political Economy of Climate Change in Kiribati' (2018) 97 Marine Policy 244.

[83] Usha Natarajan and Julia Dehm, 'Where Is the Environment? Locating Nature in International Law' (2019) 3 Third World Approaches to International Law Review: Reflections <https://twailr.com/where-is-the-environment-locating-nature-in-international-law/> accessed 2 April 2020.

[84] Dinah Shelton, 'Nature as a Legal Person' (2015) 22 Vertigo – La revue eletronique en sciences de l'environnment 22.

[85] Garrett Hardin, 'The Tragedy of the Commons' (1968) 162 (3859) Science 1243.

munities from development.[86] In the latter case the focus has been on the use of rights such as community-based property rights, to protect the interests of indigenous peoples,[87] as well as on prior informed consent and access and benefit sharing.[88] For example, the inter-American system of human rights recognises property rights as a means of protecting indigenous communities' relationship with nature:

> Territory is uniquely important for indigenous peoples, as it is a fundamental requirement for the development of their culture, spiritual life, integrity, and economic survival. Those groups consider certain places, phenomena or natural resources to be sacred, in accordance with their cosmovision and traditions. In the inter-American system, the IACHR and the I/A Court H.R.[Inter-American Commission on Human Rights and the Inter-American Court of Human Rights] have held that indigenous peoples' spiritual relationship with the space that they occupy collectively speaking is protected by Article 21 of the American Convention and Article XXIII of the American Declaration. They have also expressly recognized the right of indigenous and tribal peoples to the natural resources situated in the territories that they have 'traditionally used and [that are] necessary for the very survival, development and continuation of such people's way of life'.[89]

In this example the right to property is also combined with rights to cultural identity, non-discrimination and self-determination.[90] Even though the close relation between indigenous communities and nature cannot be reduced to a matter of possession and use, when traditional lands are involved, the right to property remains the basic foundation of the Inter-American Court of Human Rights jurisprudence.[91]

Property rights are, however, inadequate to address transboundary problems, be that transboundary pollution or the management of transboundary species. They are also problematic as a means to preserving traditional interactions between humans and the environment. For example, if a particular indigenous people's subsistence lifestyle is largely dependent on resources distributed across large expanses of territory,[92] and their seasonal movement patterns are restricted to an area delimitated by legal (property) boundaries, their lifestyle may then become impossible to sustain. Such boundaries may also disrupt the intimate spiritual relationship between the identity and cultural integrity of indigenous peoples and their environment.[93]

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86 Peter H Pearse, 'From Open Access to Private Property: Recent Innovations in Fishing Rights as Instruments of Fisheries Policy' (1992) 23 Ocean Development and International Law 71.

87 Daniel Barstow Magraw and Lauren Baker, 'Globalization, Communities and Human Rights: Community-based Property Rights and Prior Informed Consent' (2007) 35 Denver Journal of International Law & Policy 413.

88 Morgera (n 64); Marchegiani, Morgera and Parks (n 55).

89 Inter-American Commission on Human Rights *Situation of Human Rights of the Indigenous and Tribal Peoples of the Pan-Amazon Region*, OAS/Ser.L/V/II. Doc. 176 (29 September 2019) 31.

90 The link between property and the protection of human rights is not, however, new and can be traced back to the seventeenth century. See Lorenzo Cotula, 'Land, Property and Sovereignty in International Law' (2017) 25 Cambridge Journal of International and Comparative Law 219.

91 Inter-American Commission on Human Rights, *Indigenous and Tribal Peoples' rights of their ancestral lands and natural resources*, OEA/Ser.L/V/II. Doc. 56/09 (30 December 2009), paras 56, 58. For an alternative approach, based on the notion of *vida digna* developed in the jurisprudence of the Inter-American Court of Human Rights, see Tomas M Antkowiak, 'Rights, Resources, and Rhetoric: Indigenous Peoples and the Inter-American Court' (2013) 35 University of Pennsylvania Journal of International Law 113.

92 Inter-American Commission on Human Rights (n 89) 39.

93 Ibid.

Relying on property rights may also undermine traditional, sustainable land management practices by 'placing ancestral land rights on the same footing as the private rights acquired by commercial developers'.[94] A further problem is that using (property) rights as a means to protect the environment is dependent upon the benefit or utility attached to that environment. Without a perceived benefit or utility, the likelihood of right holders taking action to protect the environment is significantly reduced. In the context of breaches of the planetary boundaries these limitations are significant. It may appear to benefit a landowner more in the short term to clear a forest for farming, for example, than to maintain the forest to protect the biosphere.

Despite these problems, we have continued to use rights as an innovative way of protecting the environment, but emphasis is now placed on a different form of rights. Rather than property rights, we focus on human rights to (a healthy) environment and rights of nature.[95] The origins of the right to a healthy environment are found in Principle 1 of the 1972 Stockholm Declaration,[96] and such rights have since been adopted in numerous regional treaties and gained recognition in the national laws and constitutions of more than 100 States across the world.[97] In many instances, procedural rights have also been added to these substantive rights. The right is perceived to protect

> nature and the environment not only because of its connection with a utility for the human being or for the effects that its degradation could cause on other people's rights, such as health, life or personal integrity, but because of its importance for the other living organisms with whom the planet is shared, also deserving of protection in themselves.[98]

More recently some States have started to recognise the legal rights of rivers,[99] and fauna,[100] as a way of ensuring the protection of these entities.

These developments in relation to the right to a healthy environment and the appropriateness of granting rights to nature might suggest a move away from commodification of nature.[101] The granting of rights to nature, in particular, suggests a move away from mere satisfaction of the needs and desires of natural persons to a clearer understanding of the intrinsic value of nature, which requires the consolidation and further expansion of human responsibilities towards the

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94 Cotula (n 90) 243.

95 For a discussion on the use of a variety of rights, including the right to housing, and the right to food, see Cotula, ibid.

96 United Nations Conference on the Human Environment, Declaration of Principles (16 June 1972) UN Doc. A/CONF.48/14/Rev.1 59.

97 John H. Knox, 'Report of the Special Rapporteur on the Issue of Human Rights Obligations relating to the Enjoyment of a Safe, Clean, Healthy and Sustainable Environment' (24 January 2018) UNGA A/73/188.

98 Inter-American Court of Human Rights (15 November 2017) *Advisory Opinion* OC-23 requested by the Republic of Colombia: Environment and Human Rights (15 November 2017) 28.

99 Lidia Cano Pecharroman, 'Rights of Nature: Rivers that Can Stand in Court' (2018) 7 Resources 13.

100 Oliver A Houck, 'Noah's Second Voyage: The Rights of Nature as Law' (2017) 31 Tulane Environmental Law Journal 1.

101 Even though the right to a healthy environment has been broadly interpreted by the Inter-American Court of Human Rights to encompass both non-humans and humans, its overall development has privileged an anthropocentric perspective. See Louis J Kotzé, 'The Anthropocene, Earth System Vulnerability and Socio-ecological Injustice in an Age of Human Rights' (2019) 10(1) Journal of Human Rights and the Environment 62.

preservation of nature's natural cycles. The introduction of rights for nature creates the possibility of the legal acknowledgement of the world as a living being. It opens space for the articulation, in the legal framework, of ways of living that reject the current development model and the continuing commodification of nature, as well as the boundaries created between humans and nature. If we are to avert further breaches of the planetary boundaries, then the ability to articulate and embrace within law such different conceptions of our relationship with the environment is key. Views such as those of the Andean peasant communities which challenge our perceptions of the separateness of humans from the environment, and from the consequent damage to that environment which underpins the breaches of the planetary boundaries we are beginning to experience, are essential to transforming the role of law. In the view of the Andean peasants:

> This live world continually re-creates itself through mutual caring by all living beings. This caring depends on an intimate and ongoing dialogue between all living beings (including, again, people, nature, and the gods), a sort of affirmation of the essence and will of those involved. This dialogue is maintained through continual interactions that are social and historical.
>
> Each plot, for instance, demands different cultivation routines, different practices of caring.
>
> […]
>
> Practices and events are never repeated out of a pre-established scheme; on the contrary, knowledge is continually re-created as part of a commitment to strengthening and enriching reality, not to transforming it.[102]

If we are to modify the relationship between law, rights and commodification, then we need to continue to engage with such alternative frames of consciousness that perceive and sense nature differently and continue to innovate our approaches to rights. The value of such perspectives in this context will depend on the epistemic plurality they enable and the degree to which they offer examples of a shared human faculty towards repairing and caring for (all) life. This epistemic plurality should reveal the need to revise the assumed conceptual posture reflected in the first photograph of Earth from space, in which we are external to Earth, as this position facilitates the dissemination of the mistaken view that 'it is we who surround the environment, not the other way around'.[103] There are, however, a number of challenges to embracing other voices in our development of law.

3.2 The Challenges of Embracing Other Voices

A first challenge in ensuring different viewpoints are reflected in law is to find appropriate frames of understanding. The view of the Andean peasant communities given above is one among several which do not assume that economic development is a goal to pursue or that there is a stage of 'underdevelopment' to be overcome. A second challenge is to incorporate those understandings into law, and, as discussed above, our legal procedures do not yet appear able to ensure the incorporation of this broader range of understandings into our legal systems, at least not at the speed required to ensure that the planetary boundaries are not breached. If we are to incorporate such wider world views into law, we must draw more fully on the under-

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[102] Escobar (n 46) 169.

[103] Vassos Argyrou, *The Logic of Environmentalism: Anthropology, Ecology and Postcoloniality* (Berghahn Books, 2005) at 95 quoted in Natarajan and Dehm n 83 at 6.

standings provided by disciplines other than law, the natural sciences and economics. We know, for example, that culture and popular media can influence the development of law.[104] The question we have is how to harness culture and popular media to deliver the changes we require to protect the biosphere, or prevent pollution loads exceeding the environment's capacity to absorb it. As Maguire notes, for example, 'perspectives from the humanities have a great deal to offer when looking for explanations as to why climate policies might not work in practice, and in exploring the human issues that arise in the implementation of climate policy'.[105] Perhaps they will also provide answers as to how best to induce effective changes in human behaviour. It is not, however, simply a matter of finding wider perspectives. For such understandings to influence the shape of new laws, or the better implementation of existing laws, both policy-makers and lawyers need to have the ability to recognise and understand contributions from these different disciplinary perspectives. Doing so, however, requires these groups to expand their methodological toolkit and skills to embrace the findings that other disciplines bring to law-making and the understandings offered by local and indigenous communities. For example, we need tools to enable us to move beyond understanding local accounts of lived experiences as true or false representations of reality, and towards understanding them as instances of discourse and counter-discourse that involve (local and global) power relations,[106] which develop understanding of the plurality of views of nature, the environment, development, sustainability and thus might prompt us to think more critically of actions that lead to land system changes, or over-consumption of freshwater, or the emission of pollutants.

The third challenge is that to be truly effective in tackling transnational issues, such as prevention of breaches of the planetary boundaries, these wider perspectives must be embraced at the international level. This would require a fundamental reconsideration of the law and its reliance on the fundamental concept of the rights associated with State sovereignty. Such a fundamental reconsideration appears unlikely in the near future. Although States have, through the rapid development of international law, agreed to limit rights, such as the freedom of fishing on the high seas, it might nonetheless be more appropriate to describe the overall focus of international environmental law as ensuring that no harm is caused to the territory or interests of other States, as first clearly expressed in the *Trail Smelter* arbitration. As such, the concept of sovereignty as traditionally understood and the idea(l) of development remain unchallenged.

A final challenge to adopting these new approaches is that the approaches themselves challenge existing rights and, given our aversion to loss,[107] the existing right holders may contest any changes to their rights which are, or are perceived to be, a diminution of their rights. There are many cases where investors have contested changes to their rights, such as the conversion of riparian rights into permits and 'expropriation of land to create national parks'.[108] Similar objections are also raised at the international level. For example, whaling States' responses to the adoption of the moratorium on whaling have clearly indicated their

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[104] Diana Wagner, 'Competing Cultural Interests in the Whaling Debate: An Exception to the Universality of the Right to Culture' (2004–05) 14 Transnational Law & Contemporary Problems 831 at 853.

[105] Maguire (n 59) 77.

[106] Escobar (n 46) 170.

[107] Daniel Kahneman and Amos Tversky, 'Prospect Theory: An Analysis of Decision under Risk' (1979) 47(4) *Econometrica* 263.

[108] Cotula (n 90).

unwillingness to give up particular cultural or economic practices. Such objections are also often raised by companies and other non-State actors through lobbying of individual States or lobbying at intergovernmental meetings. Taking concrete action to avert the catastrophic damage associated with breaches of the planetary boundaries will inevitably mean that rights must be restricted. It can no longer be acceptable to emit chemical pollutants at the scale they are being emitted, or to systematically change land use, for example, from forest to farmland or from farmland to urban areas. The challenges to these restrictions from current right holders, be they landowners, States or the holders of human rights, will make ensuring that we do not cross the planetary boundaries extremely challenging.

4. CONCLUSION: A CHANGING ROLE FOR LAW?

Our chapter has so far painted a somewhat gloomy picture of the ability of law, as it is currently framed, to prevent breaches of the planetary boundaries, given the primacy conferred to rights rather than responsibilities within legal systems and within the discipline itself. While various forms of rights have been used, sometimes innovatively, to try to protect the environment, and while they form the foundations upon which limitations of the actions of States and other actors may be built, we have demonstrated that there are problems with relying upon the concept of rights. Rather than playing a leading role in the fight to protect our environment, our laws and the rights they grant privilege the positions of some in respect of resources and entrench the liberal market economic focus on development through the mechanism of rights. When scientists have demonstrated that action is needed, for example, to address nitrogen and phosphorous flows and limit atmospheric aerosol loading, lawmakers have oftentimes prioritised the interests of right holders.[109] What hope then is there that law will have a role to play in the adoption of the precautionary approach necessary to protect our planetary boundaries?

Our suggestion is that if law is to play a role that is something more than a memorial to our folly in relation to the environment, it requires an urgent and critically comprehensive reconsideration, in terms of the content of law, its implementation and enforcement. We mentioned earlier in this chapter the need to draw upon understandings and world views which depart from the 'norm' of the liberal market economy and we have pointed to the need to draw more heavily on the understandings some indigenous peoples have of the world. The danger of relying exclusively on this approach is that any new understandings will be received by the legal system and lawyers, and interpreted, in light of existing legal concepts. In other words, the incorporation of 'novel' concepts will be shaped by the autopoietic or self-referential nature of law,[110] and the bounded rationality of decision-makers will prevent them from moving beyond the current mode of understanding.[111] The effect will be continued

[109] Elizabeth A Kirk, 'Science and the International Regulation of Marine Pollution' in Donald Rothwell et al (eds), *Handbook on the Law of the Sea* (Oxford University Press 2015) 516.

[110] Niklas Luhman, 'The Unity of the Legal System' in Gunther Teubner (ed), *Autopoietic Law: A New Approach to Law and Society* (Walter de Gruyter 1987) 12; Gunther Teubner, *Law as an Autopoietic System* (Anne Bankowska and Ruth M Adler trs, Blackwell 1993).

[111] Max Rheinsten (ed), *Max Weber on Law in Economy and Society* (Harvard University Press 1947); Max Weber, *The Theory of Social and Economic Organisation* (Collier-Macmillan 1968). Put simply, bounded rationality refers to the fact that all humans are limited in their capacity to know and understand and thus make decisions within the bounds of the knowledge and understanding they possess.

path dependency[112] in the way we address environmental issues through law-making and implementation.[113] For example, we may continue to focus on rights as mechanisms to deliver solutions to our environmental problems even when the concept of rights may have nothing within its toolbox that can provide a solution to the continuing commodification of nature. Alternatively, our attempts to respond to 'new' understandings may lead us to focus on adaptation to the consequences of transgressing the planetary boundaries, rather than prevention of that breach.

A clearer focus is therefore needed in the search for alternative world views. We suggest that this focus must provide a counterpoint to the prevailing notion of rights in law; and so, we propose a focus on *responsibilities*. This would require consideration of, for example, the responsibilities of States and of non-State actors to ensure that ecosystems remain or are restored to good health, responsibilities to ensure that all relevant actors (be they States, MNCs, individuals, or others) preserve valuable chemicals such as nitrogen and phosphorous in closed systems, and responsibilities for all to adopt energy efficiency actions to minimise emissions of greenhouse gases, to name but a few. We also suggest a responsibility to listen to alternative voices, which may fall primarily on States, corporations and majority populations.

For this proposal to work we need to be alive to the danger that even a new focus on responsibility might very well be developed, interpreted and applied in accordance with existing concepts in law which support the commodification of nature. In other words, we need to address the problems of autopoiesis in the legal system and of path dependency in decision-making, which leads to new approaches being bolted on to existing ones or interpreted and applied in light of them, and we need to support decision-makers to overcome their inevitable bounded rationality. These may appear to be insurmountable problems, but we do have existing bodies of understanding to draw upon to help tackle them. The literature on the development and lifecycle of norms reminds us of the role of norm entrepreneurs in the development and dissemination of new norms.[114] We understand the importance of the norm cascade and norm tipping points in generating compliance and we have some understanding of the ways in which the cascade and tipping point can be generated. Thus, we know that the creation, or support of epistemic communities,[115] discourse with those subject to new norms or regulations,[116] or

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[112] W Brian Arthur, 'Competing Technologies, Increasing Returns, and Lock-in by Historical Events' (1989) 99 Economic Journal 116; W Brian Arthur, *Increasing Returns and Path Dependency in the Economy* (University of Michigan Press 1994).

[113] Elizabeth A Kirk, Alison D Reeves and Kirsty L Blackstock, 'Path Dependency and Environmental Regulation' (2007) 25 Environment and Planning C: Government and Policy 250.

[114] See, for example, Martha Finnemore and Kathryn Sikkink, 'International Norms and Political Change' (1998) 52(4) International Organization 887; Christopher D Hollander and Annie S Wu, 'The Current State of Normative Agent-Based Systems' (2011) 14 Journal of Artificial Societies and Social Simulation 6; Moamin A Mahmoud et al, 'A Review of Norms and Normative Multiagent Systems' (2014) The Scientific World Journal 1; Emma Sjöström, 'Shareholders as Norm Entrepreneurs for Corporate Social Responsibility' (2010) 94 Journal of Business Ethics 177.

[115] Peter M Haas, 'Do Regimes Matter? Epistemic Communities and Mediterranean Pollution Control' (1989) 43 International Organization 377.

[116] Jan Bebbington, Elizabeth A Kirk and Carlos Larrinaga, 'The Production of Normativity: A Comparison of Reporting Regimes in Spain and the UK' (2012) 37 AOS 78.

wider provision of information[117] through, for example, the media,[118] can all be crucial in the development of new norms. What we have less understanding of, and where we need further research, is how to bring these mechanisms together in a coherent fashion to ensure that the normative change we seek will be delivered.

The proposal to focus more clearly on responsibilities of course also leads to a range of questions which, combined, could potentially provide a new research agenda. These questions include: what responsibilities should actors have in respect of the environment? How should such responsibilities be framed to ensure that they do not fall victim to the same problems of path dependency in implementation, and interpretation in light of existing understandings? How should these new responsibilities be communicated to States, companies and the public in a way that ensures they are seen as positive gains rather than potential losses of existing rights? How do we support the generation and adoption of a new norm of responsibility? How do we change legal and popular cultures rapidly in a direction that will enable a sustainable future for human populations? These questions offer some indication of the scale of the task this reconsideration of law might entail. It will not be an easy task to accomplish, but it is one that is urgently needed if we are to avoid crossing more of the planetary boundaries than have already been crossed, and to remedy the harm that has already been done.

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[117] See, for example, Marie-Louise Bemelmans-Videc, Ray C Rist and Evert Vegund, *Carrots, Sticks & Sermons: Policy Instruments & Their Evaluations* (Transaction Publishers 1998); Nathaniel Keohane and Sheila Olmstead, *Markets and the Environment* (Island Press 2007); National Research Council, *New Tools for Environmental Protection: Education, Information and Voluntary Measures* (The National Academies Press 2002); Karen Palmer and Margaret Walls, 'Using Information to Close the Energy Efficiency Gap: A Review of Benchmarking and Disclosure Ordinances' (2017) 10 Energy Efficiency 673. But see Robert B Cialdini, 'Crafting Normative Messages to Protect the Environment' (2003) 12(4) Current Directions in Psychological Science 105.

[118] Wagner (n 104).

9. International law, planetary boundaries and teleconnections[1]

Ellen Hey

1. INTRODUCTION

Planetary boundaries research conveys the daunting message that human activities are negatively affecting the Earth system and as a result are endangering human life on Earth. This chapter explores how international law contributes to the transgression of planetary boundaries by revealing *how* international law facilitates human activities by way of the free trade rule. It suggests that below its interstate surface, international law either facilitates or regulates human activity, including in ways that contribute to the transgression of planetary boundaries. Understanding how international law contributes to the transgression of planetary boundaries may facilitate taking 'into account [some of] the deeper issues of equity and causation'[2] that are involved in the transgression of planetary boundaries and that planetary boundaries research, as such, does not address.

This chapter employs the concept of 'teleconnections' to explore how international law is implicated in the transgression of planetary boundaries. The term teleconnections is used in atmospheric sciences to refer to connections between geographically non-contiguous areas, such as the El Niño phenomenon that connects weather patterns along the west coast of South America to weather patterns in Asia and the Pacific.[3] Based on the concept of teleconnections, this chapter develops a framework for analysing international law. It applies this framework to illustrate how international law, by way of the free trade rule, teleconnects producers to consumers across the globe, in ways that are not necessarily conducive to protecting the Earth system. Finally, this chapter reflects on the implications of the analysis conducted for research on planetary boundaries and on international law. Prior to analysing international law, this chapter engages with both planetary boundaries research and the concept of teleconnections.

2. PLANETARY BOUNDARIES: UNIVERSALISING AND BACKGROUNDING INTERHUMAN RELATIONS

Planetary boundaries research informs us that as a consequence of human activities, historical and extant, the boundaries of the Earth system are being transgressed and that human

1 I thank Sophia Paulini, PhD candidate, and Federica Violi, Assistant Professor, both of the Department of International and European Union Law at Erasmus School of Law, for helpful comments on an earlier draft, and Fred Bosveld, at The Royal Netherlands Meteorological Institute (KNMI), for helping me understand teleconnections. The usual disclaimer applies.

2 See quote and text referenced at n 8.

3 See the discussion below.

life on Earth is endangered as a result.[4] It underscores the idea that we are living in the Anthropocene, a new era in which humans detrimentally affect the Earth system.[5] Planetary boundaries research, as well as the idea that we are living in the Anthropocene, highlights the relationship between humanity, as a collectivity, and the Earth system. If acted upon without further nuance, the notion of planetary boundaries comes at the risk of universalising the role of humans in the process of degrading the Earth system. This is ethically problematic because not all humans, historically and currently, have contributed equally to, or suffer equally from, the degradation of the Earth system.[6] The planetary boundaries framework thus backgrounds interhuman relationships in an Anthropocene era.[7] Planetary boundaries researchers recognise this when they state the following:

> The PB [planetary boundary] approach is embedded in this emerging social context, but it does not suggest how to maneuver within the safe operating space in the quest for global sustainability. For example, the PB framework does not as yet account for the regional distribution of the impact or its historical patterns. Nor does the PB framework take into account the deeper issues of equity and causation. The current levels of the boundary processes, and the transgressions of boundaries that have already occurred, are unevenly caused by different human societies and different social groups. The wealth benefits that these transgressions have brought are also unevenly distributed socially and geographically. It is easy to foresee that uneven distribution of causation and benefits will continue, and these differentials must surely be addressed for a Holocene-like Earth-system state to be successfully legitimated and maintained.[8]

The 2019 forest fires in the Amazon may serve to illustrate this point.[9] Planetary boundaries research informs us that human-induced forest fires, such as those in the Amazon and elsewhere, will affect the Earth system and therefore should be prevented. Where prevention is impossible, these fires at least need to be contained. However, planetary boundary research does not offer guidance on who is to be involved in decision-making or who should pay for prevention or containment policies. Nor does it reveal that the forest fires might be linked to

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4 Johan Rockström et al, 'Planetary Boundaries: Exploring the Safe Operating Space for Humanity' (2009) 14 Ecology and Society 32; Johan Rockström et al, 'A Safe Operating Space for Humanity' (2009) 461 Nature, 472; Will Steffen et al, 'Planetary Boundaries: Guiding Human Development on a Changing Planet' (2015) 347 Science 1259855; Steven J Lade et al, 'Human Impacts on Planetary Boundaries Amplified Earth System Interactions' (2020) 3 Nature Sustainability 119.

5 Paul J Crutzen and Eugene F Stoermer, 'The "Anthropocene"' (2000) 41 Global Change Newsletter 17; Will Steffen et al, 'The Anthropocene: Conceptual and Historical Perspectives' (2011) 369 Philosophical Transactions of the Royal Society 842; Colin N Waters et al, 'The Anthropocene is Functionally and Stratigraphically Distinct from the Holocene' (2016) 351 Science aad2622.

6 See also Adelman, Chapter 4 in this book; Andreas Malm and Alf Hornborg,'The Geology of Mankind? A Critique of the Anthropocene Narrative' (2014) 1 The Anthropocene Review 62; Frank Biermann, 'Down to Earth: Contextualizing the Anthropocene' (2016) 39 Global Environmental Change 341; Belinda Reyers, 'Social-Ecological Systems Insights for Navigating the Dynamics of the Anthropocene' (2018) 43 Annual Review of Environment and Resources 267.

7 See contributions to Clive Hamilton et al (eds), *The Anthropocene and the Global Environmental Crisis* (Earthscan 2015).

8 Steffen et al (n 4) 8. See, also Jonathan F Donges et al, 'Closing the Loop: Reconnecting Human Dynamics to Earth System Science' (2017) 4 The Anthropocene Review 151; Kim and Kotzé, Chapter 3 in this book.

9 Jonathan Watts, 'Amazon Rainforest Fires: Global Leaders Urged to Divert Brazil from "Suicide" Path' (*The Guardian,* 23 August 2019) <www.theguardian.com/environment/2019/aug/23/amazon-fires-global-leaders-urged-divert-brazil-suicide-path> accessed 10 June 2020.

agricultural practices that teleconnect to world markets, for example the market for soy that feeds livestock for meat consumption in faraway places.[10] Planetary boundaries research, then, does not enable us to see the interhuman dimension of some of the unsustainable activities in which we engage. Adding the concept of teleconnections to the analysis may help avoid universalisation and the backgrounding of interhuman relations, principally because this concept facilitates localising teleconnected human activities and, in doing so, also foregrounds interhuman relations.

3. TELECONNECTIONS: LOCALISING AND FOREGROUNDING INTERHUMAN RELATIONS

The term 'teleconnection' derives from atmospheric sciences, which are part of Earth system science and of which planetary boundaries research is a specific outcome.[11] In atmospheric sciences the term teleconnection is used to refer to 'the climate links between geographically separated regions'.[12] An example is the so-called El Niño Southern Oscillation (ENSO). Under El Niño conditions, ENSO is characterised by an increase in ocean temperature in the Eastern and Central Pacific Ocean and increased chances of draught in, for example, Australia and Indonesia. Under La Niña conditions the reverse is the case: cooler ocean temperatures in the Eastern and Central Pacific Ocean induce increased chances of rain in, for example, Australia and Indonesia. Under 'normal' temperature conditions in the Eastern and Central Pacific Ocean, precipitation in Indonesia and Australia, as well as at other locations affected by ENSO, also exhibit 'normal' conditions. In other words, precipitation in Australia and Indonesia and ocean temperatures in the Eastern and Central Pacific Ocean are teleconnected, based on interactions between the atmosphere and the ocean.[13]

Social scientists have illustrated how humans may be connected across geographically non-contiguous areas, besides being linked to their immediate social-ecological system.[14] The COVID-19 pandemic offers an example of how we are connected globally, especially in terms of our health and economic system.[15] Some social scientists have used teleconnections as a conceptual framework. Their research illustrates how humans are connected across the globe

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10 Rufo Quintavalle, 'Politics and People Fuelling Amazon Rainforest Fires' (*Canada's National Observer*, 17 Sept. 2019) <www.nationalobserver.com/2019/09/17/opinion/politics-and-people-fuelling-amazon-rainforest-fires> accessed 10 June 2020.

11 On Earth system science see Will Steffen et al, 'The Emergence and Evolution of Earth System Science' (2020) 1 Nature Reviews Earth & Environment 54.

12 Ibid. Also see S Nigam and S Baxter, 'General Circulation of the Atmosphere | Teleconnections' in Gerald R North, John Pyle and Fuqing Zhang (eds), *Encyclopedia of Atmospheric Sciences* (2nd edn, Elsevier/Academic Press 2015) 90.

13 National Oceanic and Atmospheric Administration, 'El Niño/Southern Oscillation (ENSO) Technical Discussion' <www.ncdc.noaa.gov/teleconnections/enso/enso-tech.php> accessed 10 June 2020 and the information available at the El Niño/La Niña site of the World Meteorological Organization <www.wmo.int/pages/prog/wcp/wcasp/enso_update_latest.html> accessed 10 June 2020.

14 Oran R Young et al, 'The Globalization of Socio-ecological Systems: An Agenda for Scientific Research' (2006) Global Environmental Change 304.

15 Santiago Mas-Coma, Malcolm K Jones and Aileen M Marty, 'COVID-19 and Globalization' (2020) 9 *One Health*, 100132; Henry Farrell and Abraham Newman, 'Will the Coronavirus End Globalization as We Know It? The Pandemic Is Exposing Market Vulnerabilities No One Knew Existed'

through, for example, the way diseases spread,[16] how decisions affecting coffee production in Mexico or Vietnam affect farmers and the environment in both countries,[17] and how urbanisation affects land use in faraway places.[18] In land-use studies, teleconnections, as a conceptual framework, has served to identify relationships between, for example, soy production in Brazil and the rearing of livestock in Germany or China for meat consumption in Western Europe and China.[19] Moreover, social science research has pointed to the justice considerations involved in these teleconnections.[20]

While the concept of teleconnections has recently been employed in social science research, the identification of environmentally relevant connections across the globe is not new. An example is Tony Allan's seminal work on virtual water, dating back to the 1990s.[21] Allan illustrates how a society is able to maintain a level of food consumption that is not commensurate with the availability of water required to produce the food in question at the locality of that society. Other researchers subsequently focused on calculating the so-called water footprint of different food products, including for the production of coffee and tea at various locations for consumption in countries such as the Netherlands.[22] This manner of 'outsourcing' food production has been linked to the phenomenon known as 'land-grabbing', which often revolves around obtaining access to water.[23] Land-grabbing, or water-grabbing, in turn has been linked to the disruption of local social-ecological systems by being implicated in the displacement of local populations, water shortages and harm to local ecological systems.[24]

More recent research on environmental footprints, although not explicitly referring to the concept of teleconnections, has linked to planetary boundaries research. This research shows how, for example, greenhouse gas emissions or loss of biodiversity at a specific location on

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(*Foreign Affairs*, 16 March 2020) <www.foreignaffairs.com/articles/2020-03-16/will-coronavirus-end-globalization-we-know-it> accessed 10 June 2020.

16 W Neil Adger, Hallie Eakin and Alexandra Winkels, 'Nested and Teleconnected Vulnerabilities to Environmental Change' (2009) 7 Frontiers in Ecology and the Environment 150, 153–54.

17 Ibid 154–55. On how climate change exacerbates teleconnections see Susanne C Moser and Juliette A Finzi Hart, 'The Long Arm of Climate Change: Societal Teleconnections and the Future of Climate Change Impacts Studies' (2015) 129 Climatic Change 13.

18 Karen C Seto et al, 'Urban Land Teleconnections and Sustainability' (2012) 109 Proceedings of the National Academy of Sciences 7687.

19 Edward Challies, Jens Newig and Andra Lenschow, 'What Role for Social-ecological Systems Research in Governing Global Teleconnections' (2014) 27 Global Environmental Change 32 (describing the German case 33–34); Adrea Leschow, Jens Newig and Edward Challies, 'Globalization's Limits to the Environmental State? Integrating Telecoupling into Global Environmental Governance' (2016) 12 Environmental Politics 136. More generally Rosamond Naylor et al, 'Losing the Links between Livestock and Land' (2005) 310 Science 1621.

20 Esteve Corbera et al, 'Environmental Justice in Telecoupling Research' in Cecile Friis and Jonas Ø Nielson (eds), *Telecoupling* (Palgrave 2019) 213.

21 John Allan, 'Policy Responses to the Closure of the Water Resources' in Peter Howsam and Richard Carter (eds), *Water Allocation and Management in Practice* (Chapman and Hall 1996) 2; John Allan, 'Virtual Water: A Strategic Resource, Global Solutions to Regional Deficits' (1998) 36 Ground Water 545.

22 Ashok Chapagain and Arjen Hoekstra, 'The Water Footprint of Coffee and Tea Consumption in the Netherlands' (2007) 64 Ecological Economics 109.

23 See also Cooper, Chapter 18 in this book.

24 Ellen Hey, 'Virtual Water, "Land Grab" and International Law' in Laurence Boisson de Chazournes, Christina Leb and Mara Tignino (eds), *International Law and Freshwater: The Multiple Challenges* (Edward Elgar 2013) 298.

Earth are connected to products and their consumers elsewhere on the globe. It suggests that planetary boundaries research include the calculation of unsustainable levels of consumption – footprints – at the level of human activities or communities, such as in States.[25] The Earth Commission, together with the Science Based Targets Network (SBTN) composed of non-governmental organisations (NGOs) and other partners, seems to be taking on this challenge. The Earth Commission aims to deliver by 2021 'a high-level synthesis of scientific knowledge on the biophysical processes that regulate Earth's stability and targets' and to 'explore social transformations required for sustainable development to reach these targets'. SBTN will then translate this outcome 'into tangible science-based targets for Earth, specifically tailored to cities and companies'. These targets are to enable 'cities and companies to reduce their impact on and restore our oceans, freshwater, land, and biodiversity'.[26]

Social science research shows that the concept of teleconnections enables the identification of links between human activities at various locations on Earth, which collectively produce an unsustainable result that contributes to the transgression of planetary boundaries. The concept enables us to bring interhuman relations into the picture and thereby adds nuance to the insight that planetary boundaries research offers into the relationship between humanity and the Earth system. It also facilitates presenting policy-makers with a fuller picture of the ethical dimensions, as reflected in human rights, and the political considerations involved in the choices they make.

4. TELECONNECTIONS AS A CONCEPTUAL FRAMEWORK FOR ANALYSING INTERNATIONAL LAW

Social science research then, reveals that teleconnections, besides being a natural phenomenon, can also be conceptualised as ensuing from human systems. Social science research typically identifies the global economic system and the process of globalisation as root causes of unsustainable teleconnections.[27] However, research rarely focuses on analysing how international law maintains the unsustainable teleconnections identified by social science research.

Teleconnections as a conceptual framework, I suggest, enables asking certain questions of international law that planetary boundaries research does not, and that may be overlooked in legal analysis. First, which rules of international law establish or maintain the type of

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[25] Daniel W O'Neill et al, 'A Good Life for All Within Planetary Boundaries' (2018) 1 Nature Sustainability 88; Davy Vanham et al, 'Environmental Footprint Family to Address Local to Planetary Sustainability and Deliver on the SDGs' (2019) 693 Science of the Total Environment 133642; Tiina Häyhä et al, 'From Planetary Boundaries to National Fair Shares of Global Safe Operating Space: How Scales Can Be Bridges?' (2016) 40 Global Environmental Change 60. Also see The Global Footprint Network <www.footprintnetwork.org/our-work/ecological-footprint/> accessed 10 June 2020.

[26] 'Earth Commission to Identify Risks, Guardrails, and Targets for the Planet' (19 September 2019) Press Release <https://earthcommission.org/2019/09/19/earth-commission-to-identify-risks-guardrails-and-targets-for-the-planet/> accessed 10 June 2020; Johan Rockström, Joyeeta Gupta and Dahe Qin, 'Earth System Alert' (29 November 2019) *Project Syndicate* <www.project-syndicate.org/commentary/earth-commission-protect-natural-systems-by-johan-rockstrom-et-al-2019-11?barrier=accesspaylog> accessed 10 June 2020.

[27] See Johan Rockström, 5 *Reasons Why the Economy Is Failing the Environment, and Humanity* (World Economic Forum 10 January 2017) <www.weforum.org/agenda/2017/01/5-reasons-why-the-economy-is-failing-the-environment-and-humanity/> accessed 10 June 2020.

unsustainable teleconnections identified by social science research? Second, what are the characteristics of these rules? Third, which actors are involved in determining the content of the relevant rules? Fourth, which interests are prioritised or sidelined in these teleconnections? Fifth, and based on the answers to the previous questions, what conclusions might be drawn for regulating human activities by way of international law in view of the planetary boundaries framework?

These five questions suggest a framework for analysing international law based on the concept of teleconnections. The first four questions serve to map teleconnections as they are maintained by international law. The fifth normative question enables international law research to link to planetary boundaries research by addressing 'deeper issues of equity and causation'[28] involved in the transgression of planetary boundaries as related to international law. The following section of this chapter applies this framework to illustrate how international law, its free trade rule in particular, is implicated in maintaining teleconnections that are implied in transgression of the planetary boundaries.

5. INTERNATIONAL LAW: ESTABLISHING AND QUALIFYING TELECONNECTIONS

It may seem trite to state that international law establishes legal relationships between States, even if human rights law and international criminal law establish, respectively, rights and duties for individuals and international investment law establishes mainly rights for foreign direct investors. This generally accepted characterisation of international law illustrates how we tend to think about the international legal system, that is, as primarily interstate law. Yet, the statement conceals that below its State-centred surface, international law *facilitates or regulates human activity*. One example is the free trade rule, which facilitates human activity by enabling producers of goods to engage in trade in all parties to the World Trade Organization (WTO).[29] Another example is the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer (Montreal Protocol), which regulates human activities related to the production and consumption of ozone-depleting substances and trade therein.[30] Neither WTO law nor the Montreal Protocol directly address producers or consumers, yet through the rights and duties attributed to States they facilitate (WTO law) or regulate (Montreal Protocol) human activity. This section first shows how the free trade rule establishes and maintains teleconnections by acting as a default rule. It then illustrates the difficulties involved in qualifying the teleconnections established by this default rule.

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[28] See text at n 8.

[29] See the emphasis on expanding the free trade system in the Preamble of the WTO 'Marrakesh Agreement Establishing the World Trade Organization' <www.wto.org/english/docs_e/legal_e/04-wto_e.htm> accessed 10 June 2020.

[30] United Nations Environment Programme (UNEP) 'About Montreal Protocol' <www.unenvironment.org/ozonaction/who-we-are/about-montreal-protocol> accessed 10 June 2020. See also Du Toit, Chapter 14 in this book.

5.1 The Free Trade Rule as a Default Rule

The free trade rule teleconnects producers of goods in all WTO members to consumers in all other WTO members. It does so by way of the 'most favoured nation' principle and the principle of 'national treatment' that are included in the 1947/1994 General Agreement on Tariffs and Trade (GATT).[31] These principles require that like products be treated in the same manner, regardless of the State of export and regardless of whether the product was imported or produced nationally. For producers of goods located in WTO members, these principles establish an almost worldwide level playing field in which producers have access to consumers in all other WTO members.[32]

The free trade rule, besides establishing teleconnections, also functions as a default rule. Its default nature lies in the requirement that, in principle, the rule can only be qualified by way of international agreement. In other words, if there is no international agreement to distinguish between goods based on how their production processes contribute to environmental degradation, and thus to qualify the free trade rule, the rule applies by default. The implication for present purposes is that, in order to protect planetary boundaries from possible harmful effects arising from international trade in unsustainably produced goods, international agreement needs to be reached.

International agreement can be reached within the WTO, as demonstrated by the WTO General Council's waiver decisions on access to affordable medicines, and on the Kimberley Process Certification Scheme.[33] However, such decisions are rare and controversial.[34] For example, during the late 1990s, WTO members were not able to agree on a decision to somehow link labour standards (or at least some labour standards) to WTO law.[35] Furthermore, to the best of my knowledge, waiver decisions have not addressed environmental protection. International agreement on environmental considerations, in practice, then, will have to be

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[31] Arts 1 and 4 GATT.

[32] The WTO has 164 members, compared to 193 UN members.

[33] The decision to exempt essential medicines from WTO disciplines was taken by the General Council on 30 August 2003, *Implementation of paragraph 6 of the Doha Declaration on the TRIPS Agreement and public health*, WT/L/540 (2 September 2003). In 2017 this decision was incorporated into the TRIPS Agreement. The first decision to exempt from WTO disciplines the certification scheme for so-called war or blood diamonds was taken in by the General Council on 26 February 2003, *Waiver Concerning Kimberley Process Certification Scheme for Rough Diamonds* WT/L/518 (27 May 2003). The decision has since then been extended, most recently by the General Council on 26 July 2018, *Extension of waiver concerning Kimberley Process Certification Scheme for Rough Diamonds*, WT/L/1039 (30 July 2018), which extended the exemption to 31 December 2024.

[34] See Isabel Feichtner, 'The Waiver Power of the WTO: Opening the WTO for Political Debate on the Reconciliation of Competing Interests' (2009) 20 European Journal of International Law 616. Also relevant are the negotiations on subsidies to the fisheries sector, and illegal, unreported and unregulated fishing more in general, which started within the WTO in 2001 and are still ongoing: see WTO 'Negotiations on fisheries subsidies' <www.wto.org/english/tratop_e/rulesneg_e/fish_e/fish_e.htm> accessed 10 June 2020.

[35] Sean Turnell, 'Core Labour Standards and the WTO' (2002) 13 The Economics and Labour Relations Review 105, 108–19; Rachel Harris and Gillian Moon, 'GATT Article XX and Human Rights: What Do We Know from the First 20 Years' (2015) 16 Melbourne Journal of International Law 432. Also see WTO, 'Labour Standards: Consensus, Coherence and Controversy' <www.wto.org/english/thewto_e/whatis_e/tif_e/bey5_e.htm> accessed 10 June 2020.

reached outside the WTO and meet WTO law standards, for example by way of multilateral environmental agreements (MEAs), discussed below.

In WTO law, the default nature of the free trade rule is evidenced, among others, by the Appellate Body's *US–Shrimp* rulings.[36] The Appellate Body found that, based on article XX GATT, unilateral measures distinguishing between products based on processes and production methods (PPMs) are allowed only if they have been the subject of serious negotiations with all States involved.[37] The fact that agreement had been reached with other States was used to illustrate 'that consensual and multilateral procedures are available and feasible', and the Appellate Body found that negotiations had to be pursued with all States, including with Malaysia (the appealing State *in casu*).[38] However, after the good faith efforts of the United States to negotiate a multilateral agreement that included Malaysia, the Appellate Body found that, in this case, Malaysia was deemed not to have a veto in the negotiations,[39] and that therefore the conclusion of an agreement including Malaysia was not required in order to avoid arbitrary or unjustified discrimination under the chapeau of article XX GATT.[40] By concluding that Malaysia did not have a veto in an adequate negotiation process, the Appellate Body created some flexibility in the requirement that the free trade rule, in case of PPMs, can only be qualified by international agreement. However, it also held that '[c]learly, and "as far as possible", a multilateral approach is strongly preferred' in order to qualify the free trade rule.[41]

The 1994 Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement) and the 1994 Agreement on Technical Barriers to Trade (TBT Agreement) explicitly require that measures regulating, for example, food safety or labelling schemes be based on 'international standards, guidelines or recommendations, where they exist' or 'relevant international standards, [if they] exist or their completion is imminent'.[42] Similarly, under the SPS Agreement, risk assessments and the appropriate level of SPS protection, such as for food safety, are to be determined 'taking into account risk assessment techniques developed by the relevant international organizations'.[43] In other words, SPS or TBT measures that qualify the free trade rule require international agreement. The SPS Agreement explicitly points to relevant standard-setting bodies such as the Codex Alimentarius Committee (CAC) for food safety.[44] The TBT Agreement does not itself point to such bodies, but it is generally agreed that relevant standard-setting bodies include the International Organization for Standardization (ISO) and, for food labelling, the CAC. The Appellate Body, moreover, in the *US–Tuna II*

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36 *United States – Import Prohibition of Certain Shrimp and Shrimp Products*, AB-1998-4, WT/DS58/AB/R (Report of the Appellate Body), 12 October 1998 and *United States – Import Prohibition of Certain Shrimp and Shrimp Products – Recourse to Article 21.5 of the DSU by Malaysia*, AB-2001-4, WT/DS58/AB/RW (Report of the Appellate Body), 22 October 2001.

37 *US–Shrimp*, paras 170–185 AB-1998-4 and paras 115–134, i.p. para. 123, AB-2001-4.

38 *US–Shrimp*, para 170, AB-1998-4 and para 128, AB-2001-4.

39 *US–Shrimp*, para 123, AB-2001-4.

40 *US–Shrimp*, para 124, AB-2001-4.

41 *US–Shrimp*, para 124, AB-2001-4.

42 Art 3(1), SPS Agreement; arts 2(4) and (5), TBT Agreement.

43 Art 5(1), SPS Agreement.

44 Art 3(4) and para 3(a), Annex A, SPS Agreement.

case,[45] determined that for an international organisation to qualify as a standard-setting body under the TBT Agreement, it must be open to all WTO members or their bodies.[46]

The default nature of the free trade rule, then, serves to protect the teleconnections that it establishes between producers and consumers. Moreover, in the regulatory bodies to which the default rules point – ISO and CAC – the relevant private sector is known to be well represented, even if in CAC States formally take the decisions.[47] Relatedly, ISO and CAC have been criticised for foregrounding certain scientific understandings and thereby universalising certain insights and interests.[48] In addition, developing States reportedly have a hard time actually participating in the decision-making procedures that apply in ISO and CAC.[49] As a result of these traits of the decision-making procedures, private sector actors, at least, co-regulate and developing States are at a disadvantage. Concomitantly, the interests of private sector actors and developed States are likely to be prioritised, whereas those of developing States are likely to be sidelined.

In sum, the free trade rule establishes a network of international relations in which producers are able to teleconnect to consumers and in which producers themselves play a significant regulatory role when it comes to qualifying the default rule. This characterisation of the teleconnections established by the default free trade rule, however, is not the complete picture. To complete the picture, international law needs to be examined, more generally, in terms of how it relates to the teleconnections established by the default free trade rule and possibly qualifies it.

5.2 The Difficulty of Qualifying the Default Free Trade Rule

Consideration of international law more broadly, and how it influences the network in which producers are teleconnected to consumers, provides a patchy picture. First, while MEAs seek to regulate the activities of producers, most do not directly qualify the free trade rule. Second, human rights law and international criminal law either address producers in a limited manner or do not address producers at all. Third, when it comes to environmental protection, preferential trade agreements (PTAs) generally provide rather weak qualifications of the free trade rule. In the analysis below, this chapter addresses first MEAs and thereafter the other three areas of international law: human rights law, international criminal law and PTAs.

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45 *United States – Measures Concerning the Importation, Marketing and Sale of Tuna and Tuna Products*, AB-2012-2, WT/DS381/AB/R (Report of the Appellate Body) 6 May 2012 (*US–Tuna II*).

46 *US–Tuna II*, para 399, AB-2012-2.

47 Sanderijn Duquet and Dylan Geraets, 'Food Safety Standards and Informal International Lawmaking' in Ayelet Berman et al (eds), *Informal International Lawmaking: Case Studies* (Torkel Opsahl Academic EPublisher 2012) 395, 406–12; Panagiottis Delimatsis, 'Global Standard Setting 2.0: How the WTO Spotlights ISO and Impacts the Transnational Standard-Setting Process' (2018) 28 Duke Journal of Comparative & International Law 273.

48 Delimatsis ibid; Alessandra Arcuri, 'The Coproduction of the Global Regulatory Regime for Food Safety Standards and Limits of a Technocratic Ethos', *EUI Working Papers*, RSCAS 2014/97, <https://cadmus.eui.eu/handle/1814/32833> accessed 10 June 2020.

49 Duquet and Geraets (n 47); Delimatsis (n 47).

5.2.1 Multilateral environmental agreements

A first point to note is that the environmental consequences of many products and production processes are not covered by MEAs. The production of plastics and trade in plastics, for example, is not regulated by a multilateral binding instrument, even if numerous voluntary initiatives are being taken.[50] Similarly, the environmental consequences of the production and trade in soy for the rearing of livestock and the production of meat in faraway places are not regulated by international law, even if the biodiversity regime addresses land use and the climate change regime has started to address greenhouse gas emissions related to agriculture.[51]

Some trade-related MEAs, such as the Montreal Protocol, referred to above, and the 1989 Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (Basel Convention), directly address the default free trade rule. The Montreal Protocol does so by requiring the phasing-out, and eventually banning, of trade in ozone-depleting substances.[52] The Basel Convention applies a prior informed consent procedure to trade in hazardous wastes. Importing States thereby have a conditioned measure of discretion in determining whether they will allow hazardous waste to enter their territory.[53] These types of agreements, because they are open to all States, presumably meet the standard set by the WTO Appellate Body in its *US–Tuna II* ruling.[54] However, using these agreements to qualify the free trade rule may face another obstacle: the fact that a State may not be a party to the agreement in question. Think of the United States which has not ratified, only signed, the Basel Convention.[55] On the one hand, such States may have seriously engaged in the negotiation process that led a number of States to conclude the MEA in question; on the other hand, these States are relying on their sovereign prerogative by not consenting to the MEA in question. Many trade-related MEAs address the problems associated with non-parties or

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50 Guilia Carlini and Konstantine Klein, 'Advancing the International Regulation of Plastic Pollution Beyond the United Nations Environment Assembly Resolution on Marine Litter and Microplastics' (2018) Review of European, Comparative and International Environmental Law 234.

51 Jonathan Verschuuren, 'The Paris Agreement on Climate Change: Agriculture and Food Security' (2016) 7 *European Journal of Risk Regulation* 54. Also see United Nations Framework Convention on Climate Change 'Introduction to Land Use' <https://unfccc.int/topics/land-use/the-big-picture/introduction-to-land-use> accessed 10 June 2020.

52 Other MEAs taking a similar approach include the Minamata Convention on Mercury (adopted 10 October 2013, entered into force 16 August 2017) art 31 Registration No. 54669; the Convention on International Trade in Endangered Species of Wild Fauna and Flora (adopted 3 March 1973, entered into force 1 July 1975) 993 UNTS 243; and the International Convention on the Control of Harmful Anti-fouling Systems on Ships (adopted 5 October 2001, entered into force 7 September 2010) IMO Treaty Series No. 13 (2012).

53 Other MEAs employing a prior informed consent procedure, even if not identical to the Basel Convention procedure, include the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemical and Pesticides in International Trade (adopted 10 September 1998, entered into force 24 February 2004) 2244 UNTS 337; and the Cartagena Protocol on Biosafety to the Convention on Biological Diversity (adopted 29 January 2000, entered into force 11 September 2003) 2226 UNTS 208. David Langlet, *Prior Informed Consent and Hazardous Trade: Regulating Trade in Hazardous Goods at the Intersection of Sovereignty, Free Trade and Environmental Protection* (Wolters Kluwer 2009).

54 See text at n 46.

55 Secretariat of the Basel Convention, 'Parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal' <www.basel.int/Countries/StatusofRatifications/PartiesSignatories/tabid/4499/Default.aspx> accessed 10 June 2020.

parties that have submitted a reservation or opted out of a particular regulation, by requiring State parties to apply the same or similar regulations in their trade-related relations with such States.[56] How the WTO Appellate Body would rule in a situation where MEA-based rules are applied to non-parties, whenever it might be in a position to do so,[57] remains uncertain.

Other MEAs more indirectly address the default free trade rule by adopting measures that States are to apply to human activities taking place within their jurisdiction or control. The 1992 Convention on Biological Diversity (CBD) provides an example. By stressing that its provisions 'apply in relation to each Contracting Party',[58] it suggests that its provisions and the regulations adopted by its conference of the parties (COP) are not applicable in interstate relations, unless States agree thereto.[59] It is unclear how this provision relates to the duty of States to cooperate in protecting biodiversity,[60] and more specifically to the preambular paragraph that provides 'that the conservation of biological diversity is a common concern of humankind'.[61] Furthermore, how the WTO Appellate Body might rule in a situation where an importing State seeks to apply, for example, recommendations on protected areas adopted by the COP of the CBD[62] to unsustainably produced soy, can only be guessed. On the one hand, the CBD is open to all States and the recommendations have been the object of serious negotiations and have been internationally agreed. On the other hand, their voluntary nature is explicitly referred to in the text. The climate change regime similarly does not address international trade relations in terms of greenhouse gas emissions involved in the production of a product. For example, it does not require that the greenhouse gas outputs' associated PPMs, or footprints, be reflected in the price of products.[63] Whether the WTO Appellate Body, or any other dispute settlement body associated with the WTO, would allow an importing State to distinguish between products based on PPMs related to the greenhouse gases emitted during their production process in the absence of international agreement remains uncertain.[64] However, this might change if the distinction between markets for sustainably and unsustainably produced products is extended beyond the energy market and beyond the regime of the 1994 Agreement on Subsidies and Countervailing Measures.[65]

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56 See for example art 10 CITES and art 4 Montreal Protocol.

57 Jennifer Anne Hillman, 'A Reset of the World Trade Organization's Appellate Body'(*Greenberg Center for Geoeconomic Studie*s, 14 January 2020) <www.cfr.org/report/reset-world-trade-organizations-appellate-body> accessed 10 June 2020; Tommaso Soave, 'Who Controls WTO Dispute Settlement? Reflections on the Appellate Body's Crisis from a Socio-Professional Perspective' EJIL Talk*,* 13 January 2020 <www.ejiltalk.org/who-controls-wto-dispute-settlement-reflections-on-the-appellate-bodys-crisis-from-a-socio-professional-perspective/> accessed 10 June 2020. Also see 'EU and 15 World Trade Organization Members Establish Contingency Appeal Arrangement for Trade Disputes' (*Press Release European Union*, 17 March 2020) <https://trade.ec.europa.eu/doclib/press/index.cfm?id=2127> accessed 10 June 2020.

58 Art 4, CBD.

59 See also Somsen and Trouwborst, Chapter 12 in this book.

60 Art 5, CBD.

61 Para 3, Preamble, CBD.

62 Decision 14/8. Protected areas and other effective area-based conservation measures, CBD/COP/DEC/14/8, 30 November 2018.

63 Daniel Bodansky, Jutta Brunnée and Lavanya Rajamani, *International Climate Change Law* (Oxford University Press 2017) 327–49. Also see text after n 22.

64 See text at and after n 37.

65 *Canada – Certain Measures Affecting the Renewable Energy Generation Sector (Canada–Renewable Energy)*, AB-2013-1, WT/DS412/AB/R (Report of the Appellate Body), 6 May 2013, paras 5.188–5.191.

In sum, trade-related MEAs are able to qualify the default free trade rule directly. However, these types of MEAs apply to a relatively limited number of products or production processes. Moreover, how the application of MEA-based regulations to non-parties might be assessed in terms of WTO law remains uncertain. Other MEAs (in fact, most MEAs) do not directly address the teleconnection established by the free trade rule, even if they seek to regulate the activities of producers operating within a State's jurisdiction or control.

5.2.2 Human rights and international criminal law

Human rights law is important for regulating human activities, including for how (foreign) producers involved in international trade must act in order to protect the environment.[66] Human rights establish rights for individuals and States are the duty-holders. The duties resting on States include the positive obligation to ensure that actors operating within their jurisdiction or control (including (foreign) producers involved in international trade) do not contribute to the violation of human rights. Yet, it has been difficult, in particular for developing states, to ensure that foreign producers involved in international trade uphold human rights. Moreover, despite numerous attempts, it has proven difficult, through human rights law, to directly address the responsibilities of home States and private sector actors, including those of (foreign) producers engaged in international trade.[67] At present, the 2011 Guiding Principles for Business and Human Rights are the most authoritative, but legally non-binding, normative framework governing the roles of host States, home States and private sector actors.[68] While these rules have great merit and indeed seek to condition the activities of producers, if and how they are able to qualify the free trade rule remains uncertain. Human rights law thus has only been able to qualify the free trade rule to a limited extent.

For its part, while international criminal law establishes duties for individuals, the Statute of the International Criminal Court (ICC) does not recognise ecocide as a crime.[69] This entails that private sector actors implicated in environmental destruction and the many human rights violations often associated with the extractive industries,[70] are not addressed by international criminal law. In other words, international criminal law does not qualify the teleconnection established by the free trade rule.

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[66] Alan Boyle, 'Human Rights and the Environment: Where Next?' (2012) 23 European Journal of International Law 613.

[67] Scott Jerbi, 'Business and Human Rights at the UN: What Might Happen Next' (2009) 31 Human Rights Quarterly 299.

[68] For further information see United Nations Human Rights, 'Business and Human Rights' <www.ohchr.org/EN/Issues/Business/Pages/BusinessIndex.aspx> accessed 10 June 2020. Florian Wettstein, 'Normativity, Ethics and the UN Guiding Principles on Business and Human Rights: A Critical Assessment' (2015) 14 Journal of Human Rights 162.

[69] Anastacia Greene, 'The Campaign to Make Ecocide an International Crime: Quixotic Quest or Moral Imperative?' (2019) 30 Fordham Environmental Law Review 1. Also see Isabella Kaminski, 'Vulnerable Nations Call for Ecocide to Be Recognized As an International Crime' (*Climate Liability News*, 6 December 2019) <www.climateliabilitynews.org/2019/12/06/ecocide-international-criminal-court-vanuatu/> accessed 10 June 2020.

[70] Greene ibid; Alexander Dunlap, 'The Politics of Ecocide, Genocide and Megaprojects: Interrogating Natural Resource Extraction, Identity and the Normalization of Erasure' (2020) Journal of Genocide Research.

5.2.3 Preferential trade agreements

As mentioned, qualifying the default free trade rule by agreement in the WTO, whether by means of human rights or by environmental standards, has remained controversial and has only succeeded on a few occasions.[71] Instead, human rights and environmental concerns, among other non-trade issues, have been introduced in agreements concluded under the WTO's General System of Preferences (GSP) and in PTAs. However, the extent to which these types of agreements are able to effectively and legitimately qualify the free trade rule is a topic of much debate, for several reasons.[72] First, practice shows that only more serious violations of human rights, labour standards and anti-corruption standards have led to the suspension or revocation of trade concessions based on agreements concluded by the European Union under the GSP.[73] It has furthermore been suggested that the European Union only applies these sanctions against smaller developing States.[74] Second, trade concessions granted under PTAs are difficult to suspend or revoke because of the costs and interests involved, also for a developed State party to a bilateral PTA.[75] Third, the environmental provisions included in PTAs are often soft and not enforceable,[76] even if it has been established that they may enhance environmental cooperation under certain conditions.[77] Fourth, questions have been raised regarding who specifically benefits most from the harmonisation of regulations based on PTAs. It has been suggested that large transnational corporations, in particular those that spread their production processes over various States, gain most and that smaller producers are displaced from the market.[78]

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71 See text at nn 33–35.

72 Leonardo Baccini, 'The Economics and Politics of Preferential Trade Agreements' (2019) 22 Annual Review of Political Science 75; Ingo Borchert et al, 'The Pursuit of Non-Trade Policy Objectives in EU Trade Policy' (2020) Universite Libre de Bruxelles Working Papers ECARES 2020-09 <http://respect.eui.eu/wp-content/uploads/sites/6/2020/04/Conditionality.pdf> accessed 10 June 2020; Paola Conconi, 'Linking Trade to Non-Trade Issues, Selected Survey of Literature' (2018) Universite Libre de Bruxelles <http://respect.eui.eu/wp-content/uploads/sites/6/2020/01/D2.1-Issue-Linkage.pdf> accessed 10 June 2020; Henrik Horn, Petros C Mavroidis and Andre Sapir, 'Beyond the WTO? An Anatomy of EU and US Preferential Trade Agreements' (2010) The World Economy 1565; Lisa Lechner, 'The Domestic Battle Over the Design of Non-trade Issues in Preferential Trade Agreements' (2016) 23 Review of International Political Economy 840.

73 Borchert et al, ibid, 22 and 26–28. On how the European Union uses its consumer market power to regulate production process globally see Anu Bradford, *The Brussels Effect: How the European Union Rules the World* (Oxford University Press 2020).

74 Borchert et al (n 72) 28.

75 Ibid 23.

76 Ibid 23–24. Jean-Frédéric Morin and Sikina Jinnah, 'The Untapped Potential of Preferential Trade Agreements for Climate Governance' (2018) 27 Environmental Politics 541.

77 Nuno Limão, 'Trade Policy, Cross-border Externalities and Lobbies: Do Linked Agreements Enforce More Cooperative Uutcomes?' (2005) 67 Journal of International Economics 175; Jean-Frédéric Morin and Rosalie Gauthier Nadeau, 'Environmental Gems in Trade Agreements: Little-known Clauses for Progressive Trade Agreements' (2017) *CIGI Papers No. 148*, <www.cigionline.org/sites/default/files/documents/Paper%20no.148.pdf> accessed 10 June 2020; Noémie Laurens and Jean-Frédéric Morin, 'Negotiating Environmental Protection in Trade Agreements: A Regime Shift or a Tactical Linkage?' (2019) 19 International Environmental Agreements: Politics, Law and Economics 533.

78 Baccini (n 72) 86–88; Conconi (n 72) 10. See also Kim and Kotzé, Chapter 3 in this book.

5.3 International Law and the Regulation of Human Activity

Below its interstate surface, international law teleconnects producers to consumers based on the default free trade rule. Qualifying this default rule requires international agreement in case of PPMs. But, as is well known, international agreement is increasingly difficult to attain, especially considering the present lack of enthusiasm for pursuing multilateral solutions on the part of some influential States. The latter is evidenced by the failure of States to agree to adopt a binding framework-type MEA in the form of the Global Pact for the Environment, instead opting to adopt a political declaration in the coming years.[79]

The extent to which other rules of international law, such as those in MEAs, are able to qualify the default free trade rule offers a patchy picture that shows the limited extent to which MEAs address production process and are able to qualify the free trade rule. The picture also is fraught with uncertainty given the nature of WTO law. This situation raises questions as to the nature of the duty of States to cooperate in order to protect the environment. In the interaction between rules of international law, it seems as if this duty is qualified by the default free trade rule. This is not a promising situation for the protection of planetary boundaries because it entails that international law prioritises the interests of producers who, by way of the free trade rule, are teleconnected to consumers all over the world, instead of prioritising the duty to cooperate to protect the Earth system.

From the point of view of the logics of the international legal system, the constitutionalisation of norms of international environmental law and human rights law, either by way of customary international law or the development of *jus cogens* norms,[80] or by way of the development of a *Grundnorm* setting out an overarching goal for international environmental law, might address some of the problems related to the functioning of the default free trade rule.[81] Although, in terms of the latter suggestion, the question remains how an environmental *Grundnorm* would interact with the default free trade rule, which Bosselmann and Kim identify as the overarching goal of international trade law.[82] Perhaps more significantly, neither the constitutionalisation of international environmental law or of human rights law nor the development of an environmental *Grundnorm* is likely to emerge without States cooperating to this end and exhibiting relevant State practice.

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[79] See UNGA Res. 73/333 Follow-up to the report of the ad hoc open-ended working group established pursuant to General Assembly Resolution 72/277, 30 August 2019, UN Doc. A/RES/73/333 (5 September 2019), para (b). Opinions about the adequacy of the content of document have varied, also among academics. See for example Margaret Young, 'Global Pact for the Environment: Defragging International Law?' EJIL Talk, 29 August 2018 <www.ejiltalk.org/global-pact-for-the-environment-defragging-international-law/> accessed 10 June 2020; Louis J Kotzé and Duncan French, 'A Critique of the Global Pact for the Environment: A Stillborn Initiative or the Foundation for *Lex Anthropocenae*?' (2018) 18 International Environmental Agreements: Politics, Law and Economics 811. For information about the Global Pact see United Nations 'Towards a Global Pact for the Environment' <https://globalpact.informea.org/> accessed 10 June 2020.

[80] Louis J Kotzé and Wendy Muzangaza, 'Constitutional International Environmental Law for the Anthropocene?' (2018) 27 Review of European, Comparative and International Environmental Law 278.

[81] Rakhyun E Kim and Klaus Bosselmann, 'International Environmental Law in the Anthropocene: Towards a Purposive System of Multilateral Environmental Agreements' (2013) 2 Transnational Environmental Law 285. See also Kim and Kotzé, Chapter 3 in this book.

[82] Ibid 294.

If this is so, could PTAs perhaps provide an alternative for moving forward? Given the uncertainties related to the extent to which PTAs currently qualify the free trade rule in order to protect the environment, their self-regulatory character and their lack of institutional oversight, they are likely to be no more than one of many elements that would come into play in efforts to protect planetary boundaries. Furthermore, considering prevailing legitimacy concerns, especially around who profits and to what extent, it is doubtful whether PTAs currently are able to take 'into account the deeper issues of equity and causation' that arise in the transgression of planetary boundaries and in which the teleconnections established by the free trade rule are implicated. The initiatives taken by the Earth Commission and SBTN might offer a way forward to the extent that, even while they remain voluntary, these could lead to teleconnections being integrated into the footprints of cities and companies. Moreover, the 2019 initiative to negotiate an Agreement on Climate Change, Trade and Sustainability (ACCTS) taken by New Zealand, Costa Rica, Fiji, Iceland and Norway may provide a step forward. ACCTS aims to abolish tariffs on environmental goods and services, abolish fossil fuel subsidies and introduce voluntary eco-labelling schemes. Once adopted the ACCTS would be open to all States.[83]

International law also offers an additional option, namely, prohibiting certain activities until regulation is available. This approach has been pursued for deep seabed mining in the 1982 United Nations Convention on the Law of the Sea and its 1994 Implementation Agreement, which subject deep seabed mining to regulation by the International Seabed Authority;[84] for Antarctic mineral resources exploitation, which has been banned indefinitely;[85] and for fishing in high-seas areas of the Arctic, which has been banned until regulations are in place.[86] In addition, in 2010, the parties to the CBD adopted a legally non-binding moratorium on geoengineering that may harm biodiversity.[87] Obviously, this approach faces the difficult hurdle of requiring international agreement before qualification of the free trade rule becomes a fact.

6. CONCLUSION: PLANETARY BOUNDARIES, THE FREE TRADE RULE AND RESEARCHING TELECONNECTIONS

This chapter presented a rather daunting challenge for international law, for scholars of international law and for planetary boundaries researchers. This challenge has been underlined again by the COVID-19 pandemic, which re-emphasises the need for reinvigorated multilateral approaches and a body of international law that provides an operating space within the Earth

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[83] For information, see New Zealand Foreign Affairs and Trade, 'Agreement on Climate Change, Trade and Sustainability (ACCTS) negotiations' <www.mfat.govt.nz/en/trade/free-trade-agreements/climate/agreement-on-climate-change-trade-and-sustainability-accts-negotiations/> accessed 10 June 2020; Jaime de Melo, *Negotiations for an Agreement on Climate Change, Trade and Sustainability (ACCTS): An Opportunity for Collective Action* (International Economics 2020) <www.tradeeconomics.com/wp-content/uploads/2020/04/JDM-ACCTS-2.pdf> accessed 20 June 2020.

[84] Art 137(2), UNLOSC and para 1, Section 1, Annex I to the 1994 Agreement Relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea of 10 December 1982.

[85] Art 7, 1991 Protocol on Environmental Protection to the Antarctic Treaty.

[86] Art 3, 2018 Agreement to Prevent Unregulated High Seas Fisheries in the Central Arctic Ocean.

[87] Paras 8(w) and (x), CBD, Resolution X/33 (2010); see Convention on Biological Diversity 'Climate-related Geoengineering and Biodiversity' <www.cbd.int/climate/geoengineering/> accessed 10 June 2020.

system for all life on Earth. This chapter concludes by briefly reflecting on a circumscribed research agenda that might make a small contribution towards such an endeavour.

This chapter showed that the concept of teleconnections can be put to work in analysing international law. It illustrated that the free trade rule protects the teleconnections that social scientists have identified as among the situations that foster the transgression of planetary boundaries. Importantly, the analysis also demonstrated that the free trade rule comes with the risk of universalising, unless further qualified. In particular, the free trade rule universalises the benefits that ensue from the free trade rule. The free trade rule does not consider whose interests have been or are being prioritised or sidelined. Instead, the free trade rule assumes that all profit equally, despite the fact that it has been shown that transnational companies profit most, with smaller producers often being pushed out of the market. The risk of universalising is a common trait that the free trade rule shares with the concept of planetary boundaries, suggesting that both require further nuance. Most notably, both come with the risk of overlooking the deeper issues of equity and causation that are involved in the transgression of planetary boundaries.

Integrating the concept of teleconnections in our research may help to avoid this gap. More specifically, adding the concept of teleconnections to planetary boundaries research might enable it to introduce additional nuance to its findings by localising some of the root causes of the transgression of planetary boundaries and how these are related to elements of international law, including the free trade rule and other rules of international law (see below). This approach would point policy-makers to the deeper issues of equity and causation involved in the transgression of planetary boundaries by identifying the localities at which harm to the Earth system arises and the root causes at the source of that harm, which are often located elsewhere.

For international lawyers, I suggest, there might be an interesting research agenda to pursue that focuses on the concept of teleconnections as employed in this chapter. The research framework set out above can be applied to other areas of international law, which might establish and maintain unsustainable teleconnections, including, for example, the law of the sea (in particular the freedoms of navigation and fishing), international civil aviation law and international investment law. My hypothesis is that the freedom of navigation and the freedom of fishing might also operate as default rules and that civil aviation law and international investment law might also harbour rules that operate as default rules. The research agenda might also encompass how international law fosters, or could foster, more sustainable teleconnections, including those being established by voluntary initiatives such as for the use of plastics or the initiatives of the Earth Commission. A central question would be: what norms are these voluntary initiatives engendering that might be relevant for the development of international law, or law more generally? PTAs also deserve more scrutiny. For example: do PTAs strengthen or qualify the free trade rule both in terms of human rights protection and the protection of the environment? In this respect, it will be particularly interesting to see how the ACCTS evolves.

Ultimately, in order to protect the Earth system, we need a radical change of ethics – one in which the message conveyed by planetary boundaries research is taken seriously and in which the deeper issues of equity and causation related to the transgression of planetary boundaries are internalized.[88] To achieve that change, it is imperative that planetary boundaries research,

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[88] See also Adelman, Chapter 4 in this book.

research focused on international law specifically, and the social sciences more generally, provide further insights into *how* our current socio-economic and legal system sustain teleconnected human activities that contribute to the transgression of planetary boundaries.

10. Compliance with planetary boundaries in international law

Jonas Ebbesson

1. WHAT IS THERE TO COMPLY WITH?

Staying within the 'safe operating space' defined by the planetary boundaries – presented and proposed in 2009,[1] and revised in 2015[2] – depends on the aggregate performance of numerous States, not the performance of one or a few States only. Therefore, even if the planetary boundaries became part of international law, States' performance or *compliance* would not be examined directly against them as legal standards or norms of conduct. Rather, the planetary boundaries would amount to legally defined objectives, to be achieved and operationalised through concrete obligations with examinable criteria. Alternatively, they could influence legal concepts, principles and obligations more subtly, through jurisprudence and doctrine, and thus push the development of customary law.

Given the complexities and uncertainties surrounding the planetary boundaries, just granting them legal recognition would not ensure that we actually stay within the safe operating space. Obviously, it would depend on States' capabilities to perform and adapt in light of the planetary boundaries. The normative impact of the planetary boundaries would also depend on legal factors, for instance on the strictness of the obligations and restrictions addressing the planetary boundaries; on whether a precautionary approach is taken in defining these norms;[3] and on the institutional structures in place to check compliance.[4]

Currently, however, the planetary boundaries do not have any formal legal status at all, so concern with performance and compliance with them in legal terms may seem pointless. But it is not. First, they are legally relevant, despite their lack of legal status. Second, given the attention to the planetary boundaries in national and international policy-making, how they would be reflected if granted legal recognition should be considered. In exploring the theme of compliance in the nexus of global environmental change at the planetary scale, I start by explaining why the planetary boundaries are relevant in international law. After expanding, in Section 2, on the legal relevance of planetary boundaries, I briefly describe in Section 3 how they have been used creatively in assessments of States' performance at the national level outside the legal domain. This is followed in Section 4 by an appraisal of some cases where the notion of 'safe operating space' is reflected in multilateral environmental agreements (MEAs).

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1 Johan Rockström et al, 'A Safe Operating Space for Humanity' (2009) 461 *Nature* 472; Johan Rockström et al, 'Planetary Boundaries: Exploring the Safe Operating Space for Humanity' (2009) 14 Ecology & Society 32.

2 Will Steffen et al, 'Planetary Boundaries: Guiding Human Development on a Changing Planet' (2015) 347 Science 736.

3 Such an approach is reflected in the proposed planetary boundaries: see Rockström et al 2009 (n 1) and Steffen et al (n 2).

4 See Kim and Kotzé, Chapter 3 in this book.

In focusing on compliance, I follow the distinction between implementation and compliance made in earlier studies with regard to MEAs and soft-law instruments.[5] Thus, implementation of international norms refers to measures that incorporate the international norms into domestic law, whether by domestic legislation or regulation. Most often MEAs need such implementing measures to be operational in the domestic context.[6] Yet, the means of implementation as well as the legislation look different in different countries depending on the international norms and the domestic legal tradition and structure. Compliance goes beyond implementation and is concerned with 'factual matching' of State behaviour and international norms,[7] and 'whether countries in fact adhere to the provisions of the accord and to the implementing measures that they have instituted'.[8] In other words, it refers to a State performing as required by the international agreement, either as set out in specific procedural obligations (for example, the requirement to monitor and report) or as set out in substantive obligations (such as reducing or phasing out the use of a certain substance, imposing certain technology standards on an industry, ensuring the protection of certain species or sites, or ensuring participatory rights for members of the public). These specific obligations may have to be understood or interpreted in light of the purpose and context of the normative framework – which could be to remain within a planetary boundary.[9]

Compliance with international environmental law involves a broad range of considerations, including practical reasons for failure to comply, the legal implications of non-compliance, the institutional procedures for compliance control and the effectiveness of compliance reviews.[10] In this chapter, my main concern is whether the planetary boundaries as such can be complied with in the first place. If not, how can compliance in relation to planetary boundaries be meaningfully examined in legal terms?[11]

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[5] Harold K Jacobson and Edith Brown Weiss, 'Strengthening Compliance with International Environmental Accords: Preliminary Observations from a Collaborative Project' (1995) 1 Global Governance 119, 123–24; Dinah Shelton, 'Introduction: Law, Non-Law and the Problem of "Soft-Law"' in Dinah Shelton (ed), *Commitment and Compliance: The Role of Non-binding Norms in the International Legal System* (Oxford University Press 2003) 1, 5.

[6] Edith Brown Weiss, 'Understanding Compliance with International Environmental Agreements: The Baker's Dozen Myths' (1999) 32 University of Richmond Law Review 1554, 1562f.

[7] Shelton (n 5).

[8] Jacobson and Brown Weiss (n 5) 119.

[9] Ibid at 124–25 refers to this as 'the spirit of the treaty'. This comes close to the general rule of interpretation in the Vienna Convention on the Law of Treaties, article 31(1), that the terms of the treaty shall be interpreted in 'their context and in the light of its object and purpose'.

[10] On compliance with international environmental law, see Jacobson and Brown Weiss (n 5) 119; Shelton (n 5) 1; Abram Chayes and Antonia Handler Chayes, 'On Compliance' (1993) 47 International Organization 175–205; Ronald B Mitchell, 'Compliance Theory: A Synthesis' (1993) 2 Review of European Community and International Environmental Law 327; Ronald B Mitchell, 'Compliance Theory' in Daniel Bodansky et al (eds), *Oxford Handbook on International Environmental Law* (Oxford University Press 2007) 893–921; Edith Brown Weiss and Harold K Jacobson (eds), *Engaging Countries: Strengthening Compliance with International Environmental Accords* (MIT Press 1998); Brown Weiss (n 6); Jutta Brunnée et al (eds), *Promoting Compliance in an Evolving Climate Regime* (Cambridge University Press 2011).

[11] While not considering the planetary boundaries, much of the environmental law research in Sweden in the 1990s focused on how to 'operationalise' the legally recognised environmental objectives (whether in national, EU or international law), that is, how to ensure through substantive and procedural norms that the environmental objective could indeed be reached. See eg Staffan Westerlund, *Miljörättsliga grundfrågor* (Nordisk Ministerråd 1987); Staffan Westerlund, *En hållbar rättsordning: Rättsvetenskapliga*

2. WHAT HAS LAW GOT TO DO WITH IT?

2.1 Planetary Boundaries Are Legally Relevant

Today, the planetary boundaries have no formal status in international law. They have never been presented or proposed as legal norms against which implementation or compliance should be examined. Nor are they intended or perceived as guidance for the interpretation or application of existing laws at the international or national level. None of the proposed planetary boundaries has yet been transformed into any treaty regime, and none is reflected in customary international law. They do not reflect 'soft law' either, in the sense of opinion of States through normative instruments adopted with political legitimacy, and thus potentially affecting the application, interpretation or understanding of international law.[12] It follows that there is neither a legal obligation for States to monitor their performance with respect to the planetary boundaries, nor a legal obligation to somehow implement or comply with them.

Yet, the proposed planetary boundaries *are* legally relevant. They have had a great impact on Earth system science, other sustainability-related sciences and environmental discourse generally. And they have had significant normative impact on environmental governance and policy-making in national and international contexts.[13] While the exact boundaries may be subject to debate, some of the boundary themes are indeed the raison d'être for international and national legal regimes, and a few of them – such as climate change and ozone layer depletion – are even matched by legal frameworks of global scope and scale, set up before the planetary boundaries were proposed.[14] Still, this does not turn the planetary boundaries into legal norms (not even soft law). So, what makes them legally relevant?[15]

2.2 Input on Established Concepts and Existing Legal Frameworks

First, provided that the planetary boundaries are or will be duly recognised by the international community to understand the Earth system, they may compel us to re-examine and re-construe already established concepts and to reinterpret *existing* treaty provisions in light of new circumstances.[16] This could be the case when there is an international treaty regime in place for a specific boundary theme.[17] For example, the planetary boundaries could provide important factual information for determining which measures are 'necessary to prevent, reduce and

paradigm och tankevändor (Iustus förlag 1998); Lena Gipperth, *Miljökvalitetsnormer: En rättsvetenskaplig studie i regelteknik för operationalisering av miljömål* (Uppsala universitet 1999); Jonas Ebbesson, *Compatibility of International and National Environmental Law* (Kluwer Law International 1996); Jonas Christensen, *Rätt och kretslopp: studier om förutsättningar för rättslig kontroll av naturresursflöden, tillämpade på fosfor* (Iustus förlag 2000).

12 On compliance with 'soft law' instruments, see Shelton (n 5).

13 See below.

14 On this issue, see Jonas Ebbesson, 'Planetary Boundaries and the Matching of International Treaty Regimes' (2014) 59 Scandinavian Studies in Law 259. See also respectively, Verschuuren, Chapter 13, and Du Toit, Chapter 14, in this book.

15 This draws on Jonas Ebbesson, 'Social-Ecological Security and International Law in the Anthropocene' in Jonas Ebbesson et al (eds), *International Law and Changing Perceptions of Security – Liber Amicorum Said Mahmoudi* (Brill 2014) 71, 80–82.

16 See also Hey, Chapter 9 in this book.

17 Ebbesson (n 14).

control pollution of the marine environment', as set out in the 1982 United Nations Convention on the Law of the Sea,[18] or for when and how comprehensive 'precautionary measures' must be taken to anticipate, prevent or minimise the causes of climate change, as provided for in the 1992 United Nations Framework Convention on Climate Change (UNFCCC).[19] If the planetary boundaries are incorporated in international policy documents or decisions by conferences of the parties in treaty regimes, they may also be normatively relevant for the interpretation of open-ended and general provisions of existing treaties.[20] In such cases, it would be possible to review compliance, not with the planetary boundaries, but with existing international norms in light of the understanding of planetary boundaries.

If sufficiently recognised and accepted, the planetary boundaries would also be relevant as factual information when considering States' performance subject to due diligence obligations or equity under general international law. For instance, the solid science on climate change is relevant for the due diligence obligation to reduce emissions of greenhouse gases, so as not to cause harm to other States and areas beyond the limits of national jurisdictions; this also applies in the case of a State which is not a party to the Paris Agreement. Another example is how land-system change, for example through deforestation, could be reviewed under the principle of no harm because of its various transboundary impacts on biodiversity, food production and fresh water flows.[21] Moreover, the understanding of the scales of the underlying social-ecological processes – whether they are truly global processes or rather regional processes that may affect the planet in the aggregate – and their impacts could be relevant when determining what constitute international obligations *erga omnes*.

2.3 Input for New Legal Ideas, Approaches and Concepts

Second, the proposed planetary boundaries may push for new legal ideas, approaches and concepts to prevent further or anticipated social and ecological degradation, and to promote common security for the biosphere.[22] Here too, the relevance of the planetary boundaries would be mainly factual, although increasing acceptance of such boundaries would generate political expectations and ethical claims too.[23] In addition, if incorporated in political declarations and policy documents, they could provide normative backing for new legal developments and approaches. Such new approaches may include introducing new legal restrictions and constraints for States and other actors in existing legal frameworks, and possibly new ways of monitoring performance and examining whether States and other actors implement or comply with applicable norms. Increasing acceptance of the planetary boundaries may also inspire completely new treaty regimes.[24] Finally, as argued at the outset, if reflected or incor-

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[18] 1982 United Nations Convention on the Law of the Sea (1982) 21 ILM 1261; art 194(1). See also Diz, Chapter 17 in this book.

[19] 1992 United Nations Framework Convention on Climate Change (1992) 31 ILM 849. Examples from Ebbesson (n 15) 81.

[20] Cf. Vienna Convention on the Law of Treaties (adopted 23 May 1969, entered into force 27 January 1980) 1155 UNTS 331, art 31(3).

[21] See Morrow, Chapter 19 in this book.

[22] Ebbesson (n 15) 80–92.

[23] See, specifically, Adelman, Chapter 4, and Kim and Kotzé, Chapter 3, in this book.

[24] Edgar Fernández Fernández and Claire Malwé, 'The Emergence of the "Planetary Boundaries" Concept in International Environmental Law: A Proposal for a Framework Convention' (2019) 28 Review of European, Comparative and International Environmental Law 48.

porated in international or national policy documents, action plans and so forth, the planetary boundaries may give normative support, through *opinio juris* via jurisprudence and doctrine, for the development of customary international law. This, of course, also triggers general questions about compliance with international law.

2.4 Proposals for Planetary Boundaries in International Law

Although the planetary boundaries may push for changes in international law, I am not convinced by the proposal by Biermann that 'certain standards that are fundamental to preserve and protect the nine planetary boundaries would fall under the injunction of *jus cogens*'.[25] There is nothing to suggest that any standard of international law today would have the status of *jus cogens* just because of a link to a planetary boundary. Moreover, as I will discuss further below, even if legal norms were somehow developed in relation to a planetary boundary, with few exceptions, such norms would not be defined as complete prohibitions against all activities that could challenge the boundary in question. Rather, such norms would take the form of restrictions or obligations to take certain measures, so that the cumulative effects of all activities do not transgress the boundary, but it would not be of a *jus cogens* nature.

In line with the above argument about pushing for new ideas, Fernández and Malwé have proposed that a 'framework convention on planetary boundaries' be adopted, which recognises the necessity of maintaining 'Holocene-like conditions' and the existence of ecological tipping points. This would include some elements that can be found in existing framework conventions (although they do not specifically propose any obligations on monitoring or reporting, or any mechanism for the review of compliance).[26] Yet it would not set out detailed requirements on what to do, achieve or avoid, or on how to comply. While they propose that it would recognise the need for setting quantitative boundary levels and oblige the parties to apply the precautionary principle,[27] they do not consider *how* the planetary boundaries should indeed be reflected in the legal norms, since that would be for future, additional instruments to set out. Therefore, if such a framework treaty is to be established, the proposal does not guide the consideration of how (except in terms of the application of the precautionary principle) any legal obligation to safeguard and operationalise the planetary boundaries would be structured or defined, or how implementation of, or compliance with, such norms would be examined.

In similar, albeit more general terms, Chapron and colleagues propose that 'environmental legislation must at a minimum act as legal boundaries that prevent human activities from reaching and breaching planetary boundaries'.[28] While one can sympathise with the call for stricter environmental legislation, it is another matter to conclude as to when legislation is in fact adequate and sufficient to safeguard the planetary boundaries. The same applies with regard to the proposed 'critical test of legal boundaries' effectiveness'; that is, 'whether, when human activities collide with them, they hold, become porous or are pushed beyond plane-

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[25] Frank Biermann, 'Planetary Boundaries and Earth System Governance: Exploring the Links' (2012) 81 Ecological Economics 4, 8.

[26] Fernández Fernández and Malwé (n 24) 53ff.

[27] Ibid 54–55.

[28] Guillaume Chapron et al, 'Bolster Legal Boundaries to Stay within Planetary Boundaries' (2017) 1 Nature Ecology & Evolution 1.

tary boundaries.'[29] One can again agree in the abstract, but the question is *how* to examine *when* and *whether* the law is pushed beyond planetary boundaries. In this respect, neither the proposal of a framework convention nor the emphasis on 'legal boundaries' effectiveness' explains whether the performance of States or other actors should be reviewed directly on the basis of the planetary boundaries. Still, this would be an essential legal issue if the planetary boundaries were incorporated or reflected in legal frameworks.

It is obvious that law affects social-ecological systems and their resilience positively or negatively, in local, regional or global settings.[30] Similarly, the legal structures, regimes and institutions, in local, regional and global settings, are important factors for the prospect of staying within any planetary boundary.[31] Yet, when moving from abstract thinking, the test of the effectiveness of a law or legal regime involves both the substantive norms on, for example, the protection of biodiversity or emissions of nutrients, and the procedural, institutional and practical features.

3. COMPLIANCE WITH THE PLANETARY BOUNDARIES – OUTSIDE THE LEGAL DOMAIN

Despite my preliminary points about the difficulty in applying the planetary boundaries directly as criteria against which to examine States' performance and compliance, this is exactly what has been done *outside the legal domain*. The notion of planetary boundaries evolved from advancements in Earth system science, and this inspired further research on resilience at the planetary scale. These studies are not limited to examining how the planetary boundaries relate to Earth system governance theory,[32] but also consider and apply the planetary boundaries directly in sustainability assessments at regional and national levels.[33]

In those studies where the planetary boundaries are used to develop or assess national policies, a crucial issue is how to 'downscale' the boundaries to the level or scale of a specific country.[34] Downscaling means determining a boundary at the national level based on the

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29 Ibid.

30 Ebbesson (n 15) 71, 80–82; Jonas Ebbesson, 'The Rule of Law in Governance of Complex Socio-Ecological Changes' (2010) 20 Global Environmental Change 414.

31 Ebbesson ibid; Jonas Ebbesson and Carl Folke, 'Matching Scales of Law with Social-Ecological Contexts to Promote Resilience' in Ahjond S Garmestani and Craig R Allen (eds), *Social-Ecological Resilience and Law* (Columbia University Press 2014) 265.

32 See eg Victor Galaz et al, 'Global Environmental Governance and Planetary Boundaries: An Introduction' (2012) 81 Ecological Economics 1; Victor Galaz et al, 'Polycentric Systems and Interacting Planetary Boundaries – Emerging Governance of Climate Change – Ocean Acidification – Marine Biodiversity' (2012) 81 Ecological Economics 21–32; and Biermann (n 25).

33 See eg Björn Nykvist et al, *National Environmental Performance on Planetary Boundaries: A Study for the Swedish Environment Protection Agency* (Swedish Environment Protection Agency 2013); Hy Dao et al, 'National Environmental Limits and Footprints based on the Planetary Boundaries Framework: The Case of Switzerland' (2018) 52 Global Environmental Change 49; Megan J Cole et al, 'Tracking Sustainable Development with a National Barometer for South Africa using a Downscaled "Safe and Just Space" Framework' (2014) Proceedings of the National Academy of Sciences of the USA 111, E4399; and Kai Fang et al, 'Understanding the Complementary Linkages between Environmental Footprints and Planetary Boundaries in a Footprint-Boundary Environmental Sustainability Assessment Framework' (2015) 114 Ecological Economics 218.

34 See also Kim and Kotzé, Chapter 3; Bleby, Holley and Milligan, Chapter 2 in this book.

boundary at the planetary level, or setting 'the exclusive share of the planet's resources as allocated to a given country. An exclusive share means that the total of all country shares sum up to the global limit.'[35] The different concepts, methods and means explored to that end are useful also for legal reflections.

Translating the planetary boundaries into a corresponding set of national boundaries simply by downscaling the boundaries to per capita shares of the global operating space may appear the most straightforward strategy. This would make the contribution of Luxembourg comparable with that of China. However, for different reasons, this approach does not work. For some boundary themes, such as the rate of biodiversity loss/biosphere integrity, it is not even possible to make such calculations.[36] Moreover, as pointed out by Nykvist *et al* when exploring this route, a simple per capita calculation would not consider the fairness of such a crude distribution of space,[37] neither within the territory of the country nor in transboundary contexts. There are also at least two radically different ways of calculating the per capita share related to a country, with great differences in outcome. The first approach is to consider only the territorial performance, that is, only the emissions related to the production within a country, without taking exports or imports into account. This has been the approach in the UNFCCC reporting. The second is to calculate the per capita share on consumption performance, which means that the emissions and resources used are attributed to a country based on the consumption of its citizens, not on where the consumed goods were produced.[38] In addition, Dao and colleagues argue that downscaling by a strict per capita method, that is, dividing the global limit by the global population, also has other drawbacks:

1. Per capita calculations do not take account of the different needs of inhabitants and the different amount of resources needed to satisfy these needs;
2. Past emissions and use of resources are not considered; and
3. The role of countries, being the current main way of allocating resources between people, is not considered.[39]

In legal terms, it is relatively simple for some situations (leaving aside uncertainties and means of monitoring) to examine compliance with an obligation based on per capita calculation of emissions and production. Yet the arguments above, about why we should not rely on a strict per capita method only when assessing a State's performance in light of the planetary boundaries, are relevant also for legal contexts. While no obligation of international law has yet been defined on the basis of a strict per capita calculation, arguments for and against such calculations have featured in the background in legal contexts, for instance in the negotiations of the Montreal Protocol on Substances that Deplete the Ozone Layer[40] and the Kyoto Protocol to the UNFCCC.[41]

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35 Dao et al (n 33) 52.
36 See Trouwborst and Somsen, Chapter 12 in this book.
37 Nykvist et al (n 33).
38 Ibid 11, 41–43.
39 Dao et al (n 33) 52.
40 Montreal Protocol on Substances that Deplete the Ozone Layer, 26 ILM (1987) 1550, as amended.
41 1997 Kyoto Protocol to the United Nations Framework Convention on Climate Change, 37 ILM (1997) 22.

A further method in environmental sustainability assessments, explored by Fang and colleagues, is to complement the planetary boundaries with environmental or ecological 'footprints'.[42] After having identified different definitions,[43] they specify 'environmental footprints' as 'a measure of human pressure on the planet's environment in relation to resource extraction and waste emission'.[44] With this complementary approach, the planetary boundaries are seen as a means to ensure that the footprints do not cause undesirable effects: 'a simultaneous assessment of environmental footprints and related capacity thresholds is therefore of vital importance, representing the evolution of the backtracking towards a prognostic and preventive measure that helps prevent human activities from triggering undesirable environmental changes.'[45] An advantage of the dual approach, which includes the planetary boundaries in environmental assessments, is that it moves from focusing on issues in isolation to addressing them simultaneously from an integrated perspective. Nevertheless, the authors emphasise the 'scale problem' in these assessments and point to the fact that the non-transgression of one planetary boundary does not necessarily guarantee a sustainable society, since regional or local boundary exceedance may cause irreversible environmental damage, in particular 'when it comes to aggregated issues that are spatially heterogeneous and local-regional in scale'.[46] They suggest that the development of measurable local and regional boundaries could serve as a basis for environmental sustainability assessments applied to the allocation of responsibility for creating sustainable societies at multiple scales.[47] This would also have to be taken into account if the planetary boundaries were incorporated into legal frameworks.

Finally, through a method developed by Raworth, indicators and boundaries for environmental stress are combined with indicators for social concerns, thus adding the dimension of social wellbeing – that is, a 'safe and just space for humanity' framework – to the planetary boundaries. This means staying within the outer ceiling – the planetary boundaries – and the inner foundation – the minimum social foundation.[48]

By downscaling the planetary boundaries and applying a 'safe and just space for humanity' framework, Cole and colleagues have used this approach to assess a State's performance in relation to the environmental ceiling and the social foundation.[49] In downscaling the planetary boundaries, commentators have identified three types of environmental boundaries: one type referring to dimensions that are inherently global in nature (such as climate change and ozone layer depletion); a second which represents national limits for land and freshwater resources;[50] and a third which combines the global dimension with the local negative impacts ('local biophysical thresholds and a national safe boundary').[51] Here too, the performance assessment is not only based on a simple per capita calculation, but also includes several social welfare

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[42] Fang et al (n 33).
[43] For references, see ibid at 218.
[44] Ibid at 221.
[45] Ibid at 218–226, 219.
[46] Ibid at 225.
[47] Ibid.
[48] Kate Raworth, *A Safe and Just Space for Humanity: Can We Live within the Doughnut?* (Oxfam Discussion Paper, February 2012); Kate Raworth, *Doughnut Economics: Seven Ways to Think Like a 21st Century Economist* (Random House Business Books 2017).
[49] Eg Cole et al (n 33).
[50] See also Cooper, Chapter 18 in this book.
[51] Cole et al (n 33) 4401.

indicators (referring to social deprivation, basic services, public goods, livelihood and living standards) and other available data, creating a 'barometer' to examine how a country fares between the ceiling and the foundation.[52]

These examples show constructive attempts to apply, build on, develop and combine the proposed planetary boundaries with other criteria, whether referring to social justice or footprints, when examining States' performance. While useful for the assessment of States' performance and for sustainability plans, the studies show the difficulty in applying the planetary boundaries directly as benchmarks. In none of the studies canvassed in this section were the planetary boundaries simply downscaled by a per capita calculation. These studies indicate the difficulty of applying the planetary boundaries when States' obligations, responsibilities and compliance are examined in legal terms.

4. COMPLIANCE WITH THE PLANETARY BOUNDARIES IN LEGAL CONTEXTS

4.1 The Definitions of the Planetary Boundaries

The variety of the boundary themes is reflected in the ways in which they are defined. Any attempt to transform a boundary into law would have to take these peculiarities into account.

First, while some of the planetary boundaries refer to truly global processes (such as climate change and ozone layer depletion), other boundaries are set for the global aggregate, yet with strong regional operating scales (such as biosphere integrity, biogeochemical flows, land-system change, freshwater use and atmospheric aerosol loading). Some boundaries are defined both at the planetary and at the biome, basin or regional levels. This is especially relevant when matching treaty regimes: is it more feasible to address the planetary boundaries in global or regional frameworks, or at both scales?

Second, several planetary boundaries are interdependent, which means that transgressing one boundary affects the positions of other boundaries.[53] This complicates assessments of States' performance, and it poses particular challenges for legal frameworks intended to address the boundary theme(s), both in defining the legal obligations and in the review of compliance. For instance, how would a compliance mechanism consider measures taken that are very positive with respect to one boundary theme, but adverse with regard to another (such as promoting the use of wood, hydropower or wind power as energy sources to prevent climate change while it may cause negative effects for biodiversity)?[54]

Third, the degree of detail differs significantly from one planetary boundary to the other. For atmospheric carbon dioxide and ozone-depleting substances, even though the boundaries relate to 'pre-industrial' levels, they are set in rather detailed figures. For ocean acidification, the boundary is defined as '$\geq$80% of the pre-industrial aragonite saturation state of mean surface ocean'.[55] While such references to pre-industrial situations do not prevent the moni-

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52 Ibid 4401–02.

53 See Kim and Kotze, Chapter 3, and Bleby, Holley and Milligan, Chapter 2, in this book.

54 See, on the related issue of regime interaction and the planetary boundaries, Piselli and Van Asselt, Chapter 7 in this book.

55 Steffen et al (n 2) 4.

toring or assessment of the performance of States, they cannot be used as legal criteria when examining compliance. They are simply too vague and unclear to function as benchmarks. The boundary for biosphere integrity (rate of biodiversity loss) is set at a rate of extinction loss per million of species and year, which also cannot be used directly as a criterion against which States' compliance can be examined.

Fourth, the 'zone of uncertainty, sometimes large, […] associated with each of the boundaries' encapsulates 'both gaps and weaknesses in the scientific knowledge base and intrinsic uncertainties in the functioning of the Earth system'.[56] For sustainability governance, uncertainty may not reduce the value of the boundaries or the idea of thinking in terms of boundaries as such. And a precautionary approach that is intended to ensure a safe space for human development requires action even when there are uncertainties in calculations. In legal contexts, the degree of uncertainty matters both for the institutional design and for the drafting of obligations against which compliance is to be examined. A good example, further described below, is how the key obligations in the global regime concerning the stratospheric ozone layer were changed a couple of times in the 1990s in light of new research showing the need for a quicker reduction and phase-out.[57]

Fifth, some of the boundary themes have 'strong regional operating scales', and 'not all Earth-system processes included in the PB [planetary boundary] approach have singular thresholds at the global/continental/ocean basin level'.[58] It may be even more difficult to establish effective regimes for these processes than for those with known large-scale thresholds.[59] In this context, proponents of the planetary boundary framework emphasise the need to focus on the sub-global level to understand the functioning of the Earth system as a whole: '[T]he PB [planetary boundary] framework is therefore meant to complement, not replace or supersede, efforts to address local and regional environmental issues.'[60] These insights too would have to be taken into account if the boundaries were transformed into law.

The planetary boundaries inspire further research in sustainability science, and they may be used in planning, policy-making and assessments of States' performance. Still, when examining a State's performance in light of a boundary, it is more a matter of whether the State moves in the right direction, as compared with other States, than of distinctly determining compliance or non-compliance. For the reasons stated, and as is further described below, it would be just about impossible to apply the planetary boundaries directly in legal contexts in order to make any sound conclusion on compliance.

4.2 The Design of Goal-Oriented Norms and Boundaries in Existing International Law

An international obligation to stay within a certain planetary boundary is a goal-oriented norm, that is, an obligation of result, in this case referring to physical or biological criteria. Compliance with such obligations would depend not on the means but on what is actually achieved or avoided in the physical world. Goal-oriented norms are used in some national

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56 Ibid 2.
57 See also Du Toit, Chapter 14 in this book.
58 Steffen et al (n 2) 2.
59 Ibid 2.
60 Ibid 3.

systems and in European Union law, for instance when environmental quality standards apply. In European Union law, directives set both objectives and binding standards regarding the maximum or minimum levels of pollutants for air and water, and the member states are obliged to implement these standards through national legislation and to comply with them.[61] The environmental quality standards have legal effects for private actors, and some such standards even grant substantive and procedural rights for members of the public. There are not many examples of obligations in international environmental law that are defined by goal-oriented norms, although the principle of good neighbourliness, that is, of not causing harm of significance to other States, sets out what States must avoid in terms of adverse effects.[62]

A major difficulty in applying goal-oriented norms in international contexts – and in examining compliance with such norms – is the attribution of responsibility; that is, to link a certain effect, such as transgressing an environmental quality standard or a planetary boundary, to one specific actor. As mentioned, most often, the crossing of such a boundary is the aggregate result of the performance of several actors. It is difficult to make such assessments of performance in non-legal settings. In a legal setting, which involves concerns with predictability, attribution and responsibility, it is even more complicated, if at all possible, to do so, in particular on a planetary scale.

So, if it is not feasible to transform and apply the planetary boundaries directly as legal obligations to be complied with, what alternatives are there? In replying to this question, I will use a few existing treaty regimes to illustrate how international law may relate to the notion of boundaries or limits that cannot be transgressed.

4.3 Air Pollution Convention and Its Protocols

A useful case study to illustrate how reviewable legal obligations can be defined to address a complex environmental problem is the regional approach taken in the 1979 Convention on Long-range Transboundary Air Pollution.[63] This treaty regime is relevant for a few planetary boundaries (ocean acidification, aerosol loading and phosphorous and nitrogen cycles), even though the regime does not adequately match these boundary themes in terms of scale. It also served as a model for the later development of treaty arrangements at a global scale.

The Air Pollution Convention is a framework convention, applicable to the United Nations Economic Commission for Europe (UNECE) region (Europe, United States, Canada and countries that were former regions of the Soviet Union), in which the parties recognise the environmental problems at stake, agree on some general principles of action and establish a platform for long-term cooperation, albeit without any clear commitments to reduce their emissions. Contrary to some other framework treaties, it does not define any objective, which reflects the notion of a boundary, limit or safe operating space. The different protocols under the Air Pollution Convention, adopted to address emissions of sulphur and nitrogen oxides to combat acidification, emissions of heavy metals and measures to deal with ground level

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[61] For an overview of EU directives setting environmental quality standards or objectives for air and water, see David Langlet and Said Mahmoudi, *EU Environmental Law and Policy* (Oxford University Press 2016) 212–15 and 224–29.

[62] For an analysis of goal-oriented norms in international law and some (not very recent) examples, see Ebbesson (n 11) 90–91 and 163–79.

[63] Convention on Long-Range Transboundary Air Pollution (1979) 18 ILM 1442.

ozone and eutrophication, use different regulatory approaches. Yet the key obligations in all protocols, based on the acknowledgement that the environmental effects are not local and thus not dependent on the exact location of each polluting source, have been defined by national percentage reduction rates.[64]

The first protocol to the Convention, adopted in 1985, applied to emissions of sulphur and obliged all parties to reduce their total annual emissions and their transboundary fluxes by at least 30 per cent by 1993 compared to 1980 levels.[65] In this case, the same reduction rate was set for all parties. In parallel, the Convention parties agreed on a scheme to monitor and evaluate the transmissions of air pollutants. A fixed obligation that is clearly linked to the performance of each party, in combination with a monitoring and evaluation scheme, made it possible to improve the review of compliance by the parties. It also made it possible to develop and refine the means of defining the obligations of the parties. The monitoring of emissions has been used in subsequent protocols where the percentage reduction rates for emissions are no longer equal for all parties, but rather set in a differentiated way based on different factors. Among these factors – and now we approach the goal-oriented dimension – are the notions of 'critical load' and 'critical level'.

In particular, the 1999 Protocol to Abate Acidification, Eutrophication and Ground-Level Ozone, while defining the key obligations in terms of national percentage reduction rates, builds on 'critical loads' and 'critical levels'.[66] In the Protocol, these concepts are defined as follows:

> Critical load: 'a quantitative estimate of an exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur, according to present knowledge.'[67]
>
> Critical level: 'concentrations of pollutants in the atmosphere above which direct adverse effects on receptors, such as human beings, plants, ecosystems or materials, may occur, according to present knowledge.'[68]

Just like the planetary boundaries, the critical loads and critical levels seem to imply a safe operating space, in this case the space *below* which significant harmful effects do not occur, and *above* where they do. The concepts appear both in the objective of the Protocol and as a basis for the calculation of the reduction rates for emissions of different substances. Thus, the objective of the Protocol is:

> to control and reduce emissions of sulphur, nitrogen oxides, ammonia, volatile organic compounds and particulate matter … and to *ensure*, as far as possible, that in the long term and in a stepwise approach, taking into account advances in scientific knowledge, atmospheric depositions or concentrations *do not exceed*:
> … the *critical loads* of acidity, …;

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64 Ebbesson (n 11) 136–44.

65 Protocol to the 1979 Convention on Long-range Transboundary Pollution on the Reduction of Sulphur Emissions or their Transboundary Fluxes by at Least 30 Per Cent (1988) 27 ILM 707.

66 1999 Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution to Abate Acidification, Eutrophication and Ground-Level Ozone (30 November 1999) UN Doc. ECE/EB.AIR/1991/1 (15 October 1999, as amended 4 May 2012) UN Doc. ECE/EB.AIR/114 (6 May 2013).

67 1999 Protocol, article 1(12).

68 Ibid, article 1(13).

… the *critical loads* of nutrient nitrogen, …;
… the *critical levels* of ozone, …;
… the *critical levels* of particulate matter, …;
… the *critical levels* of ammonia, …[69]

So, while not at the planetary scale, the obligations to reduce emissions to certain rates are linked to the idea of a safe operating space. Still, the key legal obligations are not directly defined by the critical load or critical level. Instead, the critical loads have been used to define the objective and to legitimise the differentiated reductions levels for the parties, and as relevant aspects to take into account when applying and interpreting the provisions of the protocols.

In this way, the obligation to reduce the national annual emissions by a certain percentage rate, in combination with specific obligations referring to the technology used for each installation, *operationalise* the objective not to cause harmful or adverse effects as defined by the critical loads and levels. It provides a differentiated strategy in setting the percentage reduction rates for the parties. It also makes compliance review easier, since it is then a matter of monitoring the emissions attributed to each party rather than trying to link any aggregate effects beyond the critical loads or levels to specific parties. While the operationalisation facilitates compliance control, it is another story whether the obligations are strict enough to achieve the intended objective – in this case of not transgressing the critical loads and levels. As we will see, there are examples in other treaty regimes where it was clear at the outset that even full compliance with the legal obligations would not be sufficient to achieve the underlying objective.

4.4 Vienna Convention and Montreal Protocol

On the global scale, a similar approach to that of air pollution governance was taken for ozone layer depletion, which is very explicitly one of the planetary boundary themes. The 1985 Vienna Convention on the Protection of the Ozone Layer is structured as a framework convention, with no clearly defined objective.[70] Yet the preambular account, that the parties are '[d]etermined to protect human health and the environment against adverse effects resulting from modifications of the ozone layer',[71] reflects the idea of a safe operating space, although it is not formally defined as an objective in the operational part of the treaty.

The Vienna Convention also establishes a platform for long-term cooperation and further action, including regulation and law-making through protocols. The law-making protocol in this respect is the 1987 Montreal Protocol.[72] While the Montreal Protocol also defines the obligations of the parties in terms of national percentage reduction rates, thus resembling the legal approach of the Air Pollution Convention, here the national reduction rates refer to consumption/production rather than emissions. Originally, the parties agreed to a 50 per cent reduction of consumption/production of some ozone-depleting substances (mainly

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[69] Emphasis added. The critical loads and critical levels essentially apply to the parties in Europe and in the area of the former Soviet Union, whereas for the United States and Canada other references are used.
[70] 1985 Convention for the Protection of the Ozone Layer (1987) 26 ILM 1529.
[71] Ibid, preamble.
[72] As amended; see (n 40). See also Du Toit, Chapter 14 in this book.

chlorofluorocarbons (CFCs)) by 1999 compared to 1986 levels.[73] These reduction rates were quickly made stricter in light of new scientific evidence and reduced uncertainty regarding the impact of ozone-depleting substances and the availability of substitutes, and it was agreed as early as 1990 to phase out these substances first by 2000, and then by 1996.[74] Later on, more ozone-depleting substances were added to the Montreal Protocol and the reduction pace was amended further to achieve a quicker phase-out trajectory. Given the global scale of this treaty regime, the North–South dimension has been highly important, as a matter of equity and justice, throughout the negotiations of the Montreal Protocol.[75] This is reflected in numerous ways, one of which is that developing countries whose annual calculated levels of the controlled substances were below a certain level were granted a ten-year delay in complying with the prescribed control measures.[76]

The planetary boundary for the stratospheric ozone layer, defined as '<5% decrease in column ozone levels for any latitude with respect to 1964-1980 values',[77] would not have worked as a benchmark for compliance review. First, it would be too vaguely defined as a legal obligation, and second, keeping within the boundary would depend on the combined measures on which all parties embarked. In the Montreal Protocol, rather than by a direct reference to the safe operating space, the objective was operationalised through obligations which could be more easily examined in terms of compliance. The Montreal Protocol has been instrumental in successfully operationalising the objective of protecting human health and the environment against adverse effects resulting from modifications of the ozone layer, as set out in the Vienna Convention.[78] This appears to be the only proposed boundary theme where the boundary is not transgressed.[79]

4.5 UNFCCC, Kyoto Protocol and Paris Agreement

A rather similar approach to that taken for air pollution and ozone layer depletion was taken in the legal framework for climate change, which is also an explicit planetary boundary theme. However, the UNFCCC actually sets out the objective in the operational part of the treaty, namely as achieving 'stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropocentric interference with the climate system'.[80] This is clearly a planetary boundary approach, and it reflects the idea of a safe operating space, although the UNFCCC does not quantify what must be achieved or avoided in terms of greenhouse gas concentration.

As the title of the treaty indicates, like the Air Pollution Convention and the Vienna Convention, the UNFCCC provides the legal framework for the regime, and it was obvious at the outset that more specific norms of conduct would be required in addition to the defined

73 Montreal Protocol art 3.
74 See Ebbesson (n 11) 140f.
75 Karin Mickelson, 'Competing Narratives of Justice in North-South Environmental Relations: The Case of Ozone Layer Depletion' in Jonas Ebbesson and Phoebe Okowa (eds), *Environmental Law and Justice in Context* (Cambridge University Press 2009) 297. See also Adelman, Chapter 4 in this book.
76 Montreal Protocol on Substances that Deplete the Ozone Layer art 5.
77 Rockström et al (n 1).
78 Convention for the Protection of the Ozone Layer, preamble.
79 Rockström et al (n 1).
80 1992 United Nations Framework Convention on Climate Change art 2.

objective and the general principles. This was first done with the 1997 Kyoto Protocol.[81] Also in this instance the planetary boundary-style objective of the UNFCCC was operationalised so as to make it possible to examine compliance. The 1997 Kyoto Protocol is based on a similar logic as the protocols to the Air Pollution Convention and the Montreal Protocol by setting national percentage reduction rates ('quantified emission limitation or reduction commitment' as a percentage of a base year or period);[82] in this case for six greenhouse gases for the so-called Annex I parties.

The North–South dimension has not been less significant in the climate change context than in the ozone layer regime, and this is reflected in the Kyoto Protocol, where the obligation to reduce 'the aggregate anthropogenic carbon dioxide equivalent emissions' only applied to the 'Annex I' parties.[83] Even though this was an important first step to further the aims of the UNFCCC through specific obligations, it was clear from the outset that the prescribed rates for the Annex I parties – leading to an aggregate reduction of 4.2 per cent by this group of parties (excluding the United States) – were insufficient to meet the objective of stabilising greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropocentric interference with the climate system.

While the key obligations to reduce the emissions of greenhouse gases lacked sufficient ambition to achieve the underlying objective of the UNFCCC, they did operationalise the objective so as to make it possible to examine compliance by the parties.

The 2015 Paris Agreement[84] takes a radically different approach when compared to the Kyoto Protocol, both in the way it sets the objective and in the way it is intended to operationalise and achieve this objective. The Paris Agreement is actually the first international, *legally binding* instrument which clearly defines a planetary boundary, and a safe operating space, in figures – although in terms of temperature, rather than CO_2 concentration: 'Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognising that this would significantly reduce the risks and impacts of climate change.'[85]

The objective of the Paris Agreement is compatible with that of the UNFCCC, yet it defines the safe operating space in measurable terms. While the objective of the Paris Agreement does not in itself imply an obligation for the parties, as is the case for all treaties, it is normative and relevant when interpreting other parts of the treaty.

The other major difference compared to the Kyoto Protocol, and also to the protocols for air pollution and ozone layer depletion discussed above, is how the Paris Agreement is intended to operationalise the precise objective of not transgressing the temperature of 1.5°C above pre-industrial levels. The method used in the other protocols, where the obligations are defined as national reductions in certain percentage rates, is built on three assumptions. First, it is possible to monitor the relevant performance. Second, it is possible to examine compliance. Third, provided full compliance by all parties, the degree to which the objective is achieved

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[81] See also Verschuuren, Chapter 13 in this book.
[82] Kyoto Protocol art 3(1) and annex B.
[83] Ibid art 3(1).
[84] Paris Agreement to the United Nations Framework Convention on Climate Change (12 December 2015) UN Doc. FCCC/CP/2015/L.9/Rev.1.
[85] Ibid art 2(1a).

could somehow be predicted, in mathematical, bio-chemical or other terms, by calculating the aggregate effect of the efforts.

The logic of the Paris Agreement is different. Rather than prescribing the reduction rate of the net emission of greenhouse gases for each State or concrete measures to be taken, it obliges each party to itself define its commitments to reduce emissions of greenhouse gases, that is, its 'nationally determined contribution' (NDC). The Paris Agreement is a treaty under international law, yet the parties are not required to reduce their net emissions to a specific extent. Instead, it is for each party to decide how to proceed and also what to achieve in terms of net emissions in light of the objective of 1.5–2.0°C. The main reason for this approach is simply that there was no other way to reach an agreement by the international community, which also includes the States with the highest net contributions of greenhouse gases, such as China, the United States and India. Compared with the protocols in which national reduction rates are set out, the difference is not that one would not be able to monitor a State's performance in light of its NDC. It would be possible, but probably more complicated than under the Kyoto Protocol, since the parties are given some leeway in defining the reductions to be made. Nor is the difference between the Paris Agreement and the Kyoto Protocol that compliance with the NDC cannot be examined, even though this may also be more complicated than under the Kyoto Protocol, for the same reason. Still, if the NDC is defined in a sufficiently clear way, then it will indeed be possible to conclude whether the party concerned has lived up to its commitment.

The main difference has not to do with compliance or compliance control, but rather with the difficulty of predicting beforehand whether full compliance by the parties will – jointly – achieve the objective, especially since it is not clear from the outset what each party is expected to do or achieve. Rather than analysing the legal requirements stemming from this obligation, it suffices to conclude that whatever each party is obliged to comply with, based on its own NDC, does not refer directly to the planetary boundary set out in the Paris Agreement. Instead, the criteria for compliance refer to actions more clearly linked to the specific party itself. In conclusion, the safe operating space defined by the Paris Agreement is an important objective with legal effects. Yet, it does not amount to a legal obligation in itself against which compliance by the parties could be examined. Also in this instance, then, the objective is operationalised through more specific obligations addressed to each party.

4.6 Convention on Biological Diversity and Its Protocols

The final example of a global treaty that is clearly linked to a planetary boundary is the 1992 Convention on Biological Diversity (CBD).[86] The planetary boundary for 'biosphere integrity' (originally 'rate of biodiversity loss') differs from those on stratospheric ozone and climate, by involving two components (functional and genetic diversity), and it has a regional dimension – which is not the case for ozone layer depletion and climate change.[87] Contrary to the framework conventions on air pollution, ozone layer depletion and climate change, the CBD provides both a framework for further cooperation and action, including further law-making and regulation through protocols, and a number of generally defined obligations to be imple-

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86 1992 Convention on Biological Diversity, 31 ILM (1992) 818. See also Somsen and Trouwborst, Chapter 12 in this book.

87 Steffen et al (n 2) 4–6.

mented. To date, two protocols have been adopted under the CBD: the Cartagena Protocol on Biosafety (with supplementary protocol on liability and redress),[88] and the Nagoya Protocol on Access and Benefit-sharing.[89]

By including in the definition of 'biological diversity' both diversity of ecosystem and diversity within and between species, the CBD confirms the functional as well as the genetic dimensions of diversity, which are also emphasised by the planetary boundary. Still, in all respects, the planetary dimension and the notion of a safe operating space are less evident in the CBD than in the regimes of ozone layer depletion and climate change.

Rather than being defined as a planetary boundary or safe operating space, the objective of the CBD is defined more generally, as 'the conservation of biological diversity, sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources'.[90] The obligations are not clearly linked to a common global process, planetary boundary or safe operating space. Instead, they provide a broad range of policy and practical measures to be taken (for several provisions 'as far as possible, and as appropriate') in order to promote biodiversity. The CBD protocols deal with implementation of specific aspects and operationalise certain parts of the CBD, but none of them links to any planetary dimension either. So, while the CBD explicitly represents a boundary theme for which there is a global regime in place (in addition to numerous other global and regional treaties on the protection of species and the natural environment), the notion of a planetary boundary is reflected neither in the CBD itself, nor in its protocols.

4.7 Preliminary Conclusion on the Legal Approaches

In addition to the mentioned treaty regimes, which refer to a few boundary themes only, there are treaty regimes of global scope of relevance also for some of the other boundary themes. Yet, none of them refers to a planetary boundary, limit or safe operating space. The main conclusion from the short survey above is that not even in the treaties where the notion of a planetary boundary is clearly reflected are the obligations defined by the boundary itself. Accordingly, compliance is not directly dependent on whether a defined planetary boundary is exceeded. Rather, whether a planetary boundary is somehow expressed as an objective in current international law, in figures or more general terms (and whether in the operative part or the preamble of the treaty), is relevant when interpreting other provisions of the treaty, and thus also when examining compliance with these other provisions intended to operationalise the objective. This supports the conclusion that planetary boundaries cannot be directly transformed into a legal norm to be complied with, and should rather be operationalised through more specific obligations.

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88 Cartagena Protocol on Biosafety to the Convention on Biological Diversity, 39 ILM (2000) 1027; Nagoya – Kuala Lumpur Supplementary Protocol on Liability and Redress to the Cartagena Protocol on Biosafety (14 December 2010) UN Doc. UNEP/CBD/BS/COP-MOP/5/17.

89 Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity (29 October 2010) UN Doc. UNEP/CBD/COP/DEC/X/1.

90 Convention on Biological Diversity art 1.

4.8 Monitoring, Implementation and Compliance in International Law

The degree to which an international objective is achieved depends not only on how the objective is operationalised through other norms, but also on other legal factors, such as available procedures and institutions for monitoring, reporting and examining of compliance. Of course, it is also determined by extra-legal elements, including practical concerns and priorities, economic capacities and the complexity and uncertainty in defining the objective.

Staying in the legal sphere, requirements to monitor and report on performance, implementation and compliance are standard elements in MEAs of global and regional scope. The processes for reviewing, monitoring and reporting differ; in some cases this is carried out by a secretariat, in others by a specific body. Today, numerous treaty regimes of global and regional scope, including those mentioned above on air pollution, ozone layer depletion and climate change, establish some form of compliance mechanism, with specific mandates to review expected cases of non-compliance by the parties.

The mandate, integrity, degree of independence and capacity of these mechanisms differ; so too do the triggers for review and response measures in case of non-compliance. A common feature is that compliance mechanisms include legal analyses, interpretations and conclusions on whether the party concerned complies with its legal obligations. The compliance mechanisms are usually also entrusted with facilitative functions, in order to assist a party to become compliant. Even though the compliance mechanisms focus on cooperative problem-solving under each respective treaty regime, and do not have the 'adversarial posture of the law on state responsibility',[91] compliance still involves legal questions of breach of treaty and responsibility for performing in good faith with the treaty obligations. This is one of the reasons why the methods and analyses of States' performance – including downscaling the planetary boundaries in non-legal settings, as described above – cannot be transferred directly to legal reviews of compliance.

A new compliance mechanism set up for a planetary boundary, or a set of boundaries, could build on current experiences. A key issue to consider would be to what extent its function is to examine and conclude on compliance, and whether this review should be combined with advisory and follow-up functions. An alternative approach would be to mandate the compliance mechanism mainly to facilitate and advise on suitable ways of performance for specific parties in specific cases, given the many prevailing uncertainties, complexities, thresholds, capacities and so forth.

The two approaches have different advantages. The first alternative would reduce the scope for self-serving interpretations of the parties and clarify which States perform as required and which do not. This could help improve the degree of compliance by putting legal and political pressure on the parties that are lagging behind in the implementation, or doing too little in other respects. The second alternative would provide for a constructive process, facilitation and dialogue within a legal framework to push for certain measures to be taken, without alluding to State responsibility or non-compliance under international law.

91 Jutta Brunnée, 'Promoting Compliance with Multilateral Environmental Agreements' in Brunnée et al (n 10) 41.

Most existing compliance mechanisms perform both these functions,[92] but the emphasis may be more on the one or the other aspect. The key function of the compliance mechanism would influence the obligations to monitor and report on the performance in light of the boundary theme(s) covered, the composition of the mechanism (lawyers, natural scientists, and so on), the triggers for compliance review (for example, only by treaty parties or also by members of the public or expert communities?) and the follow-up mechanism.

Most likely, it would also influence the drafting of the legal provisions of the treaty to be complied with. If the primary function of the compliance mechanism would be to conclude on compliance and on enforcement (albeit of a softer form), the compliance procedure would require a significant degree of predictability and transparency, and thus clearly defined obligations. However, if the main function would be of a facilitating nature, and to advise, give good reasons and assist the party concerned in taking suitable measures without making a clear conclusion of non-compliance, then the obligations could be of a more general and less precise nature. In this respect, it is not obvious that more precise obligations would result in better compliance by the parties.[93] The balancing of these procedural and substantive dimensions would influence the effectiveness and the legitimacy of the compliance mechanism.

5. CONCLUSIONS

But we are not quite there yet. Despite increasing recognition of the proposed planetary boundaries in international governance, they have no formal status in international law, and it is an open question whether they will be transposed directly into legal norms. The examples offered above show the potential of using global treaty regimes as a means for governing the planetary boundaries and staying within a safe operating space. The examples also show the potential for building on planetary boundaries in legal contexts.

The boundary themes are diverse. Some of them, like biosphere integrity, land-use change and fresh water use, have stronger regional operating scales than others, and some are more uncertain or complex than others. Even so, all the boundary themes require governance at the global, regional and national levels, and there are good reasons for developing institutions and legal regimes of a global scope and scale to address them all.

If legal and institutional measures are taken to govern the planetary boundaries, would only one, all or several boundary themes be covered by one regime? Or would there be one regime for each boundary theme? After all, it is already complicated to address one planetary boundary theme in a legal framework of global scale, both in defining legal obligations and in examining compliance. Yet, the interactions among the planetary boundaries would suggest that several boundary themes could be considered jointly. Therefore, in establishing a suitable global regime, a balance must be struck between its scope and depth, that is, in terms of the ambition of covering as many boundary themes as possible while being fairly specific about what is required by the parties and what can be examined in terms of compliance.

Finally, as mentioned at the outset, the planetary boundaries may also push the development of customary international law through jurisprudence and doctrine. In this way the plane-

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[92] The most obvious case is the Compliance Committee under the Kyoto Protocol. For comprehensive critical analyses and assessments, see Brunnée et al (n 10).

[93] See Brown Weiss (n 6) 1572.

tary boundaries and the concept of a safe operating space could influence established legal concepts, such as principles of due diligence, precaution, common but differentiated responsibilities, standing, common concerns and common interests. This could afford the notions of planetary boundary and safe operating space a more profound status in international law, without amounting to legal standards in themselves. It would allow the planetary boundaries to be considered in a broader and more flexible manner, for instance with respect to one or many boundaries and in the relations between different treaty regimes. This, in itself, would arguably add a new dimension to compliance with international law.

11. Exploring the planetary boundaries' wasteland: international law and the advent of the Molysmocene

Michael Hennessy Picard and Olivier Barsalou

1. INTRODUCTION

There are now many neologisms to describe the new geological epoch as a result of human impacts on the Earth system. The worn-out 'Anthropocene'[1] dominates the debates. Several other buzzwords compete for a place 'under the sun'[2] in contemporary expert vocabularies and social vernaculars to describe the global conditions of life on Earth. Capitalocene,[3] Plantatiocene,[4] Plasticene,[5] Pyrocene,[6] Necrocene,[7] Urbanocene[8] and several others,[9] such as Thanatocene, Polemolocene, Thermocene, Phagocene or even Carnivalocene,[10] have been coined to encapsulate and show how our conceptions of being as humans on Earth should or will develop. For instance, James Lovelock, the Gaia theorist, uses the expression 'Novacene' to describe a not-so-distant future in which humanity is overtaken by super intelligent robots,[11]

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1 Simon Lewis and Mark A Maslin, 'Defining the Anthropocene' (2015) 519 Nature 171; Will Steffen et al, 'The Anthropocene: Conceptual and Historical Perspectives' (2011) 369 Philosophical Transactions of the Royal Society A 842.

2 John Robert McNeill, *Something New Under the Sun: An Environmental History of the Twentieth-Century World* (WW Norton 2000).

3 Andreas Malm, *Fossil Capital: The Rise of Steam Power and the Roots of Global Warming* (Verso 2016); Jason W Moore, *Capitalism in the Web of Life: Ecology and the Accumulation of Capital* (Verso 2015).

4 Donna Haraway, *Staying with the Trouble: Making Kin in the Chthulucene* (Duke University Press 2016) 49; Cory Ross, *Ecology and Power in the Age of Empire: Europe and the Transformation of the Tropical World* (Oxford University Press 2017); Alfred W Crosby, *Ecological Imperialism: The Biological Expansion of Europe, 900–1900* (new edn, Cambridge University Press 2004).

5 Linsey E Raham et al, 'A Plasticene Lexicon' (2020) 150 Marine Pollution Bulletin 110714; Christina Reed, 'Dawn of the Plasticene Age' (*New Scientist*, 31 January 2015) 28.

6 Stephen J Pyne, *Fire: A Brief History* (2nd edn, University of Washington Press 2019).

7 Justin McBrien, 'Accumulating Extinction: Planetary Catastrophism in the Necrocene' in Jason W Moore (ed), *Anthropocene or Capitalocene: Nature, History, and the Crisis of Capitalism* (PM Press 2016) 116.

8 Eduardo Mendieta, 'Edge City: Reflections on the Urbanocene and the Plantatiocene' (2019) 7 Critical Philosophy of Race 81.

9 Christophe Bonneuil and Jean-Baptiste Fressoz, *L'événement anthropocène: la Terre, l'histoire et nous* (new edn, Seuil 2016).

10 David Chandler, 'Rethinking the Anthropocene as Carnivalocene' (*E-International Relations*, 11 April 2019) <www.e-ir.info/2019/04/11/rethinking-the-anthropocene-as-carnivalocene/> accessed 24 May 2020.

11 James Lovelock, *Novacene: The Coming Age of Hyperintelligence* (Allen Lane 2019).

while Donna Haraway refers to the concept of 'Chthulucene'[12] to highlight the profound interweaving of the human and nonhuman.

In their own ways, these neologisms convey some truths about the global conditions of life on Earth. Yet, as this chapter argues, they fall short in their attempt to provide a clear description of a contemporary era that has become saturated with pollution and waste.[13] The descriptive limits of these neologisms are threefold. First, they draw the contours of a dystopian present inheritor of our (the human species') many moral (and mortal) sins, while Earth destruction and pollution should be conceived as normal and logical consequences of human activities and not as an immoral abnormality. Second, these neologisms rest on a productivist/destructive reading and, therefore, a highly deterministic account of a future in the making, and that is now unfolding right before our eyes. Yet, every day, a new world is being redesigned in the ashes of our productivist/destructive world.

Finally, these terms stress the effects of specific social configurations, whether they be colonial (Plantatiocene) or capitalistic (Capitalocene), as they are based on an 'epistemic sediment' of the Holocene, namely that of appropriation and accumulation 'which is reactivated in many critical commentaries on the Anthropocene'.[14] As this chapter argues, social configurations not only assemble life and nature, that is, productive forces on a global scale; they also organise the redistribution and dispersion of pollution around the globe, a fact that is often ignored.[15] We inhabit waste, dirt and pollution.[16] And waste, dirt and pollution inhabit us.[17] Waste is a fundamental physical determinant of life and death in all known ecosystems.

Because of the descriptive, moral/ethical and normative lacunae that we sketched above, we wish to revive an old concept: Molysmocene. The term *Molysmocene* was coined in the 1960s by a French marine biologist named Maurice Fontaine[18] to refer to a future wasteland era – an era in which we presently live.[19] *Molysmos* means 'defilement', 'filth' or 'stain' in Greek

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[12] Haraway (n 4).

[13] Don DeLillo, *Underworld* (Scribner 1997) 287:

> Civilization did not rise and flourish as men hammered out hunting scenes on bronze gates and whispered philosophy under the stars, with garbage as a noisome offshoot, swept away and forgotten. No, garbage rose first, inciting people to build a civilization in response, in self-defence. We had to find ways to discard our waste, to use what we couldn't discard, to reprocess what we couldn't use. Garbage pushed back.

[14] Alan Pottage, 'Holocene Jurisprudence' (2019) 10 Journal of Human Rights and the Environment 153, 153.

[15] Anna Grear, 'Deconstructing Anthropos: A Critical Legal Reflection on "Anthropocentric" Law and Anthropocene "Humanity"' (2015) 26 Law and Critique 225.

[16] Rosalind Fredericks, *Garbage Citizenship: Vital Infrastructures of Labor in Dakar, Senegal* (Duke University Press 2018); Kathleen M Millar, *Reclaiming the Discarded: Life and Labor on Rio's Garbage Dump* (Duke University Press 2018). For documented examples of non-human animals inhabiting anthropogenic waste, see Kelsi Nagy and Phillip David Johnson II (eds), *Trash Animal: How We Live with Nature's Filthy, Feral, Invasive, and Unwanted Species* (University of Minnesota Press 2013); Bradley van Paridon, 'When Litter Becomes Habitat: In a Busy and Polluted Italian Port, Living Things Thrive on Anthropogenic Debris' (*Hakai Magazine*, 9 March 2020) <www.hakaimagazine.com/news/when-litter-becomes-habitat/> accessed 24 May 2020.

[17] Kieran D Cox et al, 'Human Consumption of Microplastics' (2019) 53 Environment, Science & Technology 7068.

[18] Maurice Fontaine, *Rencontres insolites d'un biologiste autour du monde* (L'Harmattan 1999) 36–37.

[19] Baptiste Monsaigeon, *Homo détritus: Critique de la société du déchet* (Seuil 2016) 15.

(μολυσμός). In the *Letters to the Corinthians*, the Apostle Paul reveals in his second epistle: 'Therefore, having these promises, beloved, let us cleanse ourselves from all defilement [*molysmos* in Greek] of flesh and spirit, perfecting holiness in the fear of God' (2 Corinthians 7:1).

One may ask why we chose to use the term Molysmocene, and to add yet *another* neologism to the already long list. Three reasons explain this choice. First, pollution, waste and dirt collectively embody the law's residual category or missing object *par excellence*.[20] As Philippe Sands and colleagues underline, in the case of 'wastes – which traditionally have been regulated incidentally to the attainment of other objectives – the overall international response has been fragmented, ad hoc and piecemeal'.[21] This situation is partly caused by the lack of reliable data.[22] However, available data tend to indicate that household and municipal solid wastes represent an extremely small percentage of all the wastes generated. For instance, a 2012 Canadian government report calculated that household and municipal waste amounted to less than 3 per cent of all the waste created. The majority, some 97 per cent of all the solid waste, was made of oil sands tailings, mine tailings, mine waste rock and livestock manure.[23] More troubling, the report did not include data on manufacturing and agricultural waste (other than manure). In addition, the extreme tonnage of industrial waste, its heterogeneity and industries' self-reporting deficiencies present vexing problems not only for accounting but also for the law, both domestic and international. As a result, mining, petrochemical and other synthetic waste (such as submarine tailings disposal, or microplastic and textile effluence) remains largely invisible to both domestic and international environmental law.[24] The persistent perception that waste and pollution are not urgent concerns and that they are less harmful than one might think has been intentionally created by States and corporations, such as the petrochemical and mining sectors, which question scientifically established consensus on toxicity levels by setting up impossible standards of proof.[25] Ecological risks, although visible and evident to both the corporations that create them and the affected communities that suffer from these risks, are rendered less visible to the governance bodies in charge of regulating them.[26] By resurrecting the term Molysmocene from the abyss of marine biology, we

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20 For a full discussion of this claim, see Olivier Barsalou and Michael Hennessy Picard, 'International Environmental Law in an Era of Globalized Waste' (2018) 17 Chinese Journal of International Law 887. See also Natasha Affolder, 'Transnational Environmental Law's Missing People' (2019) 8 Transnational Environmental Law 463.

21 Philippe Sands and Jacqueline Peel, *Principles of International Environmental Law* (2nd edn, Cambridge University Press 2018) 570.

22 World Bank, *What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050* (World Bank 2018).

23 Statistics Canada, 'Human Activity and the Environment: Waste management in Canada / 2012 – Updated' (14 September 2012) <www150.statcan.gc.ca/n1/en/pub/16-201-x/16-201-x2012000-eng.pdf?st=52GFgKh8> accessed 11 June 2020. See also Derek Kellenberg and Arik Levinson, 'Waste of Effort? International Environmental Agreements' (2014) 1 Journal of the Association of Environmental and Resource Economists 135; Carla Sbert, *The Lens of Ecological Law: A Look at Mining* (Edward Elgar 2020).

24 Catherine Coumans, 'Into the Deep: Science, Politics and Law in Conflicts over Marine Dumping of Marine Waste' (2018) 68 International Social Science Journal 303. See also Frisso and Kirk, Chapter 8 in this book.

25 Janet Kourany and Martin Carrier (eds), *Science and the Production of Ignorance: When the Quest for Knowledge Is Thwarted* (MIT Press 2020).

26 Ibid.

modestly endeavour here to reintroduce the critical issue of toxic waste as a matter of concern in collective legal consciousness.

Second, waste – as an object, a phenomenon and an experience – is universal (however unevenly distributed around the globe), very much like the Capitalocene, for instance, is. However, contrary to the latter, waste's universality will always remain with humans and non-humans, notwithstanding the survival of neoliberal capitalism.[27] Very little of human waste is biodegradable, and the waste that is not is now being buried in the Earth's crust and may become part of our species' geological legacy.[28] While waste has always been part and parcel of human and nonhuman activities,[29] with the rise of industrial extraction and technological mass production, mineral and synthetic markers show how human waste and pollution have become a major geological force in the context of the Molysmocene.[30]

Third, the Molysmocene makes explicit a commonly shared, yet implicit, commonality that exists among all the other neologisms: each rests on an explicit characterisation of the global distribution of wealth (affluence) but remains silent on the issue of pollution, waste and dirt (effluence).[31] The Molysmocene, however, foregrounds the idea that *affluence and effluence are mutually constitutive*, because they inevitably form what ecological economists call the 'joint production' of (neg)entropy or wealth/waste.[32] In sum, the Molysmocene is the dark mirror of the Anthropocene: life is lived with, on, in and through waste, pollution and dirt.

One of the most critical challenges today is that the joint production of (neg)entropy has reached a stage of irreversible overaccumulation by contamination. The overaccumulation of waste functions in tandem with the disruptive relations between property and prosperity. While the financial sector continues to accumulate unprecedented profits, resource extraction is surpassing the Earth's natural regeneration rates, while often having the greatest impact on those most vulnerable to exploitation.[33] The production of wastes is greater than can be absorbed by the planet's sink mechanisms.[34] Thus, in stratigraphic terms, sedimentary deposits of trash now form part of a new geological record, as waste is becoming a new layer of the Earth's crust on the top of the lithosphere. This crust of civilisational waste (explicated by global plastics pollution, among others) we call the *littersphere*. The biosphere, the atmosphere and the lithosphere are increasingly conditioned by their interaction with the toxic littersphere. For example, some parts of the oceans are so polluted with plastic waste that international shipping lanes must be rerouted for freighters to reach their destination and unload yet more containers of disposable plastic.[35] If the Molysmocene characterises a world fossilised by

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[27] On the universal character of waste, Mary Douglas, *Purity and Danger: An Analysis of Concepts of Pollution and Taboo* (Routledge 1984).

[28] Ben Dibley, 'The Technofossil: A Memento Mori' (2018) 5 Journal of Contemporary Archaeology 44.

[29] Olli Lagerspetz, *A Philosophy of Dirt* (Reaktion Books 2018).

[30] Christopher J Preston, *The Synthetic Age: Outdesigning Evolution, Resurrecting Species, and Reengineering Our World* (MIT Press 2018).

[31] Lewis and Maslin (n 1).

[32] Kozo Mayumi and Mario Giampietro, 'Entropy in Ecological Economics' in John Proops and Paul Safonov (eds) *Modeling in Ecological Economics* (Edward Elgar 2004) 80.

[33] See Adelman, Chapter 4 in this book.

[34] Carl Folke et al, 'Reconnecting to the Biosphere' (2011) 40 AMBIO 719.

[35] Jennifer Gabrys 'Sink: The Dirt of Systems' (2009) 27 Environment and Planning D: Society and Space 666.

the unprecedented accumulation of anthropogenic waste across the globe, what does it tell us about the operation of the law?

This chapter is essentially a conceptual study investigating the legal implications of the Molysmocene. Environmental governance of planetary boundaries not only rests on definitional misunderstandings, miscalculated environmental costs and methodological inconsistencies;[36] it also carries pitfalls in the framing of environmental issues themselves. However, what if the shortcomings of environmental regulation are part of a more fundamental problem: the erasure of waste from most discussions on planetary boundaries? What if the lack of an understanding of waste flows is one of the most crucial limitations in advancing towards a comprehensive regime of international environmental law?[37] Without knowledge of the extent and severity of the global waste crisis, scientists argue, it is impossible to develop coherent strategies to mitigate ecological harm. Therefore, this chapter attempts to shift our gaze towards a legal object, which has now become so visible that it can no longer be erased from human perception: waste.

Our hypothesis is that the breaching of planetary boundaries may partly be attributed to waste production in the Molysmocene. We argue that waste has irreversibly encroached, and continues to encroach, on the planetary boundaries of the Earth system. In order to successfully carry out their goals, calls for global environmental governance must therefore at least: (i) consider waste as a primary threat to the preservation of planetary boundaries; (ii) consider international law's historic role in facilitating waste accumulation and dispersion; (iii) acknowledge the pivotal role waste may have in shifting and reordering the boundaries of law itself. We discuss each of these issues below.

2. THE BOUNDARIES OF PLANETARY WASTE

What is commonly referred to as the threat to planetary boundaries constitutes a sanitised normativity to address the global impact of human waste. The planetary boundaries concept is a framework designed to guide sustainable development policies and to help identify a safe operating space for humanity within the confines of the planetary boundaries. While we support the idea of identifying Earth's limits to human activities and their negative externalities, we are uncertain that it sets the right boundaries or limits, because it does not include and/or fully consider the aspect of waste. Other researchers appear to also share our scepticism. A recent study suggests that the planetary boundaries might provide an incomplete picture because the model tends to underplay the significance of waste generation, waste's relation to all of the planetary boundaries and the impacts of waste on the entire Earth system.[38] The study suggests: '[t]hough seldom emphasized, the crux of the limits to sustainable environmental dynamics lies in waste (mis-)management, which sets where boundary values might be.'[39] The

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[36] See Kim and Kotzé, Chapter 3, Bleby, Holley and Milligan, Chapter 2, in this book. See also Jennifer Clapp, 'What the Pollution Havens Debate Overlooks' (2002) 2 Global Environmental Politics 11.

[37] Stephanie Borrelle et al, 'Opinion: Why We Need an International Agreement on Marine Plastic Pollution' (2017) 114 Proceedings of the National Academy of Sciences 9994.

[38] Andrea Sophia Downing et al, 'Learning from Generations of Sustainability Concepts' (2020) 15 Environmental Research Letters.

[39] Ibid 2.

study concludes that 'waste accumulation' is the 'primary problem'[40] and the source of transgression for at least six of the nine planetary boundaries originally identified by Rockström and his team.[41] In light of the need to more explicitly include waste as a central consideration in the planetary boundaries framework, we enumerate below the nine planetary boundary transgressions commonly referred to in the context of the Anthropocene and translate them into the language of the Molysmocene, which, we believe, more accurately details the scope and severity of global waste distribution.[42]

The first boundary, climate change, results from the steady increase in atmospheric carbon dioxide emissions, that is, air pollution:[43] 'CO_2 concentration has risen from 280 parts per million (ppm) on the eve of the industrial revolution to 400 ppm in 2013, a level unmatched for 3 million years.'[44] Primary sources of carbon dioxide pollution come from hazardous activities such as cement production, deforestation and burning of fossil fuels such as coal, oil and natural gas. Climate change is essentially instigated by the great acceleration in greenhouse gas-based pollution.

A second boundary, ocean acidification, is related to CO_2 pollution, as it decreases the pH of water, killing corals, shellfish and plankton.[45] Ocean acidification is closely linked to a third planetary boundary, which is the rate of biodiversity loss; a central concern and part of the debate focusing on the Sixth Mass Extinction event.[46] This extinction is caused by, among other sources, industrial and consumer pollution, such as pesticides on land or plastic waste in oceans. Modern farming and transportation methods pollute water tables, rivers and estuaries with excessive nitrates and CO_2, which in turn increases global warming and biodiversity loss. Global freshwater (itself another boundary) and its rich biodiversity is polluted by chemical and industrial waste, which now also affects climate patterns and water cycles.[47] Biochemical flows of pesticides and chemical fertilisers, such as phosphorous and nitrogen, contribute to the pollution of fragile and diverse ecosystems,[48] while toxic chemical contamination from persistent organic pollutants and other endocrinal disruptors have been shown to be a major factor of biodiversity loss. A recent study shows that more than 40 per cent of the global insect population has become extinct as a result of the intensive use of pesticides and anthropogenic eradication campaigns.[49] Similarly, persistent organic compounds have caused dramatic reductions in bird populations and impaired reproduction and development in marine

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40 Ibid 16.

41 Johan Rockström et al, 'Planetary Boundaries: Exploring the Safe Operating Space for Humanity' (2009) 14 Ecology & Society 32.

42 Will Steffen et al, 'Planetary Boundaries: Guiding Human Development on a Changing Planet' (2015) 347 Science 1259855.

43 See Verschuuren, Chapter 13 in this book.

44 Bonneuil and Fressoz (n 9) 19.

45 See Diz, Chapter 17 in this book.

46 Elizabeth Kolbert, *The Sixth Extinction: An Unnatural History* (Henry Holt & Company 2014). See also Somsen and Trouwborst, Chapter 12 in this book.

47 Stockholm Resilience Centre, 'The Nine Planetary Boundaries' <www.stockholmresilience.org/research/planetary-boundaries/planetary-boundaries/about-the-research/the-nine-planetary-boundaries.html> accessed 24 May 2020. See Cooper, Chapter 18 in this book.

48 Ibid.

49 Francisco Sánchez-Bayo and Kris AG Wyckhuys, 'Worldwide Decline of the Entomofauna: A Review of its Drivers' (2019) 232 Biological Conservation 8.

mammals.[50] It is thus clear that both biodiversity and biosphere integrity more generally are severally impacted by human waste.

Entropic deforestation, industrial agriculture and the dumping of various pollutants are also responsible for land-system change. Land-system change is a fourth boundary transgression,[51] and in this context relates to land converted to cropland and land for waste deposits (more generally known as landfill sites). Many countries, such as the United States, are now running out of landfill space for their municipal, commercial, mining, hazardous and radioactive wastes.[52] The fifth boundary, stratospheric ozone depletion, is caused by chemical pollution, aerosol loading and the release of dust and smoke.[53] Atmospheric aerosol loading, the sixth boundary, is caused by the same chemical pollutants, which accumulate within the atmosphere at varying levels depending on the region.[54] The seventh boundary relates to the large quantities of chemical fertilisers such as nitrogen and phosphorus used in agricultural production, of which only a fraction is consumed by the plants or animals, with the rest accumulated in soil, lakes, rivers and oceans.[55] As was already intimated above, human pressures on freshwater reserves and systems, the eighth boundary, disrupt normal water cycles. Overconsumption and pollution caused by municipal, commercial and industrial waste leaking and waste dumping seriously endanger global water reserves.[56] Finally, chemical pollutants such as persistent organic pollutants, heavy metals and radionuclides, as well as the release of novel chemical entities, could have potentially irreversible and unpredictable synergic effects on living organisms.[57]

In sum, the human-driven production of waste may be considered as one of the principal drivers of planetary boundary transgression. This amounts, in the words of French geographer and Marxian theorist, Henri Lefebvre, to a *terracide* – the killing, destruction or death of the Earth.[58] When garbage pushes back, the Anthropocene – the geological epoch shaped by humans – becomes the Molysmocene – a geological epoch shaped by the waste of humans. What role does international environmental law play in organising waste accumulation and dispersion and, ultimately, in disrupting Earth system processes?

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50 Michael Fry, ‘Reproductive Effects in Birds Exposed to Pesticides and Industrial Chemicals’ (1995) 103 Environmental Health Perspectives 165; Maria Cristina Fossi and Cristina Panti (eds), *Marine Mammal Ecotoxicology: Impacts of Multiple Stressors on Population Health* (Academic Press 2018).

51 See Morrow, Chapter 19 in this book.

52 World Bank (n 22).

53 See Du Toit, Chapter 14 in this book.

54 See Duvic-Paoli and Webster, Chapter 15 in this book.

55 United Nations World Water Assessment Programme (WWAP), *The United Nations World Water Development Report 2017. Wastewater: The Untapped Resource* (UNESCO 2017); Javier Mateo-Sagasta, Sara Marjani Zadeh and Hugh Turral, *More People, More Food, Worse Water? A Global Review of Water Pollution from Agriculture* (Food and Agriculture Organization of the United Nations & the International Water Management Institute 2018). See also Diz, Chapter 17 in this book.

56 World Bank (n 22).

57 Martí Nadal, Marta Schuhmacher and José L Domingo, ‘Long-Term Environmental Monitoring of Persistent Organic Pollutants and Metals in a Chemical/Petrochemical Area: Human Health Risks’ (2011) 159 Environmental Pollution 1769. See also Paloniitty, Nzegwu and French, Chapter 20 in this book.

58 Stuart Elden, ‘Terracide – Lefebvre, Geopolitics and the Killing of the Earth’ in Kathryn Yusoff, Nigel Clark and Arun Saldanha (eds), *Geo-Social Formations* (Punctum Books, forthcoming). See also Anna Lowenhaupt Tsing et al (eds), *Arts of Living on a Damaged Planet: Ghosts and Monsters of the Anthropocene* (University of Minnesota Press 2017).

3. BOUNDARY BINARIES: SOVEREIGNTY AND PLANETARY BOUNDARIES

International law is a set of norms, practices, institutions and discourses associated with the production of order, unity and coherence, while the idea of waste, pollution and dirt, by its very nature, remains synonymous with disorder and anarchy. The international legal order was historically construed in terms of its ability to distance and externalise waste that was seen to be created by the 'uncivilised' in the name of and for the benefit of the 'civilised'.[59] The common definition of waste is deeply rooted in the colonial legacy of international law. Waste was a metaphor used by European States to classify peoples between orderly, productive and sovereign communities, on the one hand, and 'unproductive' and 'wasteful' agents (including in particular indigenous peoples), that were also deprived of legal subjectivity as a result of such a classification, on the other hand.[60] From Locke, to Vattel, to the League of Nations, the appeal to the legal concept of waste was instrumental in dispossessing 'savages' from their uncultivated land (or the more commonly used 'waste land') for the purpose of accumulation, enslavement and enclosure.[61] In the pre-industrial era, the idea of waste, and everything that went with that impulse, was therefore construed as a legal, moral and ethical justification for the colonisers' political economy of plunder in the so-called New World. International law, by expelling 'superfluous' peoples regarded as 'wasteful' in the colonies, enshrined the right for its legal subjects – States – to extract valuable resources from within their boundaries.[62] Even marginalised people in cities faced a similar fate.[63] According to one interpretation, enclosures in England were 'a struggle over the land-use designation of "waste" in which advocates of the enclosures came to see open lands as a wasted commons'.[64] Waste became the shameful antithesis to wealth in England, both in the colonies and in cities which, with England at the time being a colonial superpower that determined the foundations of international law, helped shape the political economy and social norms of the international legal order. Waste and pollution constituted an affront to authority and an injury to political and social legitimacy, and were seen to be an impediment to the creation of wealth.

'Cleaning', 'organising', and 'unifying' are thus constitutive of the 'good' international legal order and must be interpreted, in the context of the Molysmocene, as purifying rituals in which legal subjects purged themselves of defilement. As the British anthropologist Mary

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[59] Liliana Obregón Tarazona, 'The Civilized and the Uncivilized' in Bardo Fassbender and Anne Peters (eds), *The Oxford Handbook of the History of International Law* (Oxford University Press 2012) 917; Brett Bowden, 'The Colonial Origins of International Law: European Expansion and the Classical Standard of Civilisation' (2005) 7 Journal of the History of International Law 1. On the process of civilisation, see Norbert Elias*, The Civilizing Process: Sociogenetic and Psychogenetic Investigations* (Blackwell 2000).

[60] Susan Marks, 'Law and the Production of Superfluity' (2011) 2 Transnational Legal Theory 1.

[61] Mark Neocleous, 'War on Waste: Law, Original Accumulation and the Violence of Capital' (2011) 75 Science & Society 506.

[62] Usha Natarajan and Kishan Khoday, 'Locating Nature: Making and Umaking International Law' (2014) 27 Leiden Journal of International Law 573; Ileana Porras, 'Appropriating Nature: Commerce, Property, and the Commodification of Nature in the Law of Nations' (2014) 27 Leiden Journal of International Law 641.

[63] See Aust and Nijman, Chapter 6 in this book.

[64] Jesse Goldstein, 'Terra Economica: Waste and the Production of Enclosed Nature' (2013) 45 Antipode 357.

Douglas astutely underlined in 1966, dirt and pollution are not isolated phenomena; they are a part of a classificatory system and organising scheme of the order itself:

> Dirt then, is never a unique, isolated event. Where there is dirt there is system. Dirt is the by-product of a systematic ordering and classification of matter, in so far as ordering involves rejecting inappropriate elements. This idea of dirt takes us straight into the field of symbolism and promises a link-up with more obviously symbolic systems of purity.[65]

International law plays such an organising, unifying and purifying role: it constitutes and institutes orderly normalness structured around affluence, while discarded waste is meant to be expelled from the realm of sovereignty and legal subjectivity. However, with time, international law's creation of impregnable sovereign boundaries allowed the trespassing of planetary boundaries.[66] From 1750 onward, that is, with the advent of the industrial age, and in sharp contrast to the earlier colonial period, 'waste' became associated with polluted water and air, which were considered to be side effects of economic development and industrialisation.[67] International law thus allowed legal subjects associated with the State to exploit and acquire territory and property at the expense of the biophysical properties of the Earth – which gradually became saturated, as a result, by the overaccumulation of waste in the industrial era.

With the global expansion of modern capitalism in the nineteenth and twentieth centuries, international law became mainly preoccupied with affluence, that is, the production, distribution and protection of wealth.[68] Effluence and all the negative externalities generated by the creation of wealth have, at least until very recently, been a peripheral matter of concern from which many marginalised and vulnerable people still suffer today;[69] the colonial legacies of the wealth created by waste still continue under the guise of (global) unequal ecological exchanges and ecological debts.[70] International law is therefore associated with the structural disadvantages faced by the global south in being confronted with the disproportionate amount of waste generated by the industrialised global north and exported to the global south. As a 2018 World Bank report points out:

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65 Douglas (n 27) 36–37.

66 Louis J Kotzé, 'International Environmental Law and the Anthropocene's Energy Dilemma' (2019) 36 Environmental and Planning Law Journal 437.

67 François Jarrige and Thomas Le Roux, *La Contamination du monde: Une histoire des pollutions à l'âge industriel* (Seuil 2017).

68 Kate Miles, *The Origins of International Investment Law: Empire, Environment and the Safeguarding of Capital* (Cambridge University Press 2013). For instance, the environment historian Gregory Cushman has shown that guano – animal waste – steered colonial explorations around the world and, in particular, opened up the Pacific Ocean and fuelled agricultural and economic development primarily in North America and Western Europe, in *Guano and the Opening of the Pacific World: A Global Ecological History* (Cambridge University Press 2013).

69 On the toxic colonial legacy of waste, see Antony Anghie, 'The Heart of My Home: Colonialism, Environmental Damage, and the Nauru Case' (1993) 34 Harvard International Law Journal 445; Myra J Hird and Alexander Zahara, 'The Arctic Wastes' in Richard Grusin (ed), *Anthropocene Feminism* (University of Minnesota Press 2017) 121–45; on the racialized distribution of waste, see Dorceta Taylor, *Toxic Communities: Environmental Racism, Industrial Pollution, and Residential Mobility* (New York University Press 2014); on the gendered distribution of waste, see Melanie Samson, 'Producing Privatization: Re-articulating Race, Gender, Class and Space' (2010) 42 Antipode 404.

70 Alf Hornborg and Joan Martinez-Alier, 'Ecologically Unequal Exchange and Ecological Debt' (2016) 23 Journal of Political Ecology 328.

> Solid waste management is a universal issue that matters to every single person in the world. […] For example, the East Asia and Pacific region is the region that currently generates most of the world's waste at 23%. And although they only account for 16% of the world's population, high-income countries combined are generating over one-third (34%) of the world's waste. […] And with over 90% of waste openly dumped or burned in low-income countries, it is the poor and most vulnerable who are disproportionately affected.[71]

The colonial legacy of the concept of waste also inhabits the historical evolution of international law. The 1941 Trail Smelter Arbitration case, an 'iconic'[72] event in the history of international environmental law, is revered in the field for having created two core principles of contemporary international environmental law: States' duty to prevent transboundary environmental harm and the duty to compensate damages. In this case, offensive fumes from one country troubled the sovereign sense of order and wellbeing of another country. International law was summoned to re-establish that order by designing new rules governing relations between sovereign States and by recognising a duty not to cause transboundary air pollution and harm. This threshold implicitly recognises a right to pollute as long as it does not harm another sovereign State.[73] As one commentator observed, 'in the process [of the Trail Smelter Arbitration], air pollution became an accepted, culturally sanctioned consequence of industrial capitalism, and 'smoke eating' a normal part of everyday life'.[74]

The more recent problem of global plastic pollution further illustrates the underlying 'right to pollute' logic found in the working of international environmental law and, more generally, global governance mechanisms.[75] A 2015 study shows that the global production of plastic rose from 2 million metric tons (Mt) in 1950, to 380 Mt in 2015. The total amount of plastics produced from 1950 through to 2015 is 7800 Mt. Half of this – 3900 Mt – was produced between 2002 and 2015.[76] Ultimately, 'around 4900 Mt – 60% of all plastics ever produced – were discarded and are accumulating in landfills or in the natural environment'.[77] And yet, there is nothing in international environmental law that seeks to explicitly and comprehensively tackle this disaster. As it stands, international environmental law applicable to plastic pollution remains at best inefficient and at worst non-existent.

One of the main challenges is to accurately monitor and mitigate the environmental load of the plastic industry by tracing the physical flows of plastic pollution across the many global supply chains and to regulate these. Much like dark matter in the realm of particle physics, the world of microplastics remains in the shadows of human perception. At the current stage

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71 Cody Ellis, 'World Bank: Global Waste Generation Could Increase 70% by 2050' (*Waste Dive*, 23 September 2018) <www.wastedive.com/news/world-bank-global-waste-generation-2050/533031/> accessed 11 June 2020; World Bank (n 22).

72 David C Caron, 'Foreword' in Rebecca Bratspies and Russell A Miller (eds), *Transboundary Harm in International Law: Lessons from the Trail Smelter Arbitration* (Cambridge University Press 2006) xix.

73 *United States v Canada* [1938] United Nations Reports of International Arbitral Awards [1941] 3, 1905.

74 James R Allum, '"An Outcrop of Hell": History, Environment, and the Politics of the Trail Smelter Dispute' in Bratspies and Miller (n 72) 13, 18.

75 Peter Dauvergne, 'Why Is the Global Governance of Plastic Failing the Oceans?' (2018) 51 Global Environmental Change 22.

76 Roland Geyer, Jenna R Jambeck and Kara Lavender Law, 'Production, Use, and Fate of all Plastics Ever Made' (2017) 3 Sciences Advance 1, 1.

77 Ibid 3.

of scientific understanding, only 1 per cent of the synthetic tide visibly ends up on the ocean surface, while the remaining 99 per cent is unaccounted for.[78] How should international environmental law regulate this issue – admittedly a very difficult task? Another aspect of this challenge, which also reflects the inadequacies of global plastics governance, emanates from our restricted definition of 'plastic waste'. As geographers point out, we tend to exaggeratedly focus on downstream plastic waste (curbing consumers' behaviour and so on) instead of engaging in serious policy reforms to curb the production of plastics.[79] International environmental law seems unable and unwilling to address this issue.

A further concern and difficulty for international environmental law is that most plastic pollution is released during extraction and production processes, which vastly exceeds the waste produced after consumption. Spanning a complex network of global supply chains, various sources of land, air and water pollution are seldom addressed by environmental law. The CO_2 emissions from oil extraction, transportation and refining, as well as the microparticles released by petrochemical production sites, are just two examples of the wide scope of plastics contamination, which continues to fail to be monitored by national and international environmental agencies.[80] Although the 1996 Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters calls on all parties to establish national pollution registers, there is no internationally agreed strategy for the collection of data.[81] The erosion of the efficacy of such information disclosure obligations reflects, among others, the dominance of capitalist, corporatised and consumer-driven market perspectives on social welfare within the main body of environmental law.[82] Relatedly, the Protocol on Pollutant Release and Transfer Registers, which was signed by 38 States and which entered into force in 2009, is not designed to reduce pollution levels.[83] While admittedly critically necessary and a step in the right direction, it must 'merely' enhance public access to information through the establishment of coherent, integrated, nationwide pollutant release

[78] Erik Van Sebille et al, 'A Global Inventory of Small Floating Plastic Debris' (2015) 10 Environmental Research Letters 124006; Michael Marshall, 'We May Have Missed Half the Microplastic in the Ocean' (*New Scientist*, 23 May 2020) 12.

[79] Max Liboiron, 'Redefining Pollution and Action: The Matter of Plastics' (2016) 21 Journal of Material Culture 87; Josh Lepawsky, *Reassembling Rubbish: Worlding Electronic Waste* (MIT Press 2018).

[80] Therese M Karlsson et al, 'The Unaccountability Case of Plastic Pellet Pollution' (2018) 129 Marine Pollution Bulletin 52; Aaron Lechner and David Ramler, 'The Discharge of Certain Amounts of Industrial Microplastic from a Production Plant into the River Danube is Permitted by Austrian Legislation' (2015) 200 Environmental Pollution 159.

[81] Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters (adopted 25 June 1998, entered into force 30 October 2001) 2161 UNTS 447; Kristina Saarinen, 'A Method to Improve the International Comparability of Emission Data from Industrial Installations' (2003) 6 Environmental Science & Policy 355. See also Ebbesson, Chapter 10 in this book.

[82] Michael Mason, 'So Far but No Further? Transparency and Disclosure in the Aarhus Convention' in Aarti Gupta and Michael Mason (eds), *Transparency in Global Environmental Governance: Critical Perspectives* (MIT Press 2014) 85. On the welfarist idea in international law, see Emmanuelle Jouannet, 'What Is the Use of International Law? International Law as a 21st Century Guardian of Welfare' (2007) 28 Michigan Journal of International Law 815.

[83] Protocol on Pollutant Release and Transfer Registers to the Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters (adopted 21 May 2003, entered into force 8 October 2009) 2626 UNTS 119.

and transfer registers. Yet, many carbon-intensive countries around the world – specifically Canada, the United States, China and some Latin American States and African States – are not parties to the Protocol.[84]

A final concern, which also complicates international environmental law's response to the problem of global plastic pollution, is that plastic is not geographically equally produced and dispersed. It is unevenly distributed both at the source and at the sink. A 2016 MacArthur Foundation report found that, at the source, 95 per cent of plastic producing companies are headquartered in the European Union and the United States.[85] Moreover, 'the United States, Europe and Asia jointly account for 85% of plastics production, roughly split equally between the United States and Europe on the one hand and Asia on the other'.[86] The global plastic demand is expected to reach 334,83 Mt and a value of approximately USD 654,38 billion by 2020.[87] The MacArthur Foundation report further adds that at the sink, 82 per cent of all plastic leakage in the environment occurs in Asia, due mainly to a lack of waste management infrastructure.[88] An estimated 4.4 to 12.7 million metric tons of plastic waste are thus added to the oceans annually, which often ends up on South Asian shores.[89] A 2017 study concluded that up to 95 per cent of the world's ocean plastic waste originates from just ten rivers: eight in Asia and two in Africa.[90] With reference to the plastic life-cycle, one is tempted to conclude that international law clearly contributes to ordering and structuring the production, circulation, distribution and dispersion of plastic, from the oil well to the merchant shelves and to the landfills. However, when one looks at the plastic death-cycle, international environmental law seems to all but disappear from the picture. Net flows of plastic waste continue to be dispersed in the form of plastic pellets, microfibres and industrial externalities outside of sovereign jurisdictions, impacting riverbeds, streams and oceans across sovereign borders.[91] Whereas plastic wealth accumulates on the enclaved telluric grounding of the sovereign *Behemoth*, plastic waste is immersed into the ebb and flow of a thalassic *Leviathan*.

These relative and variable legal processes not only illustrate the anthropocentric ontology of international law and of international environmental law in particular,[92] but also highlight the anthropocentric sovereign enclosure of the world by extractive and capital-driven States, which rests on planetary exposure to an unsustainable accumulation of waste. As a consequence, the *terra nullius* of the Anthropocene is now facing the *terra saturate* of the

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[84] Ibid.

[85] World Economic Forum, Ellen MacArthur Foundation and McKinsey & Company, 'The New Plastics Economy – Rethinking the Future of Plastics' (16 January 2016) <www.ellenmacarthurfoundation.org/publications> accessed 24 May 2020.

[86] Ibid 37.

[87] PR Newswire, 'Plastics Market Worth $654.38 Billion By 2020' (6 July 2015) <www.prnewswire.com/news-releases/plastics-market-worth-65438-billion-by-2020-grand-view-research-inc-511720541.html> accessed 24 May 2020.

[88] World Economic Forum et al (n 85) 33 and 38.

[89] Jenna R Jambeck et al, 'Plastic Waste Inputs from Land into the Ocean' (2015) 347 Science 768.

[90] Christian Schmidt et al, *Export of Plastic Debris by Rivers into the Sea* (2017) 51 Environment Science & Technology 12246.

[91] Patricia Villarrubia-Gómez, Sarah E Cornell and Joan Fabres, 'Marine Plastic Pollution as a Planetary Boundary Threat – The Drifting Piece in the Sustainability Puzzle' (2018) 96 Marine Policy 213, 219.

[92] Louis J Kotzé and Rakhyun E Kim, 'Earth System Law: The Juridical Dimensions of Earth System' (2019) 1 Earth System Governance 100003.

Molysmocene: an emerging world in which waste has engulfed the planetary boundaries. *Terra nullius* was a legal fiction engineered to dispossess 'non-civilised' peoples from their lands and activities.[93] With the planet now saturated with waste, *terra saturate* more accurately expresses this new geological condition. International law accelerated, or at least has not prevented, the transition from *terra nullius* to *terra saturate*. Human production of waste as *matter out of place,* according to Mary Douglas,[94] engineered a *planet out of space*, in the words of Michel Serres.[95] Therefore, in the Molysmocene, waste must be conceived of as a strategy for land appropriation.[96] Moreover, the foregoing analysis that we have conducted through the lens of the Molysmocene would suggest that colonial expansion is what caused a massive increase of waste accumulation and pollution, which transformed a bountiful land into a toxic void; precisely the *terra nullius* that 'uncivilised' people were accused of 'wasting'.

4. WASTE SHIFTING AND REORDERING THE BOUNDARIES OF INTERNATIONAL LAW

The rise of the Molysmocene compels us to radically shift our understanding of international law. *Terra saturate* is deeply intertwined with international law in the twenty-first century. In *terra saturate* international law, and in the present case international environmental law, are strategies of avoidance and of redistributive affluence which, ultimately, reproduce the structural toxic tropes of the Anthropocene. How do we survive in a world saturated with waste? How does or should international law operate in such a world? How does or should international law organise the distribution of affluence and effluence in the context of ever-increasing waste?

In this section, we argue that the Molysmocene is in a process of reconfiguring the boundaries of international law. Kotzé and French coined the term *Lex Anthropocenae* to designate the need for transformative public and private global governance efforts to better protect Earth system integrity and tackle the socio-ecological crisis.[97] Along similar lines, in this section we wish to stress the importance of *Lex Molysmocenae*. We argue that the very ubiquity of waste is itself a source of normativity;[98] generally associated with 'disorder', waste forces itself upon us to reorder the law. This is so because waste is now (re)drawing the biophysical parameters

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93 Lauren Benton and Benjamin Straumann, 'Acquiring Empire by Law: From Roman Doctrine to Early Modern European Practice' (2010) 28 Law and History Review 1.

94 Douglas (n 27).

95 Michel Serres, *Malfeasance: Appropriation through Pollution?* (Stanford University Press 2011).

96 One has only to think of all the land reclamation projects aimed at transforming landfills into public parks. See Martin V Melosi, *Fresh Kills: A History of Consuming and Discarding in New York City* (Columbia University Press 2020); Marie-Noëlle Carré and François-Michel Le Tourneau, 'Les espaces-déchets, d'autres grands espaces américains' (2015) 45 L'espace géographique 265; Marie-Noëlle Carré and Marcelo Pires Negrão, 'Les déchets et l'aménagement des territoires de Buenos Aires et Rio de Janeiro' (2015) Espaces et sociétés 17.

97 Louis J Kotzé and Duncan French, 'A Critique of the Global Pact for the Environment: A Stillborn Initiative or the Foundation for Lex Anthropocenae?' (2018) 18 International Environmental Agreements: Politics, Law and Economics 811.

98 Hyo Yoon Kang, 'Law's Materiality: Between Concrete Matters and Abstract Forms, or How Matter Becomes Material' in Andreas Philippopoulos-Mihalopoulos (ed), *Routledge Handbook for Law and Theory* (Routledge 2018) 453.

of risk analysis that frame social and legal responses to the socio-ecological crisis.[99] This new *Lex Molysmocenae* does not rest on the fragmented reality that exists between specialised institutions or various branches of international law. Rather, it emerges from the convergence of international environmental law and international political economy to incorporate waste into global value chains. In other words, the negative externalities of globalisation – once discarded and managed by environmental law – are increasingly now being recycled into positive values and goods that are regulated by international economic law.[100]

The 2017 Chinese ban on foreign waste imports is illustrative of this reordering of the boundaries of global economic and environmental regulation. When China decided to ban the import of foreign waste, the effects (political, legal, economic and otherwise) of this decision, rippled throughout the world. For example, the World Bank estimates that 270 million tonnes of waste are recycled every year.[101] According to the Bureau of International Recycling, all this recycled waste has developed into a USD 200 billion industry globally.[102] Yet, on 31 December 2017, China, which used to be the global recycling trade centre of the world, abruptly closed its borders to imports of recycled material following the enactment of the so-called National Sword policy.[103] The policy imposes new standards for scrap imports which most countries cannot technically meet (such as 0.5 per cent contamination levels for paper, wood, ferrous and wire cables imports).[104] This was a difficult requirement for many countries to fulfil, especially countries in Europe, as well as the United States. In the case of Europe, plastic waste exports from the European Union grew by more than 400 per cent from 2002 to 2015, with more than 85 per cent of the European Union's plastic waste exports going to China in 2012.[105] As for the United States, waste was its largest export to China, contributing 16 million tons in 2016, which amounted to a total of USD 5.2 billion. Between 1988 and 2016, China imported USD 81 billion worth of plastic waste. Since the ban was imposed, western countries have been struggling to find new dumping sites for their plastics.[106] Rather revealingly, the

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99 Downing et al (n 38); Preston (n 30).

100 Daniel Hoornweg, Perinaz Bhada-Tata and Chris Kennedy, 'Environment: Waste Production Must Peak this Century' (2013) 502 Nature 615.

101 World Bank (n 22).

102 Leslie Hook and John Reed, 'Why the World's Recycling System Stopped Working' (*Financial Times*, 25 October 2018) <www.ft.com/content/360e2524-d71a-11e8-a854-33d6f82e62f8> accessed 24 May 2020; NASDAQ Global News Wire, 'Global $1296.04 Billion Solid Waste Management Market Analysis and Forecasts 2017–2022' (10 March 2017) <https://globenewswire.com/news-release/2017/03/10/934258/0/en/Global-1296-04-Billion-Solid-Waste-Management-Market-Analysis-and-Forecasts-2017-2022.html> accessed 24 May 2020.

103 Katy O'Neill, 'The New Global Political Economy of Waste' in Peter Dauvergne and Justin Alger (eds), *A Research Agenda for Global Environmental Politics* (Edward Elgar 2018) 87.

104 World Trade Organization (WTO) (Technical Barriers to Trade (TBT) Information System – Notification from People's Republic of China), 'G/TBT/N/CHN/1225', 15 November 2017: 'Waste and scrap of paper or paperboard' HS:4707; ICS: 13.030.50. Recovered (waste and scrap) paper or paperboard. (HS 4707). Recycling (ICS 13.030.50), 15 November 2017; G/TBT/N/CHN/1227 of 15 November 2017 concerning 'Waste and scrap of iron and steel' HS: 7204; ICS: 13.030.50. Ferrous waste and scrap; re-melting scrap ingots of iron or steel. (HS 7204). Recycling (ICS 13.030.50).

105 Meadhbh Bolger, 'China Is No Longer the EU's Plastic Dumping Ground: What's Next?' (2 November 2017, updated 5 February 2018) <www.euractiv.com/section/circular-economy/opinion/china-is-no-longer-the-eus-plastic-dumping-ground-whats-next/> accessed 24 May 2020.

106 Erin McCormick et al, 'Where Does Your Plastic Go? Global Investigation Reveals America's Dirty Secret' (*The Guardian*, 17 June 2019) <www.theguardian.com/us-news/2019/jun/17/recycled-plastic-america-global-crisis> accessed 24 May 2020.

Chinese ban on foreign waste imports was not notified to the Basel Secretariat in terms of the Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal of 1989,[107] but instead to the World Trade Organization (WTO),[108] despite the fact that rubbish and pollution remain rarely adjudicated by WTO panels and committees.[109] This means that waste, though formally managed and regulated under domestic and international *environmental* norms, currently rather seems to be considered a commodity that must be regulated by international *economic* law. The Chinese notification to the WTO is therefore a clear example that waste has become a global commodity reordering the boundaries of law itself.

Whereas international law has historically been predominantly preoccupied with creating affluence at the expense of effluence, the boundaries separating affluence and effluence are now collapsing. The Molysmocene's *Terra saturate* highlights the limits of the planetary boundaries and the need to internalise ever-growing quantities of waste, dirt and pollution into anthropocentric capitalism. Geoengineering strategies, so-called debt-for-nature programmes and bioprospecting have emerged as strategies designed to extend and deepen the limits of *terra nullius*. In parallel, other strategies, institutional arrangements and mechanisms are emerging to integrate waste into the material economy that is concerned with the production and circulation of goods and services, in addition to the financial economy. Carbon markets, ecological fiscality, disaster risk insurances and a variety of taxes have been created to change consumer behaviour and compel actors to integrate their negative externalities (pollution, dirt and waste) into their economic activities.[110] Regrettably, acting as bridges between the worlds of the Anthropocene and the Molysmocene, these strategies still rest on 'affluence/productivist' ontologies.[111]

These strategies further appear to be similar to what James Scott called 'high modernism', that is, the confidence and ability in well-intentioned plans for improving the human condition that rest on schematic visions that, often unintentionally, violently disrupt complex interdependencies.[112] These strategies, projects and discourses also tend to reproduce trite socio-technical imaginaries and (perhaps *false*) beliefs in socio- and techno-engineering. Projects such as 'smart cities'[113] and 'green cities',[114] for example, loosely connect the sociotechnical

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[107] Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (adopted 22 March 1989, entered into force 5 May 1992) 1673 UNTS 57.

[108] WTO – TBT Committee, 'Notification', 18 July 2017, G/TBT/N/CHN/1211.

[109] United States – Standards for Reformulated and Conventional Gasoline (US-Gasoline), WTO AB Report, WT/DS2/AB/R, 20 May 1996; European Communities – Measures Affecting Asbestos and Asbestos-Containing Products (EC – Asbestos), WTO AB Report, WT/DS135/AB/R (5 April 2001). See also the WTO Committee on Trade and Environment under the Doha Development Agenda, Doha WTO Ministerial Declaration, WT/MIN(01)/DEC/1, 20 November 2001.

[110] For a detailed list of the strategies, see the United Nations Development Program (UNDP), *Sustainable Development Goal(s) Financing Solutions*, <www.sdfinance.undp.org/content/sdfinance/en/home/solutions.html?main-content_columnControl_col-1_list_start=0> accessed 24 May 2020.

[111] For such a reading but from a critical perspective, see Raj Patel and Jason W Moore, *A History of the World in Seven Cheap Things: A Guide to Capitalism, Nature, and the Future of the Planet* (University of California Press 2017).

[112] James C Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed* (Yale University Press 1998).

[113] Anthony M Townsend, *Smart Cities: Big Data, Civic Hackers, and the Quest for a New Utopia* (WW Norton 2014).

[114] Catherine Phillips and Jennifer Atchison, 'Seeing the Trees for the (Urban) Forest: More-Than-Human Geographies and Urban Greening' (2018) 51(2) Australian Geographer 155–68.

imaginary of artificial intelligence to that of waste management,[115] whereas the 'Green New Deal'[116] simply recycles Keynes' economic heterodoxy, and the 'Blue New Deal'[117] seeks to mobilise the oceans in the fight against global warming. These projects and visions reflect on the transformation of values and ideas surrounding waste and pollution: waste/pollution as a negative value is turned into a resource to which is attached a positive economic value or, at least, a potential component of any economic system. In that sense, the *Lex Molysmocenae* draws *Anthropo*s back into the landfill, among the objects *Anthropos* had once itself discarded. Ultimately, *Lex Molysmocenae* allows waste to colonise, to sift through and to reorder *terra saturate*.

5. CONCLUSION

This chapter has argued that waste production has fundamentally and irreversibly encroached on planetary boundaries in the Molysmocene. Waste is the primary threat to the preservation of planetary boundaries and to staying within the safe operating space, while international (environmental) law has historically facilitated the dispersion of waste on a *terra saturate*. Humans need to acknowledge the pivotal role waste has played, and continues to play, in shifting and reordering the boundaries of the law itself.

How can we live on *terra saturate*? How can we imagine life on a planet saturated with waste, and one that is permanently damaged?[118] One logical response would be to seek to bridge the worlds of the Anthropocene and the Molysmocene through discourses and practices of adaptation and resilience.[119] Regarding the latter concept, David Chandler observes:

> resilience as a policy framework of adaptation appears to be drawing to a close as it lacks an adequate agential or transformative aspect: it is always too oriented to adapting to feedbacks and modulating around sustaining what exists. When what exists is the problem itself, in terms of anthropogenic global warming and climate change, then it is clear that critical thought and policy practice need to go beyond imaginaries of resilience.[120]

Planet Earth is messy, toxic, irradiated, polluted, and those effects are unevenly distributed around the globe. In a sense, waste (re)produces power relations and injustices,[121] which cannot simply be answered by more adaptation, resilience or (economic) circularity.[122] There

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115 See Aust and Nijman, Chapter 6 in this book.

116 Naomi Klein, *On Fire: The (Burning) Case for a Green New Deal* (Simon & Schuster 2019).

117 Elizabeth Warren, *We Need a New Blue Deal for the Oceans* (Warren Democrats) <https://elizabethwarren.com/plans/blue-new-deal> accessed 24 May 2020.

118 Tsing et al (n 58).

119 Jonas Ebbesson and Ellen Hey, 'Introduction: Where in Law Is Social-Ecological Resilience?' (2013) 18 Ecology and Society 25; Reinette Biggs et al, 'Toward Principles for Enhancing the Resilience of Ecosystem Services' (2012) 37 Annual Review of Environment and Resources 421.

120 David Chandler, 'Resilience and the End(s) of the Politics of Adaptation' (2019) 7 Resilience: International Policies, Practices, and Discourses 304, 305.

121 Max Liboiron, Manuel Tironi and Nerea Calvillo, 'Toxic Politics: Acting in a Permanently Polluted World' (2018) 48 Social Studies of Science 331.

122 Federico Savini, 'The Economy that Runs on Waste: Accumulation in the Circular City' (2019) 21 Journal of Environmental Policy & Planning 675; Francisco Valenzuela and Steffen Böhm, 'Against

is no longer any primordial or pure state from which history can be written anew. There is no clean slate as we are to continue living in, through and with dirt, waste and pollution.[123]

In his *Passagenwerk* (Arcades Project), Walter Benjamin explains that the law of ruin and decay is written within the code of conception of modern cities.[124] Decline is in the design of technological societies, where the debris of humanity ascribe themselves *a priori*, rather than *a posteriori*. The Molysmocene is an era where the law of ruin is neither a crisis nor a problem to be solved, but a condition to be lived in and lived with. Rather than proposing a new stream of environmental law in the Anthropocene, the Molysmocene invites us to 'stay with the rubble'. One stays with the rubble by reassembling fractured objects, such as electronic waste[125] and discarded textiles,[126] or by sheltering in orchards that have been cultivated in bomb craters.[127]

Wasted Politics: A Critique of the Circular Economy' (2017) 17 Ephemera: Theory & Politics in Organization 23.

[123] Alexis Shotwell, *Against Purity: Living Ethically in Compromised Times* (University of Minnesota Press 2016).

[124] Susan Buck-Morss, *The Dialectics of Seeing: Walter Benjamin and the Arcades Project* (MIT Press 1991).

[125] Lepawsky (n 79).

[126] Gustav Sandin and Greg Peters, 'Environmental Impact of Textile Reuse and Recycling' (2018) 184 Journal of Cleaner Production 353.

[127] Leah Zani, 'Bomb Ecologies' (2018) 10(2) Environmental Humanities 528.

PART III

PLANETARY BOUNDARIES AND THE LAW

12. Loss of biosphere integrity (biodiversity loss and extinctions)

Han Somsen and Arie Trouwborst[1]

1. INTRODUCTION

Biosphere integrity[2] is one of the two 'core' planetary boundaries, but, worryingly, the available evidence on global biodiversity[3] loss indicates that this boundary has already been severely transgressed. To return to the 'safe' side of the boundary it is imperative to prevent any further loss of biological diversity and of ecological integrity,[4] and to carry out ambitious restoration efforts across the globe. To achieve either, it would appear that law, including international law, has a role to play.

In this chapter we consider this role, with an emphasis on international law (including European law). Many legal instruments exist that are of direct relevance to conserving and restoring biosphere integrity, particularly the body of law commonly referred to as nature[5] con-

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1 This chapter forms part of the research project *Constitutionalizing the Anthropocene*, <www.tilburguniversity.edu/about/schools/law/about/departments/plg/research/anthropocene>, Tilburg Law School. For helpful comments on an earlier version of this chapter, the authors thank Tilburg Law School colleagues and participants in the *Constitutionalizing the Anthropocene* research cluster: Tobias Arnoldussen, Kees Bastmeijer, Anna Berti Suman, Michael Leach, Hans Lindahl, Phillip Paiement, Marie Petersmann and Nairita Roy Chaudhuri.

2 The notion of 'biosphere integrity' is introduced below in Section 2.

3 'Biological diversity' (biodiversity for short) is defined in the Convention on Biological Diversity (CBD) (adopted on 5 June 1992, entered into force 29 December 1993) 1760 UNTS 79 art 2 as 'the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems'.

4 'Ecological integrity', according to Zachary Wurtzebach and Courtney Schultz, 'Measuring Ecological Integrity: History, Practical Applications and Research Opportunities' (2016) 66 BioScience, 446, 447, is 'most commonly understood as a holistic concept and framework that focuses on conserving native biodiversity, using the natural or historic range of variation as a reference point, and promoting resilience (i.e., the capacity to "reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks").' An oft-cited definition of ecological integrity is the one given by Jeffrey D Parrish, David P Braun and Robert S Unnasch, 'Are We Conserving What We Say We Are?' (2003) 53 BioScience, 851, 852: 'The ability of an ecological system to support and maintain a community of organisms that has species composition, diversity, and functional organization comparable to those of natural habitats within a region. An ecological system has integrity when its dominant ecological characteristics (e.g., elements of composition, structure, function, and ecological processes) occur within their natural ranges of variation and can withstand and recover from most perturbations imposed by natural environmental dynamics or human disruptions.'

5 While aware of intricate philosophical debates on the meaning of the word 'nature', we align our usage of the term in this chapter with the way it is employed in nature conservation law. In the latter context, in most instances the use of the term appears representative of its common dictionary meaning, as in the 'phenomena of the physical world collectively, including plants, animals, the landscape, and

servation law (or, alternatively, as wildlife law, or biodiversity conservation law).[6] We discuss strengths and shortcomings of this legal framework, and identify normative and institutional challenges in the light of current knowledge on the planetary boundary of biosphere integrity and its transgression. In doing so, we attempt a normative interpretation of the planetary boundaries framework with regard to biosphere integrity. That interpretation in turn provides a template for the critical evaluation of the law, particularly international nature conservation law. In the latter part of this chapter, we contemplate the apparent need for systemic changes to legal regimes, singling out the complex but, we believe, indispensable role reserved for nature rights in the urgent effort to return the cumulative impact of human activities to the safe side of the biosphere integrity boundary.

2. BIOSPHERE INTEGRITY – DEFINITION AND MEASUREMENT

This section introduces the planetary boundary of biosphere integrity, its significance and its transgression, by drawing on the key work on planetary boundaries by Rockström and colleagues[7] and Steffen and colleagues,[8] and other scientific literature. The biosphere is the 'totality of all ecosystems (terrestrial, freshwater, and marine) on Earth and their biota' (biota meaning flora and fauna). As Steffen and colleagues explain:

> These ecosystems and biota play a critical role in determining the state of the Earth system, regulating its material and energy flows and its responses to abrupt and gradual change. Diversity in the biosphere provides resilience to terrestrial and marine ecosystems. The biosphere not only interacts with the other planetary boundaries but also increases the capacity of the Earth system to persist in a given state under changes in these other boundaries. The ultimate basis for the many roles that the biosphere plays in the Earth-system dynamics is the genetic code of the biota, the basic information bank that defines the biosphere's functional role and its capacity to innovate and persist into the future.[9]

Thus, biological diversity plays a crucial role in providing ecological functions that ensure the underlying resilience of other planetary boundaries.[10] Indeed, biosphere integrity is recognised as one of two 'core' boundaries, the other being climate change, 'each of which has the

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other features and products of the earth, as opposed to humans or human creations': see Lexico, 'Nature' (Lexico powered by Oxford Dictionary, 2020) <https://www.lexico.com/en/definition/nature> accessed 25 June 2020; or 'all the animals, plants, rocks, etc. in the world and all the features, forces, and processes that happen or exist independently of people': see Cambridge Dictionary, 'Nature' (Cambridge University Press, 2020) <https://dictionary.cambridge.org/dictionary/english/nature> accessed 25 June 2020. Exceptions occur, however, as in the UNGA Res 37/7 World Charter for Nature (28 October 1982) UN Doc. A/RES/37/7 (1982), which emphasises that '[m]ankind is a part of nature' (Preamble).

6 'Nature conservation law' is understood in this chapter as the aggregate of legal instruments having as their objective the conservation, restoration and/or sustainable use of nature, biodiversity, wildlife, particular species or populations of wild flora and/or fauna or particular natural areas or ecosystems.

7 Johan Rockström et al, 'Planetary Boundaries: Exploring the Safe Operating Space for Humanity' (2009) 14 Ecology and Society, 32.

8 Will Steffen et al, 'Planetary Boundaries: Guiding Human Development on a Changing Planet' (2015) 347 Science, 1259855.

9 Ibid 1259855-8.

10 Rockström et al (n 7).

potential on its own to drive the Earth system into a new state should they be substantially and persistently transgressed'.[11]

In one sense, biosphere integrity can be understood as ecological integrity at a global scale. Biosphere integrity requires that both the *genetic* diversity and the *functional* diversity of life on Earth are at sufficient levels. Genetic diversity refers to the aforementioned 'information bank'. Functional diversity refers to the 'value, range, distribution, and relative abundance of the functional traits of the organisms present in an ecosystem or biota'.[12] Both types of diversity, genetic and functional, are difficult to quantify. The search is still on for control variables that would enable their accurate measurement, but interim control variables have been identified that can be used for the time being, namely extinction rate for genetic diversity and a Biodiversity Intactness Index (BII) for functional diversity.[13]

Functional diversity is particularly difficult to measure, especially at higher (regional and global) levels. The interim control variable proposed by Steffen and colleagues, the BII,[14] assesses change in population abundance resulting from human activities across a wide range of taxa and functional groups at the level of an ecosystem or biome, using pre-industrial abundance as point of reference.[15] A proposed preliminary boundary has been set at 90 per cent of the BII, although it is clear that much uncertainty remains regarding the precise relationship between the BII and Earth system functioning.[16] In the longer term, the concept of 'biome integrity' could also become a useful measure of functional diversity, gauging the functioning and persistence of the broad scale of biomes – that is, large naturally occurring animal and plant communities occupying a major habitat (such as grassland, savanna, tropical rainforest, tundra).[17] Further research is needed, however, to arrive at a robust and science-based operational control variable for each biome.[18]

For genetic diversity, 'phylogenetic species variability' (PSV), which is used to quantify evolutionary relatedness,[19] could be an appropriate control variable, but a lack of data continues to prevent its use.[20] Therefore, 'global extinction rate' has been adopted as an interim control variable, even though this too has its downsides, and is 'measured inaccurately and with a time lag'.[21] In comparing these variables and the associated boundaries, Steffen and colleagues say:

> There may be a considerable risk in using extinction rate as a control variable, because phylogenetic (and functional) diversity may be more sensitive to human pressures than species-level diversity. In principle, the boundary should be set at a rate of loss of PSV no greater than the rate of evolution of new PSV during the Holocene. Because that is unknown, we must fall back on the (imperfectly)

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11 Steffen et al (n 8) 1259855-1.
12 Ibid 1259855-5.
13 Ibid 1259855-5-6; Rockström et al (n 7).
14 Robert J Scholes and Reinette Bigs, 'A Biodiversity Intactness Index' (2005) 434 Nature 45.
15 Steffen et al (n 8) 1259855-6.
16 Ibid.
17 Ibid.
18 Ibid.
19 Matthew R Helmus et al, 'Phylogenetic Measures of Biodiversity' (2007) 169 The American Naturalist E68; Georgina M Mace et al, 'Approaches to Defining a Planetary Boundary for Biodiversity' (2014) 28 Global Environmental Change 289.
20 Steffen et al (n 8) 1259855-5.
21 Ibid.

known extinction rate of well-studied organisms over the past several million years – about 1 per million species-years – and add a large uncertainty bound, raising the boundary to 10 per million species-years. The risk is that, although the Earth system can tolerate a higher-than-background level of extinction for a time, we do not know what levels of, or types of, biodiversity loss may possibly trigger non-linear or irreversible changes to the Earth system.[22]

3. TRANSGRESSING THE BOUNDARY, OR: ENTERING THE EREMOCENE

The available evidence on global biodiversity loss indicates that the planetary boundary of biosphere integrity is currently severely transgressed, and increasingly so. As Rockström and colleagues put it in 2009, 'humanity has already entered deep into a danger zone'.[23] Regarding functional diversity, an extensive 2016 study showed that the BII has already dropped below the 'safe' planetary boundary of 90 per cent across almost two-thirds of the world's land surface, with grassland biomes and biodiversity hotspots particularly affected.[24] Besides, concerns have arisen that the BII approach may render too optimistic a picture and underestimate real losses of functional diversity.[25] Regarding genetic diversity, there is particularly strong evidence that the current extinction rate is well beyond the suggested boundary of ten extinctions per million species-years. Indeed, it is well documented that the accelerating worldwide depletion of biodiversity is of such magnitude that it qualifies as a 'mass extinction' event.[26] As Edward Wilson observes, 'all of the available evidence points to the same two conclusions. First, the Sixth Extinction is under way; and second, human activity is its driving force.'[27]

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[22] Ibid 1259855-5-6.

[23] Rockström et al (n 7).

[24] Tim Newbold et al, 'Has Land Use Pushed Terrestrial Biodiversity Beyond the Planetary Boundary? A Global Assessment' (2016) 353(6296) Science, 288.

[25] Philip A Martin, Rhys E Green and Andrew Balmford, 'The Biodiversity Intactness Index May Underestimate Losses' (2019) 3 Nature Ecology & Evolution, 862.

[26] See, eg, this selection of sources: James A Estes et al, 'Trophic Downgrading of Planet Earth' (2011) 333(6040) Science 301; Stuart L Pimm et al, 'The Biodiversity of Species and their Rates of Extinction, Distribution, and Protection' (2014) 344(6187) Science 1246752; Rodolfo Dirzo et al, 'Defaunation in the Anthropocene' (2014) 345(6195) Science 401; Malcolm L McCallum, 'Vertebrate Biodiversity Losses Point to a Sixth Mass Extinction' (2015) 24(10) Biodiversity and Conservation 2497; Newbold et al (n 24); Christopher N Johnson et al, 'Biodiversity Losses and Conservation Responses in the Anthropocene' (2017) 356(6335) Science 270; Gerardo Ceballos, Paul R Ehrlich and Rodolfo Dirzo, 'Biological Annihilation Via the Ongoing Sixth Mass Extinction Signaled by Vertebrate Population Losses and Declines' (2017) 114(30) Proceedings of the National Academy of Sciences, E6089; Yinon M Bar-On, Rob Phillips and Ron Milo, 'The Biomass Distribution on Earth' (2018) 115(25) Proceedings of the National Academy of Sciences 6506; and Nico Eisenhauer, Aletta Bonn and Carlos A Guerra, 'Recognizing the Quiet Extinction of Invertebrates' (2019) 10 Nature Communications 50. Informative background reading can be found in any of the following books: Richard Leakey and Roger Lewin, *The Sixth Extinction: Patterns of Life and the Future of Humankind* (Anchor Books 1996); Elizabeth Kolbert, *The Sixth Extinction: An Unnatural History* (Henry Holt & Co 2014); Gerardo Ceballos, Anne H Ehrlich and Paul R Ehrlich, *The Annihilation of Nature: Human Extinction of Birds and Mammals* (John Hopkins University Press 2015); Edward O Wilson, *Half-Earth: Our Planet's Fight for Life* (Liveright Publishing 2016).

[27] Wilson, ibid 55.

Recently, the evidence on global biodiversity loss has been comprehensively reviewed by the Intergovernmental Science-Policy Platform for Biodiversity and Ecosystem Services (IPBES). Its authoritative 2019 summary report concludes, *inter alia*, that nature 'across most of the globe has now been significantly altered by multiple human drivers, with the great majority of indicators of ecosystems and biodiversity showing rapid decline', and that human actions 'threaten more species with global extinction now than ever before'.[28] These illustrative excerpts from the report speak for themselves:

> Seventy-five percent of the land surface is significantly altered, 66 per cent of the ocean area is experiencing increasing cumulative impacts, and over 85 per cent of wetlands (area) has been lost […] Approximately half the live coral cover on coral reefs has been lost since the 1870s, with accelerating losses in recent decades due to climate change exacerbating other drivers. The average abundance of native species in most major terrestrial biomes has fallen by at least 20 per cent […] In areas of high endemism, native biodiversity has often been severely impacted by invasive alien species. Population sizes of wild vertebrate species have tended to decline over the last 50 years on land, in freshwater and in the sea. Global trends in insect populations are not known but rapid declines have been well documented in some places […] An average of around 25 per cent of species in assessed animal and plant groups are threatened, suggesting that around 1 million species already face extinction, many within decades, unless action is taken to reduce the intensity of drivers of biodiversity loss. Without such action, there will be a further acceleration in the global rate of species extinction, which is already at least tens to hundreds of times higher than it has averaged over the past 10 million years.[29]

As regards insects and other invertebrates, researchers have recently called attention to the 'quiet and underappreciated extinction' of such species, despite the importance of many invertebrates in ecosystem functioning.[30] Indeed, certain species – dubbed 'ecosystem engineers' or 'keystone species' – are especially important to biosphere integrity, including also large carnivores and large herbivores.[31] As Rockström and colleagues acknowledge, 'the loss of top predators and structurally important species, such as corals and kelp, results in disproportionately large impacts on ecosystem dynamics'.[32] Some recent statistics on the distribution of biomass among wild and domesticated animals are particularly revealing. Of all bird biomass on Earth, approximately 70 per cent presently consists of chickens and other farmed poultry, and 30 per cent are all the birds belonging to all wild bird species together.[33] Even more strikingly, of the world's terrestrial mammalian biomass, 60 per cent is now livestock and 36 per cent is humans themselves, with all remaining wild animals together, from shrews to elephants, accounting for only 4 per cent.[34] To describe this 'biologically final age in which the planet exists almost exclusively by, for, and of ourselves', Edward Wilson coined the term 'Eremocene' – Age of

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[28] IPBES, Summary for Policymakers of the Global Assessment Report on Biodiversity and Ecosystem Services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES, 29 May 2019) IPBES/7/10/Add.1, 4.

[29] Ibid.

[30] Eisenhauer, Bonn and Guerra (n 26) 3.

[31] See, eg, Estes et al (n 26); David W Macdonald et al, 'Conserving Large Mammals: Are They a Special Case?' in David W Macdonald and Katherine J Willis (eds), *Key Topics in Conservation Biology*, vol. 2 (Wiley-Blackwell 2013) 277; William J Ripple et al, 'Status and Ecological Effects of the World's Largest Carnivores' (2014) 343 Science, 1241484; William J Ripple et al, 'Collapse of the World's Largest Herbivores' (2015) 1 Science Advances, e1400103.

[32] Rockström et al (n 7).

[33] Bar-On, Phillips and Milo (n 26).

[34] Ibid.

Loneliness – as an alternative for ‘Anthropocene’: ‘the age of people, our domesticated plants and animals, and our croplands all around the world as far as the eye can see.’[35]

4. A ROLE FOR LAW

The main causes of biodiversity loss are habitat loss, overexploitation, invasive alien species, pollution and climate change – which in turn are driven by a combination of human population overshoot and oversized per-capita ecological footprints.[36] Unfortunately, the IPBES reports that anthropogenic drivers of biodiversity loss – such as unsustainable agriculture, forestry, fisheries and aquaculture; harmful land and sea use changes; pollution; and invasive alien species introductions – are ‘increasing globally’.[37] To return to the safe side of the biosphere integrity boundary it is imperative, first, to effectively prevent any further losses of biodiversity and ecological integrity, and second, to effectively carry out ambitious restoration efforts across the globe. In the short term, this quite simply requires safeguarding as much biodiversity as possible through conservation and restoration. In the longer term, it requires what the IPBES report calls ‘transformative change’ in social, economic and technological structures within and across nations,[38] in order to make human interaction with biodiversity sustainable. Crucial components include reserving sufficient space for nature and using it ‘in a way and at a rate that does not lead to the long-term decline of biological diversity’, as the Convention on Biological Diversity (CBD) puts it.[39] To illustrate the dimensions of the former challenge, various recent studies indicate that approximately 40–50 per cent of the Earth’s surface should be set aside as areas where nature conservation and restoration has priority, whereas current protected areas cover only 15 per cent of the world’s land (only one-third of which is effectively managed) and 7 per cent of the oceans (only one-seventh of which is effectively managed).[40]

A role is clearly reserved for law, with respect to the required short-term and long-term actions alike – while bearing in mind that law is but one of many social regulatory institutions. Being binding and enforceable, legislation can provide ‘legal boundaries that prevent human activities from reaching and breaching planetary boundaries’.[41] Conceptually, it is easy to grasp the notion that ‘legal boundaries must translate the physical reality of a finite world into law and thereby delimit acceptable levels of human activity’.[42] Legislation can outlaw, con-

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35 Wilson (n 26) 20.

36 See *inter alia* the sources mentioned in n 26.

37 IPBES (n 28) 23.

38 Ibid 27.

39 CBD art 2.

40 Eric Dinerstein et al, ‘An Ecoregion-Based Approach to Protecting Half the Terrestrial Realm’ (2017) 67 BioScience 534; Jonathan Baillie and Ya-Ping Zhang, ‘Space for Nature’ (2018) 361(6407) Science 1051; Wilson (n 26); James R Allan et al, ‘Conservation Attention Necessary Across at Least 44% of Earth’s Terrestrial Area to Safeguard Biodiversity’ (under review, preprint) <www.biorxiv.org/content/10.1101/839977v1> accessed 25 June 2020; for detailed information regarding current protected area coverage in individual continents and countries, see Protected Planet, ‘Discover the World’s Protected Areas’ (ProtectedPlanet, 2014–20) <www.protectedplanet.net> accessed 25 June 2020.

41 Guillaume Chapron et al, ‘Bolster Legal Boundaries to Stay within Planetary Boundaries’ (2017) 1 Nature Ecology & Evolution, 0086, 1.

42 Ibid.

dition and require certain human actions. Examples include prohibitions of harmful projects such as road construction in protected areas; restrictions on the introduction of alien species; the regulation of hunting, fishing and other uses of wildlife to ensure their sustainability; and active requirements to designate protected areas, take habitat restoration measures or reintroduce species. The global IPBES assessment also pays some attention to the role of law, calling *inter alia* for the 'effective implementation of multilateral environmental agreements' and recognising that 'changes in laws and policies can enable and underpin changes in resource management and consumption and, in turn, changes in individual and collective behaviour and habits can facilitate the implementation of policies and laws'.[43] To perform their role of helping to ensure that collective human activities are returned to the safe side of the biosphere integrity boundary and other planetary boundaries, *and kept there*, laws must (i) have adequate content, that is, be fit for purpose, and (ii) be adequately applied.

An extensive body of legislation of relevance to biodiversity conservation and restoration is already in force today. This includes many domestic laws in countries around the world, and overarching legislative frameworks at intergovernmental and supranational levels, with a specific focus on biodiversity (or wildlife, or natural areas).[44] Indications are that in practice such nature conservation legislation, *when adequately crafted, interpreted and implemented*, can indeed make crucial contributions to biodiversity conservation, and that biodiversity would have been even worse off today without the current legislation.[45] At the same time, there is the bare fact that all the past and present laws together have not prevented the current biodiversity crisis from unfolding. Whereas planetary boundaries are immutable, the boundaries imposed by legislation are not, and may be set incorrectly or even ignored.[46]

While acknowledging that the scope and content, interpretation and implementation of laws are interlinked, we now concisely explore each of these issues in turn.

5. SCOPE AND CONTENT OF THE LAW

Generic commitments to conserving and restoring ecological integrity on a global scale do exist, but remain largely limited to non-binding instruments.[47] One example is the 1992 Rio Declaration on Environment and Development, according to which 'States shall cooperate in a spirit of global partnership to conserve, protect and restore the health and integrity of the Earth's ecosystem'.[48] Stronger formulations, although similarly non-binding in nature,

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43 IPBES (n 28) 30–31.

44 See, eg, Michael Bowman, Peter Davies and Catherine Redgwell, *Lyster's International Wildlife Law* (2nd edn, Cambridge University Press 2010); Arie Trouwborst et al, 'International Wildlife Law: Understanding and Enhancing Its Role in Conservation' (2017) 67 BioScience 784.

45 Ibid.

46 Chapron et al (n 41). Biodiversity law, in these terms, has 'failed to meaningfully contribute to regulatory efforts that aim to keep humanity from reaching and breaching these [planetary] boundaries': Louis J Kotzé and Rakhyun E Kim, 'Earth System Law: The Juridical Dimensions of Earth System Governance' (2019) 1 Earth System Governance 100003.

47 Rakhyun E Kim and Klaus Bosselmann, 'Operationalizing Sustainable Development: Ecological Integrity as a *Grundnorm* of International Law' (2015) 24 Review of European, Comparative and International Environmental Law 194.

48 Rio Declaration on Environment and Development, UN Doc. A/CONF.151/26 (Vol. I) (1992), Principle 7.

can be found in the World Charter for Nature adopted by the United Nations (UN) General Assembly in 1982, which requires *inter alia* that the 'essential processes' of nature 'shall not be impaired' and that the 'genetic viability on the earth shall not be compromised'.[49]

The currently extant *binding* nature conservation instruments are subject to various further shortcomings. One of these concerns the scope of these legal instruments, in terms of the countries, areas, species and issues to which they apply. Significant gaps remain in all of these respects,[50] as also noted in the gap report compiled in the process towards a Global Pact for the Environment.[51] This is true even for the most charismatic megafauna such as large carnivores.[52] Much bigger gaps remain concerning invertebrates and plants. A glance at the appendices to international treaties and national legislation for wildlife conservation reveals that these predominantly contain vertebrate animals, and are thus not representative of biodiversity as a whole, or indeed of threatened biodiversity.[53]

Other shortcomings concern the obligations themselves as set out in the various instruments. Some of these are phrased in strong, unequivocal and unqualified language, but many are not.[54] The latter can result from (i) the strength of the obligation as such (for example, using 'should' instead of 'shall'; (ii) creating obligations of effort (for example, using 'endeavour' or 'promote') rather than result; and (iii) the inclusion of qualifying language (for example, requiring something 'where feasible' or 'appropriate'). A variety of fairly typical examples can be found in Article III of the Convention on Migratory Species (CMS), which sets out the obligations of contracting parties regarding endangered migratory species listed in Appendix I of the Convention:[55]

> Parties that are Range States of a migratory species listed in Appendix I shall *endeavour*:
> (a) to conserve and, *where feasible and appropriate*, restore those habitats of the species which are of importance in removing the species from danger of extinction;
> (b) to prevent, remove, compensate for or minimize, *as appropriate*, the adverse effects of activities or obstacles that seriously impede or prevent the migration of the species; and
> (c) *to the extent feasible and appropriate*, to prevent, reduce or control factors that are endangering or are likely to further endanger the species, including strictly controlling the introduction of, or controlling or eliminating, already introduced exotic species.
> Parties that are Range States of a migratory species listed in Appendix I shall prohibit the taking of animals belonging to such species. Exceptions may be made to this prohibition only if:
> (a) the taking is for scientific purposes;

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49 World Charter for Nature (n 5) Principles 1 and 2.

50 Chapron et al (n 41).

51 *Gaps in International Environmental Law and Environment-Related Instruments: Towards a Global Pact for the Environment*, UN Doc. A/73/419 (2018); see also Duncan French and Louis J Kotzé, 'Towards a Global Pact for the Environment': International Environmental Law's Factual, Technical and (Unmentionable) Normative Gaps' (2019) 28 Review of European, Comparative and International Environmental Law 25.

52 See for some examples Arie Trouwborst, 'Global Large Carnivore Conservation and International Law' (2015) 24(7) Biodiversity and Conservation 1567; Arie Trouwborst, 'Global Large Herbivore Conservation and International Law' (2019) 28(14) Biodiversity and Conservation 3891.

53 eg Bar-On, Phillips and Milo (n 26), and other sources mentioned in Steffen et al (n 8).

54 See, eg, Louis J Kotzé, 'International Environmental Law's Lack of Normative Ambition: An Opportunity for the Global Pact for the Environment?' (2019) 16 Journal for European Environmental and Planning Law 213.

55 Convention on the Conservation of Migratory Species of Wild Animals (adopted on 3 June 1979, entered into force 1 November 1983) 1651 UNTS 333.

(b) the taking is for the purpose of enhancing the propagation or survival of the affected species;
(c) the taking is to accommodate the needs of traditional subsistence users of such species; or
(d) extraordinary circumstances so require;
provided that such exceptions are precise as to content and limited in space and time. Such taking *should* not operate to the disadvantage of the species.[56]

The taking prohibition is evidently a strong and unqualified obligation, except in the use of 'should' in the last condition for exemptions. The other obligations in Article III are riddled with qualifying language. As for another example, virtually all obligations in the CBD are qualified by the phrase 'as far as possible and as appropriate'.[57] This language appears to reflect the 'worrying lack of normative ambition' observed by Kotzé and Kim in environmental law at large, which continues to persist 'at a time when precisely such ambition is critically required in the Anthropocene'.[58]

6. INTERPRETATION THROUGH THE LENS OF THE BIOSPHERE INTEGRITY BOUNDARY

Prima facie, such references to feasibility and appropriateness appear to confer an ample margin of discretion on individual contracting parties to determine what they, in particular instances, consider to be feasible and appropriate. That is not to say that the obligations involved are rendered legally meaningless. Regarding feasibility, this may entail a lowering of the standard for the poorest countries, but much less so for developed states. Regarding appropriateness, we argue that the available evidence concerning the worsening transgression of the biosphere integrity boundary discussed above can go a long way in settling the interpretation of what is 'appropriate'. Article 8 of the CBD on *in-situ* conservation provides an eminent example:

Each Contracting Party shall, as far as possible and as appropriate:
(a) Establish a system of protected areas or areas where special measures need to be taken to conserve biological diversity;
(b) Develop, where necessary, guidelines for the selection, establishment and management of protected areas or areas where special measures need to be taken to conserve biological diversity;
(c) Regulate or manage biological resources important for the conservation of biological diversity whether within or outside protected areas, with a view to ensuring their conservation and sustainable use;
(d) Promote the protection of ecosystems, natural habitats and the maintenance of viable populations of species in natural surroundings;
(e) Promote environmentally sound and sustainable development in areas adjacent to protected areas with a view to furthering protection of these areas;
(f) Rehabilitate and restore degraded ecosystems and promote the recovery of threatened species, inter alia, through the development and implementation of plans or other management strategies;
(g) …;
(h) Prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species;

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56 Ibid arts III(4)–(5). Emphasis added.
57 CBD arts 5–11 and 14.
58 Kotzé and Kim (n 46).

(i) Endeavour to provide the conditions needed for compatibility between present uses and the conservation of biological diversity and the sustainable use of its components;
(j) …;
(k) Develop or maintain necessary legislation and/or other regulatory provisions for the protection of threatened species and populations;
(l) Where a significant adverse effect on biological diversity has been determined pursuant to Article 7, regulate or manage the relevant processes and categories of activities; and
(m) Cooperate in providing financial and other support for in-situ conservation outlined in subparagraphs (a) to (l) above, particularly to developing countries.[59]

Viewed in light of current knowledge about the biodiversity crisis and its consequences, there is evidently a strong presumption that *all* of the actions enumerated in Article 8 are highly 'appropriate', and it would be hard to argue otherwise.[60] To illustrate, for most states, present knowledge regarding the transgression of the biosphere integrity boundary indicates that meeting the obligation to '[re]habilitate and restore degraded ecosystems'[61] *actually* requires colossal efforts as a matter of public international law.

Similar considerations apply regarding the interpretation of the aforementioned CMS Article III, and a host of other provisions in other (inter)national legal instruments. To offer one further example, the United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Convention[62] sets out, *inter alia*, the following obligation regarding 'natural heritage':[63]

> To ensure that effective and active measures are taken for the protection, conservation and presentation of the cultural and natural heritage situated on its territory, each State Party to this Convention shall endeavor, in so far as possible, and as appropriate for each country: […] to take the appropriate legal, scientific, technical, administrative and financial measures necessary for the identification, protection, conservation, presentation and rehabilitation of this heritage.[64]

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59 CBD art 8.

60 This conclusion is reinforced by the parties' own strategic Aichi Biodiversity Targets for 2020 in the Tenth meeting of the Conference of the Parties to the CBD (18–29 October 2010 – Nagoya, Aichi Prefecture, Japan) COP 10 Decision X/2, 2010, which are themselves non-binding but provide clear pointers as to what must be considered 'appropriate' in this context. Good examples are Target 12 ('By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained'); Target 6 ('By 2020 all fish … stocks … are managed and harvested sustainably'); Target 7 ('By 2020 areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity'); and Target 8 ('By 2020, pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity').

61 CBD art 8(f).

62 Convention Concerning the Protection of the World Cultural and Natural Heritage (adopted on 16 November 1972, entered into force 17 December 1975) 1037 UNTS 151.

63 According to art 2 of the Convention, 'natural heritage' includes those areas 'which constitute the habitat of threatened species of animals and plants of outstanding universal value from the point of view of science or conservation', as well as 'natural sites or precisely delineated natural areas of outstanding universal value from the point of view of science, conservation or natural beauty'.

64 Ibid art 5(d).

7. APPLICATION OF THE LAW

Returning to the CBD, the depressing statistics on the accelerating worldwide loss of biodiversity plainly demonstrate that the Convention's 196 contracting parties are *not* implementing the actions indicated in Article 8 to the extent that this is possible and appropriate. In fact, it would seem that across the board, implementation of international nature conservation law is far from perfect.[65] Even where obligations are strongly phrased and unambiguous, like the aforementioned taking prohibition of the CMS, they can be, and have been, ignored in practice with relative impunity.[66] Without any pretence of comprehensiveness, we briefly explore below what the reasons for this could be.

Part of the explanation appears to lie with the nature of public international law and the difficulty of enforcing it, including the limited possibilities of invoking it before international and national courts. Indeed, there appears to be a link between the greater effectiveness of European Union (EU) biodiversity conservation law[67] when compared to international treaties, and the elevated enforceability of EU law – which can be invoked directly before national courts, and which is also subject to a supranational enforcement mechanism involving the European Commission (EC) and EU Court of Justice (CJEU).[68] Even here, however, the majority of the species and habitat types that have been the focus of EU biodiversity conservation law for decades still have an unfavourable conservation status.[69]

Effectiveness of international wildlife treaties is also impaired by shortcomings in the functioning of the executive bodies of various legal regimes, the International Whaling Commission being a particularly prominent example.[70] One recurrent problem is the failure of parties to apply their own guidance on science-based decision-making when it comes to their voting behaviour, for instance in regional fisheries management organisations, and in the Conference of the Parties (COP) of the Convention on International Trade in Endangered Species (CITES).[71]

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[65] Bowman, Davies and Redgwell (n 44); Trouwborst et al (n 44).

[66] eg Arie Trouwborst, 'Aussie Jaws and International Laws' (2014) 2 Cornell International Law Journal Online 41.

[67] Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds [2009] OJ L20/7 (Birds Directive); Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora [1992] OJ L206/7 (Habitats Directive).

[68] Paul F Donald et al, 'International Conservation Policy Delivers Benefits for Birds in Europe' (2007) 317 Science 810; Floor M Fleurke and Arie Trouwborst, 'European Regional Approaches to the Transboundary Conservation of Biodiversity: The Bern Convention and the EU Birds and Habitats Directives' in Louis J Kotzé and Thilo Marauhn (eds), *Transboundary Governance of Biodiversity* (Martinus Nijhoff 2014) 128; Fiona J Sanderson et al, 'Assessing the Performance of EU Nature Legislation in Protecting Target Bird Species in an Era of Climate Change' (2015) 9 Conservation Letters, 172.

[69] European Commission, *The State of Nature in the European Union, Results from Reporting under the Nature Directives 2007–2012* (EEA Technical report No 2/2015, 2015) 219 final.

[70] See, eg, Ed Couzens, *Whales and Elephants in International Conservation Law and Politics: A Comparative Study* (Earthscan/Routledge 2014).

[71] Two CITES examples are the recent listing of the giraffe (*Giraffa camelopardalis*) despite scientific advice to the contrary, and the long-standing, ostensibly arbitrary export quotas for leopards (*Panthera pardus*). See Arie Trouwborst, Andrew J Loveridge and David W Macdonald, 'Spotty Data: Managing International Leopard (*Panthera pardus*) Trophy Hunting Quotas amidst Uncertainty'

Critical limitations result, furthermore, from basic capacity shortages, corruption and other governance issues, which unfortunately are particularly pervasive in many developing countries – where most (threatened) biodiversity remains – and which can radically affect compliance with nature conservation law.[72]

Essentially, however, the lack of effectiveness of international law in halting and reversing the global biodiversity crisis appears to be the result of a persistent lack of political will.[73] The same appears to be true for national legislation. Around the globe, domestic biodiversity conservation laws have frequently been the focus of attempts – subtle or not so subtle – to weaken their impact, usually in the light of competing socio-economic ambitions. A 2017 study identified and documented 39 different tactics that have been employed by governmental stakeholders (no less) to diminish the effectiveness of conservation legislation.[74]

8. A TRANSFORMATIVE AGENDA: *LEX ANTHROPOCENAE*

The preceding sections critically considered the notion of biosphere integrity and the role and scope of (international) nature conservation law in protecting biodiversity, highlighting the considerable potential for its unfaithful interpretation and application, and identifying 'capture' of public (enforcement) authorities by special (business) interests as an important source of ineffectiveness of such laws.[75] Additional investment in science – and regulatory innovation, transparency, accountability and enforcement mechanisms – as well as in political capital is therefore a precondition for significant improvements in the performance of those legal regimes.

We now explore these themes prospectively and hence rather more speculatively, approaching the planetary boundary of biosphere integrity as a vector for connecting those investments with a paradigm consistent with the new age of the Anthropocene. Anthropogenic alterations of the chemical composition of the atmosphere led Nobel Prize-winning atmospheric chemist Paul Crutzen to coin the term 'Anthropocene', observing that 'humans are overwhelming the

(in press) Journal of Environmental Law; and Daniel WS Challender and Douglas C MacMillan, 'Investigating the Influence of Non-State Actors on Amendments to the CITES Appendices' (2019) 22(2) Journal of International Wildlife Law and Policy 90.

72 See, eg, Bowman, Davies and Redgwell (n 44); Chapron et al (n 41); Geoffrey Wandesforde-Smith, 'Looking for Law in All the Wrong Places: Dying Elephants, Evolving Treaties, and Empty Threats' (2016) 19 Journal of International Wildlife Law and Policy 365.

73 In the end, as acknowledged by Trouwborst et al (n 44) 784, 'international law cannot accomplish more than what the world's diverse and changeable national administrations, and ultimately the societies they represent, want it to'.

74 Chapron et al (n 41).

75 Capture occurs 'when agencies consistently adopt regulatory policies favored by regulated entities'. See Sidney Shapiro, 'The Complexity of Regulatory Capture: Diagnosis, Causality, and Remediation' (2012) 17 Roger Williams University Law Review, 221, 221. There is an extensive literature on regulatory capture of environmental policy. See eg Lindsay Dillon et al, 'The Environmental Protection Agency in the Early Trump Administration: Prelude to Regulatory Capture' (2018) American Journal of Public Health 108.

great forces of Nature'.[76] Similar human-induced changes of other parts of the biosphere have occurred since, boding catastrophe for humans as much as for other species.

Regardless of whether the Anthropocene formally becomes the new geological epoch, the critical self-reflection set in motion by the idea brings into sharp focus profound disconnections between environmental law's most unshakable presuppositions and the realities defining our present world. In that vein we posit that future environmental law at large and nature conservation law in particular, above all, must free itself from the stranglehold exercised by three fundamental beliefs that come in the shape of legally formalised but false nature/culture, local/global and public/private dichotomies.[77] A transformative process of systemic change is thus required towards *Lex Anthropocenae*,[78] involving 'radical and innovative legal approaches to proactively enable and govern human-dominated Earth-system transformations for sustainability'.[79]

Indeed, challenges to the nature/culture dichotomy, on which we focus in the remainder of this chapter, for environmental law imply a fundamentally revised normative footing, a significantly expanded scope and a reappraisal of the policy roles of technologies that have driven the collapse of the nature/culture divide. A no less intimidating challenge is for that reform process simultaneously to avoid risks of unproductive disruption of the crucial protective legal regimes currently in place. In the abstract, what hence needs to be accomplished is for the trilogy of duties to 'preserve, protect and restore' the environment to remain at the heart of nature conservation law, but without the nature/culture dichotomy unduly dictating its scope.[80] Presently, however, with the exception of some indigenous cultures,[81] and despite occasional signs of a conceptual narrowing of the nature/culture divide in more recent wildlife laws,[82] legal systems invariably create categorical divides between human culture and nature and, in doing so, structurally privilege humans.

Most strikingly, and unlike nature, humans enjoy legal personality and a legally protected right to life.[83] After Watson and Crick deciphered the structure of DNA as common building

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[76] Will Steffen, Paul J Crutzen and John R McNeill, 'The Anthropocene: Are Humans Now Overwhelming the Great Forces of Nature?' (2007) 36 Ambio 614.

[77] Han Somsen, 'The End of European Union Environmental Law: An Environmental Programme for the Anthropocene' in Louis J Kotzé (ed) *Environmental Law and Governance for the Anthropocene* (Hart 2017) 353; Johan Rockström, *Bounding the Planetary Future: Why We Need a Great Transition* (Great Transformation Initiative 2016) <https://greattransition.org/images/GTI_publications/Rockstrom-Bounding_the_Planetary_Future.pdf> accessed 25 June 2020; Will Steffen et al (n 8) 737.

[78] Louis J Kotzé and Duncan French, 'A Critique of the Global Pact for the Environment: A Stillborn Initiative or the Foundation for *Lex Anthropocenae*?' (2018) 18 International Environmental Agreements: Politics, Law and Economics 811.

[79] Kotzé and Kim (n 46).

[80] Expressed in art 191(1) Treaty on the Functioning of the European Union (TFEU), OJ [2016] C 202/47, as follows: 'Union policy on the environment shall contribute to pursuit of the following objectives: … preserving, protecting and improving the quality of the environment …'

[81] See eg Enrique Salamón, 'Kincentric Ecology: Indigenous Perceptions of the Human-Nature Relationship' (2000) 10 Ecological Applications, 1327.

[82] See Benjamin Cretois et al, 'What Form of Human-Wildlife Coexistence is Mandated by Legislation? A Comparative Analysis of International and National Instruments' (2019) 28(7) Biodiversity and Conservation 1729, who 'found that a shift from a human-nature dualism to an integration paradigm occurred in the legal frameworks during the last 20-30 years'.

[83] See, for example, art 2(1) of the European Convention on Human Rights (adopted on 4 November 1950, entered into 3 September 1953) 213 UNTS 221: 'Everyone's right to life shall be protected by law.

blocks for all life, the apparent absence of a biological basis for affording humans such exclusive privilege has fuelled challenges to this anthropocentric legal imaginary.[84] A fact that may illustrate the spuriousness of treating humans as divorced from nature is the 98 per cent of our DNA we share with chimpanzees, and the still respectable 35 per cent we have in common with daffodils.[85] Such facts might be thought to help dispel ideas about fundamental human uniqueness, but small genetic variations clearly matter a great deal, and genetics therefore ultimately is not helping the cause of emancipating nature.

On the contrary, gene technologies that have flourished since the discovery of DNA have reinforced the idea of human dominion, finding its ultimate expression in the award of exclusive property rights for biotechnological inventions, even if these involve biological material occurring in nature.[86] Unlike age-old practices of selective breeding that are constrained by species barriers, gene-editing technologies are uninhibited by such natural obstacles and therefore effectively are gateways to boundless cultural endeavours. These and other technological interventions in humankind's environment, including nanotechnology and synthetic biology, make increasingly unanswerable the question whether cells, species, habitats, or skies, rivers and oceans, are artefacts or products of nature. The global patentability of inventions involving biological material occurring in nature gives further credence to the claim that the project of nature's total cultivation is approaching completion.

That observation is an obvious source of profound angst and sorrow, and clearly must have ramifications for the foundations and nature of positive nature conservation law. Understandable calls for an ecocentric turn may miss the crucial point that such a rebalancing exercise in itself, while clearly called for, will not fundamentally address the falsehood of the dichotomy that precipitates the biodiversity crisis.[87] Rather than merely relinquishing some of its dominance over nature, humanity can no longer avoid facing up to the daunting reality that it bears full and final responsibility for a complex nature/culture singularity of which it is

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No one shall be deprived of his life intentionally save in the execution of a sentence of a court following his conviction of a crime for which this penalty is provided by law.'

84 See, eg, the Great Ape Project advocating for rights for non-human primates <www.projetogap.org.br/en/> accessed 25 June 2020.

85 Jonathan M Marks, *What It Means to Be 98% Chimpanzee: Apes, People, and Their Genes* (University of California Press 2003). On many stakeholders' reluctance to embrace these insights, Michael Bowman, 'Animals, Humans and the International Legal Order: Towards an Integrated Bioethical Perspective' in Werner Scholtz (ed) *Animal Welfare and International Environmental Law* (Edward Elgar 2019) 38, observes at 111: 'while we have no qualms about explaining the intrinsic value of other life-forms essentially in biological terms, we continue to exhibit a grave reluctance to treat human dignity in similar fashion. It is almost as though human dignity might somehow evaporate if we were to examine and analyse it more closely, and through the scientific lens that we conventionally employ to scrutinize the rest of the natural world.'

86 See, eg, art 3(2) of Directive 98/44/EC on the Legal Protection of Biotechnological Inventions, OJ L [1998] L 213/13: 'Biological material which is isolated from its natural environment or produced by means of a technical process may be the subject of an invention even if it previously occurred in nature.' Also art 4(2): 'Inventions which concern plants or animals shall be patentable if the technical feasibility of the invention is not confined to a particular plant or animal variety.' On property rights and their impact on nature see David Grinlinton and Prue Taylor (eds), *Property Rights and Sustainability* (Brill 2011).

87 Haydn Washington et al, 'Why Ecocentrism Is the Key Pathway to Sustainability' (2017) 1 The Ecological Citizen 35; Helen Kopnina et al, 'The "Future of Conservation" Debate: Defending Ecocentrism and the Nature Needs Half Movement' (2018) 217 Biological Conservation, 140.

a dominating but vulnerable part.[88] That responsibility implies a legal regime that conceives of humankind at the same time as part, guardian and (re)creator of biodiversity. The international community of states already acknowledged this complexity and responsibility to a significant extent when, in 1982, the UN General Assembly adopted the World Charter for Nature.[89] The Charter simultaneously acknowledges that, on the one hand, '[m]ankind is a part of nature and life depends on the uninterrupted functioning of natural systems', and, on the other, that '[m]an can alter nature and exhaust natural resources by his action or its consequences and, therefore, must fully recognize the urgency of maintaining the stability and quality of nature'.[90]

By way of response to the particular challenge just described, we suggest that, in relatively simple ways, law can play a leading role by granting nature legal personality so that it comes to enjoy rights on a par with humans and entities that enjoy legal personality (see Section 9 of the chapter). If the planetary boundary of biosphere integrity serves the articulation of these rights, a rebuttable presumption arises that *all* species and their habitats enjoy a degree of legal protection, *regardless of where they are located*, unless they pose threats to biosphere integrity. Nature rights informed by global planetary boundaries hence not only correct the conceptual nature/culture schism, but also contribute to challenging local/global and present/future generation divides that, in environmental law, translate into spatially and generationally restricted participation in environmental decision-making and access to justice.

As regards compliance, widely recognised as the Achilles' heel of nature conservation law (see Section 7 above), we argue that (new) technologies have crucially constructive roles to play, both now and increasingly in the future.[91] For instance, modern surveillance techniques can and should dramatically improve the rate of detection of breaches of the law. Mindful of the near certainty of the continued capture of enforcement agencies by special interest groups and assaults on future nature rights by elected representatives of majorities, we also explore the use of technologies to represent nature as right-holder. For the purpose of that discussion, it is useful to distinguish rights that are articulated in self-executing fashion and rights whose fulfilment requires discretionary (positive) intervention on the part of (public) authorities, as is the case, for example, with Article 8 of the CBD (see Section 10 below).

Finally, with the ultimate rationale of planetary boundaries anthropocentrically being the safeguarding of 'a safe operating space for humankind', we draw brief attention to the potentially important role of nature rights to regulate 'environmental enhancement'. Unlike duties to restore ('improve') the environment to a *status quo ante*, we distinguish enhancement initiatives as unprecedented engineered expressions of humankind's final responsibility for the planet's habitability for humans and other species. Nature rights in that context serve as countervailing forces, moderating human rights-based claims that incentivise or mandate recourse to, for example, climate engineering or gene-editing technologies (see Section 11 below).

Realising all too well that the totality of these issues and ideas amounts to a formidable agenda for reform, our suggestions are tentative, explorative and abstract, and are meant to assist in identifying the right questions to ask about the future shape of nature conservation law.

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88 Kim and Bosselmann (n 47).
89 World Charter for Nature (n 5).
90 Ibid Preamble.
91 See Ebbesson, Chapter 10 in this book.

9. PLANETARY BOUNDARIES: NATURE'S TRUMP CARD?

Half a century after Christopher Stone introduced the notion of Rights of Nature in 1972,[92] his idea is making a global comeback. In fact, increasingly, jurisdictions across the globe are affording legal personality to nature (predominantly to rivers).[93] The different ways in which this may be accomplished need not be discussed here; important for our purposes is merely our point of departure that the award of legal personality to nature may address the nature/culture divide, and that planetary boundaries have a key role to play in that endeavour.

First, preempting the accusations of 'empty rhetoric' notions that nature rights inevitably attract, it is useful to point out that nature conservation law may be in dire need of precisely this kind of formal legal symbolism.[94] Moreover, as the history of emancipation of minorities and women suggests, although granting nature rights in itself will not be sufficient to bridge the nature/culture divide, the grant of rights to nature appears a prerequisite for its emancipation. Just like the grant of male rights to emancipate their spouse is unlikely to deliver women from male dominance, human rights to a clean environment may not serve the emancipation of nature from human abuse. This does not amount to an argument against human rights to a clean environment of course, but it shows that there clearly is a role for nature rights notwithstanding the existence of a human right to a clean environment, and that human rights to a clean environment may even delay or complicate the realisation of nature's emancipation and protection.[95]

How theoretically to conceive and, in concrete legal terms, to express nature rights is a question occupying numerous scholars. Current understandings significantly draw upon innovative developments in jurisdictions such as Ecuador, Bolivia and New Zealand, where nature rights already are part of the legal system.[96] For the purpose of this chapter, however, it is neither desirable nor viable extensively to explore the many theoretical and practical challenges to which nature rights give rise; it suffices to discuss in general terms how the planetary boundary of biosphere integrity may service the idea of nature rights.[97]

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92 Christopher Stone, *Should Trees Have Standing?* (Oxford University Press 2010).

93 Lidia C Pecharroman, 'Rights of Rivers that Can Stand Up in Court' (2018) 7 Resources 1; Erin L O'Donnell and Julia Talbot-Jones, 'Creating Legal Rights for Rivers: Lessons from Australia, New Zealand, and India' (2018) 23 Ecology and Society 7; Guillaume Chapron, Yaffa Epstein and José Vicente López-Bao, 'A Rights Revolution for Nature' (2019) 363(6434) Science 1392.

94 See Carl Wellmann, *The Proliferation of Rights: Moral Progress or Empty Rhetoric* (Westview Press 1999), in particular ch 5. On constructive symbolic uses of regulation in the context of equal treatment see Bart MJ van Klink, *De Wet als Symbool: Over Wettelijke Communicatie en de Wet Gelijke Behandeling van Mannen en Vrouwen bij de Arbeid* (WEJ Tjeenk Willink 1998).

95 Marcus Düwell and Gerhard Bos, 'Human Rights and Future People – Possibilities of Argumentation' (2016) 15 Journal of Human Rights 231; Louis J Kotzé, 'The Anthropocene, Earth System Vulnerability and Socio-Ecological Injustice in an Age of Human Rights' (2019) 10 Journal of Human Rights and the Environment 62. See also Adelman, Chapter 4 in this book.

96 See Cameron La Follette and Chris Maser, *Sustainability and the Rights of Nature* (CRC Press 2017).

97 For a useful overview, see Stanford Encyclopedia of Philosophy, 'Rights' (The Stanford Encyclopedia of Philosophy, 2020) <https://plato.stanford.edu/entries/rights/#pagetopright> accessed 25 June 2020.

If nature rights essentially are articulations of planetary boundaries, hence critical thresholds of global application, nature rights primarily acquire the character of negative rights.[98] In terms of primary EU environmental law, that is, Article 191(1) TFEU, these rights correlate with public duties to 'preserve' the environment.[99] In those instances, the obligation of states is to refrain from violating the integrity of ecosystems, and nature rights establish immunity against such assaults.[100] We might alternatively say that nature rights are trump cards that, if played, execute a right for nature to be left alone.[101] The implications of these negative nature rights invite comparison with those attached to the status of species of flora and fauna that have been recognised as 'species of Community interest' under the Habitats Directive, particularly those species listed in Annex IV of the Directive.[102] Negative immunity rights of species engage with regard to anthropogenic threats to these species' 'favourable conservation status',[103] which is understood as follows:

> conservation status will be taken as "favourable" when: population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats, and the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future, and there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a longterm basis.[104]

Member states are required to effectively prohibit the killing, capturing, uprooting, and so on of animals and plants belonging to Annex IV species.[105] Unlike the obligation to maintain or restore a favourable conservation status for species (or populations), however, a host of social, economic and ecological interests may override this protective status of individual animals and plants:

> *Provided* that there is no satisfactory alternative and the derogation is not detrimental to the *maintenance of the populations of the species concerned at a favourable conservation status* in their natural range, Member States may derogate from the provisions of Articles 12, 13, 14 and 15 (a) and (b):
> (a) in the interest of protecting wild fauna and flora and conserving natural habitats;

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98 While the holder of negative rights is entitled to non-interference, positive rights entitle right-holders to provision of some good or service. Ibid.

99 TFEU, art 191(1). An exploration of legal personhood in EU environmental law is provided by Hendrik Schoukens, 'Granting Legal Personhood to Nature in the European Union: Contemplating a Legal (R)evolution to Avoid an Ecological Collapse?' (2018) 15 Journal for European Environmental & Planning Law 309.

100 Wesley N Hohfeld, 'Some Fundamental Legal Conceptions as Applied in Judicial Reasoning' (1913) 23 Yale Law Journal 16.

101 Ronald Dworkin, 'Rights as Trumps' in Jeremy Waldron (ed), *Theories of Rights* (Oxford University Press 1985) 153.

102 A profound difference, however, flows from the underlying rationale of global biosphere integrity that informs these rights, implying that nature rights do not arise by virtue of prior exercises of jurisdiction premised on territorial sovereignty (in this example the listing of species under the Habitats Directive), but because of what we might term *terraediction* vested in the planet having eco-territorial application.

103 According to ibid art 2(2), measures taken pursuant to the Habitats Directive 'shall be designed to maintain or restore, at favourable conservation status, natural habitats and species of wild fauna and flora of Community interest'.

104 Ibid art 1(i).

105 Ibid arts 12–13.

(b) to prevent serious damage, in particular to crops, livestock, forests, fisheries and water and other types of property;
(c) in the interests of public health and public safety, or for other imperative reasons of overriding public interest, including those of a social or economic nature and beneficial consequences of primary importance for the environment;
(d) …
(e) …[106]

It is clearly more appropriate under this constellation to conclude that protected species such as wolves, dolphins and bats enjoy a 'right' to a favourable conservation status than to maintain that individually they enjoy a 'right to life'. Not unlike human dignity, in fact, this favourable conservation status under the Habitats Directive is non-negotiable.[107] The EU aquatic environment similarly would enjoy a right to 'good ecological status'.[108] Other candidate foundations for nature rights include the 'intrinsic value' of biodiversity or flora and fauna, as recognised in various international legal instruments,[109] and the goal of 'ensuring that the population of each species is at least sufficient for its survival' which may tentatively be derived from international nature conservation law at large.[110]

The imperative of ecological integrity, as expressed in the biosphere integrity boundary and various other planetary boundaries, evidently bolsters the aforementioned notions, and appears to provide a solid core for nature's global immunity rights.[111]

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[106] Ibid art 16(1). Emphasis added.

[107] See Roger Brownsword, 'Human Dignity from a Legal Perspective' in Marcus Düwell et al (eds), *The Cambridge Handbook of Human Dignity: Interdisciplinary Perspectives* (Cambridge University Press 2014) 3: 'In other words, the principal purpose of the UDHR [Universal Declaration of Human Rights] was to put down a nonnegotiable marker against the denial of human dignity. From the Declaration onwards, governments should not be permitted to say to any human being, "you do not count, you have no value as an individual". This did not require a deep philosophical justification; and it was a cosmopolitan principle that applied to all humans in their dealings with governments. Quite simply, humans have a dignity – a dignity that governments should always respect.'

[108] Dir. 2000/60/EC Establishing a Framework for Community Action in the Feld of Water Policy, OJ [2000] L 327/1.

[109] The Preamble to the CBD (n 2) recognizes the 'intrinsic value of biological diversity'; the Preamble to the (Bern) Convention on the Conservation of European Wildlife and Natural Habitats (19 September 1979, entered into force 1 June 1982) ETS 104, recognizes that 'wild flora and fauna constitute a natural heritage of … intrinsic value'; art 3(1) of the Protocol to the Antarctic Treaty on Environmental Protection (adopted October 4 1991, entered into force 14 January 1998) 30 ILM 1461 (1991), requires that 'the intrinsic value of Antarctica' shall be a 'fundamental consideration' in the planning and conduct of human activities; and the Preamble to the World Charter for Nature (n 4) affirms that '[e]very form of life is unique, warranting respect regardless of its worth to man'. On the concept of intrinsic value (and its inherent limitations as an operational principle) see, *inter alia*, Mattia Fosci and Tom West, 'In Whose Interest? Instrumental and Intrinsic Value in Biodiversity Law' in Michael Bowman, Peter Davies and Edward Goodwin (eds), *Research Handbook on Biodiversity and Law* (Edward Elgar 2016) 55; and Michael Bowman (n 85).

[110] Bowman (n 85) 111.

[111] See also Kim and Bosselmann (n 47).

10. SELF-EXECUTING NATURE RIGHTS?[112]

The planetary boundary of biosphere integrity hence has the potential to serve the crucial role of substantively articulating nature's negative immunity rights, which are triggered when planned human activities exceed the tolerance thresholds it specifies. Yet, this still leaves us with the crucial matter of ensuring that nature actually *does* play its trump cards and invokes its immunity rights. Nature cannot stand up for itself (or, some would say, nature 'lacks agency'), and public authorities captured by electorates and business interests cannot be trusted to act as nature's faithful custodians.[113]

A technology-based, and increasingly viable, response to the quest to secure the faithful representation of nature, is to isolate human agency from the business of ensuring observance of nature's rights.[114] Technologies already are routinely deployed to design out the *possibility* of breaches of, for example, property and privacy rights. This happens each time we are unable to copy or edit pdf files, are barred from entering certain spaces without a smart card, or are cut off from a service when we default on credit card payments.[115] There is no *prima facie* reason why technologies should not also play that role in upholding wildlife law obligations. Nature rights in fact strengthen the moral justification for uses of technologies that constrain exercises of human agency, although, as will become clear, technology-driven compliance with nature's negative immunity rights is less problematic than securing positive restorative nature rights (for example, the reintroduction of species or restoration of habitats). The well-developed doctrine of direct effect of EU environmental law may illustrate the issues at stake.

As the Court of Justice has underscored all too frequently, the core of EU environmental law consists of obligations of result.[116] The essence of these obligations is that they leave Member States no discretion as to *what* needs to be realised, but at times provisions of EU environmental law also circumscribe precisely *how* those results are to come about. In those circumstances, provisions are 'directly effective', and national courts in cases of non-compliance can perform the obligation without fear of overstepping their judicial mandates. The clearest examples of such provisions are straightforward prohibitions, such as bans on toxic substances or genetically modified organisms (GMOs), prohibitions on altering protected habitats or on exceeding ambient air or aquatic limit values, and so forth. In general terms, the condition for direct effect is that provisions be clear, precise and unconditional, not leaving national authorities any discretion as to their implementation. Directly effective prohibitions are articulations of the general duty enshrined in Article 191(1) TFEU to 'preserve' the environment, and correlate with negative nature rights.

Gradually, however, the CJEU has extended the range of provisions of EU environmental law that can directly be relied upon by right-holders to certain discretionary positive obli-

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112 On the ambiguity of the terms 'self-executing' and 'direct' effect, see Alicia Hinarejos, 'On the Legal Effects of Framework Decisions and Decisions: Directly Applicable, Directly Effective, Self-executing, Supreme?' (2008) 14 European Law Journal 620.

113 Bruno Latour, 'Agency at the Time of the Anthropocene' (2014) 45 New Literary History 1.

114 For a fuller exploration of this theme, see Han Somsen, 'When Regulators Mean Business: Regulation in the Shadow of Environmental Armageddon' (2011) 40 Rechtsfilosofie & Rechtstheorie 47.

115 Ibid.

116 Han Somsen, 'Discretion in European Environmental Law: An Analysis of ECJ Case Law' (2003) 40 Common Market Law Review 1413.

gations to act, by isolating from these provisions the discretionary elements until only an unconditional and unambiguous 'directly effective' core remains.[117] Without it being necessary to explore that case law at length, the example of the numerous provisions contained in environmental directives requiring public authorities to draw up improvement programmes may suffice. Article 11 of the Water Framework Directive, for example, requires Member States to establish 'programmes of measures'.[118] Many, if not most, of the measures contained in the programmes involve prior exercises of significant degrees of discretion, ruling out any possibility for citizens directly to claim their performance. Yet, according to Article 11(3) of the Directive, some measures *shall* be taken as 'minimum requirements to be complied with'. Those measures, like the underlying obligation to establish programmes of measures in the first place, lend themselves to being invoked directly by EU citizens in cases of non-compliance.[119] Such obligations to act are expressions of the duty articulated in Article 191 TFEU to 'improve' (restore) the environment, and correlate with positive nature rights.

As an illustration of a more general line of thinking, this short excursion into EU law is fruitful if we imagine a future in which nature has acquired legal personality. The essence of direct effect, in the words of judge Mancini, is 'to take Community law out of the hands of politicians and bureaucrats and to give it to the people'.[120] There is no obvious reason, in such a future world in which nature is a right-holder, to assume that such 'directly effective' nature rights cannot similarly free nature from the shackles of politicians, bureaucrats, corporations and well-intentioned non-governmental organisations (NGOs).

Such a prospect is not unrealistic, because nature rights, premised as they are on the planetary boundary of biosphere integrity, lend themselves to be articulated in ways that are clear, precise and unconditional. That paves the way for securing compliance with those rights even in the face of public opposition, as if they were directly effective. As regards compliance with existing environmental standards ('rights'), technologies that extinguish the very option of non-compliance then come to perform the same function as courts that uphold directly effective provisions of environmental law, neutralising risks of sabotage by public and private actors. Examples that come to mind are 'pingers' that automatically scare away dolphins from fishing vessels to enforce protective regimes for cetaceans,[121] various panoptical surveillance regimes to monitor compliance with aquatic and ambient emission standards, emission-reducing applications of automated vehicles, and so forth.

For future environmental standards to remain consistent with the planetary boundary of biosphere integrity and its derived nature rights, we should next consider the potential role of

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[117] Pal Wennerås, *The Enforcement of EC Environmental Law* (Oxford University Press 2007). See *Aannemersbedrijf P.K. Kraaijeveld BV e.a. v Gedeputeerde Staten van Zuid-Holland* [1996] ECR I-5403, C-72/95, para 50; *Paul Abraham and Others v Région wallonne and Others* [2008] ECR I-1197, C-2/07, para 37; *Mellor* [2009] ECR I3799 C75/08, para 50; *Commission of the European Communities v Ireland* [2009] ECR I-6277, ECJ, C-427/07, para 41.

[118] Somsen (n 114).

[119] See Hinarejos (n 112).

[120] G Federico Mancini and David T Keeling, 'Democracy and the European Court of Justice' (1994) 57 Modern Law Review 175.

[121] Ruth H Leeney et al, 'Effects of Pingers on the Behaviour of Bottlenose Dolphins' (2007) 87 Journal of the Marine Biological Association of the United Kingdom 129.

automated algorithmic decision-making.[122] Algorithmic decision-making has become a reality in many fields of public decision-making, including taxation and environmental permitting.[123] Initially perhaps only for simple directly effective prohibitions, algorithmic decision-making substantially reduces risks of backsliding on binding commitments. Technologically, a relatively simple planetary boundary such as CO_2 would appear to lend itself well to automated permit procedures, for example, regarding the construction of coal-fired plants, air traffic movements, the number of livestock, fertiliser use per acreage, water consumption for industrial processes, and so forth.

In contrast to the fulfilment of negative nature rights, the discretion left to public authorities to decide the most appropriate way to fulfil obligations to 'improve' the environment implies that correlating positive nature rights at present are poor candidates for technology-driven compliance. For example, in pursuit of restoring good ecological quality of European rivers and the return of certain protected species of salmonids, public authorities have a choice to remove or reconstruct certain hydropower installations,[124] and to pursue rewilding initiatives through reintroduction of species, or in future even by means of de-extinction through cloning.[125] That being said, advances in data science, artificial intelligence and other new technologies undoubtedly will gradually bring compliance with more discretionary restorative obligations to act, and corresponding positive nature rights, within reach of automated decision-making and enforcement. At present, however, there is a real and underexplored potential for technologies and algorithmic decision-making to allow nature's trump cards to be played and immunity rights to be secured *as a matter of course*, in the same way as the right to life is routinely invoked by agents whose lives are threatened.

That vision goes against the grain of one of the defining features of environmental governance, that is, the centrality of deliberation.[126] In reality, however, as regards nature's negative immunity rights, what would be curtailed is deliberation about compliance, while what is fundamental – the immunity right itself (a legal expression of the planetary boundary of biosphere integrity) – will remain subject to public scrutiny and debate. Yet, proposals to revert to automated decision-making and enforcement are deeply controversial for another reason: it is the idea of ruling out intentional non-compliance that militates most violently against visions of moral communities that are 'founded on the indivisible, universal value[s] of *human digni-*

[122] Steven W Running, 'A Measurable Planetary Boundary for the Biosphere' (2012) 337 Science 1458.

[123] Johan Wolswinkel, *Willekeur of Algoritme? Laveren tussen Analoog en Digitaal Bestuursrecht* (Tilburg University 2020); Bruno Lepri et al, 'Fair, Transparent, and Accountable Algorithmic Decision-making Processes' (2018) 31 Philosophy & Technology 611.

[124] Somsen (n 116); see also Anna GC Lejon, Birgitta M Renöfält and Christer Nilsson, 'Conflicts Associated with Dam Removal in Sweden' (2009) 14(2) Ecology and Society 4.

[125] Alejandro E Camacho, 'Going the Way of the Dodo: De-Extinction, Dualisms, and Reframing Conservation' (2015) 92 Washington University Law Review, 849; Jamie Lorimer, 'Probiotic Legalities: De-Domestication and Rewilding Before the Law' in Irus Braverman (ed) *Animals, Biopolitics, Law: Lively Legalities* (Routledge 2016).

[126] Cameron Holly, Neil Gunningham and Clifford Sheering, *The New Environmental Governance* (Earthscan 2012); Walter F Baber and Robert V Bartlett, *Consensus and Global Environmental Governance* (Earthscan 2015); John S Dryzek and Jonathan Pickering, 'Deliberation as a Catalyst for Reflexive Environmental Governance' (2017) 131 Ecological Economics 353.

ty'.[127] Such communities derive the label 'moral' from agents' deliberate choice to do the right thing as much as from the right thing being done.[128] The examples alluded to earlier, of digital watermarks and engine interrupters used by commercial actors to secure private interests, imply that this objection should be insufficient to prevent technologies from being introduced to protect the public interest in securing respect for nature's right.

11. BEYOND RESTORATION: NATURE RIGHTS AND REGENESIS

One final *sui generis* phenomenon on the rise which warrants brief attention here is the deployment of technologies to recreate nature, anthropocentrically and exclusively perceived as humankind's infrastructure. The brilliant and controversial American scientist George Church, popularly associated with his quest to revive the woolly mammoth, captures that project with the term 'regenesis'.[129] Examples that come to mind are the use of gene-editing technologies to address the spread of alien invasive species, carbon dioxide removal and solar radiation management technologies to fight climate change, and the genetic modification of disease-spreading mosquitoes and other insects deemed harmful.

In the context of policies to protect biodiversity, we will term the deployment of environmental technologies 'regulatory' if their use is aimed at channelling human behaviour in support of those policies.[130] A simple example of a regulatory technology consists of barriers that impede car access to a wildlife reservation. Insofar as regulatory technologies target human behaviour, they clearly affect human rights (such as privacy rights, property rights, and so on) and vice versa. In contrast, environmental technologies are 'non-regulatory' when they do not target behavioural change, often even leaving humans entirely unaffected. The deployment of non-regulatory environmental technologies therefore does not normally encounter human rights constraints. An example of a non-regulatory technology would be the construction of roadside fencing in combination with a fauna overpass to ameliorate the impact of a road passing through a natural area.

Unlike, for example, rules restricting private car use to reduce CO_2 levels, a policy of atmospheric carbon dioxide removal is largely unproblematic from the perspective of the human rights to property, privacy, and so forth. Leaving aside potentially different risk levels, non-regulatory technological fixes generally encounter fewer legal obstacles than a regulatory response, and hence may be the more attractive option for policy-makers and citizens alike.

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[127] See Preamble of the Charter of Fundamental Rights of the European Union, OJ [2010] C 83/02 (authors' emphasis).

[128] Somsen (n 116).

[129] George Church, *Regenesis: How Synthetic Biology Will Reinvent Nature and Ourselves* (Basic Books 2012). Similarly on legal implications of environmental enhancement, Han Somsen, 'Towards a Law of the Mammoth?' (2016) 7(1) European Journal of Risk Regulation 109.

[130] Early but insightful thoughts on 'regulation' are found in Lawrence Lessig, 'The Constitution of Code: Limitations on Choice-based Critiques of Cyberspace Regulation' (1997) 5 CommLaw Conspectus 181.

Moreover, global minimum standards of patent law incentivise private actors to fully exploit the technological cultivation of the biosphere.[131] Hence, patentable genetic manipulation of insects for the sake of controlling the spread of disease or agricultural pests does not trigger any obvious human rights concerns, and neither is nature conservation law likely to protect the (presumably common) insect species involved. Regarding de-extinction, for example, the default position in the EU Habitats Directive would appear to be that this is allowed, unless the (patented) revived species pose a threat to a favourable conservation status of other species, or fall foul of definitions of invasive alien species. Likewise, increasing the reflectiveness of clouds or land surface in order to reflect more of the sun's heat back into space (patentable 'albedo enhancement') meets no other legally articulated constraint than the precautionary principle, and the technology's deployment thereby hinges on a normatively sterile risk/risk assessment.

The human right to a clean environment hardly constrains such environmental initiatives, and may potentially mandate them.[132] The 'respect, protect, fulfil' framework used for the conceptualisation and concretisation of economic, social and cultural rights textually corresponds with obligations such as those articulated in Article 191 TFEU to 'preserve, protect and improve' the environment.[133] The normative priority of human rights implies that the duty to 'improve' the environment interpretively amounts to a 'duty to fulfil' (and not the other way round), and environmental human rights could obligate environmental enhancement (climate engineering, gene editing, and so on) regardless of whether there is a historical ecological reference point compatible with enhancement outcomes.

Whether there should be limits to biosphere enhancement pursued in fulfilment of environmental human rights is accordingly a crucial and timely preliminary question to address. Absent nature rights, apart from the contingent precautionary principle and nature conservation law that fails to offer protection to a host of (invertebrate) species, there are therefore no general high-order normative principles constraining the wholesale technological cultivation of the biosphere. How nature rights will precisely affect the regulatory tilt that currently encourages enhancement of the biosphere, will ultimately depend on their conceptual and theoretical grounding as well as on their concrete legal articulation. In the abstract, however, nature's immunity rights carve out a currently non-existent no-go zone for enhancement interventions.[134] It is true that positive nature rights conceivably could give rise to discrete obligations for species to be reintroduced, revived or enhanced, and habitats to be (re)created. But if conceived in the way we have proposed, such policies will always be in support of the higher-order aim of securing biosphere integrity. These suggestions, in fact, do not deviate much from the classic maxim proposed by Aldo Leopold in 1949: 'A thing is right when it

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[131] Art 27 of the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS Agreement) articulates a global minimum standard as regards patentable subject matter, which encompasses various forms of biotechnology, nanotechnology and synthetic biology. It provides: 'Patents shall be available for any invention, whether products or processes, in all fields of technology provided they are new, involve an inventive step and are capable of industrial application.'

[132] Han Somsen, 'From Improvement towards Enhancement: A Regenesis of Environmental Law at the Dawn of the Anthropocene' in Roger Brownsword, Eloise Scotford and Karen Yeung (eds), *Oxford Handbook on the Law and Regulation of Technology* (Oxford University Press 2017) 379.

[133] Ibid.

[134] Kim and Bosselmann (n 47).

tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise.'[135]

12. CONCLUSION

Although both the genetic and functional diversity of life on Earth are difficult to quantify, existing indicators show that the core planetary boundary of biosphere integrity has been severely transgressed in both respects. Despite such uncertainty, our analysis does confirm that the biosphere integrity boundary has a legally meaningful role to play.

Regarding existing (inter)national wildlife legislation, this planetary boundary and its present state of transgression could have a potentially significant influence on the interpretation and scope of obligations currently in force. That said, it is unfortunately not to be expected that the law as it stands, whether global or domestic, is up to the urgent task of reversing the transgressions which it had until now been unable to prevent in the first place. This appears to be due to persistent flaws both in the legal framework's design and in its application.

Regarding the future development of (inter)national nature conservation law, the planetary boundary of biosphere integrity also acts as a catalyst and vector for the direction of long overdue fundamental change. The reforms needed, as highlighted by the prospects of the formalisation of the Anthropocene as the new geological epoch in which we live, are substantial.

We have argued that the planetary boundary of biosphere integrity provides purpose and direction for nature rights that can help bridge a conceptually and empirically false nature/culture divide. That divide, it is widely acknowledged, fatally undermines the effectiveness of existing environmental law, wildlife legislation included. We have therefore argued for ecological integrity to constitute the non-negotiable core of nature rights (analogous to EU practice with regard to the Habitats Directive), and for the human species to be a legally acknowledged part of nature (in line with the World Charter for Nature). We have further argued for technologies to play roles in representing nature, and in securing compliance with its rights.

Humans are the single most serious global threat to ecological integrity, and thereby, of course, also to themselves. We must either learn to manage ourselves as a species, which also implies asking difficult questions about our abundance and range, or accept the fatal inevitability that our safe operating space will increasingly rapidly continue to collapse.

The ramifications of these insights will for many be profoundly uncomfortable, but we believe they are necessary and right. Although law has important roles to play, the existential challenges we face clearly call for the different social and natural sciences to work in concert,[136] and for individual and collective courage and resolve to act on what thus emerges as the right thing to do.

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[135] Aldo Leopold, *A Sand County Almanac – With Essays on Conservation from Round River* (Oxford University Press 1966) 262.

[136] See also Collins, Chapter 5 in this book.

13. Climate change

Jonathan Verschuuren

1. INTRODUCTION

The planetary boundary on climate change is probably the boundary that has received the most legal recognition and attention of all. It is hard to imagine international climate change law *not* taking an Earth system perspective, as the climate system is a global system that is affected by the combined impact of anthropogenic greenhouse gas emissions across the globe. Since 1992, with the signing of the United Nations Framework Convention on Climate Change (UNFCCC),[1] the international community has been trying to establish a global legal mechanism with the aim of keeping climate change within Earth system limits, although a specific quantified boundary was only adopted in 2009. This experience of almost 30 years makes it possible to assess whether this planetary boundary has been explicitly recognised in international and domestic law, and if so, how exactly. We can also now assess what the impact of these attempts has been, if any.

This chapter does not discuss what the role of an Earth system or planetary boundaries approach potentially could or should entail. This is done elsewhere in this book, and the general conclusion seems to be that the planetary boundaries framework usefully offers a science-based argument in pursuit of a limits-based approach to environmental governance.[2] Furthermore, it stimulates the adoption of environmental policy objectives connected to the Earth system that should be respectful of its critical processes, while fostering a sense of urgency for those seeking ambitious reform.[3] Finally, there is a view that the global nature of the framework could enhance a sense of global responsibility for Earth system protection, while at once providing a foundation for enhanced international collaboration.[4]

In the light of these observations, this chapter attempts to discover whether, and if so *how*, an Earth system-based planetary boundaries approach is applied in climate change law. Section 2 will first analyse the climate change boundary: what it entails, and how we are doing in observing this boundary. This section will largely rely on scientific literature on planetary boundaries and on climate science literature, such as reports by the Intergovernmental Panel on Climate Change (IPCC). Section 3 will then focus on international law, and specifically on the following questions: how has the planetary boundary been recognised in international climate change law, from the UNFCCC to the Paris Agreement;[5] and how has the international community attempted to remain within this boundary? These questions will be answered by

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[1] United Nations Framework Convention on Climate Change (adopted in 9 May 1992, entered into force 21 March 1994) 1771 UNTS 107, 31 ILM 849.

[2] See Collins, Chapter 5 in this book.

[3] See Bleby, Holley and Milligan, Chapter 2 in this book.

[4] Ibid.

[5] Paris Agreement (adopted in 13 December 2015, entered into force 4 November 2016) Registration No. 54113, 55 ILM 740.

reviewing relevant legal texts. The same questions will be addressed in Section 4, but with a focus on the domestic level. As the aim of this section is primarily to show how a planetary boundaries approach can be adopted at the domestic level in more general terms, it does not embark on a comprehensive survey among a wide range of countries. The relatively narrow focus of this chapter also limits the number of laws and cases to be assessed. Therefore, the chapter only reviews a few advanced domestic climate change laws – namely, those of the United Kingdom (UK), France and Germany – and arguably the most prolific climate change litigation case to date: *Urgenda v The Netherlands*.[6] Section 5 concludes the discussion.

2. WHAT DOES THE PLANETARY BOUNDARY ON CLIMATE CHANGE ENTAIL?

The IPCC's Special Report 'Global Warming of 1.5° C' (SR15) explains why human-induced climate change is an important factor to consider in assessments determining if Earth has possibly entered a new geological epoch labelled the Anthropocene:

> Although rates of change in the Anthropocene are necessarily assessed over much shorter periods than those used to calculate long-term baseline rates of change, and therefore present challenges for direct comparison, they are nevertheless striking. The rise in global CO_2 concentration since 2000 is about 20 ppm per decade, which is up to 10 times faster than any sustained rise in CO_2 during the past 800,000 years […] AR5 [Fifth Assessment Report] found that the last geological epoch with similar atmospheric CO_2 concentration was the Pliocene, 3.3 to 3.0 Ma […] Since 1970 the global average temperature has been rising at a rate of 1.7°C per century, compared to a long-term decline over the past 7,000 years at a baseline rate of 0.01°C per century […] These global-level rates of human-driven change far exceed the rates of change driven by geophysical or biosphere forces that have altered the Earth System trajectory in the past […]; even abrupt geophysical events do not approach current rates of human-driven change.[7]

In their 2015 *Science* article on the nine planetary boundaries, Steffen and colleagues defined a dual climate change boundary: an atmospheric CO_2 concentration between 350 and 450 parts per million (ppm), and an increase in top-of-atmosphere radiative forcing of between +1.0 and +1.5 watt per square metre on the Earth's surface (W m^2) relative to preindustrial levels (with a zone of uncertainty).[8] The CO_2 concentration boundary was chosen because carbon dioxide

[6] Due to space constraints and in order not to over-complicate the chapter, it was decided to not include an assessment of European Union (EU) climate change law. The European Commission Proposal for a Regulation of the European Parliament and of the Council establishing the framework for achieving climate neutrality and amending Regulation does mention 'planetary boundaries' once, in one of the considerations preceding the legal text, but it does so in passing only, while also referring to several other concepts. Furthermore, this proposal does not bring drastic changes to the EU's existing climate change laws, except that the European Commission tries to claim more regulatory powers.

[7] Myles Allen et al, 'Framing and Context' in Valérie Masson-Delmotte et al (eds), *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty* (IPCC 2018) 49, 54.

[8] Will Steffen et al, 'Planetary Boundaries: Guiding Human Development on a Changing Planet' (2015) 347 Science 1259855, 1259855-4. This boundary remained largely unchanged compared to the 2009 article: Johan Rockström et al, 'A Safe Operating Space for Humanity' (2009) 461 Nature 472–75,

has a very long lifetime in the atmosphere (up to 200 years) and is emitted in very large quantities. According to the IPCC's Fifth Assessment Report (AR5), in 2011 the concentration of CO_2 in the atmosphere was 391 ppm, exceeding the preindustrial level by about 40 per cent.[9] In October 2019, the level was 408.53 ppm.[10] The total radiative forcing for 2011 relative to 1750 is +2.29 W m^2, again according to the AR5.[11] It can therefore be concluded that the CO_2 concentration boundary is in the uncertainty zone and is rapidly approaching the outer limit of 450 ppm, whereas the radiative forcing boundary has already been transgressed.

The latter is particularly worrying, as this seems to be a variable that is more difficult to control than atmospheric CO_2 concentration, which is largely determined by the burning of fossil fuels. The radiative forcing boundary is much broader because it also takes into account other greenhouse gases, such as methane (CH_4) and nitrous oxide (N_2O), both of which have stronger climate forcers, but with a shorter lifetime than CO_2. The radiative forcing variable also takes into account the impact of aerosols on the climate and other so-called Earth system feedbacks. Aerosols, such as those associated with the burning of fossil fuels, have a cooling effect, which disappears when we stop burning fossil fuels, thus leading to a temperature increase. Other factors that affect Earth's energy balance include, for instance, the release of greenhouse gases through permafrost thawing, increasing forest fires and increased ozone exposure.[12] The combined impact of these various factors (which also all influence one another) is difficult to assess as there are many uncertainties associated with Earth system feedbacks. Further uncertainties are caused by uncertain additional agricultural and land use change emissions through increased greenhouse gas-intensive food demand in the coming decades, and by uncertain positive impacts through increased carbon dioxide removal that might be achieved through large-scale afforestation, for example.[13] Despite these uncertainties, the IPCC concluded that the changing emissions of non-CO_2 forcers (particularly the reduction in cooling aerosol precursors) cause additional near-term warming and reduce the remaining carbon budget compared to the CO_2-only budget.[14]

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473. Only the zone of uncertainty with regard to the CO_2 concentration boundary was reduced from between 350 and 550 to between 350 and 450 ppm.

[9] IPCC, 'Summary for Policymakers' in Thomas F Stocker et al (eds), *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (IPCC 2013) 3, 11.

[10] According to data from the Mauna Loa Observatory, Hawaii (NOAA) 'Earth's CO2 Home Page' (ProOxygen, 2007-2020) <www.co2.earth/> accessed 19 November 2019.

[11] IPCC (n 9) 13.

[12] Joeri Rogelj et al, 'Mitigation Pathways Compatible with 1.5°C in the Context of Sustainable Development' in Masson-Delmotte et al (n 7) 93, 104. See also Du Toit, Chapter 14 in this book.

[13] Ibid.

[14] Ibid at 106.

3. RECOGNITION OF THE PLANETARY BOUNDARY ON CLIMATE CHANGE IN INTERNATIONAL LAW

3.1 The Birth of International Climate Change Law: A Long Pregnancy

Although climate change has been discussed by some as an environmental problem from as early as the late nineteenth century, and increasingly since the late 1950s,[15] early international environmental law did not focus on climate change. The 1972 Stockholm Declaration does not mention climate change, although, remarkably, the preamble does already invoke 'Anthropocene language'. It states, for example, that 'in the […] evolution of the human race on this planet a stage has been reached when, through the rapid acceleration of science and technology, man has acquired the power to transform his environment in countless ways and on an unprecedented scale'.[16] In 1979, a panel of experts convened by the United States National Academy of Sciences, concluded that a doubling of the global CO_2 level compared to preindustrial levels would probably lead to warming of about 3°C (plus or minus 50 per cent) in the twenty-first century.[17] In 1985, climate experts from 29 countries called upon the international community to draft an international agreement to limit greenhouse gas emissions, in a meeting that was sponsored by the United Nations Environment Programme (UNEP) and the World Meteorological Organisation (WMO).[18] Three years later, both international organisations managed to solicit sufficient support for the endorsement of the creation of the IPCC by the United Nations General Assembly (UNGA).[19] In this Resolution, the UNGA not only endorses the creation of the IPCC, but also 'recognizes that climate change is a common concern of mankind, since climate is an essential condition which sustains life on earth', and 'determines that necessary and timely action should be taken to deal with climate change within a global framework'.[20] Furthermore, the UNGA urges 'governments, intergovernmental and non-governmental organizations […] to treat climate change as a priority issue.'[21] The global climate law framework was created four years later, with the adoption of the UNFCCC at the UN Conference on Environment and Development in Rio de Janeiro in 1992.[22] Finally, international climate change law was born, with near-universal coverage of 198 States.[23]

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15 For an informative account of the history of climate science, see Spencer R Weart, *The Discovery of Global Warming. Revised and Expanded Edition* (2nd edn, Harvard University Press 2008).

16 Declaration of the United Nations Conference on the Human Environment (16 June 1972) UN Doc.A/CONF.48/14, para 1.

17 Weart (n 15) 100.

18 Declaration of the United Nations Conference on the Human Environment (16 June 1972) UN Doc.A/CONF.48/14.

19 UNGA Resolution 43/53 'Protection of Global Climate for Present and Future Generations of Mankind' (6 December 1988) A/RES/43/53.

20 Ibid at paras 1–2.

21 Ibid at para 6.

22 See n 1.

23 As per 2018, see the UNFCCC 'List of Parties' (UNFCCC 2020) <https://unfccc.int/process/parties-non-party-stakeholders/parties-convention-and-observer-states> accessed 3 December 2019.

3.2 First Phase: A Framework Without a Quantified Planetary Boundary

In its very first preambular paragraph, the UNFCCC starts by indicating its planetary scope in acknowledging 'that change in the Earth's climate and its adverse effects are a common concern of humankind'. The preamble also acknowledges 'that the global nature of climate change calls for the widest possible cooperation by all countries and their participation in an effective and appropriate international response, in accordance with their common but differentiated responsibilities and respective capabilities and their social and economic conditions'. The UNFCCC neither provides any specific quantified target, such as those offered by the climate change boundary discussed above, nor does it prescribe a certain limit to the rise of the global average temperature. Instead, it aims at 'stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system', and adds that 'such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner'.[24]

Because it was still unclear at the time of signing what this aim actually means, the WMO requested the IPCC shortly after the Rio Conference to determine what concentrations of greenhouse gases might be regarded as 'dangerous anthropogenic interference with the climate system', and to chart a future pathway which allows for economic development which is sustainable.[25] In its 1995 report, the IPCC addressed this question, but did not come up with a clear target. It sketched several scenarios, one of which was the mid-range emissions scenario, which would lead to a rise of 2º Celsius above preindustrial levels. It was the Council of the European Union that decided in 1996 that global average temperatures should not exceed 2º Celsius above preindustrial levels and that concentration levels lower than 550 ppm CO_2 should guide global limitation and reduction efforts.[26] In its decision, the Council referred to the IPCC's report, without indicating how and why this aim was chosen. This decision did not gain wide international support, but did seem to prepare policy-makers for the adoption of an overall climate change target.[27] It was not before the 2009 Copenhagen Conference of the Parties (COP) that this target was adopted under the UNFCCC, and it took until the 2015 Paris Agreement for it to make its way into a legally binding treaty text (see further below).

As its name indicates, the UNFCCC established a framework for international collaboration in the fight against climate change. Institutions, such as the COP, the Secretariat, the Subsidiary Body for Scientific and Technological Advice (SBSTA) and the Subsidiary Body for Implementation (SBI) were created,[28] and basic rules on reporting were adopted,[29] as was

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24 Art 2 UNFCCC.

25 IPCC, 'Second Assessment Synthesis of Scientific-Technical Information Relevant to Interpreting Article 2 of the UN Framework Convention on Climate Change' in IPCC, *Second Assessment Climate Change 1995* (Rome 1995) 3.

26 European Commission, '1939th Council Meeting – Environment, Brussels, 25–26 June 1996' (PRES/96/188, 26 June 1996) Community Strategy on Climate Change, para 6, available at <https://ec.europa.eu/commission/presscorner/detail/en/PRES_96_188> accessed 3 December 2019.

27 See extensively Yun Gaoa, Xiang Gaob and Xiaohua Zhang, 'The 2°C Global Temperature Target and the Evolution of the Long-Term Goal of Addressing Climate Change – From the United Nations Framework Convention on Climate Change to the Paris Agreement' (2017) 3 Engineering 272–78.

28 Arts 7–10 UNFCCC.

29 Ibid art 12.

the option to conclude protocols under the UNFCCC.[30] Emission reduction targets have not been included, but the UNFCCC already has a fairly long list of legally binding obligations for various categories of parties. The provisions of the UNFCCC distinguish between 'all parties', 'Annex I country parties' and 'Annex II country parties'.

All parties are to: keep a national inventory of greenhouse gas emissions and sinks; implement a mitigation policy; stimulate clean technologies and practices; sustainably manage sinks (forests, oceans); integrate climate considerations into social, economic and environmental decision-making; and stimulate research, education, public awareness and broad participation.[31] The UNFCCC also lists adaptation measures to be taken by all parties, such as establishing an adaptation policy; cooperating on adaptation measures in the field of agriculture and water management (including coastal zones), especially in Africa; and integrating adaptation measures into social, economic and environmental policies.[32]

There are 43 Annex I parties: all European countries, including those in central and eastern Europe, which were in the process of converting from a communist to a market-based economy at the time of drafting the UNFCCC; the US; Canada; Australia; New Zealand; Japan; and the EU as a multilateral organisation. These States have to implement a national policy to *reduce* greenhouse gas emissions (note the different terminology compared to the provision aimed at all parties) and report emission data and measures to the COP.[33] Annex II parties are the same group, minus the central and eastern European countries that are recognised as being so-called economies in transition. These rich countries bear additional obligations aimed at the transfer of finance, technology and know-how to developing countries, aimed both at mitigation and adaptation.[34]

3.3 Second Phase: Emission Limits for Developed Countries Only

The first (and last) Protocol under the UNFCCC was adopted five years after the signing of the UNFCCC.[35] The 1997 Kyoto Protocol was a major step forward in two respects. First, it lays down legally binding emission reduction targets for all Annex I States. These reductions were differentiated based, among other things, upon historic emissions and on average were 5 per cent lower than the 1990 level, and to be achieved by 2012 at the latest.[36] The EU as a whole had a reduction target of 8 per cent, which was further differentiated among the EU member states through EU legal instruments.[37] Second, the Kyoto Protocol proposed the use of a range of flexible legal instruments,[38] some of which were aimed at using the global market

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30 Ibid art 17.
31 Ibid art 4(1).
32 Ibid.
33 Ibid art 4(2).
34 Ibid arts 4(3)–4(5).
35 Kyoto Protocol to the United Nations Framework Convention on Climate Change (adopted on 11 December 1997, entered into force 16 February 2005) 2303 UNTS 162, 37 ILM 22.
36 Ibid art 3(1).
37 Florian Stangl, 'EU Climate Policy' in Edwin Woerdman, Martha Roggenkamp and Marijn Holwerda (eds), *Essential EU Climate Law* (Edward Elgar 2015) 10, 22–23.
38 Javier de Cendra de Larragán, 'The Kyoto Protocol with a Special Focus on the Flexible Mechanism' in Daniel A Farber and Marjan Peeters (eds), *Climate Change Law* (Edward Elgar 2016) 227–38.

mechanism, such as the Emissions Trading System,[39] Joint Implementation[40] and the Clean Development Mechanism.[41]

Despite its potential for regulatory innovation, the Kyoto Protocol was a troublesome instrument because it took almost eight years to enter into force, it did not address the rapidly increasing emissions of emerging economies such as China, and the international community failed to negotiate a successor that would enter into force in 2012, when the Kyoto Protocol was to come to an end.[42] The instrument, however, cannot only be assessed negatively. The Kyoto Protocol led to the development of novel legal instruments such as the market-based instruments mentioned above, and the Adaptation Fund.[43] Moreover, an international enforcement mechanism with the power to impose (punitive) sanctions was adopted – a unique feature in international environmental law, to be sure. [44] All Annex I countries achieved the targets set by the Kyoto Protocol – even the US, which did not ratify it, and Canada, which withdrew its ratification in 2012.[45]

3.4 Third Phase: A Quantified Planetary Boundary

Although the 2009 Copenhagen COP is generally seen as a disappointment because of the failure to draft a successor to the Kyoto Protocol, the conference did adopt the global target of keeping the increase in global temperature below 2°C degrees Celsius, referring to the IPCC's AR4.[46] Following several unsuccessful COPs, it was only in 2015 when a legally binding treaty text was adopted that paved the way for future global climate change policies.[47] The Paris Agreement requires the contracting States to hold the increase in the global average temperature to well below 2°C above preindustrial levels, and to pursue efforts to limit temperature increase to 1.5°C above preindustrial levels.[48] Although the Paris Agreement does not refer to the concept of planetary boundaries, or even to the planet as such, the preamble

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[39] Art 17 Kyoto Protocol.

[40] Ibid art 6.

[41] Ibid art 12.

[42] David Freestone, 'The United Nations Framework Convention on Climate Change – The Basis for the Climate Change Regime' in Cinnamon P Carlarne, Kevin R Gray and Richard G Tarasofsky (eds), *The Oxford Handbook of International Climate Change Law* (Oxford University Press 2016) 98, at 105, 109–10.

[43] Alexander Thompson, 'The Global Regime for Climate Finance. Political and Legal Challenges' in Carlarne, Gray and Tarasofsky (n 42) 137–60.

[44] Francesca Romanin Jacur, 'The Kyoto Protocol's Compliance Mechanism' in Farber and Peeters (n 38) 239–50; Sebastian Oberthür, 'Compliance under the Evolving Climate Change Regime' in Carlarne, Gray and Tarasofsky (n 42) 120–36.

[45] Igor Shishlov, Romain Morel and Valentin Bellassen, 'Compliance of the Parties to the Kyoto Protocol in the First Commitment Period' (2016) 16(6) Climate Policy 768–82.

[46] Report of the Conference of the Parties on its fifteenth session (Copenhagen, 7–19 December 2009) FCCC/CP/2009/11/Add.1 (30 March 2010) para 2. Strictly speaking it was not until the 2010 Cancun COP that this aim had been legally adopted under the UNFCCC as the Copenhagen Accord was not formally recognised by all parties: see Gaoa, Gaob and Zhang (n 27) 276.

[47] Judith Blau, 'The Long, Long Road to Paris' in J Blau (ed), *The Paris Agreement* (Palgrave Macmillan 2017) 23.

[48] Art 2(1)(a) Paris Agreement (n 5). See further Halldór Thorgeirsson, 'Objective (Article 2.1)' in Daniel Klein et al (eds), *The Paris Agreement on Climate Change: Analysis and Commentary* (Oxford University Press 2017) 123.

does mention the 'importance of ensuring the integrity of all ecosystems, including oceans, and the protection of biodiversity, recognized by some cultures as Mother Earth'.[49] The Paris Agreement thus seems to acknowledge, to a limited extent at least, the need to view the international community's approach to climate change as part of a larger obligation on humanity to respect the rights of the planet as a whole. This remains the only implicit recognition in the body of binding international environmental law, of the rights of nature. Rights of nature had already been advocated by civil society organisations in 2010 during the 'World People's Conference on Climate Change and the Rights of Mother Earth', with the adoption by those present at the conference of the Universal Declaration of Rights of Mother Earth.[50] In several countries around the world, both legislatures and courts have accepted legal personhood both of the planet as a whole, and of natural objects such as rivers.[51] This development is generally seen as a necessary and desired impulse for, and even consequence of, adopting laws aimed at protecting the Earth system.[52]

The more global approach of the Paris Agreement is not only reflected in the fact that it has a global, planetary, target. Unlike the Kyoto Protocol, it also requires a truly global effort by all countries. All States have to submit their own nationally determined contributions (NDCs) so as to collectively achieve the global target, and States are 'to reach global peaking of greenhouse gas emissions as soon as possible' and 'to undertake rapid reductions thereafter in accordance with best available science, so as to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century'.[53] The Paris Agreement therefore more clearly reflects the need to address climate change collectively, with the aim of staying within the safe operating space of the climate change planetary boundary. Whether this new bottom-up approach towards a global aim will be successful remains to be seen.

In 2023, the first 'global stock take' will determine whether we are on track towards achieving the goal.[54] What exactly will happen if this is not achieved (and current emissions pathways suggest this will in fact be the case) is unclear. The Paris Agreement only states that the stock take's outcome 'shall inform' Parties in updating and enhancing their actions.[55] It will be interesting to see whether all parties to the agreement will continue to bind themselves

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[49] Preamble para 13 Paris Agreement.

[50] Cochabamba, Bolivia 22 April 2010 in Global Alliance for the Rights of Nature, 'Universal Declaration of Rights of Mother Earth' (Global Alliance for the Rights of Nature, 2019) <http://therightsofnature.org/universal-declaration/> accessed 28 December 2019.

[51] For a recent overview, see, among many others, Tineke Lambooy, Jan van de Venis and Christiaan Stokkermans, 'A Case for Granting Legal Personality to the Dutch Part of the Wadden Sea' (2019) 44(6–7) Water International 786, 793–96. For specific examples, see (among many others), Louis J Kotzé and Paola Villavicencio Calzadilla, 'Somewhere between Rhetoric and Reality: Environmental Constitutionalism and the Rights of Nature in Ecuador' (2017) 6 Transnational Environmental Law 401–33; Palesh Srivastav, 'Legal Personality of Ganga and Ecocentrism: A Critical Review' (2019) 4 Cambridge Law Review 151–68.

[52] Louis J Kotzé and Rakhyun E Kim, 'Earth System Law: The Juridical Dimensions of Earth System Governance' (2009) 1 Earth System Governance 100003 at 8. See also Somsen and Trouwborst, Chapter 12 in this book.

[53] Art 4(2) Paris Agreement.

[54] Ibid art 14(2).

[55] Ibid art 14(3). See further Jürgen Friedrich, 'Global Stocktake (Article 14)' in Klein et al (n 48) 319–37.

collectively to concerted follow-up actions. Such enhanced international collaboration would fit very well within a planetary boundaries approach, while it would also go some way in indicating that the planetary boundaries approach might be gaining some normative power.

4. RECOGNITION OF THE CLIMATE CHANGE BOUNDARY IN DOMESTIC LAW

4.1 Introduction

The introduction to this chapter indicated that it is difficult not to imagine international climate change law addressing the planetary climate change boundary as part of an Earth system approach. This might be a bit more difficult when looking at domestic laws and domestic litigation, because these operate within the constraints of domestic legal systems and are aimed at regulating the behaviour of citizens, businesses and authorities of countries, and the actions taking place within the jurisdiction of specific countries. This section investigates whether we are able to observe any domestic dimensions of the climate change planetary boundary that also take an Earth system approach.

4.2 Examples of Domestic Climate Laws in Europe

One of the first national climate laws was the UK Climate Change Act 2008, which set a goal for 2050 to reduce emissions by 80 per cent compared to the 1990 level.[56] In 2019, this target was raised to 100 per cent.[57] Intermediate goals have been set as well, such as the requirement to have emissions reduced by 34 per cent by 2020.[58] The independent Committee on Climate Change, instituted on the basis of the Climate Change Act 2008,[59] monitors progress towards these goals and found that already in 2018, the UK achieved a 44 per cent emissions reduction compared to the 1990 level.[60] The Committee also has powers to adjust the interim and 2050 targets, in order to ensure that climate change policy-making maintains a long-term perspective. The Committee sees it as its tasks to 'provide independent advice on setting and meeting carbon budgets and preparing for climate change, monitor progress in reducing emissions and achieving carbon budgets and targets, conduct independent analysis into climate change science, economics and policy, and engage with a wide range of organisations and individu-

[56] Section 1(1) Climate Change Act [2008] Chapter 27.
[57] The Climate Change Act 2008 (2050 Target Amendment) Order 2019, Statutory Instruments 2019-1056.
[58] Section 5(1)(a) Climate Change Act 2008.
[59] Ibid section 32.
[60] Ibid section 36. See for progress until 2018 from the Department for Business, Energy, & Industrial Strategy '2018 UK Provisional Greenhouse Gas Emissions' <https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/790086/2018-provisional-emissions-statistics-one-page-summary.pdf> accessed 29 December 2019.

als to share evidence and analysis'.[61] It is made up of experts in the fields of climate change science, economics, behavioural science and business.[62]

France adopted a new energy and climate law in 2019, which actually brought changes to existing environmental and energy laws.[63] The new legislation codifies the aims of a 40 per cent reduction by 2030, compared to 1990, and of becoming climate neutral by 2050 (an explicit reference to the Paris Agreement).[64] 'Carbon neutral' is defined as a balance between emissions and absorptions of greenhouse gases on French territory without taking international carbon credits into account. As is the case in the UK, the French law has rules on the setting of intermediate policies for prescribed time frames aimed at keeping the country on track to achieving the 2050 goal. Like the UK, France also has an independent high council for climate (*Haut Conseil pour le climat*), with similar tasks.[65] It consists of independent climate experts in the fields of climate science, energy transition, economics and agronomics.

Germany adopted the Federal Climate Change Act in 2019.[66] The *Bundes-Klimaschutzgesetz* (KSG) explicitly refers to the Paris Agreement target of keeping the global average temperature rise between 1.5 and 2 degrees,[67] and greenhouse gas emissions reduction targets of 55 per cent by 2030 and 100 per cent by 2050.[68] Germany also has an independent committee of experts, the *Expertenrat für Klimafragen*, which plays an important role in the implementation and monitoring of the KSG.[69] The KSG requires all public officials in the country, at all levels of government, to take the federal climate change goals into account in all of their decisions.[70]

When looking at these three countries, it is clear that their 2050 goal follows the Paris Agreement targets, including the target of carbon neutrality in 'the second half of this century' (note that the Paris Agreement text remains vague as to the exact year in which this objective has to be met). We can conclude therefore, that these domestic laws, despite not explicitly referring to the Earth system or planetary boundaries per se, are geared towards remaining within the planetary boundary on climate change. What is also striking is that all three countries have instituted a non-political expert committee that plays an important role in monitoring progress towards achieving the long-term climate goals. This seems an important prerequisite for avoiding short-term political interference that is often seen to impede the achievement of the longer term goals. Such an expert-driven approach might possibly also resonate very well with a science-based approach that is pursued by the planetary boundaries, translating, as this might do, objectively determined scientific determinations into laws, policies and governance initiatives aimed at addressing the climate change boundary.[71]

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61 Committee on Climate Change, 'About the Committee on Climate Change' <www.theccc.org.uk/about/> accessed 29 December 2019.

62 Ibid.

63 Loi n° 2019-1147 du (8 November 2019) relative à l'énergie et au climat, JORF n°0261 du (9 November 2019) texte n° 1, NOR: TREX1911204L.

64 Art 1(V), amending art L100-4 of the Energy Act (*Code de l'énergie*).

65 Décret n° 2019-439 du (14 May 2019) relatif au Haut Conseil pour le climat, JORF n°0112 du (15 May 2019)texte n° 1, NOR: TRER1911732D.

66 Gesetz zur Einführung eines Bundes-Klimaschutzgesetzes und zur Änderung weiterer Vorschriften vom 12. Dezember 2019, Bundesgesetzblatt I, No. 48 (17 December 2019).

67 Ibid, section 1.

68 Ibid, sections 3(1) and 1 respectively.

69 Ibid, sections 11 and 12.

70 Ibid, section 13.

71 See also Collins, Chapter 5; Kim and Kotzé, Chapter 3, in this book.

4.3 Climate Change Litigation

Domestic climate change law is also influenced by domestic climate change litigation. It is therefore interesting to determine whether an Earth system approach has been adopted by some courts in the context of climate change litigation. A key question that arises in this respect is: do courts refer to the planetary boundary of climate change and, if so, how does that impact their judgment? To date, more than one thousand climate change cases have been filed across the world, the vast majority in the US.[72] Cases are either against the government or against large carbon-emitting companies.

4.3.1 Cases against governments

When looking at the first category of cases, namely those against governments, it seems at first glance that it might be difficult for courts to follow an Earth system perspective. After all, specific individual victims of climate change damage sue specific government bodies of a certain country in a domestic court, challenging a specific action or inaction by the authorities. The famous Dutch *Urgenda* case against the State of the Netherlands,[73] however, shows that even under these decidedly localised (or non-planetary, as it were) circumstances, it is not impossible for a court to take planetary boundaries into account. The climate change non-governmental organization (NGO) Urgenda requested the District Court of The Hague to rule that:

(1) the substantial greenhouse gas emissions in the atmosphere worldwide are warming up the earth, which according to the best scientific insights, will cause dangerous climate change if those emissions are not significantly and swiftly reduced;
(2) the hazardous climate change that is caused by a warming up of the earth of 2°C or more, in any case of about 4°C, compared to the preindustrial age, which according to the best scientific insights is anticipated with the current emission trends, is threatening large groups of people and human rights;
(3) of all countries which emit a significant number of greenhouse gases in the atmosphere, per capita emissions in the Netherlands are one of the highest in the world;
(4) the joint volume of the current annual greenhouse gas emissions in the Netherlands is unlawful …[74]

The State argued that the contribution of the Netherlands to global emissions is less than 0.5 per cent.[75] Hence, the increase in the ambitions of the Dutch climate change policy as proposed by Urgenda would only lead to a further reduction of between 0.04 and 0.09 per cent of global emissions. This, according to the State,

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[72] Geetanjali Ganguly, Joana Setzer and Veerle Heyvaert, 'If At First You Don't Succeed: Suing Corporations for Climate Change' (2018) 38(4) Oxford Journal of Legal Studies 841, 843. See also the database of climate change cases kept by Columbia University: 'Climate Change Litigation Databases' (Sabin Center for Climate Change Law, 2020) <http://climatecasechart.com> accessed 8 June 2020.

[73] *Urgenda Foundation v The State of The Netherlands* [2015] ECLI (RBDHA) 7196, available online in unofficial English translation through <https://uitspraken.rechtspraak.nl/inziendocument?id=ECLI:NL:RBDHA:2015:7196> accessed 10 March 2020.

[74] Ibid at para 3.1.

[75] See for example the Global Carbon Atlas 'CO_2 Emissions' (GCP 2019) <www.globalcarbonatlas.org/en/CO2-emissions> accessed 18 December 2019.

> would not be effective on a global scale, as such a target would result in a very minor, if not negligible, reduction of global greenhouse gas emissions. After all, whether or not the 2°C target is achieved will mainly depend on the reduction targets of other countries with high emissions.[76]

This line of argumentation would suggest, among others, that the Dutch government was convinced the Netherlands' contribution to climate change at the planetary scale was insignificant, and that there was little connection between what happened in the Netherlands and what happened at a planetary Earth system scale as far as climate change is concerned.

The Court did not follow this line of reasoning. Instead of focusing on the Dutch contribution as such, the Court focused on the global approach that is needed to address climate change, and even explicitly referred to the planetary boundary of 450ppm in numerous instances throughout its judgment. It ordered the State to implement policies resulting in at least a 25 per cent reduction of greenhouse gas emissions by 2020 compared to the 1990 level. This is the lowest level of the 25–40 per cent reduction goal for Annex I countries proposed by the IPCC in its AR4 in 2007 and adopted at the UNFCCC's COP16 in Cancun in 2010.[77] In a paragraph that is significant for present purposes, the Court argued:

> It is an established fact that climate change is a global problem and therefore requires global accountability … It compels all countries, including the Netherlands, to implement the reduction measures to the fullest extent possible. The fact that the amount of the Dutch emissions is small compared to other countries does not affect the obligation to take precautionary measures in view of the State's obligation to exercise care. After all, it has been established that any anthropogenic greenhouse gas emission, no matter how minor, contributes to an increase of CO_2 levels in the atmosphere and therefore to hazardous climate change. Emission reduction therefore concerns both a joint and individual responsibility of the signatories to the UN Climate Change Convention. In view of the fact that the Dutch emission reduction is determined by the State, it may not reject possible liability by stating that its contribution is minor … Therefore, the court arrives at the opinion that the single circumstance that the Dutch emissions only constitute a minor contribution to global emissions does not alter the State's obligation to exercise care towards third parties. Here too, the court takes into account that in view of a fair distribution the Netherlands, like the other Annex I countries, has taken the lead in taking mitigation measures and has therefore committed to a more than proportionate contribution to reduction. Moreover, it is beyond dispute that the Dutch per capita emissions are one of the highest in the world.[78]

In its appeal, the State attempted to convince the Court of Appeal to repeal this line of reasoning by arguing that 'the State cannot solve the problem on its own, that the worldwide community has to cooperate, that the State cannot be deemed the party liable/causer ("primary offender") but as secondary injuring party ("secondary offender"), and this concerns complex decisions for which much depends on negotiations'.[79] The Court of Appeal, however, stuck to the reasoning of the District Court. The fact that the State cannot solve climate change on its own 'does not release the State from its obligation to take measures in its territory, within its capabilities, which in concert with the efforts of other States provide protection from the

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76 *Urgenda v Netherlands* (n 73) para 4.78.

77 Ibid at paras 2.15 and 2.50 respectively.

78 Ibid at para 4.79.

79 *The State of The Netherlands v Urgenda Foundation* [2019] ECLI (HR) 2007, para 4.6, available (in English) through <https://uitspraken.rechtspraak.nl/inziendocument?id=ECLI:NL:GHDHA:2018:2610> accessed 10 March 2020.

hazards of dangerous climate change'.[80] Interestingly, the Court of Appeals added a further *procedural* argument against the State's view that it cannot be held liable for global climate change:

> Moreover, if the opinion of the State were to be followed, an effective legal remedy for a global problem as complex as this one would be lacking. After all, each state held accountable would then be able to argue that it does not have to take measures if other States do not so either. That is a consequence that cannot be accepted, also because Urgenda does not have the option to summon all eligible states to appear in a Dutch court.[81]

The Court of Appeal thus clearly and unequivocally acknowledged the need for an effective legal remedy for global problems such as climate change. It followed Urgenda in finding that the right to life and the right to private home and family life, as laid down in the Articles 2 and 8 of the European Convention on Human Rights, form the legal basis for such a remedy.

In a final attempt to get the decision overturned, the Dutch State applied for cassation at the Netherlands Supreme Court. This is a final legal avenue in which only questions on the interpretation of the law are addressed. The Supreme Court fully upheld the Court of Appeal's judgment, using fairly similar wording as cited above. It specifically referred to the remaining global carbon budget below the planetary boundaries of 450 and 430 ppm (for 2 degrees and 1.5 degrees respectively), from which it follows that immediate action is required.[82] The Supreme Court used this as an additional reason to reject the State's view that its own actions are useless when other States do not also take action. According to the Supreme Court, every reduction, no matter how small, immediately increases the remaining global carbon budget. As a consequence, no reduction can ever be argued to be negligible.[83] The Supreme Court then ruled that the Court of Appeal was allowed to hear the case and that it could decide that the Dutch State is obliged to achieve 25 per cent reduction by the end of 2020 on account of the risk of dangerous climate change that could also have a serious impact on the rights to life and wellbeing of residents of the Netherlands.[84]

It should be stressed that the *Urgenda* case is unprecedented and, so far, has not been followed by any other court around the world in similar cases.[85] Still, this case does show that, in theory, (some) domestic courts are able to address the global governance challenges explicated by the planetary boundaries, and to take an Earth system approach, even within the confines of decidedly localised non-planetary boundaries of domestic tort law.

4.3.2 Cases against companies

Litigation against companies for their contribution to climate change seems, at first glance, to be better suited for an Earth system approach, because often such cases are against transnational companies that operate across borders through immensely complex intertwined political, legal

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[80] Ibid at para 62.
[81] Ibid at para 64.
[82] *The State of The Netherlands v Urgenda Foundation*, The Supreme Court, 20 December 2019, case 19/00135, para 4.6, available (in English) through <http://deeplink.rechtspraak.nl/uitspraak?id=ECLI:NL:HR:2019:2007> accessed 10 March 2020.
[83] Ibid at para 5.7.8.
[84] Ibid at para 8.3.5.
[85] Francesco Sindico and Makane Moise Mbengue (eds), *Climate Change and the Individual* (Springer 2020).

and socio-economic processes. Since a relatively small number of (especially transnational energy) companies have caused a considerable share of global climate change, there will be less debate about possible causality when compared to cases against governments. Research has shown that emissions traced to the 90 largest carbon producers contributed ~57 per cent of the observed rise in atmospheric CO_2, ~42–50 per cent of the rise in global mean surface temperature and ~26–32 percent of global sea level rise over the period 1890–2010.[86] In their case against Shell,[87] a group of environmental NGOs led by Friends of the Earth Netherlands relies on these and similar data, arguing that Shell is one of the world's biggest industrial contributors to global climate change.[88] In their summons, the NGOs repeatedly refer to the planetary boundary of 450 ppm, as does Shell in its reply.[89] Shell defends itself in a similar fashion as the Netherlands did in the *Urgenda* case, by stating that climate change is not caused by Shell's emissions but by the combined emissions of all emitters;[90] Shell's emissions are accordingly negligible on a global scale.[91] At the time of writing, this case was still pending with the same court that gave the *Urgenda* ruling. It remains to be seen whether the District Court of The Hague will rely on similar arguments as those used in its *Urgenda* judgment and whether this case, like the *Urgenda* case, will be a breakthrough in climate change litigation. So far, cases against the so-called carbon majors, especially those in the US, have not been very successful.[92]

5. CONCLUSION

This chapter attempted to offer a first assessment of the legal significance, and possible impacts, of the planetary boundary of climate change. More than a quarter of a century has passed since the adoption of the UNFCCC. It was not until 23 years after the adoption of the UNFCCC that a legally binding recognition of a quantified planetary boundary on climate change was laid down in the Paris Agreement. Although the world is still trying to establish how the provisions of the Paris Agreement should be interpreted and implemented, it is slowly becoming clear what the legal impact of such a legally binding recognition of the planetary boundary could be, mostly thanks to domestic legislatures and courts.

With the adoption of the Paris Agreement, the planetary boundary has been firmly codified in international law. Remaining within this boundary is a collective responsibility of all States. Recent developments within domestic law have shown, however, that the adoption of a legally binding planetary boundary also has consequences for States individually, and perhaps even for individual business corporations. In the Netherlands, courts have linked the

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86 Brenda Ekwurzel et al, 'The Rise in Global Atmospheric CO_2, Surface Temperature, and Sea Level from Emissions Traced to Major Carbon Producers' (2017) 144 Climatic Change 579.

87 *Milieudefensie (Friends of the Earth Netherlands) v Royal Dutch Shell PLC*, Case No. C/09/571932 2019/379, case pending before the District Court of The Hague (January 2020). Case documents (in Dutch) are available through Friends of the Earth, 'Tijdlijn klimaatzaak tegen Shell' <https://milieudefensie.nl/klimaatzaakshell/tijdlijn-klimaatzaak-tegen-shell> assessed 18 December 2019.

88 Summons of 5 April 2019 at 151–53, available through the above hyperlink (n 87).

89 Reply of 13 November 2019, available through the above hyperlink (n 87).

90 Ibid at para 541.

91 Ibid at para 545.

92 Ganguly, Setzer and Heyvaert (n 72) 841–68.

planetary boundary to human rights, to allow them to provide for an effective legal remedy for citizens and NGOs against insufficient domestic climate change policies. Furthermore, the courts required the State to implement stricter policies with the objective of remaining within the planetary boundary based on recommendations by the IPCC, thus forcing the authorities to follow scientific experts' advice rather than domestic political reasoning. In doing so, the courts rejected the argument that the Dutch contribution to global emissions is limited. Any emission cuts, no matter how small, are relevant as they immediately increase the remaining carbon budget and thus contribute to the world's efforts to remain below the threshold of this specific planetary boundary. In other countries, legislatures have codified the planetary boundary in domestic climate change laws, requiring all authorities to achieve full carbon neutrality by 2050. All of the countries reviewed in this chapter (UK, France and Germany) have instituted a non-political expert committee that plays an important role in monitoring progress towards achieving the long-term climate goals. These and other actions are necessary steps to staying within the safe operating space of the climate boundary.

14. Stratospheric ozone depletion[1]

Louise du Toit

1. INTRODUCTION

Stratospheric ozone depletion refers to the depletion of ozone – which plays a crucial role in absorbing solar ultraviolet radiation – in the stratosphere. This process was identified by Rockström and colleagues in 2009 as one of nine planetary boundaries, which 'define, as it were, the boundaries of the "planetary playing field" for humanity if we want to be sure of avoiding major human-induced environmental change on a global scale'.[2] The planetary boundaries are 'tightly coupled' and interdependent, and transgressing one boundary 'may both shift the position of other boundaries or cause them to be transgressed'.[3] The stratospheric ozone depletion planetary boundary occupies a different position to some other planetary boundaries, such as ocean acidification,[4] in that an international environmental law (IEL) regime to address the problem had been established well before its identification as a planetary boundary.[5] This IEL regime is largely considered to be a success in addressing ozone depletion. The primary aim of this chapter is to consider the extent to which this IEL regime is enabling us to remain within the planetary boundary on stratospheric ozone depletion.

This chapter first considers the causes and impacts of stratospheric ozone depletion, as well as the ozone depletion that has been observed. The planetary boundary on stratospheric ozone depletion, as defined by Rockström and colleagues, is discussed next. The chapter then sets out the IEL regime that relates to stratospheric ozone depletion, with a focus on the Montreal Protocol, and considers the effectiveness of IEL in responding to the problem of ozone depletion. Thereafter, the extent to which the IEL regime has enabled us to remain within this planetary boundary is considered. The link between stratospheric ozone depletion and climate change will also be considered here, to the extent that it is relevant to our capacity to remain within this planetary boundary. The final section concludes the discussion.

1 Research for this chapter was supported by the South African National Research Foundation (NRF) under grant agreement UID: 118746 and it was completed in April 2020. Opinions expressed and conclusions arrived at are those of the author and are not necessarily to be attributed to the NRF.

2 Johan Rockström et al, 'Planetary Boundaries: Exploring the Safe Operating Space for Humanity' (2009) 14 Ecology and Society 1, 1.

3 Ibid; Johan Rockström et al, 'A Safe Operating Space for Humanity' (2009) 461 Nature 472, 474.

4 See Stephens, Chapter 16 in this book.

5 Climate change presents another example where an IEL regime was established well before its identification as a planetary boundary. See Verschuuren, Chapter 13 in this book.

2. STRATOSPHERIC OZONE DEPLETION: CAUSES, IMPACTS AND OBSERVED OZONE DEPLETION[6]

The Earth's atmosphere is made up of numerous chemical elements, including nitrogen, hydrogen, oxygen and ozone. Ozone (O_3) – 'an unstable form of oxygen'[7] – is created primarily by ultraviolet (UV) radiation that is emitted by the sun. UV rays strike oxygen molecules (O_2), causing them to split into two single oxygen atoms (O). These single oxygen atoms usually quickly re-join other oxygen molecules to form ozone.[8] In this way – through the continual destruction and creation of ozone – a 'natural ozone balance' is maintained in the atmosphere.[9] This process also results in most UV radiation being absorbed by the atmosphere, primarily the stratosphere (depicted in Figure 14.1 below), where about 90 per cent of atmospheric ozone is present.[10]

Even though ozone makes up only 0.00003 per cent of the atmosphere, it plays a crucial role in protecting the Earth from UV radiation. UV radiation is divided into three bands of wavelengths, namely UV-A, UV-B and UV-C radiation.[11] Ozone completely absorbs UV-C radiation, partially absorbs UV-B radiation and absorbs minimal UV-A radiation. While UV-A radiation causes skin ageing and the deterioration of outdoor plastics and paint, UV-B radiation is particularly harmful to humans, animals and plants.[12] In humans, over-exposure to UV-B radiation can cause skin cancer, cataracts and retinal degeneration, and can adversely impact the immune system. In plants, the observed effects of excessive UV-B radiation include reduced leaf areas and plant stunting. In marine organisms, UV-B radiation may harm larvae and other plants and animals that are integral to the marine food chain.[13] The destruction of

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6 The information in this section is presented in what is considered to be the most logical order, and not necessarily chronologically.

7 Lani Sinclair, 'The Science of Ozone Depletion: From Theory to Certainty' in Stephen O Andersen and K Madhava Sarma (eds), *Protecting the Ozone Layer: The United Nations History* (Earthscan 2002) 1, 3.

8 $O_2 + UV = 2O$ (the process whereby UV reacts with an oxygen molecule to form two oxygen atoms)

$O + O_2 + M = O_3 + M$ (the process whereby an oxygen atom rejoins an oxygen molecule to form ozone (where M represents a third body))

See F Sherwood Rowland, 'Stratospheric Ozone Depletion' in Christos Zerefos, Georgios Contopoulos and Gregory Skalkaes (eds), *Twenty Years of Ozone Decline: Proceedings of the Symposium for the 20th Anniversary of the Montreal Protocol* (Springer 2009) 23, 26; NASA, 'Ozone', *NASA Earth Observatory* (NASA, 30 July 1999) <https://earthobservatory.nasa.gov/features/Ozone/ozone_2.php> accessed 25 April 2020; Susan Solomon, 'Stratospheric Ozone Depletion: A Review of Concepts and History' (1999) 37(3) Reviews of Geophysics 275, Table 1 at 278. This theory regarding the formation and destruction of ozone was first proposed by Sydney Chapman in 1930: Sydney Chapman, 'On Ozone and Atomic Oxygen in the Upper Atmosphere' (1930) 7 The London, Edinburgh and Dublin Philosophical Magazine and Journal of Science 369.

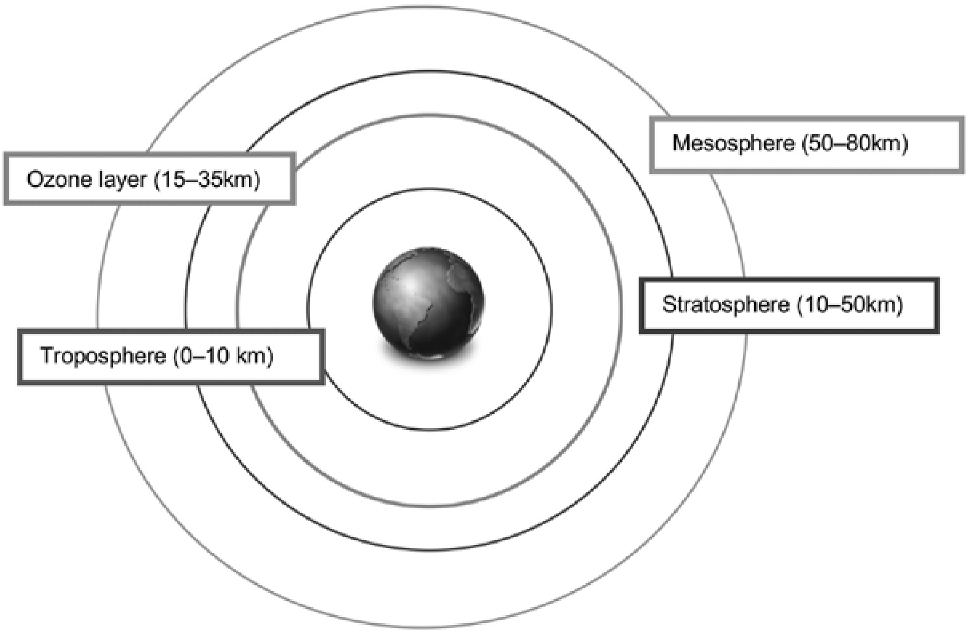
9 NASA (n 8).

10 Sinclair (n 7) 3.

11 UV-A radiation is at longer wavelengths of between 320 nanometres (nm) and 400 nm. UV-B radiation is at wavelengths of between 280 nm and 320 nm, while UV-C radiation is at wavelengths below 280 nm: Jeannie Allen 'Ultraviolet Radiation: How It Affects Life on Earth', *NASA Earth Observatory* (NASA, 6 September 2001) <https://earthobservatory.nasa.gov/features/UVB> accessed 25 April 2020.

12 Sinclair (n 7) 3.

13 Ved P Nanda, 'Stratospheric Ozone Depletion: A Challenge for International Environmental Law and Policy' (1989) 10 Michigan Journal of International Law 482, 489–90.



Source: Figure compiled using information contained in NASA (n 8).

Figure 14.1 The atmospheric layers

stratospheric ozone allows more UV radiation, primarily UV-B, to reach the Earth's surface.[14] The ozone layer is thus crucial to protect humans, animals and plants.

Measurement of atmospheric ozone began in the 1920s by Gordon MB Dobson. Ongoing monitoring revealed that measurements of ozone (measured in 'Dobson Units' (DU)) vary from day to day and throughout the year, and furthermore that ozone occurs in different quantities at different locations.[15] For instance, ozone is more abundant at the mid-latitudes and less abundant at the Poles. Furthermore, due to various processes, ozone above Antarctica decreases significantly each year in the (Antarctic) spring, around October.[16]

Chlorofluorocarbons (CFCs) were invented in 1928 as a safer (non-toxic) and more stable alternative to other substances, such as sulphur dioxide and ammonia, for use as home refrigerants.[17] Their use on a large scale began in the 1930s, and increased significantly in the 1950s and 1960s.[18] By 1985, total CFC production exceeded 1 million tonnes. Of note, per capita consumption of CFCs was ten times greater in developed countries than in developing coun-

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[14] Solomon (n 8) 275.
[15] Rowland (n 8) 25; Sinclair (n 7) 4.
[16] Solomon (n 8) 282.
[17] Sinclair (n 7) 4.
[18] Rishav Goyal et al, 'Reduction in Surface Climate Change Achieved by the 1987 Montreal Protocol' (2019) 14 Environmental Research Letters 1, 1.

tries.[19] This is a result of the fact that colonialism and asymmetric flows of global resources have resulted in unequal industrial development between developed and developing countries, which has provided the basis for environmental and other injustices.[20] This is taken up further below.

During the early 1970s, scientists – including Paul Crutzen and James Lovelock – began to present hypotheses regarding anthropogenic chemical processes (and substances) that could affect atmospheric ozone and potentially deplete ozone levels.[21] For instance, Lovelock obtained air samples in the North and South Atlantic and, in 1973, reported the presence of CFCs in every one of these samples.[22]

In 1974, Mario J Molina and FS Rowland noted that CFCs (which were then called chlorofluoromethanes) had been added to the atmosphere in increasing amounts over the preceding few decades due to their increased use. They also noted that two CFCs in particular (CF_2Cl_2 and $CFCl_3$) had been detected in the atmosphere in amounts that roughly corresponded to their global industrial production. They proposed that when these substances are released into the atmosphere, UV radiation causes them to break down, which results in the release of chlorine. Chlorine then reacts with ozone in '[a]n extensive catalytic chain reaction', which causes the 'destruction of atmospheric ozone'.[23] This process had not actually been observed in the atmosphere (that is, outside of the laboratory), nor had actual environmental harm due to this process.[24]

In the years following, further studies into the impacts of CFCs were carried out by other scientists and bodies, including the United States (US) National Academy of Scientists and the United Nations Environment Programme (UNEP), which provided support for the Molina–Rowland hypothesis.[25] Velders and colleagues state that the 'early warning' provided by Rowland and Molina led to citizen action and national regulations to limit ozone-depleting

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[19] Alexander Gillespie, *Climate Change, Ozone Depletion and Air Pollution: Legal Commentaries with Policy and Science Considerations* (Martinus Nijhoff Publishers 2006) 21.

[20] See, *inter alia*, Alf Hornborg, 'Colonialism in the Anthropocene: The Political Ecology of the Money-Energy-Technology Complex' (2019) 10(1) Journal of Human Rights and the Environment 7; Carmen Gonzalez, 'Bridging the North-South Divide: International Environmental Law in the Anthropocene' (2015) 32 Pace Environmental Law Review 407.

[21] Evidence shows that about 85 per cent of stratospheric chlorine in 1992 could be attributed to human activities: see Solomon (n 8) 281.

[22] Sinclair (n 7) 6.

[23] Mario J Molina and F Sherwood Rowland, 'Stratospheric Sink for Chlorofluoromethanes: Chlorine Atom-Catalysed Destruction of Ozone' (1974) 249 (5460) Nature 810, 810. Chlorine, released when UV radiation breaks up CFCs, reacts with ozone (thereby destroying it) to produce chlorine monoxide and an oxygen molecule (1). The resulting chlorine monoxide then reacts with a single oxygen atom to produce an oxygen molecule and a free chlorine atom (2), which is released into the stratosphere, where it goes on to destroy further ozone:

(1) $Cl + O_3 = ClO + O_2$

(2) $ClO + O = Cl + O_2$

See also F Sherwood Rowland, 'Chlorofluorocarbons and the Depletion of Stratospheric Ozone' (1989) 77(1) American Scientist 36, 36; NASA (n 8).

[24] Elizabeth R DeSombre, 'The Experience of the Montreal Protocol: Particularly Remarkable, and Remarkably Particular' (2000/01) 19 Journal of Environmental Law 49, 50.

[25] See Sinclair (n 7) 11–13.

substances.[26] For instance, in the US, amendments to the Clean Air Act in 1977 empowered the administrator of the Environment Protection Agency (EPA) to regulate substances that were reasonably anticipated to affect the stratosphere and adversely impact public health or welfare.[27] However, there was no coordinated international response for several years. Since the science was not certain, there was significant resistance. Indeed, '[a] small number of professional science skeptics challenged the Molina–Rowland theory with both plausible and fanciful explanations that were eventually disproven'.[28]

In 1981, researchers recorded a 20 per cent decline in ozone levels above Antarctica. However, since the readings were so low, it was assumed that the instrument had malfunctioned.[29] In 1985, Farman and colleagues publicly confirmed, in a seminal article, that 'the spring values of total O_3 in Antarctica have now fallen considerably'.[30] A link between the concentration of chlorine-containing substances in the atmosphere and ozone depletion had not yet been conclusively proven; however, Farman and colleagues suggested that CFCs were the likely cause.[31]

Further research revealed that such ozone depletion is seasonal and limited to springtime, and that the depletion occurs over roughly the whole of Antarctica – which gave rise to its description as the Antarctic ozone 'hole', even though it is not a 'true hole' in that there is always some column ozone present.[32] This discovery, which was described as a 'black swan' event,[33] 'rightfully raised global concern about the fate of the protective ozone layer'.[34]

It took several more years for the link between CFCs and ozone depletion to be conclusively established. In August 1987, data obtained during an Antarctic expedition 'show[ed] the lowest ozone levels ever recorded and directly implicate[d] man-made chemical compounds, chlorofluorocarbons, in the enormous ozone loss over this remote region in the Southern Hemisphere'.[35]

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26 Guus JM Velders et al, 'The Importance of the Montreal Protocol in Protecting Climate' (2007) 104(12) Proceedings of the National Academy of Sciences 4814, 4814.

27 Gillespie (n 19) 155.

28 Stephen O Andersen, Marcel L Halberstadt and Nathan Borgford-Parnell, 'Stratospheric Ozone, Global Warming, and the Principle of Unintended Consequences – An Ongoing Science and Policy Success Story' (2013) 63(6) Journal of the Air & Waste Management Association 607, 613.

29 Sinclair (n 7) 13–14.

30 Joseph C Farman, Brian G Gardiner and Jonathan D Shanklin, 'Large Losses of Total Ozone in Antarctica Reveal Seasonal ClO_x/NO_x Interaction' (1985) 315 Nature 207, 207. Prior to this, in 1984, Shigeru Chubachi published the results of his research on ozone depletion over Antarctica of below 250 DU: see Solomon (n 8) 283.

31 Solomon (n 8) 283.

32 Ibid 282. 'Column ozone' is defined as '[t]he amount of ozone in a vertical column of air extending from the Earth's surface to outer space': EPA, 'Ozone Layer Protection Glossary' <https://ofmpub.epa.gov/sor_internet/registry/termreg/searchandretrieve/glossariesandkeywordlists/search.do?details=&vocabName=Ozone%20Protection%20Glossary#formTop> accessed 20 May 2020.

33 Pawan Kumar Bhartia and Richard D McPeters, 'The Discovery of the Antarctic Ozone Hole' (2018) 350 Comptes Rendus Geoscience 335, 340.

34 Sophie Godin-Beekmann, Paul A Newman and Irina Petropavlovskikh, '30th Anniversary of the Montreal Protocol: From the Safeguard of the Ozone Layer to the Protection of the Earth's Climate' (2018) 350 Comptes Rendus Geoscience 331, 331. See also Velders et al (n 26) 4814.

35 Sinclair (n 7) 22.

While ozone depletion has been most significant at the Poles,[36] it is a global phenomenon. Indeed, measurements reveal that the abundance of ozone in many regions of the world has significantly decreased since around 1980. The reason for the intensified ozone depletion at the Poles is 'linked to heterogeneous chlorine chemistry that occurs on the surfaces of polar stratospheric clouds at cold temperatures'.[37]

It must be noted that other chemical emissions have contributed to the depletion of stratospheric ozone, including halons, carbon tetrachloride, hydrochlorofluorocarbons (HCFCs) and methyl bromide.[38] Furthermore, various greenhouse gases which are addressed under the international climate change regime, such as hydrofluorocarbons (HFCs), are implicated in the depletion of stratospheric ozone (which is taken up further below). However, chlorine-containing chemicals have been primarily responsible for the observed ozone depletion, and CFCs have been identified as the main source of stratospheric chlorine. Furthermore, anthropogenic releases of CFCs have been identified as the primary cause of the Antarctic ozone hole. Contributing to the deleterious impacts of CFCs is the fact that they have relatively long lifetimes in the atmosphere – ranging from 50 years to 500 years – and thus take time to be removed from the atmosphere, even if their emission were to cease immediately.[39]

Ozone measurements have revealed a decline in near-global ozone columns of 1.8 per cent per decade from 1980 until the mid-1990s due to increasing chlorine and bromine from ozone-depleting substances (ODSs).[40] Thus, global ozone decreased from well above 290 DU in 1980 to around 275 DU in the early 1990s.[41] Furthermore, Antarctic ozone during the Antarctic spring plunged from 225 DU in 1979 to 92 DU in 1994.[42] However, since the late-1990s, near-global ozone has not declined further and remains 'more or less stable'.[43] This is elaborated on below.

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36 Ozone depletion of 12–15 per cent each year has been observed in the Arctic region. In addition, large ozone depletion events were recorded in 1995–96, 2011, 2015–16 and 2019–20: see Jean-Pierre Pommereau et al, 'Recent Arctic Ozone Depletion: Is There an Impact of Climate Change?' (2018) 350 Comptes Rendus Geoscience 347, 352. Due to various factors, greater depletion has occurred over Antarctica. These factors include differing surface topography, atmospheric waves and circulation patterns, as well as the colder temperatures of the Antarctic winter and spring stratosphere, which lead to the formation of polar stratospheric polar clouds, which are 'a critical factor in the ozone hole': Solomon (n 8) 282, 286 and 302.

37 Solomon (n 8) 275, 279.

38 These are listed in the Annexes to the Montreal Protocol, dealt with below.

39 Solomon (n 8) 275, 277, 279. While chlorine is also produced by natural processes, such as volcanic eruptions, these result in a far smaller concentration of chlorine than anthropogenic CFCs: Solomon (n 8) 280.

40 Wolfgang Steinbrecht et al, 'Is Global Ozone Recovering?' (2018) 350 Comptes Rendus Geoscience 368, 371.

41 See World Meteorological Organisation, 'Executive Summary' *Scientific Assessment of Ozone Depletion: 2018* (2018) (Global Ozone Research and Monitoring Project – Report No. 58) <www.esrl.noaa.gov/csl/assessments/ozone/2018/> accessed 13 May 2020, Figure ES-1 at ES.16.

42 National Aeronautics and Space Administration: Goddard Space Flight Centre, 'NASA Ozone Watch' <https://ozonewatch.gsfc.nasa.gov/> accessed 20 May 2020.

43 Steinbrecht et al (n 40) 371.

3. THE PLANETARY BOUNDARY ON STRATOSPHERIC OZONE DEPLETION

Rockström and colleagues identified stratospheric ozone depletion as one of the nine planetary boundaries in recognition of the 'severe and irreversible UV-B radiation effects on human health and ecosystems'.[44] For each planetary boundary, Rockström and colleagues identify a threshold or tipping point, as well as an actual quantified boundary. Thresholds are defined as 'non-linear transitions in the functioning of coupled human–environmental systems … such as the recent abrupt retreat of Arctic sea ice caused by anthropogenic global warming', whereas boundaries are defined as 'human-determined values of the control variable set at a "safe" distance from a dangerous level (for processes without known thresholds at the continental to global scales) or from its global threshold'.[45]

Rockström and colleagues identify the Antarctic ozone hole as a 'tipping point', but recognise that there does not appear to be 'a similar threshold' in regard to global (extra-polar) stratospheric ozone as opposed to polar stratospheric ozone. However, they do note 'the possibility that global warming (which leads to a cooler stratosphere) could cause an increase in the formation of polar stratospheric clouds. Were this to happen in the Arctic region, it could trigger ozone holes over the northern hemisphere continents, with potential impacts on populations there'.[46] They nevertheless chose 'to frame the planetary boundary around extra-polar stratospheric ozone', despite acknowledging that 'there is no clear threshold around which to construct [such] a boundary'.[47] There was thus uncertainty involved in quantifying a boundary for global stratospheric ozone. Nevertheless, Rockström and colleagues propose a boundary of less than a 5 per cent reduction in column ozone levels for any latitude with reference to 1964–1980 levels.[48] In other words, global ozone levels should not fall below 276 DU.[49] This boundary is retained in the 2015 update to the planetary boundaries framework.[50]

As highlighted above, planetary boundaries are tightly coupled and transgressing one boundary may lead to other boundaries being shifted or transgressed. In this regard, global warming due to the increasing emission of greenhouse gases may lead to stratospheric cooling and the formation of polar stratospheric clouds, which are 'a critical factor in the ozone hole'.[51] There is thus a link between climate change and stratospheric ozone depletion. This highlights the need for cohesion in the planetary boundary framework as well as in IEL. This is considered in more detail below.

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44 Rockström et al (n 2) Table 1 at 8.

45 Ibid 2–3.

46 Ibid 12.

47 They provide two main reasons for this: namely, the significant influence that humans have over the drivers of the 'ozone hole "tipping point"', particularly the emission of ozone-depleting substances, as well as the 'much larger impact on humans and ecosystems' that would result from the depletion of the extra-polar ozone layer (in comparison to the purely local impacts of polar ozone holes): ibid 12.

48 Ibid. However, see Molina, who questions both the boundary and the tipping point identified by Rockström et al, and proposes what he believes to be more a 'realistic' boundary and threshold respectively: Mario J Molina, 'Identifying Abrupt Change' (2009) 3 Nature Climate Change 115.

49 Rockström et al (n 3) 473.

50 Will Steffen et al, 'Planetary Boundaries: Guiding Human Development on a Changing Planet' (2015) 347 Science 1259855, 1259855-1. However, in this update, it is stated that the boundary is 275 DU.

51 Solomon (n 8) 282, 286 and 302.

The chapter now turns to the IEL regime for stratospheric ozone depletion.

4. THE INTERNATIONAL ENVIRONMENTAL LAW REGIME

4.1 Background

As discussed above, there was significant uncertainty during the 1970s and 1980s regarding the causes of ozone depletion (with many trying to attribute it to natural causes) as well as the risk actually posed by ozone-depleting substances.[52] There was also disagreement over whether a precautionary approach should be followed, or whether conclusive evidence of ozone depletion should first be required.[53] There were several initiatives in the 1970s to address this problem, including a 1976 tripartite agreement regarding the monitoring of the stratosphere between the governments of the United States, France and the United Kingdom, as well as the 1977 World Plan of Action on the Ozone. Discussions on a draft international convention to address stratospheric ozone depletion began in 1981.[54]

4.2 The Vienna Convention

The Vienna Convention was signed in March 1985. The negotiation process – with regard to both the Vienna Convention and the Montreal Protocol (agreed to two years later) – has been described as 'particularly impressive' since negotiations were carried out (and agreement reached) 'under conditions of uncertainty, both over the existence and extent of environmental harm and the costliness of taking action to mitigate it'.[55]

Parties to the Vienna Convention, *inter alia*, noted the 'potentially harmful impact on human health and the environment through the modification of the ozone layer' and reiterated that they were '[d]etermined to protect human health and the environment against adverse effects resulting from modifications of the ozone layer'.[56] The Vienna Convention obliges Parties to 'take appropriate measures in accordance with the provisions of this Convention and of those protocols in force to which they are party to protect human health and the environment against adverse effects resulting or likely to result from human activities which modify or are likely to modify the ozone layer'.[57]

In this regard, the Convention sets out several general obligations for Parties – in accordance with their available means and capabilities – including: to '[c]o-operate by means of systematic observations, research and information exchange' in order to better understand and

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52 Scepticism regarding the 'CFC-ozone depletion theory' is evidenced in Ben C Lieberman, 'Stratospheric Ozone Depletion and the Montreal Protocol: A Critical Analysis' (1994) 2(1) Buffalo Environmental Law Journal 1.

53 See Gillespie (n 19) 152–57.

54 The international process leading to the finalisation of the Vienna Convention is discussed in detail in Andersen and Sarma (n 7).

55 DeSombre (n 24) 49. Interestingly, common concern over ozone depletion provided a rare opportunity for cooperation between the United States and the former Union of Soviet Socialist Republics during the Cold War: see Vyacheslav Khattatov, cited in Sinclair (n 7) Box 1.3 at 20.

56 Vienna Convention for the Protection of the Ozone Layer, Preamble.

57 Art 2(1).

evaluate the impacts of human activity on the ozone layer as well as the impacts of modification of the ozone layer on human health and the environment; and to '[a]dopt appropriate legislative or administrative measures and co-operate in harmonizing appropriate policies to control, limit, reduce or prevent human activities under their jurisdiction or control should it be found that these activities have or are likely to have adverse effects resulting from modification or likely modification of the ozone layer'.[58]

The Convention also provides for: ongoing research and scientific assessments, including in regard to 'the physical and chemical processes that may affect the ozone layer'; the development and exchange of scientific, technical, socio-economic, commercial and legal information; and the transmission of information.[59]

Even though the Vienna Convention did not provide for any controls on ozone-depleting substances, 'it was a promising first step, for it signified recognition by the world community that it must act promptly on this environmental challenge before the occurrence of any actual damage'.[60] It has been argued, to this end, that the Vienna Convention was probably 'the first example of the acceptance of the "precautionary principle" in a major international negotiation'.[61]

4.3 The Montreal Protocol

The Montreal Protocol was signed two years later in September 1987. Bhartia and McPeters argue that, while the Montreal Protocol would have been signed regardless, the discovery of the ozone hole over Antarctica in 1985 offered significant impetus in regard to implementing the Montreal Protocol's provisions concerning the phasing out of ozone-depleting substances.[62]

Parties to the Montreal Protocol recognise that 'world-wide emissions of certain substances can significantly deplete and otherwise modify the ozone layer in a manner that is likely to result in adverse effects on human health and the environment', and that they are '[d]etermined to protect the ozone layer by taking precautionary measures to control equitably total global emissions of substances that deplete it, with the ultimate objective of their elimination'.[63] The equitable treatment of developing countries was essential to ensuring their participation.[64] This is discussed further below.

The Montreal Protocol originally set out 'control measures' for Parties in relation to their consumption[65] and production[66] of the controlled substances included in Group I (CFCs)

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58 Arts 2(2)(a) and 2(2)(b).

59 Art 3(1) read with Annexes I and II, arts 4 and 5.

60 Nanda (n 13) 500.

61 Duncan Brack, 'Monitoring the Montreal Protocol' in Trevor Findlay (ed) *Verification Yearbook* (VERTIC 2003) 211 cited in Marco Gonzalez, Kristen N Taddonio and Nancy J Sherman, 'The Montreal Protocol: How Today's Successes Offer a Pathway for the Future' (2015) 5 Journal of Environmental Studies and Sciences 122, 124.

62 Bhartia and McPeters (n 33) 355.

63 Montreal Protocol on Substances that Deplete the Ozone Layer, Preamble.

64 See, for example, DeSombre (n 24).

65 'Consumption' is defined as 'production plus imports minus exports of controlled substances': art 1.

66 'Production' is defined as 'the amount of controlled substances produced, minus the amount destroyed by technologies to be approved by the Parties and minus the amount entirely used as feedstock in the manufacture of other chemicals': art 1.

and Group II (halons) of Annex A.[67] The Montreal Protocol initially focused only on these chemicals as they had been identified as being ozone-depleting. However, the targets for their reduction were not particularly ambitious.[68] Thus, the Montreal Protocol was initially criticised as being 'seriously flawed because its control measures are inadequate to accomplish the Protocol's objective of halting ozone depletion', and it was argued that 'drastic modifications of the Protocol are essential'.[69]

It was established that deeper reductions of CFCs were required to halt the increasing concentrations of chlorine in the atmosphere. Furthermore, over time, more chemicals were identified as being responsible for ozone depletion.[70] As a consequence, the Montreal Protocol has been successively strengthened since it came into effect in 1989 through numerous adjustments and amendments.[71] These have had the effect of, first, accelerating phaseout schedules – for instance, the Montreal Protocol originally called for the consumption of CFCs to be decreased to 50 per cent of 1986 levels by 1999, but this was adjusted to require a complete phaseout by 1996 – and, second, bringing more chemicals under the control of the Montreal Protocol.[72] These amendments have made it possible for the Montreal Protocol to 'adapt to changes in scientific understanding of the problem and its potential solutions'.[73]

The Montreal Protocol now also covers – in addition to CFCs and halons – other fully halogenated CFCs, carbon tetrachloride, methyl chloroform, hydrochlorofluorocarbons (HCFCs), hydrobromofluorocarbons, methyl bromide, bromochloromethane and hydrofluorocarbons (HFCs).[74] Different limits and phaseout schedules were established for each of these. Production and consumption of most of these substances should have ceased, subject to certain limited exceptions, such as in regard to 'essential uses'.[75]

The Montreal Protocol explicitly takes account of the special situation of developing countries. For instance, different (delayed) schedules for the phaseout of the controlled substances have been provided.[76] Furthermore, a certain amount of production of these substances is still allowed in order to 'satisfy the basic domestic needs' of developing country Parties.[77] In addition, the Multilateral Fund – a financial transfer mechanism – was created for the purpose of enabling developing country compliance with the control measures of the Montreal Protocol.[78]

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67 Art 2.

68 Arts 2(1)–(4) read with Annex A.

69 Nanda (n 13) 511, 515.

70 Gillespie (n 19) 164; Mark W Roberts, 'Finishing the Job: The Montreal Protocol Moves to Phase Down Hydrofluorocarbons' (2017) 26 Review of European, Comparative & International Environmental Law 220, 221.

71 Adjustments may be made in terms of art 2(9)(a) read with art 6, while substances may be added to (or removed from) any annex in terms of art 2(10) read with art 6. Adjustments are a noteworthy feature of the Montreal Protocol, and allow for binding adjustments to be made – for example, of the reductions of controlled substances – with the consent of only two-thirds of the Parties: arts 2(9)(c) and (d). See also DeSombre (n 24) 54.

72 Tina Birmpili, 'Montreal Protocol at 30: The Governance Structure, the Evolution, and the Kigali Amendment' (2018) 350 Comptes Rendus Geoscience 425, 427.

73 DeSombre (n 24) 49.

74 These substances are regulated in terms of arts 2A–2I, read with Annexes A, B, C and E.

75 See art 2F in regard to HCFCs, art 2G in regard to hydrobromofluorocarbons, and art 2I in regard to bromochloromethane.

76 See art 5(1) and art 5(8 *bis*) – art 5(8 *qua*).

77 See arts 2D–2J.

78 See art 10.

As noted above, such provisions were critical to ensuring developing country participation. Since developed countries had been responsible for the bulk of the production and consumption of ozone-depleting substances – which facilitated their industrial development – it was essential that they took responsibility by starting first while allowing developing countries to address their development priorities.[79] In a similar vein, in the climate change context, inequalities between developed and developing countries have given rise to various climate injustices – which have yet to be adequately addressed.[80]

The Montreal Protocol has had the effect of replacing CFCs with HCFCs, which, in turn, have been replaced by HFCs. While HFCs are beneficial for ozone in that they are largely not ozone-depleting, they have a high potential to warm the climate.[81] The consumption of HFCs increased from almost zero in 1990 to more than 1,200 million tonnes of carbon dioxide equivalent by 2010.[82] The replacement of HCFCs by HFCs was thus contributing to climate change.[83] However, in 2016, the Parties to the Montreal Protocol agreed on the insertion of article 2J (in terms of the Kigali Amendment), which provides for the phasedown of HFCs beginning in 2019.[84] The Kigali Amendment will help to 'ensure that the restoration of the ozone layer does not come at the expense of the global climate'.[85] Indeed, it has been projected that this measure will result in the avoidance of a global temperature increase of 0.2°C–0.4°C by 2100. And this is 'substantial in the context of the Paris Agreement'.[86]

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[79] See, for example, DeSombre (n 24).

[80] See Hornborg (n 20). Furthermore, Roberts and Parks propose that in order to understand the (un) willingness of parties to cooperate, it must first be identified which countries have contributed the most to climate change, which countries are most vulnerable to the impacts of climate change, and which countries will likely shoulder the costs of resolving the problem (the 'triple inequality' of responsibility, vulnerability and mitigation): J Timmons Roberts and Bradley C Parks, *A Climate of Injustice: Global Inequality, North-South Politics, and Climate Policy* (MIT Press 2007) 1, 7. Thus, climate change presents a moral challenge: Idil Boran, 'On Inquiry into Climate Justice' in Tahseen Jafry (ed), *Routledge Handbook of Climate Justice* (Earthscan 2019) 26.

[81] Thus, HFCs have low ozone-depleting potentials (ODPs) and high global warming potentials (GWPs). The ODP is 'a metric for determining the relative strength of a chemical to destroy ozone', while the GWP is 'a metric for determining the relative contribution of a substance to climate warming'. For example, the ODP of the refrigerants HFC-134a and HFC-23 is 0, while their GWPs are 1360 and 12,690 respectively. See World Meteorological Organisation (n 42) ES.13 and World Meteorological Organisation, *Scientific Assessment of Ozone Depletion: 2018* (2018) (Global Ozone Research and Monitoring Project – Report No. 58) <www.esrl.noaa.gov/csl/assessments/ozone/2018/> accessed 13 May 2020, Appendix A, Table A-1. See also Polvani et al who highlight the substantial contribution of ODSs to Arctic warming: Lorenzo M Polvani et al, 'Substantial Twentieth-Century Arctic Warming Caused by Ozone-Depleting Substances' (2020) 10 Nature Climate Change 130.

[82] Roberts (n 70) 224.

[83] Rakhyun E Kim and Klaus Bosselmann, 'Operationalising Sustainable Development: Ecological Integrity as a *Grundnorm* of International Law' (2015) 24(2) Review of European Community & International Law 194, 200.

[84] See United Nations Environment Programme 'Annex I: Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer' (Report of the twenty-eighth Meeting of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer) UNEP/OzL.Pro.28/12 <https://ozone.unep.org/sites/default/files/2019-04/MOP-28-12E.pdf> accessed 14 May 2020.

[85] Roberts (n 70) 220.

[86] World Meteorological Organisation (n 41) ES.3. The Kigali Amendment is discussed in detail by Piselli and Van Asselt, Chapter 7 in this book.

The Montreal Protocol has been described as 'a landmark in the ongoing development of international environmental law, primarily because the world community showed a rare consensus in accepting the imposition of strict controls on states for activities potentially harmful but having caused no proven specific damage or harm'.[87] While the reasons for this are elaborated on below, important factors include the special provision that was made for developing country parties, the adaptive nature of the Montreal Protocol, as well as the fact that the regime created under the Montreal Protocol earned the support of industry.[88]

It is important to note that while the Montreal Protocol was at its outset considered to be insufficient to halt ozone depletion, as a result of its flexible nature, it has continually evolved to address its main concern, namely, the protection of the ozone layer.

4.4 The International Climate Change Regime

Despite the relationship between stratospheric ozone depletion and climate change, ozone-depleting greenhouse substances that are addressed by the Montreal Protocol are excluded from the purview of the international climate change law regime. Thus, the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol are specifically only concerned with 'greenhouse gases not controlled by the Montreal Protocol'.[89]

4.5 The Sustainable Development Goals

While Goal 7 of the Millennium Development Goals (MDGs) included an indicator relating to ozone – '[o]zone-depleting substances have been virtually eliminated, and the ozone layer is expected to recover by the middle of this century'[90] – there is no reference to stratospheric ozone depletion in any of the 17 Sustainable Development Goals (SDGs) or their 169 related targets.[91] This is the case despite an attempt by the Ozone Secretariat to include an ozone-related indicator or alternatively a good governance indicator based on the experience (and success) of the Montreal Protocol.[92] Kim argues that this is 'probably because the Montreal Protocol has been a success in phasing out the use of ozone-depleting substances, and ozone depletion is no longer considered as an issue that requires urgent attention'.[93]

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87 Nanda (n 13) 510. See also DeSombre (n 24) 50.

88 See, for example, DeSombre (n 24) 52–75.

89 See, for example, UNFCCC, art 4. See also Oberthür who states that the UNFCCC and Kyoto Protocol 'do not provide any institutional link to the ozone regime': Sebastian Oberthür, 'Linkages between the Montreal and Kyoto Protocols: Enhancing Synergies between Protecting the Ozone Layer and the Global Climate' (2001) 1 International Environmental Agreements: Politics, Law and Economics 357, 368.

90 See United Nations, 'Goal 7: Ensure Environmental Sustainability' <un.org/millenniumgoals/environ.shtml> accessed 14 May 2020.

91 See United Nations, 'Sustainable Development Goals' <https://sustainabledevelopment.un.org/?menu=1300> accessed 14 May 2020.

92 United Nations Environment Programme: Open-ended Working Group of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer 'Embedding Ozone Protection in the Sustainable Development Agenda' (21 June 2013) UNEP/OzL.Pro.WG.1/33/INF/4, 17–18.

93 Rakhyun E Kim, 'The Nexus between International Law and the Sustainable Development Goals' (2016) 25(1) Review of European Community & International Law 15, 16.

4.6 The Effectiveness of IEL in Responding to Stratospheric Ozone Depletion

Described by former UN Secretary-General Kofi Annan as '[p]erhaps the single most successful international agreement to date',[94] the Montreal Protocol became the first international treaty to be universally ratified in 2010.[95]

By 2018, 99 per cent of ozone-depleting substances (controlled by the Montreal Protocol) had been phased out.[96] Chlorine and bromine in the atmosphere are decreasing.[97] Furthermore, ozone levels have not declined further since the late 1990s, and are actually beginning to recover: 'The clearest signs, so far, are ozone increases over the last 10 to 15 years in the upper stratosphere, and a decrease in the severity of the Antarctic ozone hole in September.'[98] Global ozone has increased from around 275 DU in the early 1990s to well above 280 DU in 2018. It has been projected that global ozone will return to 1980 levels (of at least 290 DU) by around mid-century.[99] Furthermore, the implementation of the Montreal Protocol has had benefits for human health, the green economy and technology transfer and, overall, it has managed to avoid financial losses.[100] The Montreal Protocol has also contributed to climate change mitigation, since CFCs and halons are powerful greenhouse gases.[101] This is taken up further below.

The success of the Montreal Protocol has been attributed to a number of factors, including the participation of developing countries,[102] its commitment to the principle of common but differentiated responsibilities;[103] the circumscribed number of ozone-depleting substances that are used in a limited number of processes, which could be substituted without too much difficulty;[104] the flexibility of the Montreal Protocol, which has allowed it to 'adapt to changing

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94 See United Nations, 'International Day for the Preservation of the Ozone Layer, 16 September' <www.un.org/en/events/ozoneday/background.shtml> accessed 14 May 2020. While it has been suggested that this regime holds lessons for addressing climate change (see, for example, Stephen O Andersen, 'Lessons from the Stratospheric Ozone Layer Protection for Climate' (2015) 5 Journal of Environmental Studies and Sciences 143, Grundmann argues that the problems of ozone depletion and climate change are profoundly different. For example, the use of CFCs was circumscribed and they were produced in a limited number of countries, while the drivers of climate change are embedded in our way of living: Reiner Grundmann, 'Ozone and Climate Governance: An Implausible Path Dependence' (2018) 350 Comptes Rendus Geoscience 435, 437.

95 Godin-Beekmann, Newman and Petropavlovskikh (n 34) 331.

96 Birmpili (n 72) 427.

97 World Meteorological Organisation (n 41) ES.15.

98 Steinbrecht et al (n 40) 371, 373.

99 World Meteorological Organisation (n 41) Figure ES-1 at ES.16, ES.42.

100 Birmpili (n 72) 426.

101 Godin-Beekmann, Newman and Petropavlovskikh (n 34) 332.

102 DeSombre (n 25) 69–75. It has been noted that developed and developing countries alike have largely complied with the phaseout schedule: Gonzalez, Taddonio and Sherman (n 61) 122. The establishment of the Multilateral Fund played an important role in facilitating the participation of developing countries.

103 Gonzalez, Taddonio and Sherman (n 61) 124–25.

104 DeSombre (n 24) 59–60. Birmpili notes that, while in the 1980s alternatives to CFCs were either non-existent or too expensive, the Montreal Protocol 'gave the signal to industry to invest in research and technology to pursue alternatives for chemicals that were thought to be indispensable': Birmpili (n 72) 427.

environmental conditions, scientific and technical understanding, and political realities';[105] and the positive involvement of industry.[106]

On the other hand, various challenges have been noted in regard to the Montreal Protocol. The production and consumption of ODSs are allowed in respect of 'essential uses'. Essential uses of CFCs in 2003 amounted to 6321,5 ODP tonnes.[107] DeSombre suggests that while the extent of the black market in ozone-depleting substances, primarily CFCs, is unknown, it has the potential to hinder efforts to restore the ozone layer.[108] Furthermore, even though reports to UNEP show that the production and consumption of CFC-11 have decreased to zero, surface measurements show an increase in levels of CFC-11.[109] In addition, the Montreal Protocol does not control the 'banks' of ODSs that are contained in, among others, air conditioning, refrigeration and firefighting equipment, which will eventually leak.[110]

Despite these concerns, it is clear that the Montreal Protocol has thus far been effective in halting ozone depletion. Rockström and colleagues argue that '[o]n balance, the case of stratospheric ozone is a good example where concerted human effort and wise decision making seem to have enabled us to stay within a planetary boundary'.[111] And it is clear that IEL has played a significant role in this endeavour.[112]

5. THE EXTENT TO WHICH IEL ENABLES COMPLIANCE WITH THE PLANETARY BOUNDARY ON STRATOSPHERIC OZONE DEPLETION

As discussed above, the framework of Rockström and colleagues establishes a limit for the depletion of ozone. Thus, ozone levels should remain above 276 DU in order to remain within this planetary boundary. On the other hand, IEL places controls on the production and consumption of various ozone-depleting substances with the object of achieving their ultimate

[105] DeSombre (n 24) 57. See also Birmpili (n 72) 430.

[106] This was in part due to the fact that the regulation presented by the Montreal Protocol translated into a financial incentive to industry to create the best substitutes to ozone depleting substances and thereby 'capture a multi-billion dollar world market': Alan S Miller, 'Incentives for CFC Substitutes: Lessons for Other Greenhouse Gases' in John C Topping (ed) *Coping with Climate Change: Proceedings of the Second North American Conference on Preparing for Climate Change* (The Climate Institute 1989) 547 cited in DeSombre (n 24) 60. Furthermore, the strict domestic regulation in the US incentivised US CFC industries to call for international regulation so that they would not be at a disadvantage in comparison to CFC industries in other countries subject to less stringent domestic regulation: DeSombre (n 24) 57–58. See further Birmpili (n 72) 427.

[107] Gillespie (n 19) 170.

[108] DeSombre (n 24) 63.

[109] Paul A Newman, 'The Way Forward for Montreal Protocol Science' (2018) 350 Comptes Rendus Geoscience 442, 444. See also World Meteorological Organisation (n 41) ES.18; Megan Lickley et al, 'Quantifying Contributions of Chlorofluorocarbon Banks to Emissions and Impacts on the Ozone Layer and Climate' (2020) 11 Nature Communications 1380; Matthew Rigby et al, 'Increase in CFC-11 Emissions from Eastern China Based on Atmospheric Observations' (2019) 569 Nature 546.

[110] Gonzalez, Taddonio and Sherman (n 61) 123, 127; Lickley et al (n 109).

[111] Rockström et al (n 2) 12.

[112] See, for a further critique of the role of law in relation to the planetary boundaries, Frisso and Kirk, Chapter 8 in this book.

elimination. While the IEL regime is concerned with the protection of the ozone layer, it does not set a limit in regard to ozone depletion (or a target for ozone restoration).

Currently, the total amount of column ozone (globally) exceeds 280 DU and is approximately 2 per cent below 1964–1980 levels.[113] We are thus well within this planetary boundary. Indeed, Rockström and colleagues note that 'because of the actions taken as a result of the Montreal Protocol (and its subsequent amendments), we appear to be on a path that avoids transgression of this boundary'.[114] Furthermore, assuming full compliance with the Montreal Protocol, it has been projected that global total column ozone will return to 1980 levels (of at least 290 DU) by around mid-century. Ozone in different regions will return to 1980 levels at different times. It is projected that the Antarctic ozone hole will slowly close and springtime ozone will return to 1980 levels by about 2060. Arctic springtime total ozone is projected to return to 1980 levels by around the 2030s. Northern hemisphere mid-latitude ozone is projected to return to 1980 levels by the 2030s, while southern hemisphere mid-latitude ozone is projected to return to 1980 levels by mid-century.[115]

Therefore, while IEL does not specifically refer to the planetary boundary on stratospheric ozone depletion, compliance with the IEL regime will ensure that we (continue to) remain within this planetary boundary. It is possibly only due to the continual refining and strengthening of the Montreal Protocol, which was initially deemed inadequate, that we have been set on a path to compliance with the planetary boundary.

More generally speaking, the approach taken in regard to the Vienna Convention and the Montreal Protocol can be described as precautionary in that they addressed environmental harm that had not yet actually been observed.[116] Indeed, the Montreal Protocol is explicitly concerned with 'protect[ing] the ozone layer *by taking precautionary measures*'.[117] Similarly, the planetary boundary framework is intended to be precautionary in that the established boundaries are set some distance away from the threshold or tipping point.[118] Furthermore, to the extent that the Montreal Protocol is based on 'sound science',[119] it is arguably in line with the planetary boundary framework which is grounded in science.[120]

As noted above, the Montreal Protocol is also contributing to climate change mitigation.[121] For instance, Velders and colleagues propose that the contribution of ozone-depleting substances to radiative forcing would likely have been far greater were it not for the implementation of the control measures under the Montreal Protocol. They state that, as of 2007, '[t]he climate protection already achieved by the Montreal Protocol alone is far larger than the reduction target of the first commitment period of the Kyoto Protocol'.[122] In addition, Goyal

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113 World Meteorological Organisation (n 41) ES.3.
114 Rockström et al (n 2) 12.
115 World Meteorological Organisation (n 41) Figure ES-1 at ES.16, ES.42, ES.27.
116 DeSombre (n 24) 50.
117 Montreal Protocol, Preamble (own emphasis).
118 See Rockström et al (n 2) 21 and Edgar Fernández Fernández and Claire Malwé, 'The Emergence of the "Planetary Boundaries" Concept in International Environmental Law: A Proposal for a Framework Convention' (2019) 28 Review of European, Comparative & International Environmental Law 48, 49.
119 See, for example, Roberts (n 70) 222.
120 Rockström et al (n 2) 1.
121 See, *inter alia*, Gonzalez, Taddonio and Sherman (n 61); Birmpili (n 72); Goyal et al (n 18); and Velders et al (n 26).
122 Velders et al (n 26) 4814.

and colleagues project the avoidance of a global temperature increase of at least 1°C (they state that this estimate is 'conservative') by 2050 as a result of the Montreal Protocol. They argue that 'even though the Protocol's main aim was to tackle the problem of ozone depletion, this international agreement also turned out to be one of the earliest and most important steps towards global warming mitigation undertaken to date'.[123] Furthermore, it has been argued that through the Kigali Amendment, the Montreal Protocol 'evolved from strictly an ozone protection agreement into an ozone and climate agreement'.[124] Thus, the Montreal Protocol, in addition to ensuring compliance with the planetary boundary on stratospheric ozone depletion, has the potential to facilitate compliance with the planetary boundary on climate change.

That being said, the impacts that increasing greenhouse gas emissions and climate change will have on ozone are currently unknown. In particular, the impacts of increasing emissions of the 'primary greenhouse gases', namely carbon dioxide, methane and nitrous oxide, are considered to be '[t]he biggest uncertainty in our future'.[125] In a similar vein, the World Meteorological Organisation states that, outside of Antarctica, carbon dioxide, methane, and nitrous oxide will be 'the main drivers of stratospheric ozone changes in the second half of the 21st century, assuming full compliance with the Montreal Protocol'.[126]

The interactions of all of the processes involved in ozone depletion and climate change are clearly complex. For instance, stratospheric cooling due to rising greenhouse gas emissions will contribute to both ozone recovery and ozone depletion.[127] In particular, it is projected that increasing concentrations of carbon dioxide and methane will 'cause global ozone levels to increase beyond the natural level of ozone observed in the 1960s, primarily because of the cooling of the upper stratosphere and a change of the stratospheric circulation', while increasing concentrations of nitrous oxide will result in the depletion of stratospheric ozone.[128] However, '[t]he wide range of future levels of CO_2, CH_4, and N_2O represents an important limitation to making accurate projections of the ozone layer'.[129] Furthermore, it is not yet known how warming of the ocean might impact the oceanic emission of chlorine- and bromine-containing compounds. Nor is it known how minor changes in the troposphere could impact the stratosphere.[130]

Human responses to global warming represent another uncertainty. It is likely that increased warming due to rising greenhouse gas emissions (along with growing populations) will lead to the increased use of air conditioning and refrigeration, which could encourage the use of ozone-depleting substances in these technologies. In addition, '[i]ntentional long-term geo-engineering applications that substantially increase stratospheric aerosols to mitigate global

[123] Goyal et al (n 18) 2–3, 6.

[124] Newman (n 109) 442. See Piselli and Van Asselt, Chapter 7 in this book, who discuss the interaction of the stratospheric ozone depletion and climate change regimes.

[125] Newman (n 109) 445.

[126] World Meteorological Organisation (n 41) ES.27.

[127] See Martin Dameris, 'Investigations of Climate–Ozone Connections with Coupled Climate–Chemistry Models (CCMs): Another Step Forward' in Christos Zerefos, Georgios Contopoulos and Gregory Skalkaes (eds), *Twenty Years of Ozone Decline: Proceedings of the Symposium for the 20th Anniversary of the Montreal Protocol* (Springer 2009) 273, 274–75.

[128] World Meteorological Organisation (n 41) ES.12.

[129] Ibid ES.31.

[130] Newman (n 109) 442, 446.

warming by reflecting sunlight would alter the stratospheric ozone layer'.[131] However, the extent of such changes are not yet known, and considerable uncertainty remains.

The foregoing reinforces the interdependence of the planetary boundaries under the planetary boundary framework while also highlighting the lack of coordination in IEL, including between the Montreal Protocol and the Kyoto Protocol.[132] The ozone regime, including through the Kigali Amendment, has largely been beneficial for the climate. Furthermore, proposals to derive further climate benefits under the Montreal Protocol – for instance, through addressing emissions that could arise from banks of CFC-11, CFC-12 and HFCs – have been mooted.[133] However, rapidly rising greenhouse gas emissions are currently beyond the control of the Montreal Protocol. Going forward, the coordination of, *inter alia*, the separate stratospheric ozone depletion and climate change legal regimes is thus critical.[134]

6. CONCLUSION

The IEL regime has responded admirably to the problem of stratospheric ozone depletion, in that it has thus far led to the decreased production and consumption of ozone-depleting substances. This, in turn, has led to decreasing concentrations of chlorine and bromine in the atmosphere, which has allowed stratospheric ozone to recover. In particular, the flexible nature of the Montreal Protocol has enabled its continual refinement through amendments and adjustments in order to address further problems as they became evident. The continual strengthening of the Montreal Protocol, and compliance therewith, has resulted in a situation whereby we currently remain within the 'safe operating space' of this planetary boundary.

However, the escalating emission of greenhouse gases and the consequent climatic changes raise much uncertainty in regard to their potential impacts on stratospheric ozone. In particular, carbon dioxide, methane and nitrous oxide have been singled out as 'the main drivers of stratospheric ozone changes in the second half of the 21st century, assuming full compliance with the Montreal Protocol'.[135] This problem highlights the interconnectedness of the boundaries under the planetary boundary framework as well as the need for cohesive international law responses in order to 'protect one if not the most important of the global commons: our precious life-sustaining atmosphere'.[136] Such measures will be crucial to ensure that we do not transgress the planetary boundary on stratospheric ozone depletion.

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131 World Meteorological Organisation (n 41) ES.32. See Kim and Kotzé, Chapter 3 in this book.
132 Jonas Ebbesson, 'Planetary Boundaries and the Matching of International Treaty Regimes' (2014) 59 Scandinavian Studies in Law 259, 269; Gonzalez, Taddonio and Sherman (n 61) 127.
133 See Piselli and Van Asselt, Chapter 7 in this book.
134 Gonzalez, Taddonio and Sherman (n 61) 127, 128.
135 World Meteorological Organisation (n 41) ES.27.
136 Gonzalez, Taddonio and Sherman (n 62) 128.

15. Atmospheric aerosol loading[1]

Leslie-Anne Duvic-Paoli and Emily Webster

1. INTRODUCTION

Air pollution features increasingly regularly in the news, as Indian cities close schools due to poor air quality,[2] and Saharan dust settles over European cities.[3] The global concentration of aerosol particles is closely associated with industrial development and has more than doubled since pre-industrial times.[4] Atmospheric aerosol loading has been proposed as one of the nine planetary boundaries because of its impacts on human health and the climate.[5] Yet, it is one of the lesser known planetary boundaries: scientific knowledge about aerosol loading and its impacts remains uncertain, and a safe boundary value, above which the effects of aerosol loading may cause unacceptable change, has not yet been identified.[6]

This chapter maps, and reflects on, the extent to which law and governance responds to the problem of atmospheric aerosol loading. It concentrates on international and regional instruments and initiatives, the geographical scope of which is best suited to protect a planetary boundary. Such an analysis is a complex task for two main reasons. First, the term ‘atmospheric aerosol loading’ has not integrated into the legal lexicon; this means that while a number of legal frameworks, in particular pertaining to air pollution, will be relevant to respond to atmospheric aerosol loading, they have not been designed to explicitly protect the planetary boundary as such. Second, unlike other global environmental challenges, such as climate change or biodiversity loss that are primarily governed by a global framework agreement,[7] a comprehensive universal instrument able to protect air quality is yet to emerge. Instead, a review of the law applicable to this planetary boundary requires an assessment of vastly different legal and political instruments that vary significantly in terms of normative status, material and geographical scope and institutional oversight.

Section 2 briefly introduces the reader to the atmospheric aerosol loading planetary boundary by presenting the sources and impacts of aerosols. Section 3 then identifies and maps two categories of instruments and initiatives governing aerosol loading: one concentrating explicitly on limiting aerosol emissions, including by regulating air pollution, and the other

1 The authors would like to thank Professor Martin Williams (Environmental Research Group, King’s College London) for sharing his extensive experience on air quality policy with us and for his guidance regarding the scientific aspects of this chapter. All errors remain ours.

2 ‘India Air Pollution at “Unbearable Levels”, Delhi Minister Says’ *BBC News* (4 November 2019).

3 ‘UK Warns of Severe Air Pollution Across Country This Week’ *Financial Times* (26 February 2019).

4 Kostas Tsigaridis et al, ‘Change in Global Aerosol Composition Since Preindustrial Times’ (2006) 6 Atmospheric Chemistry and Physics 5143.

5 Johan Rockström et al, ‘Planetary Boundaries: Exploring the Safe Operating Space for Humanity’ (2009) 14 Ecology and Society 32.

6 Ibid.

7 See, respectively, Verschuuren, Chapter 13; Somsen and Trouwborst, Chapter 12, in this book.

indirectly targeting emissions by governing their sources, such as fossil fuel combustion and land-use changes. Section 4 identifies the scientific, political and legal factors that explain why the aerosol loading planetary boundary is arguably one of the more elusive planetary boundaries for policy-makers and lawyers, and why international legal frameworks have so far struggled to provide adequate responses to the problem. Section 5 concludes, setting out recommendations in order to better protect this planetary boundary.

2. PRESENTATION OF THE ATMOSPHERIC AEROSOL LOADING PLANETARY BOUNDARY

Aerosols are defined as a 'collection of airborne solid or liquid particles, with a typical size of between 0.01 and 10 micrometer (a millionth of a meter) that reside in the atmosphere for at least several hours'.[8] Primary aerosols are the result of the direct injection of particles, such as dust or sea spray, into the atmosphere, or originate directly from combustion sources, such as the soot from poorly maintained diesel engines. Secondary aerosols, on the other hand, are the result of emission into the atmosphere of precursor pollutants (such as sulphur dioxide and ammonia), which undergo chemical reactions transforming them into aerosols after their release into the atmosphere.

Aerosols have natural or anthropogenic origins. Natural aerosols account for around 90 per cent of all global aerosols,[9] and include volcanic dust, desert dust and sea salt. Anthropogenic aerosols include particulate matter (PM), emitted directly as a 'primary' aerosol, and nitrogen oxides, sulphur oxides, volatile organic compounds and ammonia, which can react in the atmosphere, forming 'secondary' aerosols. The majority of anthropogenic aerosols are released as a result of fossil fuel combustion – due to transportation, electricity production, heating and industry – and land-use changes – such as forest burning and desertification.

The atmospheric aerosol planetary boundary was proposed mainly because of the impacts of aerosols on health and the environment. Ambient air pollution is considered by the World Health Organization (WHO) to be a major cause of disease and death globally.[10] Short-term exposure to air pollution exacerbates existing respiratory problems (such as asthma), while long-term exposure leads to increased rates of mortality from cardiovascular and respiratory diseases as well as lung cancer.[11] Children have been shown to be particularly affected by air pollution, which contributes to respiratory tract infections and causes more than half of all deaths from acute lower respiratory infections in children under five years of age in low- and middle-income countries.[12]

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8 Rajendra K Pachauri and Andy Reisinger (eds), *Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge University Press 2007) 76.

9 Adam Voiland, 'Aerosols: Tiny Particles, Big Impact' (*NASA Earth Observatory*, 2 November 2010), <https://earthobservatory.nasa.gov/features/Aerosols> accessed 2 November 2019.

10 WHO, 'Ambient Air Pollution: Health Impacts' (WHO 2019) <www.who.int/airpollution/ambient/health-impacts/en/> accessed 2 November 2019.

11 WHO, *Ambient Air Pollution: A Global Assessment of Exposure and Burden of Disease* (WHO 2016); WHO Regional Office for Europe, *Health Effects of Particulate Matter* (WHO 2013).

12 WHO, *Air Pollution and Child Health: Prescribing Clean Air* (WHO 2018) WHO/CED/PHE/18.01, 20.

Aerosols also have adverse effects on the environment and ecosystems. The acidifying effects of atmospheric deposition of nitrogen and sulphur are well known: causing major damage to plants, water bodies and buildings, contributing to water and ocean acidification and affecting nutrient and carbon cycles.[13] Ocean and coastal acidification and eutrophication, caused *inter alia* by acid rain, lead to coral bleaching and loss of marine life.[14] In addition, nutrients, including nitrates, accumulate in the soil and in water, which results in nitrogen-loving plants thriving and loss in other plant species from excessive nitrogen or sunlight deprivation.[15]

But it is mostly for its impact upon cloud formation, weather patterns and the climate that aerosol loading has been included in the planetary boundary framework. Aerosols influence regional precipitation patterns by preventing the formation of certain clouds altogether and hence reducing rainfall,[16] or by suppressing light rainfall while intensifying heavy rainfall and lightning.[17] Impacts have to be assessed locally, as geographical variations – which depend on how specific aerosols interact with existing weather patterns – can be considerable. The potentially 'substantial influence [of aerosols] on the Asian monsoon circulation' is one of the core reasons put forward by Rockström and colleagues to justify the inclusion of atmospheric aerosol loading in the planetary boundary framework,[18] and has been used as a case study to quantify a regional safe boundary.[19]

In addition, aerosols have been shown to influence the climate. They do so either directly, through scattering and absorbing radiation, or indirectly, by modifying the optical properties and lifetimes of clouds. Scientific understanding of the effects of aerosols on climate change has improved over the last decade, but uncertainty remains high because the impacts that aerosols have on the climate are difficult to model.[20] Indeed, natural aerosols – dust and sea salt – and some human-made aerosols, such as ammonium sulphate, ammonium nitrate and secondary organic aerosols – present in smog and haze – reflect radiation from the sun out into space, therefore creating a net cooling effect.[21] Volcanic eruptions emitting sulphur oxides into the atmosphere also have a short-term net cooling effect, the extent of which is more

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[13] Heleen A de Wit, Jean-Paul Hettelingh and Harry Harmens (eds), *Trends in Ecosystem and Health Responses to Long-range Transported Atmospheric Pollutants* (Norwegian Institute for Water Research, May 2016) 9. See also Diz, Chapter 17; Stephens, Chapter 16, in this book.

[14] Keith A Hunter et al, 'Impacts of Anthropogenic SOx, NOx and NH3 on Acidification of Coastal Waters and Shipping Lanes' (2011) 38(13) Geophysical Research Letters L13602.

[15] Samuel M Simkin et al, 'Conditional Vulnerability of Plant Diversity to Atmospheric Nitrogen Deposition across the United States' (2016) 113(15) Proceedings of the National Academy of Sciences of the United States of America 4086. See also Cooper, Chapter 18, in this book.

[16] Hans-F Graf, 'The Complex Interaction of Aerosols and Clouds' (2004) 303 Science 1309, 1310.

[17] Zhangqing Li et al, 'Aerosol and Boundary-layer Interactions and Impact on Air Quality' (2017) 4 National Science Review 810, 810.

[18] Rockström (n 5).

[19] Will Steffen et al, 'Planetary Boundaries: Guiding Human Development on a Changing Planet' (2015) 347 Science 1259855, 1259855-1, 1259855-7.

[20] Rajendra K Pachauri et al (eds), *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge University Press 2014) (IPCC AR5 Synthesis Report) 44; Olivier Boucher et al, 'Clouds and Aerosols' in Thomas F Stocker et al (eds), *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge University Press 2014) (IPCC AR5 Clouds and Aerosols).

[21] IPCC AR5 Clouds and Aerosols (n 20). See also Du Toit, Chapter 14 in this book.

pronounced in the Northern Hemisphere than in tropical regions.[22] Yet at the same time, other aerosols and gaseous pollutants, such as black carbon, methane and ozone, have a warming effect that was initially expected to be partially offset by the cooling effect of other aerosols, but which appears now to be much more significant.[23] As a result, scientific knowledge remains lacking regarding the medium and long-term impacts of aerosols on the climate.

3. OVERVIEW OF APPLICABLE INSTRUMENTS AND INITIATIVES RELEVANT TO THE PLANETARY BOUNDARY

Identifying the state of law and governance in relation to atmospheric aerosol loading is not an easy task given its highly fragmented nature. Two distinct, yet inter-related, types of law and governance approaches to the issue of atmospheric aerosol loading are identified below: a first route consists of regulating the emissions of aerosols, while a second route governs their sources.

3.1 Governing Air Pollutants

The first type of legal approach designed to govern this planetary boundary is concerned with restricting emissions of aerosols and gaseous pollutants, either through wide-ranging or sector-specific initiatives related to air pollution, or, more indirectly, through initiatives responding to other environmental problems, such as climate change.

3.1.1 Wide-ranging responses to air pollution

The problem of atmospheric aerosol loading is addressed by initiatives that do not only concentrate on aerosols but more generally seek to limit air pollution and improve air quality. An international treaty on air pollution remains lacking, but high-level political initiatives have multiplied in recent years. Notably, air pollution has been on the agenda of the UN Environment Assembly (UNEA) since its first session,[24] and the 2015 Sustainable Development Goals (SDGs) contain at least nine goals that are relevant to the planetary

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22 Matthew Toohey et al, 'Disproportionately Strong Climate Forcing from Extratropical Explosive Volcanic Eruptions' (2019) 12 Nature Geoscience 100.

23 IPCC AR5 Synthesis Report (n 20) 44.

24 UNEA 'Ministerial Declaration' (5 December 2017) UNEP/EA.3/L.19, para 1; and two resolutions on nationally determined ambient air quality standards and air quality monitoring, as well as resolutions relevant to the regulation of specific aerosols and gaseous pollutants or their sources. See UNEA Res 1/7, 'Strengthening the Role of the United Nations Environment Programme in Promoting Air Quality' (27 June 2014) para 2; UNEA Res 3/8, 'Preventing and Reducing Air Pollution to Improve Air Quality Globally' (3 December 2017), para 1(a); UNEA Res 4/10, 'Innovation on Biodiversity and Land Degradation' (28 March 2019); UNEA Res 4/14, 'Sustainable Nitrogen Management' (28 March 2019); UNEA Res 2/24, 'Combating Desertification, Land Degradation and Drought and Promoting Sustainable Pastoralism and Rangelands' (3 August 2016).

boundary,[25] with two targets making explicit reference to air quality.[26] The WHO also plays an important role in air quality governance. It regularly publishes air quality guidelines to aid policy-makers to set targets on air pollutants,[27] although domestic air policies – because they have to integrate technical, economic or political considerations – are inevitably laxer.[28] In 2018, the WHO hosted its first conference on air quality and health, which led to the adoption of an aspirational goal to reduce deaths from air pollution by two-thirds by 2030.[29] Initiatives of such a type are symbolically important because they reveal an emerging consensus on the recognition of air pollution as a global policy issue; however, they have not yet been followed up by global legally binding instruments that might constrain States more strongly. Instead, regional initiatives that govern air pollutants have been preferred.

The multilateral instrument of a legally binding nature that is at present possibly best suited to govern this planetary boundary is a sophisticated regional treaty, the Convention on Long-Range Transboundary Air Pollution (CLRTAP). CLRTAP was adopted under the auspices of the UN Economic Commission for Europe, and is only open for ratification to its members (which includes North American countries).[30] It offers a detailed framework to regulate aerosol and gaseous emissions by using multiple protocols that set specific emission reduction targets for sulphur,[31] nitrogen oxides,[32] volatile organic compounds,[33] heavy metals[34] and persistent organic pollutants.[35] The latest protocol, the 1999 Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone, follows a markedly different approach to the previous protocols: instead of adopting a siloed approach, regulating one type of aerosol at a time, it sets national emissions ceilings for four pollutants – sulphur dioxide, nitrogen

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25 UNGA Res 70/1, 'Transforming Our World: The 2030 Agenda for Sustainable Development' (25 September 2015) ('SDGs'), Goal 2 (food security), Goal 3 (health), Goal 7 (sustainable energy), Goal 9 (resilient infrastructure, industrialisation and innovation), Goal 11 (sustainable cities), Goal 12 (sustainable consumption and production patterns), Goal 13 (climate action), Goal 14 (marine environment) and Goal 15 (life on land).

26 SDGs, target 11.6 on reducing the environmental and human health impacts of cities, 'paying special attention to air quality', and target 3.9 on reducing deaths and illnesses from air pollution.

27 WHO, 'Air Quality Guidelines. Global Update 2005: Summary of Risk Assessment' (2006) WHO/SDE/PHE/OEH/06.02.

28 For instance, it has been established that 92 per cent of the world's population still live in places where air quality levels exceed the WHO guidelines for $PM_{2.5}$. See WHO (n 11).

29 Geneva Action Agenda to Combat Air Pollution (1 November 2018) <www.who.int/phe/news/clean-air-for-health/en/> accessed 14 November 2019.

30 Convention on Long-Range Transboundary Air Pollution (adopted 13 November 1979, entered into force 16 March 1983) 18 ILM 1442 ('CLTRAP') art 14(1).

31 Helsinki Protocol on the Reduction of Sulphur Emissions or their Transboundary Fluxes by at least 30 per cent (adopted 8 July 1985, entered into force 2 September 1987) 1480 UNTS 215 ('Helsinki Protocol'); Oslo Protocol on Further Reduction of Sulphur Emissions (adopted 14 June 1994, entered into force 5 August 1998) 2030 UNTS 122 ('Oslo Protocol').

32 Protocol concerning the Control of Emissions of Nitrogen Oxides or their Transboundary Fluxes (adopted 31 October 1998, entered into force 14 February 1991) 1593 UNTS 287.

33 Protocol concerning the Control of Emissions of Volatile Organic Compounds or their Transboundary Fluxes (adopted 18 November 1991, entered into force 29 September 1997) 2001 UNTS 187.

34 Protocol on Heavy Metals (adopted 24 June 1998, entered into force 29 December 2003) 2237 UNTS 4 ('Aarhus Protocol').

35 Protocol on Persistent Organic Pollutants (adopted 24 June 1988, entered into force 23 December 2003) 37 ILM 505 ('POPs Protocol').

oxides, volatile organic compounds and ammonia – and seeks to limit their broad-ranging environmental impacts.[36] Amended in 2012, the Protocol has become the first binding agreement to target $PM_{2.5}$ (including black carbon) emissions.[37] Assessments of the effectiveness of the Convention vary depending on how it is measured, but the treaty is generally considered to have been successful at reducing certain air pollutants.[38] The detailed air quality framework of the EU has contributed to the implementation of the CLRTAP by setting uniform rules with regard to emission reduction commitments[39] and air quality standards,[40] and by regulating some sources of air pollution, including vehicles and industrial activities.[41] While generally successful at improving air quality, the framework is currently struggling to reduce some air pollutants in Member States, as demonstrated by multiple litigation cases challenging failures by national governments to draw up appropriate air quality plans and to keep within the limit values set for specific pollutants.[42]

Other regions have, albeit less ambitiously, also sought to address the problem of air quality. In Asia, multiple regional intergovernmental cooperative efforts address air pollution,[43] with a particular emphasis on reducing acid rain caused by sulphur oxide emissions[44] and haze due to forest burning,[45] and on coordination and collaboration.[46] In Africa, four United Nations

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[36] Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone (adopted 30 November 1999, entered into force 17 May 2005) 2319 UNTS 81 ('Gothenburg Protocol').

[37] Gothenburg Protocol, 'Adoption of amendments of the text of and Annexes II to IX and addition of new Annexes X and XI' (adopted 4 May 2012, entered into force 7 October 2019) C.N.155.2013. TREATIES-XXVII.1.h ('Amended Gothenburg Protocol').

[38] See for instance, for a positive assessment, Leen Hordijk and Markus Amann, 'How Science and Policy Combined to Combat Air Pollution Problems' (2007) 37(4) Environmental Policy and Law 336; compare with Adam Byrne, 'The 1979 Convention on Long-Range Transboundary Air Pollution: Assessing its Effectiveness as a Multilateral Environmental Regime after 35 Years' (2015) 4(1) Transnational Environmental Law 37.

[39] eg Directive 2016/2284/EU of 14 December 2016 on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC [2016] OJ L344/1.

[40] Directive 2008/50/EC of 21 May 2008 on ambient air quality and cleaner air for Europe [2008] OJ L152/1.

[41] Directive 2007/46/EC of 5 September 2007 establishing a framework for the approval of motor vehicles [2007] OJ L263/1; Directive 2010/75/EU of 24 November 2010 on industrial emissions [2010] OJ L334/17.

[42] See, by way of example, litigation directed at the UK government's failure to comply with the Air Quality Directive, *R (ClientEarth) v The Secretary of State for the Environment, Food and Rural Affairs* [2013] UKSC 25; *R (ClientEarth) v Secretary of State for the Environment, Food and Rural Affairs (No. 3)* [2018] EWHC 315 (Admin); and at the EU level, see eg Case C-336/16 *European Commission v Republic of Poland* [2018] ECLI:EU:C:2018:94.

[43] Malé Declaration on Control and Prevention of Air Pollution and its Likely Transboundary Effects for South Asia (22 April 1998); Framework Convention on Preservation of Environment for Sustainable Development of Central Asia, art 8 (adopted 22 November 2006, not in force).

[44] EANET, 'Joint Announcement on the Implementation of the Acid Deposition Monitoring Network in East Asia' (25–26 October 2000) EANET/IG 2/5/2 rev; EANET, 'Instrument for Strengthening the Acid Deposition (Monitoring Network in East Asia)' (2010).

[45] ASEAN Agreement on Transboundary Haze Pollution (adopted 10 June 2002, entered into force 25 November 2003) ('ASEAN Haze Agreement').

[46] See for instance the Asia Pacific Clean Air Partnership that coordinates the clean air programmes in the region: UNEP, 'What We Do' (UN Environment Programme, 2020) <www.unenvironment.org/asia-and-pacific/asia-pacific-clean-air-partnership/what-we-do> accessed 27 March 2020.

Environment Programme (UNEP)-sponsored policy frameworks on air pollution have been developed to generate and share knowledge and strengthen institutional capacity, but their guidance remains too general to be transformational.[47] In Latin America and the Caribbean, an intergovernmental network on air pollution has been established but has not been formally institutionalized, which has resulted in minimal outputs.[48] In addition, some States have adopted bilateral air quality agreements, such as those in place in North America.[49] While these have successfully reduced aerosol emissions in some instances, their restricted geographical scope offers limited protective coverage to the atmospheric aerosol loading boundary.

3.1.2 Sector-specific responses to air pollution

General approaches to air pollution are complemented by sector-specific responses, with shipping and aviation taking steps to regulate their impacts on air pollution. International shipping is an important sector in the context of atmospheric aerosol loading: having grown by 3.8 per cent between 2000 and 2015,[50] it is responsible for increases in emissions of nitrogen oxides, volatile organic compounds and particulate matter.[51] A general duty to prevent pollution of the marine environment, including 'from or through the atmosphere', is found in the UN Convention on the Law of the Sea[52] and reproduced in regional law of the sea treaties. More specific obligations to limit aerosol emissions are found in the International Convention for the Prevention of Pollution from Ships (MARPOL),[53] Annex VI of which sets emission limits on aerosols such as nitrogen oxides and sulphur oxides, creates designated emissions control areas with stricter standards and adopts technical and energy efficiency measures as well as fuel oil standards.[54]

Similarly, the aviation sector can have a noteworthy impact on this planetary boundary because aircraft emit nitrogen oxides, sulphur oxides, ozone, methane, black carbon, hydrocarbons and water vapour. Since the late 1970s, the International Civil Aviation Organization

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47 Southern African Development Community Regional Policy Framework on Air Pollution (7 March 2008); Eastern Africa Regional Framework Agreement on Air Pollution (23 October 2008); West and Central Africa Regional Framework Agreement on Air Pollution (22 July 2009); North African Framework Agreement on Air Pollution (12–16 December 2011).

48 'Regional Plan of Action on Atmospheric Pollution', XIX Meeting of the Forum of Ministers of Environment for Latin America and the Caribbean (14 March 2014).

49 Agreement of Cooperation between the United States of America and the United Mexican States Regarding Transboundary Air Pollution Caused by Copper Smelters along their Common Border (adopted 29 January 1987, entered into force 29 January 1987) 26 ILM 33; Agreement of Cooperation between the Government of the United States of America and the Government of the United Mexican States Regarding International Transport of Urban Air Pollution (adopted 3 October 1989) 29 ILM 29; Agreement on Air Quality (Canada–US) (adopted 13 March 1991, entered into force 13 March 1991) 1852 UNTS 79, and supplementary protocol and annex on ground-level ozone (7 December 2000).

50 International Energy Agency, *Tracking Clean Energy Progress 2017* (OECD/IEA 2017) 48.

51 Naya Olmer et al, *Greenhouse Gas Emissions From Global Shipping, 2013–2015* (International Council on Clean Transportation 2017) 19–20.

52 United Nations Convention on the Law of the Sea (adopted 10 December 1982, entered into force 16 November 1994) 1833 UNTS 3, arts 212(3) and 222. See also Diz, Chapter 17, Stephens, Chapter 16, in this book.

53 International Convention for the Prevention of Pollution from Ships (adopted 2 November 1973, entered into force 2 October 1983) 1340 UNTS 184.

54 MARPOL, Annex VI Prevention of Air Pollution from Ships (entered into force 19 May 2005, revised in October 2008, entered into force 1 July 2010) MARPOL Annex VI.

(ICAO) has been working on limiting and reducing the impact of aviation emissions on local air quality in the vicinity of airports.[55] Air pollution is regulated by volume II of annex 16 of the Chicago Convention on International Civil Aviation, adopted in 1981 to govern environmental protection. It has since been regularly amended.[56] The ICAO Council is assisted by the Committee on Aviation Environmental Protection, established in 1983, to develop international standards and recommended practices. These now include standards for aircraft engine emissions covering smoke and gaseous emissions of hydrocarbons, carbon monoxide and nitrogen oxides, and controls on particulate matter emissions.[57] Yet – discounting the recent halt in its growth due to the COVID-19 pandemic – if the civil aviation sector continues to grow by approximately 5 per cent a year,[58] these measures might be lacking in ambition.

3.1.3 Co-benefits of environmental regimes

International initiatives whose main objective is not explicitly air quality governance can nevertheless protect this planetary boundary. For instance, international responses to hazardous substances, such as persistent organic pollutants[59] and heavy metals,[60] indirectly protect the planetary boundary because they can be absorbed by fine particulate matter and become aerosolised. Similarly, the recent international attention given to short-lived climate pollutants in the context of climate action – these being responsible for global temperature increases as they trap heat in the troposphere and prevent it from being radiated into space – also benefit air quality. Among them, the aerosol black carbon is thought to be the second greatest contributor to climate change after carbon dioxide,[61] and is a toxic component of global particulate matter air pollution, which is among the top ten leading risk factors for early deaths globally.[62] Black carbon emissions are governed by the Gothenburg Protocol as amended in 2012 to include black carbon within the scope of particulate matter emission reduction targets, making it the first international treaty to regulate this aerosol.[63] The International Maritime Organization (IMO) and the ICAO are also in the process of designing black carbon policies

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55 ICAO Assembly Res A40-17 ‘Consolidated Statement of Continuing ICAO Policies and Practices Related to Environmental Protection. General Provisions, Noise and Local Air Quality’ (October 2019), Appendix H ‘aviation impact on local air quality’.

56 Convention on International Civil Aviation (adopted 7 December 1944, entered into force 14 April 1947) 15 UNTS 295, Annex 16, volume II.

57 ICAO, *2019 Environmental Report* (ICAO 2019) 97–99.

58 Mauro Masiol and Roy M Harrison, ‘Aircraft Engine Exhaust Emissions and Other Airport-related Contributions to Ambient Air Pollution: A Review’ (2014) 95 Atmospheric Environment 409, 409.

59 Convention on Persistent Organic Pollutants (adopted 22 May 2001, entered into force 17 May 2005) 2256 UNTS 119. See also POPs Protocol (n 35); Amendments to the Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources (adopted 7 March 1996, entered into force 18 May 2006) art 5 and Annex III (pollution transported through the atmosphere).

60 Aarhus Protocol (n 34) Annex I; Minamata Convention on Mercury (adopted 10 October 2013, entered into force 16 August 2017) <www.mercuryconvention.org/> accessed 2 November 2019, art 8, Annex D.

61 Veerabhadran Ramanathan and Gregory Carmicheal, ‘Global and Regional Climate Changes Due to Black Carbon’ (2008) 1 Nature Geoscience 221; IPCC, ‘Summary for Policymakers’ in Valérie Masson-Delmotte et al (eds), *IPCC Special Report on the Impacts of Global Warming of 1.5°C* (Cambridge University Press 2018).

62 Joshua S Apte et al, ‘Addressing Global Mortality from Ambient PM2.5’ (2015) 49 Environmental Science & Technology 8057.

63 Amended Gothenburg Protocol (n 37) arts 2(5)-(6).

applicable to their sectors.[64] These are complemented by softer means of cooperation in the form of non-legally binding initiatives – such as the Arctic Council's framework for action on enhanced black carbon and methane emission reductions,[65] which adopted a collective, aspirational, regional goal for reducing black carbon emissions[66] – and voluntary partnerships – for instance, the Climate and Clean Air Coalition (CCAC) facilitates cooperation among various stakeholders to improve air quality.[67] As is often the case with instruments and initiatives that focus on limiting aerosol emissions, the approach is target-oriented, offering States some flexibility in deciding how to meet specific objectives while encouraging them to apply best available technologies.

4. GOVERNING POLLUTION SOURCES

A second approach to governing this planetary boundary is to regulate the main sources of aerosols. Legal responses in this category do not necessarily adopt the same command-and-control approach as those that concentrate on reducing emissions. Instead, they favour deep, structural transformations to offer alternatives to the activities responsible for aerosol emissions. The emphasis is on building capacity and fostering cooperation in sectors such as transport, energy or cooking and heating, which produce high levels of aerosol emissions. While the international community logically concentrates on anthropogenic sources of aerosols, it has sometimes also focused on natural aerosols, the emissions of which are exacerbated by human activities that result in unsustainable land and water management as well as land degradation, such as in the case of sand and dust storms.[68]

Major sources of human-made aerosols are fossil fuel combustion and land-use changes. With regards to fossil fuel combustion, a treaty prohibiting fossil fuels and encouraging renewable energy has yet to emerge.[69] Instead, this source of aerosol emissions is indirectly regulated by climate and energy instruments. By aiming to reduce greenhouse gas emissions, international climate treaties implicitly encourage a reduction in fossil fuel use, which also

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[64] Following the plan of work adopted by the IMO Marine Environment Protection Committee, MEPC 62/24 'Report of the Marine Environment Protection Committee on its Sixty-Second Session' (26 July 2011), para 4.20; ICAO Res A40-17 (n 55) Appendix H, para 5.

[65] Arctic Council, 'Framework for Action on Enhanced Black Carbon and Methane Emissions Reductions' (2015) <http://hdl.handle.net/11374/610> accessed 3 November 2019.

[66] Arctic Council, 'Expert Group on Black Carbon and Methane; Summary of Progress and Recommendations' (2017) 4 <http://hdl.handle.net/11374/1936> accessed 14 November 2019.

[67] See, for instance, Climate and Clean Air Coalition, 'Marrakech Communiqué' (14 November 2016) HLA/NOV2016/03A rev1, committing to reduce black carbon emissions through cleaner diesel fuels and vehicles.

[68] UNCCD, 'Sand and Dust Storms' (UNCCD) <www.unccd.int/actions/sand-and-dust-storms> accessed 10 June 2020.

[69] For such proposals, see Margaretha Wewerinke-Singh, *Thinking Globally, Acting Regionally: The Case for a Pacific Climate Treaty* (Pacific Islands Development Forum & Pacific Islands Climate Action Network 2016), art 3 on 'phasing-out fossil fuels'; and Anthony Burke and Stefanie Fishel, 'A Coal Elimination Treaty 2030: Fast Tracking Climate Change Mitigation, Global Health and Security' (2020) Earth System Governance 100046.

contributes to a decrease in aerosol emissions.[70] Multiple voluntary initiatives also promote access to clean energy and energy efficiency in the context of the Sustainable Energy for All Initiative and SDG 7.[71]

As for land-use changes, and in particular deforestation for agricultural purposes, international law has remained largely unresponsive, as demonstrated by the repeated failures of the international community to adopt a legally binding treaty on forest protection.[72] A major exception are the treaties adopted by the Association of Southeast Asian Nations (ASEAN) on the conservation of nature and natural resources[73] and on transboundary haze pollution,[74] both of which aim to prevent forest fires. However, the language of their provisions is weak,[75] and enforcement can be difficult, as demonstrated by high smog levels in the region due to burning of forest and peat.[76] Land-use changes are also governed by international instruments and initiatives seeking to reduce desertification[77] and combat sand and dust storms.[78]

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70 United Nations Framework Convention on Climate Change (adopted 9 May 1992, entered into force 21 March 1994) 1771 UNTS 107; Kyoto Protocol to the United Nations Framework Convention on Climate Change (adopted 11 December 1997, entered into force 16 February 2005) 2303 UNTS 162; Paris Agreement (adopted 12 December 2015, entered into force 4 November 2016) 55 ILM 740.

71 See, eg, the Clean Cooking Alliance established in 2010 to accelerate the development and distribution of clean cooking solutions to limit indoor air pollution: <www.cleancookingalliance.org/> accessed 12 November 2019.

72 See UNECD, 'Non-Legally Binding Authoritative Statement of Principles for a Global Consensus on the Management, Conservation and Sustainable Development of All Types of Forests' (21 April 1992) A/CONF.151/6; UNECD, 'Report of the United Nations Conference on Environment and Development' (14 August 1992) UN Doc A/CONF.151/26 (Vol. III) Annex III; and UNGA Res 62/98 'Non Legally Binding Instrument on All Types of Forests' (17 December 2007). For an analysis of how international law protects forests, see Leslie-Anne Duvic-Paoli, 'Trees' in Jessie Hohmann and Daniel Joyce (eds), *International Law's Objects* (Oxford University Press 2018) 504–14.

73 Agreement on the Conservation of Nature and Natural Resources (adopted 9 July 1985, not in force) art 6(2)(a) <https://environment.asean.org/agreement-on-the-conservation-of-nature-and-natural-resources/> accessed 9 March 2020.

74 ASEAN Haze Agreement (n 45) art 2.

75 For a detailed analysis of its weaknesses, see Laely Nurhidayah, Zada Lipman and Shawkat Alam, 'Regional Environmental Governance: An Evaluation of the ASEAN Legal Framework for Addressing Transboundary Haze Pollution' (2014) 15(1) Australian Journal of Asian Law 1.

76 See, eg, Jonathan Watts, 'Malaysia Complains of Smog from Indonesian Forest Fires' *The Guardian* (6 September 2019).

77 United Nations Convention to Combat Desertification in Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa (adopted 17 June 1994, entered into force 26 December 1996) 1954 UNTS 3 ('UNCCD'); Sustainable Development Goal 15; UNEA Res 2/24, 'Combating Desertification, Land Degradation and Drought and Promoting Sustainable Pastoralism and Rangelands' (3 August 2016).

78 See eg, UNCCD Decision 31/COP.13, 'Policy Advocacy Framework to Combat Sand and Dust Storms' (15 September 2017); UNEA Res 2/21, 'Sand and Dust Storms' (3 August 2016); UNGA Res 72/225, 'Combating Sand and Dust Storms' (20 December 2017), inviting the establishment of an inter-agency framework for cooperation. For regional initiatives, see, eg, Economic and Social Commission for Asia and the Pacific Resolution 72/7, 'Regional Cooperation to Combat Sand and Dust Storms in Asia and the Pacific' (24 May 2016).

5. CHALLENGES PRESENTED BY THE PLANETARY BOUNDARY FOR LAW AND GOVERNANCE

The state of the law and governance in relation to the atmospheric aerosol loading boundary, as described above, demonstrates that the international community has so far struggled to provide an appropriate response to the problem of atmospheric aerosol loading. Below we identify multiple factors that contribute to an explanation of why protecting this elusive planetary boundary has been so challenging.

5.1 Framing Disconnect

To start with, international legal responses to the aerosol loading problem are faced with a framing disconnect between the environmental problem that defines the planetary boundary and the policy and legal lexicon used to describe it. The planetary boundary employs the term ‘aerosols’ – a term that will be unfamiliar to policy-makers and lawyers and that is rarely used in legal texts. Instead, the terms ‘atmospheric degradation’ and ‘air pollution’ are usually employed by lawyers. Yet, the two terms do not necessarily fit the material scope of the planetary boundary. Atmospheric degradation is broader than aerosol loading and includes not only air pollution, but also ozone depletion and climate change.[79] Similarly, air pollution is not equivalent to aerosol loading, since air pollutants include, but are not restricted to, aerosols. Consequently, the law and governance landscape presented above is necessarily a combination of different, ad hoc regimes that are relevant to the planetary boundary but do not match it perfectly. This might explain, at least in part, why the aerosol loading boundary is one of the lesser known planetary boundaries among policy-makers and lawyers.

5.2 Scientific Complexity and Uncertainty

Addressing the governance challenges of this planetary boundary is also difficult because aerosol loading is characterised by high levels of scientific complexity and uncertainty. Pollution of any type is generally difficult to regulate, because it emanates from different sources, takes different forms and causes different impacts. Aerosols cannot be approached as a single, uniform category because their behaviour in the atmosphere is extremely complex and depends on their chemical composition as well as their geographical location. In addition, the planetary boundary itself is characterised by scientific uncertainty, since it has so far been impossible to quantify it – that is, to recognise a global threshold beyond which humanity would not be operating within a safe zone.[80] In fact, it is one of only two planetary boundaries (alongside ‘novel entities’) for which quantification has not been possible. The absence of a threshold is problematic because it fails to inspire the sense of urgency which is generally necessary to mobilise policy-makers and civil society.[81]

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79 International Law Commission (ILC), ‘Protection of the atmosphere – Texts and titles of draft conclusions 1, 2 and 5, and preambular paragraphs provisionally adopted by the Drafting Committee on 13, 18, 19 and 20 May 2015’ (22 May 2015) A/CN.4/L.851, draft guideline 1(c).

80 Rockström et al (n 5).

81 Florian Klapproth, ‘Time and Decision Making in Humans’ (2008) 8(4) Cognitive, Affective, & Behavioral Neuroscience 509, 519.

The planetary boundary is consequently also faced with major knowledge gaps regarding how aerosols interact with each other and with the climate, and how they damage human health and the environment. A fundamental element of scientific uncertainty relates to the impacts that aerosols have on total radiative forcing estimates, one of the most critical and significant uncertainties in climate change projections.[82] Tackling air pollution may reduce the cooling effect of some aerosols and lead to further surface warming. Yet, climate models remain unable to reliably predict the consequences of reducing aerosols.[83] Although scientific knowledge is improving, the complexity of the interactions has significant implications for decision-makers that lack the scientific basis to make informed and integrated decisions. While global environmental issues such as climate change and biodiversity now benefit from global science-policy interfaces that synthesize existing knowledge to facilitate decision-making, such a mechanism remains lacking in the case of air pollution. Pursuant to the precautionary principle, the absence of scientific certainty should not preclude decision-makers from taking action, but the lack of scientific clarity regarding the behaviour of aerosols can undermine the design of effective policies.[84] In addition, the evolving nature of scientific knowledge on aerosol loading means that legal instruments (as the CLRTAP model shows), need to be highly adaptive in order to best reflect the latest knowledge.

5.3 Multi-level Governance

The elusiveness of this particular planetary boundary is also due to the fact that it approaches aerosol loading as a global challenge when it is primarily a localised problem.[85] The rationale for a separate boundary on aerosol loading has in effect been justified in spatially restricted terms, on the basis of the 'effect of aerosols on *regional* ocean-atmosphere circulation'.[86] This is not to say that atmospheric aerosol loading does not have global impacts: air pollution can have major long-range transboundary effects in other regions or on the global climate. However, scientists have not been able to identify a global safe threshold for the planetary boundary. Instead, they have only been able to define with certainty a planetary boundary for aerosol loading of a regional scale – in relation to the effects of aerosols on monsoon patterns in South East Asia.[87] While air pollution is now understood as a complex issue that can have regional, hemispheric and global impacts, it has nevertheless been noted that 'the spatial heterogeneity of aerosol loading warrants more geographically specific management'.[88] This scientific reality fits well with policy-makers' reluctance, mentioned above, towards adopting a global outlook on the governance of air pollution and has resulted in governance initiatives with a regional and local focus.[89] In other words, the global (or *planetary*) outlook of this par-

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82 IPCC AR5 Synthesis Report (n 20) 44.

83 IPCC AR5 Clouds and Aerosols (n 20) 576.

84 See Collins, Chapter 6 in this book.

85 See Kim and Kotzé, Chapter 3 in this book on the issue of downscaling.

86 Steffen et al (n 19) 1259855-7 (emphasis added).

87 Ibid.

88 Ted Nordhaus, Michael Shellenberger and Linus Blomqvist, *The Planetary Boundary Hypothesis: A Review of the Evidence* (Breakthrough Institute 2012) 30.

89 UN, 'Agenda 21, Annex II to the Report of the United Nations Conference on Environment and Development (3–14 June 1992)' UN Doc. A/CONF.151/26, Chapter 9, para 9.27(c), encouraging the adoption and implementation of regional air agreements.

ticular planetary boundary fails to fully acknowledge the complexity of governance between scales.

5.4 Political Reluctance

The historical reluctance of States to govern the atmosphere presents an additional challenge to this boundary. Air pollution remains a poorly regulated problem at a global level. This does not mean it is completely disregarded by international law. After all, one of the foundational cases of international environmental law – the *Trail Smelter* case[90] – was essentially a case of air pollution. Yet, States have shown little appetite for regulating the issue comprehensively at a global level. Rules of customary international law, including the prohibition to cause transboundary harm and the duties to undertake environmental impact assessments and to cooperate, remain applicable in the context of this planetary boundary, but additional instruments are necessary given the level of specificity required to adequately respond to aerosol pollution. While in 1982 the UNEP Governing Council called for the preparation of a 'global code of conduct with respect to transboundary air pollution, drawing upon existing regional and bilateral experience',[91] the recommendation was never followed through. As a result, to date, no single comprehensive treaty governs the planetary boundary.

Admittedly, air pollution is becoming increasingly important on the international agenda, as evidenced by the recent work of the UNEA and WHO mentioned above. Yet, States generally remain unwilling to find solutions to the gaps within, and between, existing treaty regimes. Notably, the work of the ILC on the protection of the atmosphere could have filled such gaps.[92] However, its mandate was significantly restricted with regard to its outcome, which will take the form of guidelines (and not articles), as well as its content, by excluding numerous related topics currently under negotiation (such as long-range transboundary air pollution and black carbon).[93] Similarly, the SDGs do not include a standalone goal on air pollution, which could have raised the symbolic relevance of air pollution globally and possibly helped to adopt a more coordinated approach to the problem.

5.5 Legal Fragmentation

The scientific impossibility of a one-size-fits-all approach to aerosols and the political reluctance to adopt obligations to prevent atmospheric degradation have resulted in a fragmented legal landscape.[94] Fragmentation is a general problem of international environmental law that has adopted a sectoral approach to environmental problems.[95] The phenomenon is not

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[90] *Trail Smelter (United States v Canada)* (16 April 1938 and 11 March 1941), [1941] 3 RIAA 1905.

[91] UNEP Governing Council Decision 10/21 (31 May 1982).

[92] ILC, 'Report of the International Law Commission to the General Assembly on the Work of its 65th Session' (6 May–7 June and 8 July–9 August 2013) UN Doc A/68/10, 115 ('ILC Report'), para 168. For a critical analysis of the mandate, see Peter Sand, 'The Discourse on "Protection of the Atmosphere" in the International Law Commission' (2017) 26(3) Review of European, Comparative and International Environmental Law 201.

[93] ILC Report (n 92) para 168.

[94] See also Piselli and Van Asselt, Chapter 7 in this book.

[95] Rakhyun E Kim and Klaus Bosselmann, 'International Environmental Law in the Anthropocene: Towards a Purposive System of Multilateral Environmental Agreements' (2013) 2 Transnational Environmental Law 285, 286.

necessarily negative: specific instruments (either in geographical or material scope) are generally better adapted to local circumstances (environmental, economic and/or technological). Political consensus is also more easily achieved, and ambition raised, when the number of negotiating States is limited, or when the scope of the problem to be solved is limited.

However, this particular planetary boundary arguably cannot be protected in a homogenous manner without a holistic approach to aerosol loading. A first difficulty arises from the nature of aerosols: they often clump together and form complex mixtures, which means that a siloed legal approach – regulating air pollutants individually – is unable to account for the effects of their interactions.

The second challenge relates to the consequences of fragmentation: not only does regulation vary depending on the aerosol, but one aerosol might even fall under the scope of multiple legal sources applicable to different members. That is for instance the case with sulphur dioxide emissions (a source of major health problems and which is responsible for acid rain), which are regulated by a patchwork of regional and bilateral treaties.[96] While generally speaking these instruments have successfully reduced sulphur dioxide emissions,[97] such a piecemeal approach dilutes responsibility, which in turn limits accountability.

A third, and related, problem arising from fragmentation is geographical: significant portions of the planet are not covered by a legally binding transboundary agreement, and some do not even fall under a regional air pollution network.[98] While various regional air pollution arrangements exist, they are at various stages of development and often largely aspirational.[99] They are predominantly scientific networks, such as the Acid Deposition Monitoring Network in East Asia, or political endeavours, such as the Southern African Development Community Regional Policy Framework on Air Pollution,[100] that remain 'soft' in nature and often suffer from implementation deficits. Atmospheric aerosol loading cannot therefore be governed in a homogenous manner because levels of cooperation are uneven across regions and regional forums have operated so far largely in isolation. Overall, while a complex web of legal instruments protects the planetary boundary, this is under extremely limited circumstances given their restricted material and spatial scope, thereby leaving substantial gaps in the governance of the planetary boundary.

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96 Helsinki Protocol (n 31); Oslo Protocol (n 31); Agreement between the Government of Canada and the Government of the United States on Air Quality (adopted 13 March 1991, entered into force 13 March 1991) Annex I(1); MARPOL Annex VI (n 54) regulation 14 (sulphur dioxide and particulate matter).

97 See, for instance, *Canada–United States Air Quality Agreement Progress Report 2016* (2017), 4–7, noting the major reductions in sulphur dioxide as a result of the Canada–US Agreement on Air Quality.

98 Such as the Middle East and Oceania. For the geographical coverage of the main existing regional air pollution networks, see figure 1 in CLRTAP Executive Body, 'Strengthening Cooperation with Regional Air Pollution Networks and Initiatives outside the Convention. Submitted by the secretariat of the Global Atmospheric Pollution Forum' (12–16 December 2011) Informal document No 12.

99 Werner Scholtz and Jonathan Verschuuren, 'Introduction', in Werner Scholtz and Jonathan Verschuuren (eds), *Regional Environmental Law: Transregional Comparative Lessons in Pursuit of Sustainable Development* (Edward Elgar 2015) 16.

100 Southern African Development Community Regional Policy Framework on Air Pollution (n 47).

5.6 Non-Treaty-based Approaches

Political resistance towards a comprehensive framework has also resulted in the multiplication of non-treaty-based approaches to air pollution governance. For instance, traditional approaches to regulating black carbon through legally binding instruments have had limited success at the IMO and the ICAO, while the amendment to the Gothenburg Protocol covering black carbon emissions has been slow to enter into force. Conversely, voluntary initiatives have multiplied, for instance at the Arctic Council and through the CCAC. There are various reasons why these voluntary initiatives can have substantial advantages, to the extent that they might address some of the shortcomings of the more formal, treaty-based approaches.

First, consensus is generally slow to develop around legally binding instruments and relies on the existence of a common understanding of the problem and proposed solutions that are often the result of voluntary cooperation. Second, international treaties are not always sufficiently flexible to adapt to the rapid evolution of scientific knowledge over the health and environmental impacts of air pollutants, whereas voluntary initiatives are. Third, multi-stakeholder initiatives facilitate the involvement of non-State actors, and their participation is often central to facilitating implementation. For instance, the CCAC now includes 67 countries, 18 intergovernmental organisations and 57 non-governmental organisations (NGOs).[101] Similarly, *BreatheLife*, a joint campaign started in 2016 led by the WHO, UNEP and the CCAC, seeks *inter alia* to mobilise cities and subnational actors to commit to achieving WHO Air Quality Guidelines by 2030. Due to their largely aspirational qualities, these initiatives have an important role in mobilising stakeholders and building capacity. But without rigorous monitoring or reporting or a compliance process, their ability to provide a sufficiently ambitious response to the planetary air quality crisis remains uncertain.

6. CONCLUDING REMARKS AND RECOMMENDATIONS

The chapter has highlighted major gaps in our legal and policy response to atmospheric aerosol loading. Our conclusions are, however, not all entirely negative. For example, air pollution – and, therefore, aerosol loading – has recently been given more important status on the international agenda, including at the UNEA, WHO and UN General Assembly. Nevertheless, the framework offered by the planetary boundary is not necessarily helpful to mobilise the international community. Atmospheric aerosol loading remains one of the lesser known planetary boundaries in legal and policy circles, and the framework offered by the atmospheric aerosol loading planetary boundary is facing noteworthy difficulties. First, its global, planetary scope seems unable to always account for the localised impacts of atmospheric aerosol loading. Second, it is extremely difficult to make sense of the exact relationship between this planetary boundary and the other boundaries, given the complex interactions between aerosol loading and other boundary concerns such as climate change, ozone and freshwater. Third, by concentrating only on aerosol loading and not more broadly on air pollution, the planetary boundary finds itself ill at ease with existing legal frameworks. The framework therefore struggles to raise awareness and to adequately mobilise policy-makers.

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[101] Climate and Clean Air Coalition, 'Partners' <www.ccacoalition.org/en/partners> accessed 2 November 2019.

This chapter will conclude with five general recommendations on how to better respond to the problem of atmospheric aerosol loading, while acknowledging that the challenges identified in Section 4 remain substantial hurdles to the governance of this planetary boundary. A first fundamental step towards better protecting the planetary boundary lies in the gathering of solid scientific data. Indeed, further progress on the regulation of the planetary boundary is conditional on developing a common knowledge base that would be able to provide clear policy options to support well-informed governance action. Data on air quality is improving, but remains difficult to gather in low and medium-income countries.[102] Even when the data is available, difficulties remain regarding how to communicate it to policy-makers[103] and the general public.[104] Gathering scientific information to improve the quality and spatial coverage of existing data, using an Earth system science approach to facilitate inter- and multi-disciplinary collaborations and making existing knowledge widely accessible are all indispensable to the governance of the planetary boundary.

Second, attention should be given to strengthening existing instruments and initiatives. We have seen that the existing legal framework is too fragmented to offer holistic protection of the planetary boundary. However, even when a legal instrument offers partial protection to the planetary boundary, its effects are limited if emission reduction targets lack ambition and/or are not properly implemented – the regular breaching of EU air quality legislation is just one prominent example.[105] The influence of existing air quality networks and agreements might be strengthened if they were able to better coordinate their work and share scientific knowledge, best practices and policy failures. Enhanced cooperation could take different forms, including informal coordination between individual States to foster mutual learning, memoranda of understanding between different agreements or even the creation of a global confederation of networks.[106] By doing so, existing intergovernmental networks could offer more uniform coverage of this planetary boundary, thereby possibly overcoming some of the challenges arising from legal fragmentation.

Third, informal cooperative arrangements might be the most politically viable way forward. Naturally, the adoption of a global air pollution treaty would offer a more comprehensive response to atmospheric aerosol loading, but such a development is at present highly unlikely. Alternatively, progress can be achieved through informal means of cooperation facilitated by international organisations or NGOs. For instance, the Global Atmospheric Pollution Forum, which brought together regional networks, international organisations and various stakeholders, successfully provided opportunities to strengthen exchanges between regions. Similarly, political consensus is more easily reached thanks to the work of soft law initiatives focusing on issues that are geographically or materially restricted in scope, such as in the case of black carbon in the Arctic.

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[102] Nicole Wetsman, 'Air-pollution Trackers Seek to Fill Africa's Data Gap' (2018) 284 Nature 556.

[103] See, for instance, Sheila Jasanoff, *The Fifth Branch: Science Advisers as Policymakers* (Harvard University Press 1990) 101–22.

[104] R Beaumont et al, 'Social Awareness of Air Quality Information' (1999) 235(1–3) Science of the Total Environment 319.

[105] Yulia Yamineva and Seita Romppanen, 'Is Law Failing to Address Air Pollution? Reflections on International and EU Developments' (2017) 26(3) Review of European, Comparative and International Environmental Law 189, 195–97.

[106] CLRTAP Executive Body (n 98) para 73.

Fourth, it might be possible to build on existing synergies between air pollution and other environmental issues to benefit from the political mobilisation that already exists in these areas. While the interactions between the atmospheric aerosol loading boundary and other boundaries are complex, they could be used as an advantage. In particular, it has now become more apparent that climate change and air quality are tightly connected: this means that the political mobilisation in the climate regime can have important co-benefits for air quality. Certain aerosols can be regulated via the climate regime, for instance by including short-lived climate pollutants in nationally determined contributions.[107] Likewise, recognising the impacts of air pollution on biodiversity (for instance, forest degradation due to acid rain) in the context of ongoing discussion about the post-2020 biodiversity legal framework might also help address the problem more systemically.

Finally, the fragmented nature of air pollution governance offers opportunities to undertake legal experimentation at a smaller scale and to evaluate best practices. For instance, the CLRTAP, and in particular the multi-pollutant and multi-effect approach of its Gothenburg Protocol, provides a template for intergovernmental cooperation that could be replicated elsewhere. Despite its regional scope, the CLRTAP aims to be viewed as a global leader,[108] and its results are closely monitored in other regions.[109] Overall, better integration at all levels – between science and policy, between legal regimes, between different scales of governance – and the sharing of experience gained could help to alleviate the significant discrepancies that remain between the major risks posed by atmospheric aerosol loading and the existing multilateral legal and policy responses.

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[107] For an analysis of the extent to which current nationally determined contributions cover short-lived climate pollutants, see Katherine Ross et al, *Strengthening Nationally Determined Contributions to Catalyze Actions That Reduce Short-Lived Climate Pollutants* (World Resources Institute 2018).

[108] CLRTAP Decision 2018/5, ‘Long-term strategy for the Convention on Long-range Transboundary Air Pollution for 2020-2030 and beyond’ (2018), para 4.

[109] United Nations Economic Commission for Europe, ‘Entry into Force of Amended Gothenburg Protocol is Landmark for Clean Air and Climate Action’ (Press Release 4 October 2019).

16. Ocean acidification

Tim Stephens

1. INTRODUCTION

Ocean acidification is one of the nine planetary boundaries identified by Johan Rockström and colleagues as a vital limit for the safe existence of humanity.[1] Ocean acidification refers to the changing carbon chemistry of the oceans as they absorb carbon dioxide (CO_2) released by human activities. The ocean acidification planetary boundary is closely linked to the climate change boundary, as both relate to human disturbances to Earth's carbon cycle.[2] However, there are important differences, and the 'safe' threshold for climate change may not necessarily be equivalent to that for ocean acidification. Ocean acidification and related changes to ocean chemistry, including hypercapnia (excess concentration of carbon dioxide) and deoxygenation (reduced concentration of oxygen), are seriously impairing the health of marine ecosystems globally. However, they have not yet attracted concerted attention by governments, as seen in the limited or non-existent treatment of these issues by national, regional and global legal frameworks.

This chapter commences with an overview of the causes and effects of ocean acidification. The discussion then turns to the definition of the ocean acidification planetary boundary and an assessment of the boundary's strengths and limitations. As with other planetary boundaries, identifying a tolerable limit of change is not straightforward. The chapter then sets out the global legal and policy frameworks applicable to ocean acidification, including the Sustainable Development Goals (SDGs). It is seen that ocean acidification is addressed to some extent by a number of treaties but is not regulated in any comprehensive way by those regimes, either individually or collectively. The ocean acidification planetary boundary has greatest relevance to the climate regime built around the 1992 United Nations Framework Convention on Climate Change (UNFCCC) and the 2015 Paris Agreement on Climate Change, as this regime is the main forum where efforts to limit CO_2 emissions are being pursued.

2. OCEAN ACIDIFICATION: CAUSES AND CONSEQUENCES

Large volumes of CO_2 and other greenhouse gases have been emitted into the atmosphere from the burning of fossil fuels and other human activities such as land use change. The preindustrial atmospheric concentration of CO_2 in the atmosphere was around 280 parts per million by volume (ppmv) and it had reached around 315 ppmv by 1958, when the Scripps Institution

[1] Johan Rockström et al, 'Planetary Boundaries: Exploring the Safe Operating Space for Humanity' (2009) 14 Ecology and Society 32.

[2] See Verschuuren, Chapter 13 in this book.

of Oceanography commenced CO_2 measurements at the Mauna Loa Observatory in Hawaii.[3] Since this time there has been a rapid rise in the atmospheric concentration of CO_2, which as of October 2019 stood at 408 ppmv.[4] There has been an increase in the growth rate of CO_2 concentrations, from approximately 0.9 ppmv per annum in the 1960s to 2.00 ppmv in the early 2000s.[5] There is no indication that this increase is slowing, and the CO_2 that has been emitted 'remains in the atmosphere for centuries and in the oceans for even longer'.[6]

Around half of the CO_2 emitted remains in the atmosphere, while the other half is absorbed by natural systems on land and at sea.[7] The oceans have absorbed about 25 per cent of the carbon released from human activities since the nineteenth century.[8] It is this influx of CO_2 into the ocean which is causing acidification and related chemical changes. The oceans are mildly basic, and prior to the Industrial Revolution had a pH of around 8.2.[9] Since this time there has been a 0.1 unit fall in pH, which represents a 30 per cent increase in acidity.[10] The ocean environment is now more acidic than it has been for around 500,000 years.[11] As with other changes to the Earth system from human activities, ocean acidification is not able to be reversed within usual human timescales (decades or even centuries). Hughes and colleagues note that once 'marine systems have been altered by ocean acidification, they are likely to stay in a new regime for geological timescales, pointing to the imperative of action to reduce CO_2 emissions as early as possible during the current transitional period'.[12]

The chemistry of ocean acidification is well understood. When CO_2 is taken up by the oceans it reacts with H_2O to form carbonic acid (H_2CO_3), which dissociates to make hydrogen carbonate ions (HCO_3^-) and hydrogen ions (H^+). These hydrogen ions in turn combine with carbonate ions (CO_3^{2-}) in the water to form further hydrogen carbonate ions. One of the consequences of this process is that carbonate ion concentrations decrease, and this affects corals and other marine calcifiers that utilise calcium carbonate to form structures. Aragonite is a more soluble form of calcium carbonate and is therefore widely used, including in the planetary boundary context, as an indicator of ocean acidification.

Recognising the special importance of the oceans in the climate system and the carbon cycle, in 2019 the Intergovernmental Panel on Climate Change (IPCC) produced a *Special Report*

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3 NOAA Earth System Research Laboratory of the Global Monitoring Division 'Monthly Average Mauna Loa CO_2' <www.esrl.noaa.gov/gmd/ccgg/trends/mlo.html> accessed 11 June 2020.

4 Ibid.

5 Ibid.

6 World Meteorological Organization, 'Greenhouse Gas Concentrations in Atmosphere Reach Yet Another High' (WMO Press Release, 25 November 2019) <https://public.wmo.int/en/media/press-release/greenhouse-gas-concentrations-atmosphere-reach-yet-another-high> accessed 11 June 2020.

7 Jean-Pierre Gattuso and Lina Hansson, 'Ocean Acidification: Background and History' in Jean-Pierre Gattuso and Lina Hansson (eds), *Ocean Acidification* (Oxford University Press 2011) 1, 1.

8 Ibid.

9 Victoria Fabry et al, 'Impacts of Ocean Acidification on Marine Fauna and Ecosystem Processes' (2008) 65 ICES Journal of Marine Science 414, 415.

10 Tobias Friedrich et al, 'Detecting Regional Anthropogenic Trends in Ocean Acidification against Natural Variability' (2012) 2 Nature Climate Change 167.

11 Ove Hoegh-Guldberg et al, 'Coral Reefs under Rapid Climate Change and Ocean Acidification' (2007) 318 Science 1737.

12 Terry Hughes et al, 'Living Dangerously on Borrowed Time During Slow, Unrecognized Regime Shifts' (2013) 28 Trends in Evolution and Ecology 149, 153.

on Oceans and Cryosphere in a Changing Climate (SROCCC).[13] The SROCCC provides an updated assessment of climate science as it relates to the oceans and ice-covered areas, and is the first IPCC report to address ocean acidification in significant detail.[14] The SROCCC found that the global ocean has continued to warm unabated since 1970, taking up more than 90 per cent of excess heat in the climate system.[15] It is likely that the rate of warming has more than doubled since 1993.[16] Ongoing ocean heating has made marine heatwaves more intense and extensive.[17] There has been a continued rise in global mean sea level, with an acceleration in recent decades as a result of increasing ice loss from Greenland and Antarctica, continuing loss in glacier mass and the thermal expansion of the oceans.[18]

In relation to carbon chemistry, the SROCCC noted that it is very likely that the oceans have taken up between 20 and 30 per cent of CO_2 emissions since the 1980s.[19] The surface of the ocean has undergone increasing acidification.[20] Ocean surface pH has very likely declined by between 0.017 and 0.027 pH units per decade since the late 1980s,[21] and this is very likely to have placed the pH of 95 per cent of the surface ocean outside the range of background natural variability.[22] At the same time, the open ocean (to a depth of 1000m) has very likely lost oxygen by between 0.5 and 3.3 per cent.[23] These physical changes have had multiple ecosystem impacts. Since the 1950s many marine species have shifted their geographical range and seasonal behaviours in response to warming oceans, declining sea ice and biogeochemical changes.[24] This has changed species composition, abundance and biomass production,[25] and contributed to an overall decrease in maximum catch potential.[26]

The SROCCC projects that the ocean will transition to 'unprecedented conditions with increased temperatures (virtually certain), greater upper ocean stratification (very likely), further acidification (virtually certain), oxygen decline (medium confidence), and altered net primary production (low confidence)'.[27] Continued carbon uptake is virtually certain to result in the decrease of open ocean surface pH by around 0.3 pH units by 2081–2100 relative to 2006–15 if concentrations of greenhouse gases in the atmosphere continue to increase at current rates.[28] This poses risks for 'keystone aragonite shell-forming species due to crossing an aragonite stability threshold year-round in the Polar and sub-Polar Oceans by 2081-2100

13 Hans-Otto Pörtner et al (eds), *IPCC Special Report on the Ocean and Cryosphere in a Changing Climate* ('SROCCC Report' 2019) <www.ipcc.ch/report/srocc/> accessed 11 June 2020.

14 There appears to have been only one comprehensive regional assessment of ocean acidification, namely that undertaken by the Arctic Monitoring and Assessment Program in relation to the Arctic Ocean. See *AMAP Assessment 2013: Arctic Ocean Acidification* (AMAP 2013) and AMAP, *AMAP Assessment 2018: Arctic Ocean Acidification* (AMAP 2018).

15 Pörtner et al (n 13) 8.

16 Ibid.

17 Ibid 9.

18 Ibid 10.

19 Ibid 9.

20 Ibid 8.

21 Ibid 9.

22 Ibid 9.

23 Ibid 10.

24 Ibid 12.

25 Ibid.

26 Ibid 13.

27 Ibid 21.

28 Ibid 21.

(very likely)'.[29] A decrease in global biomass of marine animals and fisheries catch potential and a shift in species composition are projected to occur across all ocean ecosystems, with the rate of change highest in the tropics. Ocean acidification, oxygen loss, reduced sea ice extent and non-climatic human activities have the potential to worsen these impacts.[30]

3. THE OCEAN ACIDIFICATION PLANETARY BOUNDARY

The planetary boundaries concept was first advanced in 2009 in order to estimate 'a safe operating space for humanity with respect to the functioning of the Earth system'.[31] The original work was a 'first preliminary effort' at identifying key Earth system processes and attempted to quantify for each process the boundary level that should not be transgressed if humanity is to avoid unacceptable global environmental change.[32] In this context 'unacceptable change' was defined to mean unacceptable risks in the transition from the stability of the Holocene period to the Anthropocene.[33] The safe limits for the nine planetary boundaries were identified having regard to a safe distance either from thresholds, where the relevant process displayed threshold behaviour, or from dangerous levels, for processes not having thresholds.

Boundaries are, in the words of the authors, 'human-determined values of [a] control variable set at a "safe" distance from a dangerous level (for processes without known thresholds at the continental to global scales) or from its global threshold'.[34] This means that they involve 'normative judgements of how societies choose to deal with risk and uncertainty'.[35] The quantification of boundaries was based on control variables for each planetary boundary selected on the basis that they would provide 'the most comprehensive, aggregated, and measurable parameter for individual boundaries'.[36]

The control variable selected by Rockström and colleagues for ocean acidification was, and remains, aragonite saturation. They noted in their original work that changes to ocean CO_2 chemistry affect many marine organisms, particularly those that use carbonate ions to form calcium carbonate shells. Calcium carbonate is secreted by a number of marine organisms in the form of aragonite (such as by corals), calcite (such as by plankton) and magnesium calcite (such as by sea urchins). The concentration of carbonate ions in seawater strongly affects the saturation state of each of these types of calcium carbonate. Accordingly, as pH declines there is an accompanying fall in carbonate ion concentration and the saturation state of calcium carbonate. If the saturation state falls below one, then the calcium carbonate structure of an organism may become soluble.[37] Of the three types of calcium carbonate, aragonite is generally the more soluble form and will dissolve more readily. This makes it a suitable choice of indicator for tracking acidification.

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29 Ibid 21.
30 Ibid 25.
31 Rockström et al (n 1).
32 Ibid.
33 Ibid.
34 Ibid.
35 Ibid.
36 Ibid.
37 Ibid.

Table 16.1 *The ocean acidification planetary boundary*

Control variable	Threshold avoided or influenced by slow variable	Planetary boundary (zone of uncertainty)	State of knowledge
Carbonate ion concentration, average global surface ocean saturation state with respect to aragonite (Ωarag).	Conversion of coral reefs to algal dominated systems. Regional elimination of some aragonite- and high-magnesium calcite-forming marine biota. Slow variable affecting marine carbon sink.	Sustain ≥ 80% of the preindustrial aragonite saturation state of mean surface ocean, including natural variability (≥80%–≥70%).	1. Geophysical processes well known. 2. Threshold likely. 3. Boundary position uncertain due to unclear ecosystem response.

Source: Stockholm Resilience Centre, available at www.stockholmresilience.org/research/planetary-boundaries/planetary-boundaries/about-the-research/quantitative-evolution-of-boundaries.html.

At the time of the original planetary boundaries proposal, the aragonite saturation state (Ωarag) in the surface ocean stood at 2.9, having declined from a preindustrial value of 3.44. This is an average figure and the colder waters of the Arctic Ocean and the Southern Ocean have lower aragonite saturation values. Rockström and colleagues noted that negative impacts for many organisms are felt well above the geochemical threshold of Ωarag = 1. Coral reefs are particularly vulnerable and will experience extremely marginal conditions for Ωarag values below 3. It should also be noted that this impact combines and adds to temperature and other stressors on corals. Taking into account the saturation state at which calcification rates are substantially affected, when conditions for coral move from adequate to marginal, and when surface waters at the poles approach undersaturation, it was concluded that '[a]s a first estimate' the planetary boundary for ocean acidification is one in which the oceanic aragonite saturation state is 80 per cent higher than the preindustrial level (that is, Ωarag of 2.75). Rockström and colleagues explained that '[t]he major rationale behind this subjective value is twofold: to keep high-latitude surface waters above aragonite undersaturation and to ensure adequate conditions for most coral systems'.[38]

In 2015 Steffen and colleagues published in *Science* a refinement and update to the planetary boundary framework, which introduced a two-tier approach for several boundaries to address regional-level variations and updated the quantification of most planetary boundaries.[39] In relation to ocean acidification there was no proposal that the indicator or boundary be adjusted. Steffen and colleagues noted that '[n]o new evidence has emerged to suggest that the originally proposed boundary (≥80% of the preindustrial average annual global Ωarag) should be adjusted, although geographical heterogeneity in Ωarag is important in monitoring the state of the boundary around the world's oceans'.[40] That boundary is now being approached, as aragonite saturation is around 84 per cent of the preindustrial value.[41] Harrould-Kolieb and Hoegh-Guldberg similarly estimate that the current state of ocean acidification is 83 per cent

38 Ibid.

39 Will Steffen et al, 'Planetary Boundaries: Guiding Human Development on a Changing Planet' (2015) 347 Science 1259855.

40 Ibid.

41 Ibid, 1259855-6.

of the boundary value, and the boundary will be transgressed as early as 2030 if CO_2 emissions continue at current rates.[42]

There has been remarkably limited discussion of the ocean acidification boundary in either scientific or policy literature, which suggests that there is no strong or general objection to the methodology behind its selection. Nonetheless, some questions have been raised as to its suitability given that it is calibrated by reference to only two biophysical changes, rather than the full range of marine impacts associated with acidification. Nash and colleagues, for instance, contend that the boundary has inherent limits stemming from its definition by reference to aragonite saturation.[43] They note that the boundary 'narrowly targets' aragonite saturation state and the consequences for 'secretion of calcium carbonate'.[44] While the justification for this is the focus on 'weakest links' in the ocean ecosystem, they contend that a fuller 'characterization of this boundary would benefit from the expanding literature on other effects of ocean acidification on marine systems: physiological, for example protein synthesis, and behavioural, for example predator avoidance; photosynthesis; and nitrogen fixation'.[45] They therefore call for a broadening of the boundary's scope, to account for the 'organismal, population and ecosystem effects of ocean acidification'[46] and the way in which 'ocean acidification interacts with other boundaries, including climate change via carbon sinks, and biosphere integrity through changes to food webs arising from physiological, behavioural and photosynthetic effects'.[47]

Another limitation of the ocean acidification boundary is its global value. The ocean acidification boundary is set only at a planetary scale, and while the boundary takes particular cognisance of the polar regions which are more vulnerable to acidification,[48] the boundary does not fully account for regional variability, which is a pronounced feature of ocean acidification.[49] Even if the boundary is respected, Harrould-Kolieb and Hoegh-Guldberg note that at some locations there will be significant ocean acidification impacts, and this will call for 'efforts to alleviate impacts and redress harm even if the threshold of the planetary boundary for OA is maintained'.[50]

[42] Ellycia Harrould-Kolieb and Ove Hoegh-Guldberg, 'A Governing Framework for International Ocean Acidification Policy' (2019) 102 Marine Policy*,* 10, 12.

[43] Kirsty L Nash et al, 'Planetary Boundaries for a Blue Planet' (2017) 1 Nature Ecology and Evolution 1628, 1629.

[44] Ibid.

[45] Ibid.

[46] Ibid.

[47] Ibid.

[48] See generally John Turner et al, 'Antarctic Climate Change and the Environment: An Update' (2014) 50 Polar Record 237; Tim Stephens, 'Ocean Acidification at the Poles: Regional Responses to Marine Environmental Change in the Anthropocene' in David L Vanderwaag and Karen N Scott (eds), *Research Handbook on Polar Law* (Edward Elgar 2020).

[49] Catriona L Hurd, Andrew Lenton and Bronte Tilbrook, 'Current Understanding and Challenges for Oceans in a Higher-CO_2 World' (2018) 8 Nature Climate Change 686.

[50] Harrould-Kolieb and Hoegh-Guldberg (n 42) 12.

4. THE RELEVANCE OF THE PLANETARY BOUNDARY TO LEGAL AND POLICY RESPONSES

The ocean acidification planetary boundary has obvious policy relevance, and could be used to guide the development and implementation of national, regional and global responses. However, this does not appear to have occurred. Even the recent SROCCC, which includes extensive discussion of ocean acidification and potential regulatory responses, does not reference the planetary boundary. Similarly, the boundary has not been adopted under the rubric of the SDGs.

The relevant SDG for ocean acidification is Goal 14, which sets a goal to '[c]onserve and sustainably use the oceans, seas and marine resources for sustainable development'. SDG 14 is accompanied by a broadly cast target to '[m]inimize and address the impacts of ocean acidification including through enhanced scientific cooperation at all levels'. Rather than using aragonite saturation as the planetary boundary framework does, the indicator for achieving this target is '[a]verage marine acidity (pH) measured at agreed suite of representative sampling stations', and no 'safe' value is advanced. As Harrould-Kolieb and Hoegh-Guldberg note:

> SDG 14.3 establishes an internationally accepted goal for OA [ocean acidification] and has been selected to serve as the overarching goal of the governing framework for OA policy. However, there is no identifiable guidance, such as objectives, areas for action or activities to be implemented, offered for how this commitment should be worked towards or achieved.[51]

In lieu of a standalone policy response to ocean acidification, there has been a strong tendency to link the problem with climate change, and to rely on the temperature targets that have been identified in the development of the climate regime rather than specific ocean acidification targets.[52] The Paris Agreement sets a goal of 'holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels'.[53] Two degrees of warming is likely not to be sufficient to stay within the ocean acidification boundary, highlighting the pitfalls of relying on climate change targets as a proxy for a specific ocean acidification boundary. Nonetheless, the 1.5°C target does appear to align with the ocean acidification planetary boundary.

In its *Special Report on the Impacts of Global Warming of 1.5ºC*, the IPCC found that limiting global warming to 1.5ºC compared to 2ºC would reduce ocean acidity and consequent risks to marine biodiversity, fisheries and ecosystems, and their functions and services for human societies.[54] Harrould-Kolieb and Hoegh-Guldberg similarly observe that '[t]he mitigation of the two problems will need to be addressed simultaneously as they both require stabilization of CO_2 in the atmosphere. Keeping atmospheric levels of CO_2 consistent with RCP 2.6 would mostly maintain the integrity of the two planetary boundaries and likely avoid catastrophic impacts.'[55] RCP 2.6 refers to a scenario developed by the IPCC under which atmospheric concentrations of CO_2 are stabilised at 420 ppmv by the end of the century after an initial over-

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[51] Ibid 11.
[52] See further Verschuuren, Chapter 13 in this book.
[53] Paris Agreement, art 2(1)(a).
[54] Valérie Masson-Delmotte et al (eds), *Global Warming of 1.5°C. An IPCC Special Report, Summary for Policymakers* (Cambridge University Press 2018) 10.
[55] Harrould-Kolieb and Hoegh-Guldberg (n 42) 12.

shoot.[56] However, Harrould-Kolieb and Hoegh-Guldberg note that current emissions reduction pledges under the Paris Agreement are not sufficient to achieve this.[57]

There is no reason in principle why ocean acidification cannot be addressed in this way in conjunction with climate change. However, there are several risks in taking this climate 'catch all' approach by linking the two issues. First, mitigating climate change is concerned with all greenhouse gases, some of which might have higher warming potential than CO_2 (and have attracted greater regulation as a result),[58] whereas ocean acidification is primarily an effect of CO_2 emissions. Hence a temperature-focused approach could underplay the significance of carbon chemistry changes and result in unwitting trade-offs that lead to an overall negative outcome. Furthermore, subsuming ocean acidification within the climate change boundary obscures its visibility as a distinct global environmental challenge deserving of serious attention by governments. There therefore remains considerable value in the broad adoption and use of the boundary.

The discussion that follows provides an overview of global environmental regimes that have competence, to a greater or lesser extent, in addressing ocean acidification, and identifies the potential for the ocean acidification planetary boundary to inform their implementation.

5. THE CLIMATE CHANGE REGIME

The climate change regime is of central relevance to addressing ocean acidification because it is the main global governance mechanism though which the international community is seeking to stabilise and reduce atmospheric concentrations of greenhouse gases, including CO_2. However, as Harrould-Kolieb notes, in the development of this regime there has been a tendency to isolate the treatment of ocean acidification so that the latter is not 'swamped by, or entangled with, the politically contentious issue of climate change'.[59] Harrould-Kolieb argues:

> The framing of ocean acidification as a concurrent problem to climate change appears to have inadvertently resulted in the perverse outcome of ocean acidification being largely excluded from the work of the primary global instrument for regulating CO_2, thereby creating a significant gap in the global governance architecture for ocean acidification.[60]

The main reason for this is the content of the UNFCCC, Kyoto Protocol and the Paris Agreement, all of which have a predominantly atmospheric focus. The climate regime is primarily concerned with preventing dangerous interference with the climate system and does not expressly address other impacts from human disturbance of the Earth's carbon cycle,

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56 Ibid.

57 Ibid.

58 Note the considerable, and largely successful, efforts made under the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer to control gases that are both highly damaging to the ozone layer and are also potent greenhouse gases.

59 Ellycia R Harrould-Kolieb, '(Re)Framing Ocean Acidification in the Context of the United Nations Framework Convention on Climate Change (UNFCCC) and Paris Agreement' (2019) 19 Climate Policy 1225.

60 Ibid 1226–27.

such as ocean acidification. It is unsurprising that the UNFCCC and the Kyoto Protocol do not address the ocean chemistry impacts of carbon emissions given that they were negotiated in the 1980s and 1990s, before ocean acidification was widely identified in the scientific literature as a matter of global concern. However, the same allowance cannot be made for the Paris Agreement, which was agreed well after ocean acidification had attracted considerable scientific attention.

The UNFCCC, in Article 2, sets out the overall goal of the climate regime, which is to stabilise greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Article 1(3) defines the 'climate system' broadly, to mean the totality of the atmosphere, hydrosphere, biosphere and geosphere and their interactions. An argument can therefore be made that an impact on the hydrosphere from CO_2 emissions, such as ocean acidification, is properly within the scope of the UNFCCC.[61] However, the UNFCCC does not expressly mandate the protection of the oceans from chemical change as part of the overarching obligation under Article 3(1) to 'protect the climate system for the benefit of present and future generations of humankind, on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities'. Moreover, the UNFCCC, in Article 4(1)(d), requires parties to promote the sustainable management and conservation of carbon sinks, including the oceans, which can be viewed as encouragement to enhance the oceanic uptake of CO_2.

The 1997 Kyoto Protocol, adopted five years after the UNFCCC, reinforced the atmospheric focus of the climate regime in several ways. In particular, the Protocol grouped together the main greenhouse gases and set global and national emissions budgets having regard to their aggregate warming potential rather than by reference to the distinctive impacts of particular gases. Hence states could prioritise the control of methane (CH_4) or other greenhouse gases over CO_2, even though it is CO_2 which is primarily responsible for ocean acidification. A sizeable body of commentary subsequently discussed the constitutional and practical limitations of the UNFCCC and the Kyoto Protocol in addressing ocean issues,[62] and made some initial efforts to identify a threshold or boundary for ocean acidification that could mirror similar attempts to identify a temperature goal, which was first achieved in the 2009 Copenhagen Accord.[63] For example, Galland and colleagues observed that '[d]espite its significant role in climate regulation and vulnerability to climate change, the ocean is often relegated to footnotes and afterthoughts in the development of climate policy'.[64] They argued that oceanic threshold data could be used, in a similar way to climate sensitivity to greenhouse gases, to adopt reduction targets for CO_2 taking into account both ocean warming and ocean acidification.[65]

In contrast to the UNFCCC and the Kyoto Protocol, the ocean impacts of climate change and ocean acidification did attract some attention during negotiations for the Paris Agreement, and in subsequent Conferences of the Parties (COPs). At the Paris negotiations, 23 states signed the first 'Because the Ocean Declaration', which pledged support for work on the

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61 Ibid.

62 See, among others, Rachel Baird, Meredith Simons and Tim Stephens, 'Ocean Acidification: A Litmus Test for International Law' (2009) 4 Carbon and Climate Law Review 459.

63 Decision 2/CP.15 of the COP 15th session (30 March 2010) UN Doc FCCC/CP/2009/11/Add.1.

64 Grantly Galland, Ellycia Harrould-Kolieb, and Dorothée Herr, 'The Ocean and Climate Change Policy' (2012) 12 Climate Policy 764, 765.

65 Ibid 767.

SROCC and the formulation of an ocean action plan under the UNFCCC.[66] A second Because the Ocean Declaration was launched at COP22 in Marrakech, encouraging 'UNFCCC Parties to consider submitting Nationally Determined Contributions that promote, as appropriate, ambitious climate action in order to minimize the adverse effects of climate change in the ocean and to contribute to its protection and conservation'. Work on this ocean stream within the UNFCCC and Paris Agreement has continued since this time, and its most recent output is a guidance document, *Ocean for Climate: Ocean-Related Measures in Climate Strategies*,[67] that was published following the release of SROCCC to promote concrete actions that parties can take in their climate commitments to encourage greater ocean-focused climate action.

The preamble to the Paris Agreement refers to the 'importance of ensuring the integrity of all ecosystems, including oceans'.[68] While the operative provisions of the Paris Agreement do not address the ocean impacts of CO_2, they do establish the Nationally Determined Contribution (NDC) system, a pledge-and-review mechanism through which it will be possible for ocean acidification to be addressed more substantively over time. The NDC process is a central element of the Paris Agreement, requiring parties to prepare successive emissions reduction commitments every five years.[69] Each new NDC is to 'represent a progression beyond' the previous NDC and 'reflect its highest possible ambition'.[70] NDCs are to be guided by the climate change goals set out in Article 2 of the Paris Agreement: '[h]olding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels.'[71] The content of NDCs are also to be informed by the 'global stocktake' on collective progress to occur in 2023 and every five years thereafter.[72]

Almost all parties (184 out of 187) have now submitted NDCs.[73] A search of the NDC registry reveals that ocean acidification is referred to in only ten of these. As an example, the NDC of Kiribati includes information on ocean acidification impacts in the Pacific, noting that '[s]ince the 18th century ocean has been slowly becoming more acidic. The aragonite saturation state has declined from about 4.5 in the late 18th century to an observed value of about 3.9 ± 0.1 by 2000.'[74] While there is no reference to the ocean acidification planetary boundary in this or any other NDC, it is noteworthy that declining aragonite saturation, the indicator for the planetary boundary, is discussed. This reflects Kiribati's concern that reduced

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66 Catherine Benson Wahlén, '22 Countries Join "Because the Ocean" to Support Action on Climate Change and Oceans' (*International Institute for Sustainable Development*, 21 December 2015) <http://sdg.iisd.org/news/22-countries-join-because-the-ocean-to-support-action-on-climate-change-and-oceans/> accessed 11 June 2020.

67 Because the Ocean 'Ocean for Climate: Ocean-related measures in Climate Strategies (Nationally Determined Contributions, National Adaptation Plans, Adaptation Communications and National Policy Frameworks)' (BecausetheOcean 2019) <www.becausetheocean.org/wp-content/uploads/2019/10/Ocean_for_Climate_Because_the_Ocean.pdf> accessed 11 June 2020.

68 Paris Agreement, 13th recital.

69 Ibid art 4(2).

70 Ibid art 4(3).

71 Ibid art 2(1)(a).

72 Ibid arts 4(9) and 14.

73 NDC Registry, 'Welcome to the Interim NDC Registry' <www4.unfccc.int/sites/ndcstaging/Pages/Home.aspx> accessed 11 June 2020.

74 Republic of Kiribati, 'Intended Nationally Determined Contribution' <www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Kiribati%20First/INDC_KIRIBATI.pdf> accessed 11 June 2020.

aragonite availability will lead to conditions that are 'extremely marginal for supporting coral growth'[75] – a key interest for this small island nation in the Pacific comprising 32 coral atolls and one coral island.

An empirical analysis of NDCs by Gallo, Victor and Levin found that they generally contain quite shallow treatment of oceans issues from both mitigation and adaptation perspectives.[76] In all, 70 per cent of NDCs mention marine areas and issues, with the leading concerns being climate-related impacts on coasts (95 NDCs), ocean temperature (77 NDCs), fisheries (72 NDCs) and marine ecosystem (62 NDCs).[77] However, despite being of equivalent seriousness, ocean acidification and other chemical changes are mentioned only briefly, or not at all. There are therefore significant opportunities for ocean acidification to attract greater attention in the next round of NDCs.

The next and subsequent rounds of NDCs could reference both temperature and ocean acidification goals in setting emission reduction commitments, and explicit adoption of the ocean acidification planetary boundary could inform these pledges. This could also feed into the global stocktake process under the Paris Agreement, the first of which is to take place in 2023 (and then every five years thereafter, unless the Conference of the Parties Serving as the Meeting of the Parties to the Paris Agreement (CMA) decides otherwise). However, whether this occurs will turn on how the purpose of the agreement is construed in practice by the parties. Article 14 of the Paris Agreement requires the CMA to take stock periodically of the implementation of the agreement and to assess collective progress towards achieving the purpose of the Agreement and its long-term goals. It is Article 2 which sets out the Paris Agreement's purpose, and in relation to mitigation it refers only to temperature goals, not other impacts from greenhouse gas emissions such as ocean acidification. Incorporating consideration of ocean acidification in the global stocktake process, including an assessment of whether the planetary boundary is or will be exceeded, would be a valuable addition to the process.

6. MARINE POLLUTION REGIMES

There is an extensive body of international law which applies to various sources and types of marine pollution. Under the framework of the 1982 United Nations Convention on the Law of the Sea (UNCLOS), this collection of treaties has had significant success in curbing certain pollutants, particularly oil pollution from vessels. However, this area of law has had much less engagement with ocean pollution from atmospheric sources, including ocean acidification. Accordingly, there have been few opportunities to date to reference or incorporate the ocean acidification planetary boundary in the development and implementation of marine pollution regimes.

UNCLOS, which is often described as the 'constitution for the oceans', is a lengthy and almost universally subscribed treaty which includes an entire part comprising 45 articles which address the 'Protection and Preservation of the Marine Environment'. The core obligation, set out in Article 192, is 'to protect and preserve the marine environment'. Article 194(1)

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[75] Ibid.

[76] Natalya D Gallo, David G Victor and Lisa A Levin, 'Ocean Commitments under the Paris Agreement' (2017) 7 Nature Climate Change 833, 833.

[77] Ibid 834.

provides that states parties must take 'all measures … necessary to prevent, reduce and control pollution of the marine environment from any source'. Atmospheric pollution is specifically addressed in Article 212(1), which requires states to 'prevent, reduce and control pollution of the marine environment from or through the atmosphere'.

Ocean acidification is clearly a form of pollution of the marine environment, and results from ocean drawdown of an atmospheric pollutant, CO_2. The combined operation of Articles 192, 194 and 212 means that there is a due diligence obligation under UNCLOS to prevent ocean acidification.[78] However, there is no mechanism currently operating under UNCLOS to achieve this. In relation to marine pollution (and some other areas such as high seas fisheries), UNCLOS relies on other processes and institutions to establish applicable rules and standards to support the achievement of its obligations. Hence in the case of marine pollution from oil and other vessel source pollutants, a large number of treaties have been adopted under the auspices of the International Maritime Organization (IMO).

In relation to atmospheric pollution, Article 212(3) mirrors this structure in providing that states 'acting especially through competent international organizations or diplomatic conference, shall endeavour to establish global and regional rules, standards and recommended practices and procedures to prevent, reduce and control such pollution'. However, no such rules, standards or other norms or practices have yet been adopted in relation to ocean acidification.

The most that can be said is that there are several IMO treaties that have some application, at the margins, to the problem. The 1972 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter and the 1996 London Protocol generally prohibit the dumping of materials at sea, including CO_2. Amendments were agreed in 2006, which allow CO_2 sequestered only to be stored in or under the seabed, and not in the water column.[79] The 1973 International Convention for the Prevention of Pollution from Ships, as modified by the Protocol of 1978 (MARPOL) seeks to achieve the complete elimination of intentional pollution of the marine environment. Annex VI of MARPOL deals with atmospheric pollution from ships, and the IMO has now adopted relatively strict limits of CO_2 emissions from ships. As significant as this is, given the rising volume of greenhouse gas emissions from the global shipping industry, it obviously falls far short of a comprehensive response to the oceanic CO_2 problem.

There has been some academic discussion of a dedicated ocean acidification treaty,[80] but there is no apparent interest among states in negotiating such an instrument. Not only are the parties to UNCLOS currently occupied with negotiations on an instrument to protect biodiversity beyond national jurisdiction (BBNJ), but any such treaty would inevitably cut across the UNFCCC and Paris Agreement. In the absence of such a treaty, Harrould-Kolieb

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[78] See further Alan Boyle, 'Law of the Sea Perspectives on Climate Change' in David Freestone (ed), *The 1982 Law of the Sea Convention at 30: Successes, Challenges and New Agendas* (Martinus Nijhoff 2013) 157; Tim Stephens, 'Warming Waters and Souring Seas: Climate Change and Ocean Acidification' in Donald R Rothwell et al (eds), *The Oxford Handbook of the Law of the Sea* (Oxford University Press 2015) 777; and Diz, Chapter 17 in this book.

[79] IMO, Notification of Amendments to Annex 1 to the London Protocol (27 November 2006) IMO Doc LC-PL.1/Circ.5.

[80] Rakhyun E Kim, 'Is A New Multilateral Environmental Agreement on Ocean Acidification Necessary?' (2012) 21 Review of European Community and International Environmental Law 243; Ellycia Harrould-Kolieb and Dorothée Herr, 'Ocean Acidification and Climate Change: Synergies and Challenges of Addressing Both under the UNFCCC' (2012) 12 Climate Policy 378.

and Hoegh-Guldberg have argued for a governing framework for ocean acidification which can inform standard setting and implementation across a multiplicity of national, regional and international institutions. For instance, ocean acidification can and should be taken into account in marine spatial planning, particularly the designation of marine protected areas which can enhance marine ecosystem resilience to stressors including ocean acidification.

The BBNJ negotiations suggest that there is considerable work still to be done to elevate ocean acidification as an issue of global concern. There have now been three sessions of the Intergovernmental Conference on an internationally legally binding instrument under UNCLOS on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction.[81] A draft text[82] has been prepared which continues to be the subject of discussion and negotiations, and the term 'ocean acidification' appears four times: in the definition of 'cumulative impacts' in Article 1 alongside several other impacts; in Article 5, which sets out general principles including an obligation on states to '[a]pply an approach that builds ecosystem resilience to the adverse effects of climate change and ocean acidification'; in Article 14, which includes building resilience to ocean acidification as a relevant objective in area-based management including marine protected areas; and in Article 16, where climate change and ocean acidification are listed together as criteria for the identification of marine protected areas. In the context of the BBNJ negotiations, ocean acidification is therefore conceptualised as an impact requiring an adaptive response rather than a process which the parties are seeking to mitigate through the BBNJ instrument or under UNCLOS more generally.

7. CONVENTION ON BIOLOGICAL DIVERSITY

Ocean acidification is having multiple impacts on marine biological diversity,[83] and this has been acknowledged by the parties to the 1992 Convention on Biological Diversity (CBD) in several decisions, as well as in the Strategic Plan for Biodiversity 2011–2020 and the accompanying Aichi Biodiversity Targets which were adopted in 2010.[84] Aichi Biodiversity Target 10 addresses ocean acidification, and provides that '[b]y 2015, the multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimized, so as to maintain their integrity and functioning'. This was significant, as at the time it was the first global effort to adopt a global target for addressing ocean

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81 See Statement by the President of the Conference At the Closing of the Third Session (New York, 19–30 August 2019) <www.un.org/bbnj/sites/www.un.org.bbnj/files/bbnj_presidents_closing_statement_-_advance_unedited.pdf> accessed 11 June 2020.

82 UNGA A/CONF.232/2019/6 'Draft text of an agreement under the United Nations Convention on the Law of the Sea on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction' (17 May 2019) UN Doc A/CONF.232/2019/6 <https://undocs.org/A/CONF.232/2019/6> accessed 11 June 2020.

83 Sandra Díaz et al (eds), *Global Assessment Report on Biodiversity and Ecosystem Services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Summary for Policymakers* (IPBES 2019).

84 X/2 Decision Adopted by the Conference of the Parties to the Convention On Biological Diversity at its tenth meeting 'The Strategic Plan for Biodiversity 2011–2020 and the Aichi Biodiversity Targets' (29 October 2010) UNEP/CBD/COP/DEC/X/2. See also Somsen and Trouwborst, Chapter 12 in this book.

acidification. However, the target is overly broad and is not accompanied by any indicator such as aragonite saturation.

Preparations have been underway since 2017 to formulate a post-2020 Biodiversity Framework, and this could provide an opportunity to revise the ocean acidification target by reference to the planetary boundary. However, it appears most unlikely that the CBD will step into the territory of emissions reduction policy. As with other regimes, the primary focus of the CBD in addressing ocean acidification has been to identify and respond to the environmental impacts arising from the changing carbon chemistry of the oceans. The mitigation of ocean acidification through measures to reduce CO_2 emissions is deferred to the UNFCCC and the Paris Agreement.

8. CONCLUSION

The planetary boundaries framework, as well as highlighting scientific linkages, is also revealing of omissions in global environmental governance when the boundary cuts across multiple treaties.

Ocean acidification is one of a number of global pressures identified in the planetary boundaries framework that has not been the subject of any comprehensive response by the international community. The IPCC's SROCCC included a clear analysis of this inadequate ocean acidification governance landscape. Titled 'Policy Responses to Ocean Acidification: Is there an International Governance Gap?',[85] the assessment noted that ocean acidification is not specifically mentioned in the Paris Agreement and has been given limited attention in UNFCCC deliberations. This is despite the fact that 'ocean acidification is widely considered to be part of the climate system'.[86] At the same time, UNCLOS, and the broader regime for marine environmental protection of which it forms part, has not effectively addressed the problem.

Thus, while many bodies have an interest in the issue, there is no unifying treaty or single instrument, and the development of a new United Nations mechanism specifically to address ocean acidification has not been widely supported.[87] Instead, the report noted, with medium confidence, that 'one pragmatic approach could be enhancing the involvement of UNFCCC with acidification governance together with increased used of multilateral environmental agreements'.[88] Despite its limitations, the planetary boundaries framework offers a principled way in which this could be pursued.

The UNFCCC and the Paris Agreement will continue to have the primary competence for CO_2 mitigation and parties should use all available opportunities through the NDC and Global Stocktake process to incorporate reference to ocean acidification indicators and thresholds in pursuing emission reduction efforts. At the same time, other multilateral environmental regimes, including the CBD, also have the capacity to draw attention to the ocean acidification boundary and the extent to which it is being approached or transgressed. Collectively, this could provide additional support and reinforcement for climate regime decisions which will have lasting implications for the oceanic carbon cycle.

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85 Pörtner et al (n 13), ch 5, 130–31.
86 Ibid 130.
87 Ibid 130.
88 Ibid 130.

17. Nitrogen and phosphorus flows to the biosphere and oceans[1]

Daniela Diz

1. INTRODUCTION

Human interference with the global phosphorus (P) and nitrogen (N) cycles has been identified as a planetary boundary.[2] Alteration of the nitrogen biogeochemical cycle has already transgressed the safe levels of this planetary boundary.[3] Rockström and colleagues underline abrupt shifts in terrestrial, aquatic and marine ecosystems due to anoxia and eutrophication resulting from excess influxes of nitrogen and phosphorus.[4] Marine and coastal ecosystems have played a key role in defining planetary boundaries for nitrogen and phosphorus. Given the impossibility to address all international policy and legal instruments relevant to land, ocean and atmospheric systems, and given the important role of marine and coastal-related variables in assessing N and P planetary boundaries, this chapter focuses primarily on measures to prevent, reduce and control excess nitrogen and phosphorus input into the *marine environment* from land-based sources including agriculture (a major driver of nutrient flows). In light of this, this chapter specifically addresses this planetary boundary through the lens of the ocean governance regime, by exploring how this regime can contribute to the adoption of safe thresholds by competent authorities, while recognising its limitations.

Excessive nutrient concentrations, such as of nitrogen and phosphorus in the marine environment, have been found to impact marine biodiversity, including marine species and seabed ecosystems.[5] In addition to atmospheric deposition,[6] reactive nitrogen (N_r) enters the marine environment through rivers, streams, groundwater and wastewater treatment facilities.[7] Nitrogen and phosphorus are widely used as fertilisers globally, and run-offs from agriculture, livestock and sewage pollute the marine environment, causing eutrophication, which in turn

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1 For reasons explained later in this chapter, I focus primarily on the nitrogen and phosphorus flows to the oceans as part of the biosphere.

2 Johan Rockström et al, 'Planetary Boundaries: Exploring the Safe Operating Space for Humanity' (2009) 14 Ecology and Society 32.

3 Ibid.

4 Ibid.

5 The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), *Summary for Policymakers of the Global Assessment Report on Biodiversity and Ecosystem Services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services* (IPBES secretariat, 2019).

6 Timothy D Jickells et al, 'A Reevaluation of the Magnitude and Impacts of Anthropogenic Atmospheric Nitrogen Inputs on the Ocean' (2017) 31 Global Biogeochemical Cycles 289.

7 Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP IMO/FAO/UNESCO-IOC/UNIDO/WMO/IAEA/UN/UN Environment/UNDP), *The Magnitude and Impacts of Anthropogenic Atmospheric Nitrogen Inputs to the Ocean*. (Rep. Stud. GESAMP No. 97/ GAW Report No. 238, 2018).

degrades marine habitats such as coral reefs. Excess input of these nutrients can also alter the biogeochemistry of oceans,[8] and contribute to ocean deoxygenation[9] – ultimately leading to biodiversity loss and impacts on fisheries productivity, among other consequences. These impacts can further push the thresholds of a core planetary boundary – biosphere integrity.[10] Section 2 of this chapter introduces the planetary boundary framework in relation to the biogeochemical cycles of nitrogen and phosphorus and discusses its interface with the ecosystem approach as a means to operationalise the application of meaningful thresholds.

Despite the disperse nature of the challenge and the fragmented oceans governance system, the obligations contained under the United Nations Law of the Sea Convention[11] (UNLOSC) provide a general framework for the regulation of activities (including land-based activities) that cause excess nitrogen and phosphorus input to the oceans, as it covers all of the input sources. This chapter will particularly focus on such international obligations concerning atmospheric and non-atmospheric land-based sources of nitrogen and phosphorus input into the oceans as a type of marine pollution.[12] While the UNLOSC contains general obligations regarding land-based sources of pollution and atmospheric sources, excess nutrient pollution more specifically has also been the object of later, global[13] and regional[14] targets. However, a recent evaluation of progress in achieving the Convention on Biological Diversity[15] (CBD) Aichi Biodiversity Target 8 on reduction of pollution, including from excess nutrients, to levels that are not detrimental to ecosystem function and biodiversity, has found that implementation of the target has been poor.[16] In this context, Section 3 of this chapter analyses the legal implications of transgressing this planetary boundary through excess nitrogen pollution in the marine environment under the UNLOSC and related instruments. Under the UNLOSC regime and in particular, the CBD, the ecosystem approach plays a key role in delivering the balance between conservation and sustainability governance needed to ensure that planetary boundaries are not transgressed, and that when they are (in the case of nitrogen), it can be reversed. This is of particular importance in light of Sustainable Development Goal (SDG) 14.1 and other global and regional targets aiming to ensure that marine ecosystems' integrity and functioning are at healthy levels for generations to come.

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8 Jickells et al (n 6).

9 See IUCN, *Ocean Deoxygenation: Everyone's Problem – Causes, Impacts, Consequences and Solutions* (IUCN 2019).

10 See Somsen and Trouwborst, Chapter 12 in this book.

11 United Nations Convention on the Law of the Sea (adopted 10 December 1982, entered into force 16 November 1994) 1833 UNTS 3 (UNLOSC).

12 As per UNLOSC arts 212 and 207 respectively, as well as its interface with arts 205 and 206 on impact assessments.

13 eg under the Convention on Biological Diversity (CBD) Aichi Biodiversity Target 8, CBD Decision X/2 (2010), and the UNGA 'Transforming Our World: The 2030 Agenda for Sustainable Development' by UNGA A/RES/70/1 (21 October 2015) UN Doc A/RES/70/1 Goal 14.1.

14 eg in the Baltic Sea by Baltic Marine Environment Protection Commission, in the North East Atlantic by the Commission for the Protection of the Marine Environment of the North-East Atlantic.

15 United Nations Convention on Biological Diversity (adopted 22 May 1992, entered into force 29 December 1993) 1760 UNTS 79 (CBD).

16 IPBES (n 5).

2. BIOGEOCHEMICAL FLOWS OF PHOSPHORUS AND NITROGEN AS A PLANETARY BOUNDARY

Anthropogenic interference with the global phosphorus and nitrogen cycles has been identified as one of nine planetary boundaries.[17] The planetary boundaries framework identifies precautionary thresholds for nine Earth system processes to prevent significant destabilisation of these systems' functioning.[18] The framework adopts a traffic light system, as it were, whereby it indicates levels of a safe operating space for the Earth system's functioning (green); a buffer zone indicating increasing risk of impacts, which accounts for uncertainty in scientific information (yellow); and a dangerous level, which indicates high risk of serious impacts (red). This is similar to the way in which precautionary reference points under fish stocks' assessments are set.[19]

In 2009, Rockström and colleagues indicated that human interference with the global nitrogen cycle had already transgressed the safe (green level) planetary boundary.[20] To determine the planetary boundary, the authors used the following variants. For phosphorus: increased inflow of phosphorus to the ocean in comparison with natural background weathering in order to avoid a major oceanic anoxic event (regional or global) impacting marine ecosystems; for nitrogen: the amount of N_2 removed from the atmosphere for human use (Mt Nyr^{-1}) that would affect ecosystems' resilience through terrestrial ecosystems acidification and eutrophication of coastal and freshwater systems.[21]

From the variants used to measure the thresholds, it becomes clear that potential impacts on marine and coastal ecosystems play a key role in assessing the planetary boundaries for nitrogen and phosphorus regardless of their source. Their preliminary assessment indicated safe nitrogen thresholds of approximately 35Mt N yr^{-1} (roughly 25 per cent of the value at that time), and for phosphorus a safe boundary of ten times the natural background weathering flux of phosphorus of approximately 1 Mt P yr^{-1}.[22] The proposed nitrogen boundary would significantly reduce reactive nitrogen introduction to land, ocean and atmospheric systems, and the phosphorus boundary would prevent global ocean anoxic events such as those behind mass extinctions in the past.[23] The authors suggest that if phosphorus inflows were reduced to pre-industrial levels, the anoxic fraction would continue to rise for another thousand years, but a complete ocean anoxic event would be avoided.[24]

A more recent analysis that revises the planetary boundaries framework updated the 'phosphorus and nitrogen cycles' planetary boundary terminology to 'biogeochemical flows' more

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17 Rockström et al (n 2); Johan Rockström et al, 'A Safe Operating Space for Humanity' (2009) 461 Nature 472.

18 Ibid. See also Will Steffen et al, 'Planetary Boundaries: Guiding Human Development on a Changing Planet' (2015) 347 Science 1259855.

19 In accordance with Annex II of the Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (adopted 4 August 1995, entered into force 11 December 2001) 2167 UNTS 3 (Fish Stocks Agreement).

20 Rockström et al (n 2).

21 Ibid.

22 Ibid.

23 Ibid.

24 Ibid; Rockström et al (n 17) 472–75.

broadly, to allow for future integration of other elements that can interfere with these flows, such as silicon.[25] Furthermore, it also defined sub-global boundaries, since in some cases the transgression of boundaries at the regional level can affect the functioning of the Earth system at the global level.[26] In the case of phosphorus and nitrogen cycles, alterations at the regional level can lead to widespread eutrophication of freshwater systems, reducing availability of clean water and driving further alteration of the global hydrological cycle, while coastal eutrophication leads to dead zones and algae blooms that disrupt food webs and fisheries.[27] The updated framework suggests the following planetary boundaries and zones of uncertainty for biogeochemical flows (P and N cycles): [28]

> (a) Phosphorus global in terms of its flow from freshwater systems into the ocean (control variable): 11 Tg P yr^{-1} (11-100 Tg P yr^{-1}). This global-level boundary continues to be based on the prevention of a large-scale ocean anoxic event.
> (b) Phosphorus regional in terms of its flow from fertilisers to erodible soils (control variable): 6.2 Tg Yr^{-1} mined and applied to erodible agricultural soils (6.2 – 11.2 Tg Yr^{-1}).
> (c) Nitrogen global in terms of industrial and intentional biological nitrogen fixation (control variable): 62 Tg Nyr^{-1} (62-82 Tg N yr^{-1}) with the boundary acting as a global valve that restricts the introduction of new reactive N to the Earth system, while considering the impacts of regional distribution.

The authors estimated the globally aggregated rates of phosphorus and nitrogen application, at the time of conducting the update of the framework, to be at 14 Tg P yr^{-1} and 150 Tg N yr^{-1}.[29] It is important to note that under the updated framework, climate change and biosphere integrity have been recognised hierarchically as core planetary boundaries, providing a frame through which all the other closely interconnected planetary boundaries operate.[30] In practice this means that if one of the other boundaries is crossed, it can lead to the transgression of a core boundary without necessarily altering the integrity of the Earth system's functioning.[31] Moreover, the synergistic effects of nitrogen and phosphorus input with multiple other anthropogenic pressures on marine ecosystems, including ocean warming and acidification, can create feedback loops that lower the resilience of the system and its ability to adapt to these long-term changes.[32] Addressing excessive nitrogen and phosphorus introduction into the oceans is challenging, especially because of the diverse and multiple input sources (mainly from fluvial inputs, atmospheric and biological fixation)[33] and jurisdictions involved in the release of this nutrient into the natural environment.

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[25] Steffen et al (n 18).
[26] Ibid, Supplementary materials.
[27] Ibid.
[28] Ibid.
[29] Ibid.
[30] Ibid. See, respectively, Verschuuren, Chapter 13; Somsen and Trouwborst, Chapter 12, in this book.
[31] Ibid.
[32] See Nathan L Bindoff et al, 'Changing Ocean, Marine Ecosystems, and Dependent Communities' in Hans-Otto Pörtner et al (eds), *IPCC Special Report on the Ocean and Cryosphere in a Changing Climat*e (IPCC 2019).
[33] See Jickells et al (n 6).

2.1 Planetary Boundaries and the Ecosystem Approach

The ecosystem approach can provide a useful entry point in mainstreaming the planetary boundaries framework into the governance context. There is a high degree of alignment and complementarity between the planetary boundaries framework and the ecosystem approach. The planetary boundaries framework recognises the Earth as a 'single, complex, integrated system'.[34] The ecosystem approach is recognised by CBD Parties as 'a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way'.[35] The CBD ecosystem approach guidelines, which implicitly embrace the planetary boundaries framework, can provide guidance in implementing UNLOSC and applying nitrogen and phosphorus boundaries in a holistic manner.[36] However, the application of the ecosystem approach varies immensely from country to country and from region to region, and the full implementation of these principles is far from common practice – as evidenced by a strong focus on sectoral approaches rather than cross-sectoral approaches, and by insufficient use of cumulative impact assessments to inform ecosystem-level thresholds that are aligned with the planetary boundaries thresholds.

It is understood under the ecosystem approach that in order to maintain ecosystem integrity, ecosystems must be managed within the limits of their functioning. This is aligned with the planetary boundaries framework's concept of 'safe operating space' under which society can continue to develop and thrive, avoiding the destabilisation of the Earth system.[37] This mirrors the ecosystem approach's notion that there is only so much that a given ecosystem could be expected to produce or support, despite technological and other advancements. To ensure this is achieved, concerted efforts across sectors and nations are required for more efficient use of nitrogen and phosphorus, as well as emission reductions. Furthermore, to assess the limits of ecosystem functioning, it is important to match the spatial management unit with the natural ecosystem boundaries (see Section 3.1 below). As discussed in the next section, the ocean governance regime under UNLOSC provides a useful lens through which a number of drivers of excess nitrogen and phosphorus flows can be regulated and managed in an integrated and ecosystem-based manner if appropriate regional and global monitoring mechanisms are in place.

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[34] Steffen et al (n 18).

[35] CBD decision V/6 (2000), para 1, and Annex, part A, para 1.

[36] As noted in Section 2 above, UNLOSC's third preambular paragraph embraces a holistic approach by stating 'that the problems of the ocean space are closely interrelated and need to be considered as a whole'. A number of other UNLOSC provisions also support the notions contained in the ecosystem approach, such as arts 61, 119, 194(5), among others – see Daniela Diz, *Fisheries Management in Areas beyond National Jurisdiction: The Impact of Ecosystem Based Law-Making* (Brill 2013).

[37] See Steffen et al (n 18).

3. THE LAW OF THE SEA CONVENTION AND THE NITROGEN AND PHOSPHORUS BOUNDARIES

The UNLOSC is regarded as a 'constitution for the oceans',[38] and recognised by most members of the UN General Assembly as a legal framework for regulating all activities at sea.[39] At the time the UNLOSC was negotiated, the planetary boundaries framework and its applicability to biogeochemical cycles of nitrogen and phosphorus had not yet been developed. Despite this, excess nitrogen and phosphorus input into the oceans qualifies as pollution of the marine environment in accordance with the UNLOSC definition of pollution. Marine pollution is broadly defined as the anthropogenic introduction:

> directly or indirectly, of substances or energy into the marine environment, including estuaries, which results or is likely to result in such deleterious effects as harm to living resources and marine life, hazards to human health, hindrance to marine activities, including fishing and other legitimate uses of the sea, impairment of quality for use of sea water and reduction of amenities.[40]

Specific thresholds for what constitutes 'harm to living resources' or 'hazards to human health' are not contained under the Convention, and in this sense, the global and regional nitrogen and phosphorus planetary boundaries discussed in Section 2 above could be helpful initial thresholds to be pursued. As seen in Section 3.1 below, a potentially useful entry point for this endeavour, and the continued refinement and application of such thresholds, would be through efforts to develop meaningful indicators for SDG 14.1 on excess nutrient pollution of the marine environment.

Excess nutrient problems have been discussed in a number of international fora, including at the United Nations Environment Assembly (UNEA), which has noted that the use of nitrogen is 'extremely inefficient, with over 80 per cent of anthropogenic reactive nitrogen lost to the environment, leading to water, soil and air pollution that threatens human health and well-being and ecosystem services'.[41] Improving fertiliser efficiencies and reducing its losses, including by recycling livestock excreta into fertilisers, have been identified, for instance, as measures to be pursued in the prevention and control of excess nutrient pollution from farming.[42]

Moreover, in line with the precautionary principle (which is coincidentally also embraced by the planetary boundaries framework), UNLOSC Article 194 requires States, individually or jointly, to adopt all necessary measures to prevent, reduce and control marine pollution from any source.[43] States also have an obligation to take measures to ensure that activities under their jurisdiction or control do not cause damage to other States through transboundary pollution.[44]

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[38] Tommy TB Koh, 'A Constitution for the Oceans', Remarks by Tommy TB Koh of Singapore, President of the Third United Nations Conference on the Law of the Sea (1982). <www.un.org/Depts/los/convention_agreements/texts/koh_english.pdf> accessed 15 May 2020.

[39] UNGA Res 74/19 (2019), 6th preambular paragraph.

[40] UNLOSC art 1(1) (4).

[41] United Nations Environment Assembly (UNEA) Resolution 4/14 (2019), 3rd preambular paragraph.

[42] UNEP, *Frontiers 2018/19 Emerging Issues of Environmental Concern* (Nairobi: United Nations Environment Programme, 2019).

[43] UNLOSC art 194 (1).

[44] Ibid art 194 (2).

With respect to the source of pollution and whether it falls under Article 207 (regulating land-based sources) or Article 212 (regulating atmospheric-related sources), it is important to note that about half of the anthropogenic emissions of nitrous oxide (N_2O) originate from agriculture (through soil denitrification and nitrification processes, and nitrogen transformation in manure).[45] Nitrous oxide is also released in industrial fertiliser production.[46] Assessed levels of fertiliser use indicate that planetary boundaries have already been crossed in this regard.[47]

UNLOSC provisions on the prevention of marine pollution cover all sources and should be interpreted in light of the absolute obligation to protect and preserve the marine environment.[48] To this end, States are required to cooperate to establish 'global and regional rules, standards and recommended practices and procedures to prevent, reduce and control pollution',[49] instead of acting unilaterally through uncoordinated national measures. This cooperation is essential for avoiding crossing planetary boundaries. In this context, it is important to mention the work of UNEA, which, in the resolution mentioned above on sustainable nitrogen management, called upon the UN Environment Executive Director to consider options for the better coordination of policies across the global nitrogen cycle at the national, regional and global levels.[50] Policy coordination is important because of the impacts nitrogen has upon a wide range of ecosystems, thus highlighting the importance of integration between various policy realms ranging from atmospheric pollution to biodiversity impacts, freshwater and marine pollution, health and food security concerns.[51]

The need for cooperation in setting these standards, and in harmonising policies,[52] reaffirms the need for integrated ocean governance, as 'the problems of ocean space are closely interrelated and need to be considered as a whole'[53] – more recently reflected by the adoption of the ecosystem approach.[54] Cooperation also mandates a range of procedural obligations. States are required, for instance, to provide notification to other States in case of risk of damage,[55] and to conduct and publicise environmental impact assessments in case of potential transboundary impacts on the marine environment caused by pollution.[56]

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[45] Christel Cederberg, 'Improving Nutrient Management in Agriculture to Reduce Eutrophication, Acidification and Climate Change' in Ulf Sonesson, Joanna Berlin and Friederike Ziegler (eds), *Environmental Assessment and Management in the Food Industry: Life Cycle Assessment and Related Approaches* (Woodhead Publishing 2010) 3–15.

[46] UNLOSC art 207 (4). See also James Harrison, *Saving the Oceans through Law: The International Legal Framework for the Protection of the Marine Environment* (Oxford University Press 2017).

[47] Millennium Ecosystem Assessment (2005), 'Living Beyond Our Means: Natural Assets and Human Well-being – Statement from the Board'. See also TEEB, *TEEB for Agriculture & Food: An Interim Report* (United Nations Environment Programme, 2015).

[48] UNLOSC arts 192 and 194. See Alan Boyle, 'Marine Pollution under the Law of the Sea Convention' (1985) 79(2) The American Journal of International Law 347.

[49] UNLOSC art 207 (4). See also Harrison (n 46).

[50] United Nations Environment Assembly (UNEA) Resolution 4/14 (2019).

[51] UNEP (n 42).

[52] See UNLOSC art 207 (3).

[53] UNLOSC 3rd preambular para.

[54] See the Convention on Biological Diversity (CBD) decisions V/6 (2000) and VII/11 (2004).

[55] UNLOSC art 198.

[56] Ibid arts 204–206.

UNLOSC provisions on pollution from land-based sources,[57] and on pollution from or through the atmosphere,[58] oblige States to adopt laws and regulations to prevent, reduce and control pollution from these sources, 'taking into account internationally agreed rules, standards and recommended practices and procedures'.[59] The incorporation by reference of such standards and practices contributes to the evolutionary nature of the UNLOSC,[60] and provides a necessary link to soft-law developments, including global and regional targets and indicators. This is particularly important at the regional level, as several regional seas conventions – though substantively important – do not have compliance mechanisms,[61] and therefore the interface between regional seas conventions' standards and the obligations and responsibilities of coastal, flag and port States under the UNLOSC ensures a more systemic approach.[62]

Once the standards required under Articles 207 and 212 are established, States have an obligation of conduct to take these into account when they adopt domestic legislation to prevent, reduce and control nitrogen and phosphorus pollution. Even though States do not have the obligation to directly adopt these standards, and only to take them into account, the standards have supplemented the UNLOSC's general obligations and have guided State implementation. This is particularly relevant, given the absence of specific pollution thresholds under the UNLOSC. It is also important to note that beyond the obligation to regulate, the coastal State also has the obligation to enforce legislation and to take necessary measures to implement international rules and standards adopted by competent organisations to prevent, reduce and control pollution from land-based sources.[63] States also have the duty to cooperate on the global and regional levels, including through regional seas organisations in elaborating international rules, standards and recommended practices and procedures for the protection and preservation of the marine environment.[64]

3.1 Global and Regional Initiatives

Recognising the increasing pressures of land sources of pollution on marine ecosystems and the need to supplement the general provisions of the UNLOSC, in 1995, 109 UN members

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[57] Ibid art 207.

[58] Ibid art 212.

[59] Ibid arts 207 (1) and 212 (1).

[60] See Alan Boyle, 'Litigating Climate Change under Part XII of the LOSC' (2019) 34 The International Journal of Marine and Coastal Law 458. See also Jill Barrett, 'The UN Convention on the Law of the Sea: A "Living Treaty"?' in Jill Barrett and Richard Barnes (eds), *The Law of the Sea: UNCLOS as a Living Treaty* (British Institute of International & Comparative Law 2016) 3.

[61] Kanako Hasegawa and Elizabeth Mrema, 'UN Environment Regional Seas Programme' in David Attard, Malgosia Fitzmaurice and Alexandro Ntovas (eds) *The IMLI Treatise on Global Ocean Governance: UN Specialized Agencies*, Vol II (Oxford University Press 2018). But see OSPAR Convention, art 23, which establishes a compliance mechanism comprised by periodic reporting procedures; as well as the compliance mechanism under the Barcelona Convention under Decision IG 17/2 on Procedures and Mechanisms on Compliance under the Barcelona Convention and its Protocols (2008) UNEP(DEPI)/MED IG.17/10 Annex V. The Abidjan Convention and the Nairobi Protocol also allows for compliance mechanisms to be established.

[62] See Patricia Birnie, Alan Boyle and Catherine Redgwell, *International Law & the Environment* (3rd edn, Oxford University Press 2009).

[63] UNLOSC art 213.

[64] Ibid art 197.

adopted the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA), a non-legally binding intergovernmental mechanism. The GPA urges States to develop national programmes of action, which should be underpinned by principles including integrated coastal management and environmental impact assessment.[65] While the United Nations Environment Programme (UNEP) serves as the GPA Secretariat, regional seas programmes have an important implementation role.[66]

Intergovernmental review sessions on the implementation of the GPA have taken place periodically since 2001. Nonetheless, the soft-law nature of this mechanism has been identified as a challenge to its implementation.[67] In order to tackle this limitation, mainstreaming the GPA through the regional seas programmes has been perceived as a positive means to address land-based pollution and keep track of progress, including through diverse types of assessments conducted under regional seas organisations' auspices, as discussed below. Furthermore, in 2018, during the fourth session of the Intergovernmental Review Meeting on the Implementation of the GPA, the Bali Declaration[68] was adopted by 60 governments and by the European Union (EU), whereby agreement was reached to enhance mainstreaming of the protection of coastal and marine ecosystems, especially from threats caused by increased nutrients,[69] in support of the Agenda 2030 for Sustainable Development and its individual SDGs.[70]

Before discussing SDG 14.1 (marine pollution from land-based sources) in the context of the Agenda 2030, it is worth mentioning the Aichi Biodiversity Target 8, adopted by the Parties to the CBD as part of the 2011–2020 Strategic Plan for Biodiversity, which committed CBD Parties to bring pollution, including from excess nutrients, down to levels that are not detrimental to ecosystem function and biodiversity by 2020.[71] This is linked to the Agenda 2030 since the CBD Conference of the Parties have urged its parties to mainstream biodiversity into the SDGs through the implementation of the Aichi Targets.[72] With the expiration of the Aichi Targets at the end of 2020, a new pollution target to replace target 8 is currently being negotiated by CBD Parties for the Post-2020 Global Biodiversity Framework. The matter of excess nutrients is one of the three types of pollution highlighted in the zero draft of this new framework,[73] as these have been identified by the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) as significant drivers of biodiversity and ecosystem service loss. IPBES has indicated that '[w]hile terrestrial ecosystems have been affected by nitrogen-phosphorus fertilisers, these have had a more pernicious effect on the

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65 UNEP, 'Global Programme of Action for the Protection of the Marine Environment from Land-based Activity' (GPA) (UNEP 1995), paras 18 and 23.

66 Ibid, para 40.

67 David Vanderzwaag and Ann Powers, 'The Protection of the Marine Environment from Land-based Pollution and Activities: Gauging the Tides of Global and Regional Governance' (2008) 23 The International Journal of Marine and Coastal Law 423.

68 Intergovernmental Review Meeting on the Implementation of the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities, Fourth Session, Bali, Indonesia, 31 Oct–1 Nov 2018. <https://papersmart.unon.org/igr-meeting/sites/default/files/k1900652.pdf#overlay-context=working-docs> accessed 19 May 2020.

69 Ibid para 1(a).

70 Ibid para 2 (a).

71 CBD decision X/2 (2010), Aichi Target 8. See also Somsen and Trouwborst, Chapter 12 in this book.

72 CBD decision XIII/3, paras 10 and 14.

73 Zero Draft of the Post-2020 Global Biodiversity Framework, CBD/WG2020/3, 6 January 2020.

biodiversity of freshwater and marine habitats, leading to eutrophication and hypoxic or "dead" zones that support no aquatic life'.[74] The proposed indicators for the post-2020 nutrient pollution target so far include: nitrogen use efficiency; nitrogen and phosphate fertilisers (N+P205 total nutrients); trends in loss of reactive nitrogen to the environment; and trends in nitrogen deposition.[75] Increasing the efficiency of fertiliser use, and avoiding its inappropriate use in agriculture, has been called for by CBD Parties as a means to mainstream biodiversity into the agricultural sector.[76]

Under the Agenda 2030 for Sustainable Development, SDG 14.1 is of particular importance, as UN Member States have committed to, '[b]y 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution'. Its indicator 14.1.1 focuses on the 'index of coastal eutrophication'.[77] Other developments in the further elaboration of SDG indicators at the global level include the work of the Inter-Agency and Expert Group on Sustainable Development Goal Indicators (IAEG-SDGs) in conducting a comprehensive review of the global indicator framework for the UN Statistical Commission's consideration with a view to possibly reviewing and modifying the existing indicators.[78] Furthermore, the World Conservation Monitoring Centre has developed guidance to support States to monitor progress against the delivery of three current indicators, including SDG 14.1.1 with respect to the eutrophication index.

In preventing, reducing and controlling pollution from land-based sources, States 'shall endeavour' to align their policies at the regional level.[79] Despite the fact that most regional seas organisations prefer to adopt recommendations rather than legally binding decisions, even when they have the competency to do so, these 'recommendations can provide an indication of what is expected from States in carrying out their due diligence obligations [under UNLOSC]'.[80]

It is important to note that the ecosystem approach has been incorporated in most regional seas conventions, and this enables them to adopt plans and measures consistent with the principles and guidance developed by the CBD and by other relevant instruments. This provides an opportunity for the incorporation of the planetary boundaries framework into prevailing international environmental law, and for its thresholds to be taken into consideration. Furthermore, at the regional level, most regional seas conventions prepare state of environment reports and diverse thematic assessment reports using driver/issue-pressure-state-impact-response (DPSIR) framework indicators.[81] Illustrative eutrophication indicators based on the DPSIR

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74 IPBES, 'Models of Drivers of Biodiversity and Ecosystem Change' <http://ipbes.net/models-drivers-biodiversity-ecosystem-change> accessed 20 February 2020.

75 CBD, Zero Draft of the Post-2020 Global Biodiversity Framework, Appendices, CBD/WG2020/2/3/Add.1 (6 January 2020).

76 CBD decision XIII/3 (2016), para 32.

77 United Nations, 'Sustainable Development Goals, SDG 14, Targets and Indicators' (UN 2019) <https://sustainabledevelopment.un.org/sdg14> accessed 19 May 2020.

78 UNGA Resolution 71/313 (2017).

79 UNLOSC art 207 (3).

80 Harrison (n 46) at 82.

81 UN Environment, *Regional Seas Follow Up and Review of the Sustainable Development Goals (SDGS)* (UN Environment Regional Seas Reports and Studies No. 208, 2018). Examples of these reports include: the Caribbean State of Convention Area Report, Pacific State of Environment Report, the Baltic Sea Holistic Assessment of Ecosystem Health in the Baltic Sea, the Mediterranean Quality Status Report, the Northeast Atlantic Intermediate Assessment, the West-Indian Ocean State of the Coast Report, the

Table 17.1 Correlation between the SDG 14.1 indicator and regional seas programme indicators in relation to eutrophication

SDG Target	SDG Indicator	Regional Sea Indicator
14.1 Marine Pollution	14.1.1 Index of coastal eutrophication	a) Chlorophyll-a concentration as an indicator of phytoplankton biomass b) Locations and frequency of algal blooms reported c) Pollution hotspots: concentration of status of selected pollutant contamination in biota and sediments and temporal trends; number of hotspots d) % of national action plans ratified and operational e) Waste water: % of coastal urban population connected to sewage facilities; % of waste facilities complying with adequate standards; % of untreated waste water

Source: Adapted from UNEP (n 82) on proposed regional seas indicators for SDG 14.1.

framework include nitrogen and phosphorus emissions (for assessing pressure), concentrations (for addressing the state of the environment) and treatment connections, and investment and costs (as responses).[82]

Five regional seas programmes,[83] as well as the EU, have adopted indicators for the causes of eutrophication related to nutrient input and concentrations.[84] Indicators related to the direct effects of eutrophication, such as chlorophyll-a concentrations, biomass growth of algae and phytoplankton and water clarity/turbidity, have also been used as indicators across 18 regional seas programmes,[85] as well as by the EU, the United States and the Global Environment Facility Transboundary Waters Assessment Programme.[86] Indicators related to the indirect effects of eutrophication, such as dissolved levels of oxygen, have also been used by four regional seas programmes,[87] as well as by the EU.

The correlation between the SDG 14.1 indicator and those used by the regional seas programme in relation to eutrophication is illustrated in Table 17.1.

Chlorophyll-a concentration has been agreed as a proxy indicator as it can be more easily (and cost-efficiently) measured through satellite imagery analysis.[88] This is particularly rele-

Red Sea and Gulf of Aden State of Marine Environment Report, and the Northwest Pacific State of the Marine Environment and Economies.

[82] UNEP, *Measuring Success: Indicators for the Regional Seas Conventions and Action Plans* (UNEP Regional Seas Report and Studies No. 194, 2014).

[83] Under the Commission for the Protection of the Marine Environment of the North-East Atlantic; the Baltic Marine Environment Protection Commission; the UNEP-Mediterranean Action Plan; the Permanent Commission for the South Pacific; and the Action Plan for the Protection, Management and Development of the Marine and Coastal Environment of the Northwest Pacific Region.

[84] UNEP, *Global Manual on Ocean Statistics: Towards a Definition of Indicator Methodologies*. Draft (UNEP 2018).

[85] Ibid.

[86] Ibid. Chlorophyll-a can be detected through in situ measurements and/or through remote sensing imagery.

[87] Commission for the Protection of the Marine Environment of the North-East Atlantic; the Baltic Marine Environment Protection Commission, Action Plan for the Protection, Management and Development of the Marine and Coastal Environment of the Northwest Pacific Region, and Permanent Commission for the South Pacific.

[88] UNEP (n 84).

vant for regions where regional seas organisations lack sufficient resources to conduct in situ monitoring.

These global and regional indicators can therefore play a key role in ensuring that nitrogen and phosphorus regional and global planetary boundaries are not transgressed. However, the extent to which the planetary boundaries have been used to guide these specific governance developments is not clear. Global coordinated efforts are arguably necessary to ensure that the thresholds adopted in each region can reverse the current trends and prevent harmful concentrations of nitrogen and phosphorus input into the oceans, while at once guiding the implementation of articles 207 and 212 UNLOSC at the national and regional levels. Furthermore, the development of specific thresholds, especially at the regional level, can better inform States about risks of substantial transboundary pollution or significant and harmful changes to the marine environment, which will consequently trigger an environmental impact assessment and the publication of the assessment results.[89]

Regional seas organisations are well positioned to define ocean-basin/sub-basin specific thresholds tailored to the particular environmental conditions of the area (such as circulation patterns, ecosystem characteristics, types of inputs, and so on). This has been the case in the Baltic Sea,[90] where maximum allowable inputs and country-allocated reduction targets have been set regionally and sub-regionally, and integrated assessments are conducted on a regular basis.[91] Despite the measures adopted in 2007 (and revised in 2013) to reduce land-based inputs of nitrogen and phosphorus, the latest integrated assessment concluded that 97 per cent of the Baltic region, with reference to the period 2011–16, is considered to be eutrophied given the increasing concentrations of these nutrients, notably between 1950 and late 1980s.[92] According to the integrated assessment, despite declining trends since 1995, nitrogen and phosphorus inputs were still above the maximum allowable input thresholds, with most of the sources being riverine inputs. Maximum allowable inputs are allocated to the Baltic Marine Environment Protection Commission (HELCOM) Member States in the form of country-wide reduction targets.[93] The importance of conducting regular scientific assessments on the state of the marine environment, including with respect to eutrophication, is supported under UNLOSC Article 200. UNLOSC also provides for the obligation of States to cooperate directly or through competent organisations in the 'establishment of criteria for the formulation and elaboration of rules, standards and recommended practices and procedures for the prevention, reduction and control of pollution of the marine environment'[94] based on the information and data contained in the scientific assessments. HELCOM's maximum allowable inputs and country-allocated reduction targets are an example of such standards.

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[89] UNLOSC arts 204–206.

[90] HELCOM, *HELCOM Copenhagen Ministerial Declaration: Taking Further Action to Implement the Baltic Sea Action Plan – Reaching Good Environmental Status for a Healthy Baltic Sea* (HELCOM 2013).

[91] See HELCOM, *HELCOM Thematic Assessment of Eutrophication 2011–2016* (HELCOM 2018) and *Thematic Assessment of Cumulative Impacts on the Baltic Sea 2011–2016* (HELCOM 2018).

[92] Ibid.

[93] Ibid.

[94] UNLOSC art 201.

Nitrogen and phosphorus flows illustrate the interconnectivity of the Earth system and the multiple impacts on the biosphere as a whole.[95] The cumulative effects of excess nutrient input are felt at the ecosystem level, but also often downstream. Regional seas organisations can play an important role in setting standards at regional and sub-regional levels, ranging from upstream to downstream. The ecosystem approach guidance under the CBD requires taking into consideration not only imminent coastal zones, but also entire coastal watersheds. Such an approach has been adopted under the 1996 Mediterranean Protocol on Pollution from Land-based Sources and Activities.[96] Furthermore, the Protocol obliges its Parties to eliminate pollution from land-based sources and activities, including by phasing out certain substances,[97] such as compounds of nitrogen and phosphorus,[98] from agricultural and animal husbandry sectors as well as from fertiliser production.[99] National and regional action plans and programmes with specific measures and timelines are also required.[100] Importantly, point source discharges in the Protocol area, as well as releases into the water or air 'that reach and may affect the Mediterranean Area … shall be strictly subject to authorization or regulation by the competent authorities of the Parties'.[101] These authorisations and regulations shall take due account of monitoring elements and criteria adopted under Annex II of the Protocol, as well as of decisions or recommendations of the meetings of the Contracting Parties.[102] Like UNLOSC, the Protocol also requires its Parties to formulate and adopt common guidelines and standards for effluent discharge, taking into account local ecological, geographical and physical characteristics, as well as the economic capacity of the Parties and their need for development, the levels of existing pollution and the absorptive capacity of the marine environment.[103]

A number of studies have been conducted and models have been run to assess nitrogen and phosphorus fluxes and discharges into the Mediterranean of main European basins over the past decades.[104] Malago and colleagues, for example, have developed a conceptual model for quantifying total nitrogen and nitrate and total phosphorus and orthophosphate fluxes to identify the corresponding levels of different sources, as well as hotspots of higher pollution concentrations for priority actions.[105] This model integrates available data at the global level (it is therefore well suited for data-poor regions) and considers the interface between crop, water and nutrient impacts on water quality.[106] The parameters utilised by the model include: river basin characteristics; spatial agronomic, hydrologic and climatic characteristics; spatial information on diffuse and point sources of nitrogen and phosphorus; and measurements of

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[95] Understood to be composed of all ecosystems – including biotic and abiotic elements in the terrestrial, marine and atmospheric environments – that support life on Earth.

[96] See Mediterranean Protocol on Pollution from Land-based Sources and Activities (adopted 7 March 1996, entered into force 11 May 2008), Annex I, A.

[97] Ibid art 5 (1).

[98] Ibid Annex I, B.13.

[99] Ibid.

[100] Ibid art 5 (2).

[101] Ibid art 6 (1).

[102] Ibid art 6 (1).

[103] Ibid art 7 (2).

[104] Anna Malago et al, 'Modelling Nutrient Fluxes into the Mediterranean Sea' (2019) 22 Journal of Hydrology: Regional Studies 100592.

[105] Ibid.

[106] Ibid.

nutrient loads in surface water.[107] The results of the study show that the Nile Delta continues to influence eutrophication in the Mediterranean due to increased urbanisation and intensification of fertilisers in agricultural practices in Egypt and Turkey, while the enforcement of policies and regulations to reduce agricultural nutrient[108] and wastewater[109] discharges in Europe seems to have contributed to decreasing chlorophyll concentrations (a proxy for detecting eutrophication – as noted above) off the Rhone River mouth.[110] These findings are important in the context of regional seas, as they help identify the key sources of pollution, and they test the effectiveness of policies and laws in place to minimise, reduce and control detrimental levels of nutrient input from river basins (and specific countries) – the appropriate ecosystem unit for assessing the problem under consideration. These types of model can also help identify the necessary trade-offs across different activities or sources of pollution, while taking into account the economic capacity of developing countries and their need for economic development (as per UNLOSC Article 207(4)).

More importantly, these regional initiatives usefully illustrate how the planetary boundaries framework concerning nitrogen and phosphorus biogeochemical cycles could be translated into law, policy-making and governance initiatives. What seems to be missing, however, is a coordinated approach across and within regions to formally endorse the framework's thresholds (discussed in Section 2 above) to ensure that the nitrogen trend is reversed across the globe and phosphorus is kept within safe levels. UNEA has requested UNEP to coordinate efforts regarding nitrogen input, and in this context, regional seas programmes are well placed to coordinate these efforts across regional seas conventions.

4. CONCLUSION

The dispersed nature of excess nutrient input to the oceans constitutes one of the most challenging environmental problems to regulate, and this has practical implications for the operationalisation of the planetary boundaries framework related to nitrogen and phosphorus biogeochemical cycles. The use of fertilisers, in particular, is deeply concerning and requires coordinated efforts, regulations, scientific monitoring and enforcement mechanisms that, in turn, all rely on adequate financial and institutional resources, which are yet another challenge, especially in poorer regions of the world.

Despite these challenges, from a pure legal point of view, the UNLOSC at least offers a general international law framework that is supplemented by several policies and a range of other global and regional instruments aimed at tackling marine pollution from excess nutrients that might collectively address this boundary's primary concerns.

Most regional seas organisations have embraced the ecosystem approach (which is in general terms consistent with the planetary boundaries framework) under their conventions, and experience demonstrates that some progress has been achieved in some Baltic Sea sub-regions and in the Northeast Atlantic and the Mediterranean in slowing down negative trends of nitrogen and phosphorus input to ecosystems. Compliance mechanisms involving

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107 Ibid.
108 EU Nitrates Directive (91/676/EEC).
109 EU Urban Waste Water Directive (91/271/EEC).
110 Malago et al (n 104).

reporting procedures under regional conventions also seem to have contributed to positive outcomes.[111] Regional assessments have supported the adoption of maximum allowable nutrient input in certain regions (such as the Baltic Sea), contributing to a declining trend in nitrogen and phosphorus concentrations. Models applied to the Mediterranean region using global data has also been used to monitor progress and track areas and sectors that require further attention. Approaches such as these can be used in data-limited situations, which might be ideal in regions where resources are scarce.

Finally, in implementing an ecosystem approach and in operationalising the planetary boundaries framework, it is important to ensure that regional seas organisations (and other relevant regional frameworks) have the mandate (through their respective conventions and governance decisions) to address nutrient input to the oceans from the watershed basins to the marine realm in a coordinated manner. Despite the challenges derived from the fragmented nature of global environmental law and the complexities of dealing with both marine and terrestrial ecosystems and governance regimes, the UNLOSC continues to provide a strong overarching and evolving framework that unites relevant instruments including through the incorporation by reference of minimum agreed standards, and the recognition that a holistic approach is required to address the most complex and interrelated problems of the ocean.

[111] See Harrison (n 46).

18. Freshwater consumption and the global hydrological cycle

Nathan John Cooper

1. INTRODUCTION

Today a billion people lack access to safe drinking water and 3.6 billion live in areas with potential water scarcity.[1] Growing human population and dwindling groundwater reserves conspire to make water security[2] among the most urgent and profound of human challenges. But access to fresh water varies significantly between different regions of the globe, making it difficult to conceive of such scarcity as a truly global problem. Flash floods in Australia, drought in California and river pollution in China[3] all point towards a multifarious picture of our relationship with water. Yet fresh water is included as a singular planetary boundary, beyond which collapse of terrestrial and aquatic ecosystems is envisaged.[4] This is because behind the many varied examples, there lies a principal catalyst for global-scale manipulations of the hydrological cycle: human action.[5]

The planetary boundaries framework offers a set of thresholds for nine vital Earth system processes.[6] In so doing, it paints a compelling picture of the need to live within our limits, and is becoming acknowledged as an 'important conceptual breakthrough'.[7] Framing the aspects and processes of the Earth system within boundaries is an appealing endeavour, with considerable normative and practical potential.[8] But it is also a necessarily simplistic rendering of complex science. Focusing in this chapter on the freshwater boundary, it is important to introduce two points of distinction, in order to begin to consider the strengths and limitations of this boundary as a conceptual tool with which to pursue water security.

First, of the nine boundaries, three (climate change, ocean acidification and stratospheric ozone depletion) can be understood as 'systemic processes'. These fit well with the notion of global capacity, and through a 'top-down approach' can be scaled down from the global to

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1 United Nations World Water Assessment Programme, 'The United Nations World Water Development Report 2018: Nature-Based Solutions for Water' (2018).

2 Ministerial Declaration of the Hague on Water Security in the 21st Century (The Hague, 22 March 2000), 1 <www.worldwatercouncil.org/fileadmin/world_water_council/documents/world_water_forum_2/The_Hague_Declaration.pdf> accessed 8 June 2020.

3 Peter Beaumont, 'What's in Our Water? Report Warns of Growing "Invisible" Crisis of Pollution' (*The Guardian*, 20 August 2019) <www.theguardian.com/global-development/2019/aug/20/whats-in-our-water-report-warns-of-growing-invisible-crisis-of-pollution> accessed 8 June 2020.

4 Jonas Ebbesson, 'Planetary Boundaries and the Matching of International Treaty Regimes' (2014) 59 Scandinavian Studies in Law 260, 272.

5 Ibid.

6 Johan Rockström et al, 'A Safe Operating Space for Humanity' (2009) 461 Nature 472.

7 Michelle Maloney, 'Ecological Limits, Planetary Boundaries and Earth Jurisprudence' in Michelle Maloney and Peter Burdon (eds), *Wild Law – In Practice* (Routledge 2014) 200.

8 See Kim and Kotzé, Chapter 3, and Bleby, Holley and Milligan, Chapter 2, in this book.

national or regional levels.[9] The remaining six, including fresh water, have been described as 'aggregated processes' for which evidence of global-scale thresholds is weak. For fresh water in particular, its boundary is dependent on the availability of freshwater in any location (which varies considerably). Failure to include such sub-global variability for aggregated boundaries within the current planetary boundaries framework represents a significant methodological limitation to the framework itself.[10]

Second, hydrology distinguishes between 'blue water' (water from rainfall, entering lakes, rivers and groundwater) and 'green water' (rainfall intercepted by vegetation, or entering the soil).[11] The proposed freshwater planetary boundary refers only to blue water consumption (setting an annual planetary boundary of 4000 km^3 against a total volume of blue water resources estimated at 12,500–15,000 km^3 per year).[12] Yet any threshold for freshwater must also ensure adequate green water flows (in order to maintain rainfall from evapotranspiration).[13]

The implications of the systemic/aggregate and blue water/green water distinctions for the current freshwater planetary boundary suggest that the boundary cannot be used to directly measure appropriate global freshwater use. Similarly, it cannot be directly translated into multiple and varied geographical locations as a tool for water governance.[14] However, these methodological deficiencies should not belie the significant potential that the freshwater boundary has to promote hydrologically rigorous and ecologically adept discourse on water security, within the most prominent international regulatory domains for water governance.

Without further considering the accuracy of the freshwater planetary boundary, this chapter will focus on the boundary's conceptual potential to help us reimagine established modes of water law and governance (and by extension, to help us reimagine our relationship with water), towards an equitable and sustainable socio-hydrological future. Aiming to inform water governance on multiple levels, the freshwater boundary offers a blueprint for more sustainable consumption, in order to avoid the potential collapse of freshwater systems and the catastrophic consequences of water poverty for humans, non-humans and the Earth itself.

Moreover, it will be argued that the freshwater planetary boundary has the potential to give geo-spatial expression of the ethical imperative to use water within the threshold necessary for ecological integrity.[15] But the success of this endeavour will depend not only on better connecting water governance frameworks and programmes, but also, and fundamentally, on what identity we choose to embrace as humans.

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9 Kai Fang et al, 'The Environmental Sustainability of Nations: Benchmarking the Carbon, Water and Land Footprints against Allocated Planetary Boundaries' (2015) 7 Sustainability 11285, 11287.

10 Ibid at 11288.

11 Janos J Bogardi et al, 'Planetary Boundaries Revisited: A View through the Water Lens' (2013) 5 Current Opinion in Environmental Sustainability 581, 583.

12 Johan Rockström et al, 'Planetary Boundaries: Exploring the Safe Operating Space for Humanity' (2009) 14 Ecology & Society 1; Will Steffen et al, 'Planetary Boundaries: Guiding Human Development on a Changing Planet' (2015) 347 Science 1259855, 1259855-5.

13 Johan Rockström et al, 'The Unfolding Water Drama in the Anthropocene: Towards a Resilience-based Perspective on Water for Global Sustainability' (2014) 7 Ecohydrology 1249, 1250.

14 Bogardi et al (n 11) 581.

15 Ecological integrity has been helpfully, if somewhat anthropocentrically, defined as 'the continued healthy or proper functioning of … global- and local-scaled ecosystems and their ongoing provision of renewable resources and environmental services'. See Brendan Mackey, 'Ecological Integrity – A Commitment to Life on Earth' in Peter Blaze Corcoran, Mirian Vilela and Alide Roerink (eds), *The Earth Charter in Action* (KIT Publishers 2005) 65, 66.

The chapter considers aspects of the current state of international law and governance relating to freshwater conservation and consumption, focusing in particular on the evolution and application of an international human right to water, integrated water resources management (IWRM) and United Nations Sustainable Development Goal 6: clean water and sanitation (SDG 6). Between them, these regulatory domains make explicit claims to the fundamentality of a right to water, to water's essential developmental role and to the need for sustainable water governance over the long term.

Addressing each domain in turn, the chapter contends first that there are many institutional and operational challenges facing efforts to realise sustainable water use through each of these domains. Second, it argues that *implicit* norms of water governance also exist within each domain, not least of which is the commodification of water. Such implicit norms generate a concerted approach to water governance, sustained, as it is, by a deeply anthropocentric cosmology of human mastery.[16] Central to this is the myth that humanity can continue to consume and develop, unbounded by the physical finitude of Earth's systems.[17] Third, so tenacious has this myth proved to be that it significantly undermines the ability of the international legal order to adequately respond to the Anthropocene challenges of multiple climate crises, fast approaching planetary boundaries and the absence of intergenerational, intragenerational and interspecies equity.[18] Fourth, the chapter proposes that the destructive myth of human mastery must be rejected if water security is to be achieved. In its place we must reconnect our societies with the realities of the biosphere's limits, so that safe and just water governance, across regulatory domains, can emerge.

2. A HUMAN RIGHT TO WATER

In the international context, water security challenges are increasingly situated within human rights discourse, and access to water is acknowledged as a fundamental human right. A decade ago, United Nations (UN) General Assembly Resolution number 64/292,[19] recognising the right to water and sanitation, was adopted, with 122 votes in favour, none against and 41 abstentions. This was the first time the right to clean water and sanitation was formally recognised at the international level. It acknowledges that both water and sanitation are essential for realising all human rights. Affirmed and supported by the corresponding UN Human Rights Council Resolution[20] two months later, the human rights to water and sanitation are

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16 See eg Clive Hamilton, *Earthmasters: The Dawn of the Age of Climate Engineering* (Yale University Press 2013) 202; Sam Adelman, 'Epistemologies of Mastery' in Anna Grear and Louis J Kotzé (eds), *Research Handbook on Human Rights and the Environment* (Edward Elgar 2015) 9–27; and Anna Grear, 'The Closure of Legal Subjectivity: Why Examining "Law's Person" Is Critical to an Understanding of Injustice in an Age of Climate Crisis' in Anna Grear and Louis J Kotzé (eds), *Research Handbook on Human Rights and the Environment* (Edward Elgar 2015) 79–100.

17 See Bleby, Holley and Milligan, Chapter 2 in this book.

18 See also Adelman, Chapter 4 in this book.

19 UNGA, 'The Human Right to Water and Sanitation' Res 64/292 (3 August 2010), UN Doc A/RES/64/292.

20 UNCHR, 'Human Rights and Access to Safe Drinking Water and Sanitation' (30 September 2010), Res A/HRC/RES/15/9. Note that the mandate, responsibilities and functions of the Human Rights Council are outlined in UNGA Res. 60/251 (3 April 2006) UN Doc A/RES/60/251. These include the duties to make recommendations to the UN General Assembly for the further development of interna-

now explicitly confirmed as being part of international law, although they remain not legally binding on States.[21] Together these two resolutions mark the culmination of decades of efforts to acknowledge water as a human right at the international level.

The legal basis, obligations and normative status of the right of access to water are briefly analysed below, before considering the degree to which the emerging *rights*-based approach to water access overlaps with the 'technical' regulatory domain of IWRM and with the SDGs' agenda, and the extent to which the planetary boundaries framework, including the freshwater boundary, offers context to and possibly even challenges the normative core and practical applicability of a human right to water in the Anthropocene.[22]

Since access to sufficient clean water is undoubtedly necessary for dignified life, it may be expected that a human right to water has long been acknowledged. Despite not being explicitly mentioned as a human right in the Universal Declaration of Human Rights[23] or the International Covenant on Economic, Social and Cultural Rights,[24] access to sufficient water has been progressively recognised internationally as a human right since the 1977 UN Water Conference in Mar del Plata.[25] In 2002, General Comment No. 15, issued by the Committee on Economic, Social and Cultural Rights, re-emphasised water as a prerequisite for the realisation of other human rights and restated that access to water was itself a human right.[26] This was followed by the 2010 UN resolutions referred to above, further entrenching access to sufficient water as an internationally accepted human right to which the obligations of States party to the ICESCR apply.

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tional law in the field of human rights; and to make recommendations with regard to the promotion and protection of human rights (para 5 (c) and (i)).

[21] Ibid. Note that the above mandate of the Human Rights Council does not include empowerment to make legally binding resolutions.

[22] The Anthropocene has been unofficially proposed as a new geological epoch. The effects of the Anthropocene on water are not yet fully understood. But salination, drought and heavy rainfall are all consequences of the less predictable weather patterns experienced globally. Furthermore, so crucial is fresh water for life that pressure on water supplies adversely affects aspects of human life ranging from food security to sanitation, health and economic development. See Simon Meisch, 'The Need for a Value-Reflexive Governance of Water in the Anthropocene' in Anik Bhaduri et al (eds), *The Global Water System in the Anthropocene* (Springer International Publishing 2014) 427–37; Will Steffen, Paul J Crutzen and John R McNeill, 'The Anthropocene: Are Humans Now Overwhelming the Great Forces of Nature?' (2007) 36(8) *AMBIO* 614.

[23] UNGA, 'Universal Declaration of Human Rights' (UDHR) (10 Dec. 1948), UNGA Res. 217A (III), 3 UN GAOR (Resolutions, part 1) at 71, UN Doc. A/810 (1948).

[24] International Covenant on Economic, Social and Cultural Rights (ICESCR) (adopted 16 December 1966, entered into force 3 January 1976) 993 UNTS 3, GA Res. 2200 (XXI), 21 UN GAOR Supp. (No. 16) at 49, UN Doc. A/6316 (1966).

[25] Resolution II of the conference declared that 'All peoples, whatever their stage of development and their social and economic conditions, have the right to have access to drinking water in quantities and of a quality equal to their basic needs.'

[26] United Nations Committee on Economic, Social and Cultural Rights, General Comment 15, The right to water ('General Comment 15') (Twenty-ninth session, 2003), UN Doc. E/C.12/2002/11 (2002), reprinted in Compilation of General Comments and General Recommendations Adopted by Human Rights Treaty Bodies, UN Doc. HRI/GEN/1/Rev.6 at 105 (2003). Para 2: 'The human right to water entitles everyone to sufficient, safe, acceptable, physically accessible and affordable water for personal and domestic uses.' The comment exhorts the states parties to 'adopt effective measures to realise, without discrimination' the human right to water (para 1).

In charting the development of the human right to water it is clear that there is considerable international consensus around the existence of the right, despite the fact that it lacks some of the attributes typically expected of internationally recognised human rights (including explicit enunciation in a legally binding convention). It should be clarified at this point that a human right to water does not appear to form customary international law, because of an absence of consistent State practice. Such absence is attested to by the enduring global problem of water poverty for one billion people. 'Ironically, the same data used to promote the need for a human right to water is precisely the data that prevents it from being considered customary international law.'[27] Currently, the absence of consistent State practice also precludes a human right to water from recognition as *jus cogens*.[28]

The absence from the UDHR and ICESCR of a legally binding human right to water has meant that General Comment 15 has come to play a particularly important part in stating the nature and scope of this right. As McCaffrey observes, General Comment 15 'is the first recognition by a United Nations human rights body of an independent and generally applicable human right to water'.[29] In addition to its normative importance, and its role in focusing international opinion towards the issue of water as a human right, General Comment 15 provides the most authoritative and detailed commentary to date on the substantive content of the right to water, and the corresponding standards of action and response that States Parties to the ICESCR are expected to meet.[30] Indeed, since its publication in 2002, General Comment 15 has been influential in informing national law in various jurisdictions.[31]

General Comment 15 asserts that a human right to water derives from, and is required for, realisation of two rights: the right to an adequate standard of living and the right to the highest attainable standard of health (Articles 11 and 12 ICESCR). Therefore the elements that constitute the human right to water must be sufficient to meet these requirements of dignified life and health.[32] Paragraph 2 describes the human right to water as entitling 'everyone to *sufficient*, *safe, acceptable, physically accessible* and *affordable* water for personal and domestic uses'.[33] Together these attributes combine to state a minimum core to which a human right to water must correspond.[34]

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27 Brett Hartley and Heather J Van Meter, 'The Human Right to Water: Proposal for a Human Rights-Based Prioritization Approach' (2011) 19 Williamette Journal of International Law & Dispute Resolution 66, 84. See also Inga T Winkler, 'The Human Right to Water' in Stephen C McCaffrey, Chistina Leb and Riley T Denoon (eds), *Research Handbook on International Water Law* (Edward Elgar 2019) 242.

28 Hartley and Van Meter (n 27) 84.

29 Stephen McCaffrey, 'The Human Right to Water' in Edith Brown Weiss et al (eds) *Fresh Water and International Economic Law* (Oxford University Press 2005) 93, 101.

30 See variously Erik B Bluemel, 'The Implications of Formulating a Human Right to Water' (2004) 31 Ecology Law Quarterly 957, 972; Malcolm Langford, 'Ambition That Overleaps Itself – A Response to Stephan Tully's Critique of the General Comment on the Right to Water' (2006) 24 Netherlands Quarterly of Human Rights 433, 448–49; Melina Williams, 'Privatization and the Human Right to Water: Challenges for the New Century' (2007) 28 Michigan Journal of International Law 469, 475.

31 See Norbert Brunner et al, 'The Human Right to Water in Law and Implementation' (2005) 4 Laws 413; *Mazibuko and others v City of Johannesburg and others* [2009] JOL 21829 (W); *Mazibuko and others v City of Johannesburg and others* [2009] JOL 24351 (CC).

32 See General Comment 15, para 11, also ICESCR, preamble and arts 11 and 12.

33 General Comment 15, para 2 (emphasis added).

34 The quantity of water available for each person should take into account different conditions relating to health, climate and work. But availability should correspond to World Health Organization

Importantly, defined as such, the human right to water does not require immediate fulfilment. Consequently there is no corresponding mechanism for immediate enforceability. Rather, as set out in ICESCR Article 2, the relevant obligations of each State party are to 'take steps … to the maximum of its available resources, with a view to achieving progressively the full realization of the rights recognized in the present Covenant by all appropriate means'.[35] While General Comment 15 articulates an authoritative human right to water, what States are practically obliged to do is to take steps, to the maximum of their resources, to progressively realise this right. No doubt such an obligation, if taken seriously, would result in improvements to water access globally. What it would not do is to immediately, or indeed swiftly, realise this right, given the size of the task. The acceptability of *progressive* realisation (rather than immediate realisation or realisation within a set time frame, for instance), coupled with limited available resources, means that in some States enjoyment of a human right to water remains a long way off.

Alongside the general requirement for progressive realisation, State parties also have so-called core obligations to 'ensure the satisfaction of, at the very least, minimum essential levels of each of the rights enunciated in the Covenant'.[36] Furthermore, they are obliged 'to guarantee that the rights enunciated in the present Covenant will be exercised without discrimination of any kind'.[37]

As the foregoing discussion has shown, it is not easy to find a single independent, comprehensive and legally binding human right to water in international law. Instead, the human right to water should be considered a unique right, which Thielbörger describes as 'a right of its very own kind that must be seen in connection with national guarantees … and with other recognized human rights'.[38]

The human right to water can only be understood as a complex, multi-layered network of international, regional and national law, treaties, 'hard law' and 'soft law'.[39] Such an analysis is capable of affirming the continuing relevance of this right in international law, especially regarding the setting of a substantive core to the right, including codifying minimum standards and violations, as well as the independent monitoring of States' progress in progressively realising it. Of particular importance on this point is the mandate of the UN Special Rapporteur

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(WHO) guidelines, which state between 20 and 40 litres per person per day (lpd). See Peter H Gleick, 'Basic Water Requirements for Human Activities: Meeting Basic Needs' (1996) 21 Water International 83, 88; Peter H Gleick, 'The Human Right to Water' (1998) 1 Water Policy 496.

35 ICESCR (n 24) art 2 (1).

36 UN Committee on Economic, Social and Cultural Rights (CESCR) 'General Comment No. 3: The nature of States parties' obligations' (14 December 1990) UN Doc. E/1991/23, <www1.umn.edu/humanrts/gencomm/epcomm3.htm> accessed 8 June 2020.

37 ICESCR (n 24) art 2 (2).

38 Pierre Thielbörger, *The Right(s) to Water* (European University Institute 2010) v.

39 The terms 'hard law' and 'soft law' are useful here, although it should be noted that both terms remain inexact in their usage. Despite positivists' eschewal of soft law as a concept (on the premise that law, by definition, is binding), the principal distinction between hard law and soft law is that the former is legally binding, while the latter is not. In relation to water governance, this distinction is a useful one, since while numerous relevant sources can be identified, only some of these are binding in the strict sense. See Gregory C Shaffer and Mark A Pollack, 'Hard vs. Soft Law: Alternatives, Complements and Antagonists in International Governance' (2010) 94 Minnesota Law Review 706, 712–13.

on the Human Right to Water and Sanitation (currently held by Leo Heller).[40] The extent to which the mandate is able to effectively monitor progress, and to challenge rights violation, remains to be seen.[41]

The normative importance of affirming a human right to water at the international level should not be underplayed. But it is also important to acknowledge that, despite their international character, '[H]uman rights and the human rights movement depend on governments and on the state system'[42] for their respect, protection and fulfilment. It is beyond this chapter's remit to conduct a detailed examination of the impact of a human right to water on domestic water security across jurisdictions. But there are already notable examples of its influence.[43]

2.1 Planetary Boundaries and the Human Rights Domain

The confirmation of a right to water within the canon of human rights creates an ethical/legal imperative to raise the 'social floor' for all humans whose access to water is impaired. The planetary boundaries framework complements this anthropocentric ethic by making visible the biophysical context within which a human right to water must necessarily operate. It must be noted that, like human rights, the planetary boundaries discourse is heavily anthropocentric, focused as it is on delimiting a safe operating space *for* humans.[44] Nevertheless, the freshwater planetary boundary shows us the 'environmental ceiling' above the social floor.[45] It thereby reveals the capacity available to us, in striving to ensure fulfilment of a human right to water for everyone. While universal fulfilment of a human right to water remains essential for people's dignified existence, we also need upper limits/maximums/boundaries if water access is to become more equitable, while maintaining the integrity of the freshwater planetary boundary. Since it is estimated that humanity is currently consuming the equivalent of one and a half Earths to meet global demand, the need to see and to take notice of our environmental ceiling is more pressing than ever.[46]

The limits of the hydrological cycle, to which the freshwater planetary boundary points, should not be allowed to stifle calls to achieve universal (human) access to sufficient water. Certainly the consequences of any tension between social development and environmental

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[40] See Human Rights Council Resolution 7/22 *Human Rights and the Access to Safe Drinking Water and Sanitation* (28 March 2008) UN Doc A/HRC/RES/7/22, <http://ap.ohchr.org/documents/E/HRC/resolutions/A_HRC_RES_7_22.pdf> accessed 8 June 2020.

[41] An overview of the mandate's work is available at United Nations Human Rights Office of the High Commissioner, 'Special Rapporteur on the human rights to safe drinking water and sanitation' (OHCHR 2014) <www2.ohchr.org/english/issues/water/iexpert/index.htm> accessed 8 June 2020.

[42] Louis Henkin, 'That "S" Word: Sovereignty, and Globalisation, and Human Rights, Et Cetera' (1999) 68 Fordham Law Review 1.

[43] See eg *Mazibuko and others v City of Johannesburg and others* (n 31).

[44] As well as being anthropocentric, Kim and Kotzé remind us that the planetary boundaries are also political constructs, reflecting the 'subjective risk perceptions' of some humans and not others, thereby raising potential questions of legitimacy, in particular from the Global South. See Kim and Kotzé, Chapter 3 in this book.

[45] Rakhyun E Kim and Klaus Bosselmann, 'Operationalising Sustainable Development: Ecological Integrity as a Grundnorm of International Law' (2015) 24 Review of European, Comparative & International Environmental Law 194, 197.

[46] Maloney (n 7) 193.

sustainability must not fall on those least able to cope.[47] Instead, freshwater's finitude should be a catalyst to refocus on the equitability of water resources and a clarion call to integrate our best understanding of Earth's biophysical capacity within a just international socio-economic, political and legal order. To this end, continued emphasis on the human right to water as a legal obligation upon governments will be important, not least since the formality of law lends itself to make such claims more effectively than do non-legal formations, including the SDGs (discussed below).[48] Certainly in the water charity sector, the rhetoric of a human right to water is prevalent. This frames water-development efforts as part of realising a *human right* to water, and not just the fulfilment of a development priority or goal.[49] This is a key reason why the right to water, situated within the regulatory domain of human rights and below the environmental ceiling that the freshwater planetary boundary provides, remains necessary and effective in promoting social equity, and social-ecological security (including water security).[50]

3. INTEGRATED WATER RESOURCES MANAGEMENT

In light of the social and environmental imperatives of achieving a universal human right to water without risking transgression of the freshwater planetary boundary, it is also a priority to ensure that global stewardship of freshwater is as efficient as possible, so that Earth's fragile freshwater cycle can sustainably meet the water-based health, food, energy and other needs of a growing human population, while sustaining all other life and functions of the Earth system.

Integrated water resources management (IWRM) is a formally constructed approach to global (international, interconnected and integrated) water governance. From its inception in the mid-twentieth century it has emphasised the need for an integrated approach, to 'ensure that the development and management of water resources take place in the context of national planning and that there is real co-ordination among all bodies responsible for the investigation, development and management of water resources'.[51]

The central conceptual theme of IWRM, contained in the Dublin Statement on Water and Sustainable Development (known as the Dublin Principles), is that water resources are finite

47 Kim and Bosselmann (n 45) 197.

48 For a contemporary example of integration of the human right to water and sanitation within a successful intergovernmental development agenda, see United Nations Economic Commission for Europe/ World Health Organization (Regional Office for Europe) 'The Human Right to Water and Sanitation in Practice: Findings and lessons learned from the work on equitable access to water and sanitation under the Protocol on Water and Health in the pan-European region' (United Nations 2019): <www.unece.org/fileadmin/DAM/env/water/publications/WH_17_Human_Rights/ECE_MP.WH_17_ENG.pdf> accessed 8 June 2020.

49 See WaterAid briefing note (WaterAid 2019) <www.wateraid.org/uk/google-search?query=human+right+to+water> accessed 8 June 2020.

50 Social-ecological security (SES) is emerging in the literature as a concept that attempts to better articulate the multifarious challenges to the security of the human (and non-human) environment. In particular, it emphasises that social and human security cannot be separated from ecological security. See eg Jonas Ebbesson, 'Social-Ecological Security and International Law in the Anthropocene' in Jonas Ebbesson et al (eds) *International Law and Changing Perceptions of Security* (Brill 2014) 71, 77.

51 'Report of the United Nations Water Conference, Mar del Plata' UN Water Conference (Mar del Plata, Argentina 1977) UN Doc E/CONF.70/29.

and interdependent.[52] The Dublin Principles summarise and promote IWRM as a holistic approach to hydrological governance, emphasising its ecological, economic and social implications. Foreshadowing the freshwater planetary boundary, Principle 1 states: 'Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment.' Principle 2 states: 'Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels' (thereby also presaging SDG target 6.5 for IWRM at all levels, including transboundary cooperation).[53] Principle 3 states: 'Women play a central part in the provision, management and safeguarding of water.' Principle 4 is particularly notable, reflecting as it does an emphasis on commercialisation of water services and the commodification of water, while also affirming access to water as a fundamental right: 'Water has an economic value in all its competing uses and should be recognised as an economic good. Within this principle it is vital to recognise first the basic right of all human beings to have access to clean water and sanitation at an affordable price.'

IWRM has been criticised for lacking specific objectives, and for its lack of sensitivity to the priorities of developing States.[54] Also, echoing similar criticism levelled at sustainable development (and mentioned below), IWRM's emphasis on integrating all relevant factors has lent it more of a procedural regulatory role than a substantive agenda.[55] Nevertheless IWRM continues to provide a common basis for water sector reform across the world,[56] as well as being a specific target for SDG 6.[57]

Over recent decades, and in response to a growing understanding of water's unique and fragile role in supporting all life on Earth, IWRM's domain has expanded. With its original practical application in water engineering and freshwater supply, IWRM has steadily integrated land-based water resources (green water), food and ecosystem services, and most recently it has begun to acknowledge and respond to challenges around social-ecological interactions and feedback, including global change. In so doing, IWRM has come to complement the integrated nature of Earth system governance,[58] including the planetary boundaries framework. For freshwater, this evolution can be broadly characterised by a shift in focus from (relatively predictable) water resources, to water resilience (in an increasingly unstable and

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52 'The Dublin Statement on Water and Sustainable Development', International Conference on Water and the Environment: Development Issues for the 21st Century (Dublin, Ireland, 26–31 January 1992) <www.wmo.int/pages/prog/hwrp/documents/english/icwedece.html> accessed 8 June 2020. Hereinafter, The Dublin Statement on Water and Sustainable Development.

53 See UNGA 'Transforming Our World: The 2030 Agenda for Sustainable Development' by UNGA A/RES/70/1 (21 October 2015) UN Doc A/RES/70/1 (Agenda 2030): Sustainable Development Goal 6: Ensure availability and sustainable management of water and sanitation for all' (UN 2019) <https://sustainabledevelopment.un.org/sdg6> accessed 8 June 2020.

54 Barbara van Koppen and Barbara Shreiner, 'Moving beyond Integrated Water Resource Management: Developmental Water Management in South Africa' (2014) 30 International Journal of Water Resources Development 1, 1.

55 Bruce Mitchell, 'Integrated Water Resources Management, Institutional Arrangements, and Land Use Planning' (2005) 37 Environment and Planning 1335.

56 Van Koppen and Shreiner (n 54) 2.

57 See Agenda 2030; SDG 6, target 6.5, with associated indicators 6.5.1 and 6.5.2.

58 See Louis J Kotzé, *Global Environmental Governance: Law and Regulation for the 21st Century* (Edward Elgar 2012) 260; Rockström et al (n 6).

unpredictable water context), with a consequent emphasis on resilience-based approaches to land and water management.[59]

3.1 Planetary Boundaries and IWRM

The planetary boundaries add another dimension to the emerging picture of Anthropocene reality, which simultaneously confronts us with humanity's responsibility for manifold global biophysical challenges and disorients us with planetary instability and unpredictability. In response, we need strategies capable of coping with 'complexity, uncertainty, and surprise'.[60] The freshwater planetary boundary tells us that freshwater is finite and the hydrological cycle fragile. Moreover, we face increasingly strained and unstable human–water dynamics, which urgently require a profoundly different socio-ecological paradigm for water governance. Such a new paradigm must transcend the Dublin Principles, with their implicit acceptance of market-based solutions and their insufficient connections to social and ecological vulnerabilities. It must add normative substance to the procedural requirements of contextualisation and multi-stakeholder engagement. To this end a principle of 'sustaining rainfall' and of 'social-ecological resilience' for all water flows has been suggested.[61] But whatever the articulated principles may be, perhaps humility is the appropriate starting point from which to begin to respond to the inherently complex, uncertain and surprising context of water governance in the Anthropocene.

Without the humility to reappraise the human–water dynamic, and to reconceive our relationship with the planet beyond stability and mastery, the insights gained by the freshwater planetary boundary could actually be purposed towards greater inequity and unsustainability. In the face of rising demand, and of falling and less predictable supply (evinced by the freshwater boundary), market 'realities' and short-term political priorities are likely to conspire towards rising water prices, intensification of ecologically destructive agriculture and growing global water insecurity, among other harmful trends.[62]

4. SUSTAINABLE DEVELOPMENT GOAL 6: CLEAN WATER AND SANITATION

The SDGs mark the latest significant chapter in the work of the UN to eradicate poverty and champion development.[63] Though broader in their scope, and with more ambitious aims, the SDGs continue the model chosen for the Millennium Development Goals (MDGs). They avoid creating direct legal obligations in favour of a 'report card' approach to help monitor and improve the performance of the international community regarding the targets that have been set. While this approach aims to ensure the SDGs reach at least a similar level of success

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59 Rockström et al (n 13) 1250.

60 Marten Scheffer et al, 'Early-warning signals for critical transitions' (2009) Nature 53, 53.

61 Rockström et al (n 13) 1257.

62 Simon Meisch, 'The Need for a Value-reflexive Governance of Water in the Anthropocene' in Bhaduri et al (n 22) 427–37.

63 United Nations Resolution A/RES/70/1 (25 September 2015) UN Doc. A/RES/70/1, <https://sustainabledevelopment.un.org/?menu=1300> accessed 8 June 2020.

as their predecessors, the emphasis on voluntary commitments rather than legal obligations continues to raise serious questions. Practical concerns regarding how to effectively implement non-legally binding commitments join more normative questions about how the SDGs should best be conceived of as a development framework. What role should law play?[64] Is there a sufficiently strong ethical imperative to ensure compliance?[65] Does the 'report card' approach signal a significant shift within the international policy community towards pursuing politically ponderous but legally insubstantial ambitions? And with what consequences? Recently, the urgency of such questions around compliance has been compounded by the news that interim progress is weak:

> There is no escaping the fact that the global landscape for Sustainable Development Goal implementation has generally deteriorated since 2015, hindering the efforts of Governments and other partners. Moreover, the commitment to multilateral cooperation, so central to implementing major global agreements, is now under pressure.[66]

Regarding water specifically, SDG 6 (along with its eight targets and 11 indicators) aims to 'ensure the availability and sustainable management of water and sanitation for all'.[67] Its universal aim makes for easier compatibility with the human right to water (discussed above) than did its predecessor, in the MDGs.[68] Similarly, its stated commitment to full implementation of IWRM at all levels (target 6.5) connects SDG 6 to both of the foregoing domains. However, the most recent review of SDG 6 suggests that the goal will not be met by 2030 without doubling the current annual rate of progress. For example, in 2017, 60 per cent of people globally, and only 38 per cent of people in least developed countries, had soap and water for handwashing at home.[69] This sobering statistic gains fresh relevance in the current context of the COVID-19 pandemic – where handwashing is acknowledged as a primary defence, as well as a specific SDG 6 target.[70] Indeed, COVID-19 is now being described as a 'fight against water inequality'.[71]

Driven by growing, if grudging, international consensus around worsening environmental conditions, the SDGs generally, and SDG 6 in particular, give greater acknowledgement to

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64 See eg Duncan French and Louis J Kotzé (eds), *Sustainable Development Goals: Law, Theory and Implementation* (Edward Elgar 2018).

65 See Ebbesson, Chapter 10 in this book.

66 Report of the Secretary-General, 'Progress towards the Sustainable Development Goals' (2019) UN Doc E/2019/68, paras 22, 38, 12.

67 Agenda 2030.

68 MDG 7.C: 'to halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation.' The explicit aim of this target is to reduce, but not eradicate, water poverty. As such, it is difficult to read this as compatible with the corresponding human rights claims that *everyone* is entitled to access to safe drinking water and basic sanitation.

69 Progress of Goal 6 in 2019: Agenda 2030.

70 See World Health Organization, 'Who *Saves Lives: Clean Your Hands* in the Context of Covid-19' (WHO, n.d.) <https://www.who.int/infection-prevention/campaigns/clean-hands/WHO_HH-Community-Campaign_finalv3.pdf> accessed 8 June 2020.

71 Ranjan Panda, 'In India, Fight against Corona Is a Fight for Water, against Inequality' (*SixDegrees*, 10 April 2020) <www.sixdegreesnews.org/archives/28138/in-india-fight-against-corona-is-a-fight-for-water-against-inequality> accessed 8 June 2020.

ecological protection and sustainability than did the MDGs.[72] But they fall short of situating themselves within a 'single priority goal'[73] of ecological integrity, as has been proposed by leading commentators.[74] Doubtless, such a reconceptualisation implies 'a hierarchical order for the elements for sustainable development: the biophysical environment comes first, and human society and the economy second'.[75] It is difficult to contradict this order once we accept that 'society lies within nature, and the economy lies within society'[76] – despite the affront to orthodox capitalist and neoliberal economics that this represents.[77]

As has already been illustrated regarding the contextualisation of the human right to water, and also by an increasingly resilience-oriented IWRM approach, water security must be pursued through sustainability. This inevitably requires adequate and continued water access for present and future generations (intergenerational equity), within the limits necessary to protect the integrity of the freshwater cycle. In short, water governance in any and all regulatory domains should walk hand in hand with genuinely sustainable development. However, the seriously slow progress made towards achieving SDG 6, and the absence of sufficiently clear normative guidance within the commonly agreed definitions of sustainable development, leave SDG 6 without the transformative energy to meet this task.[78]

The term 'sustainable development' was first defined in the 1987 Brundtland Report as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs'.[79] As such it was recognised that environmental resources are limited, but these were cast as relative limits arising from 'the present state of technology and social organization'.[80] Thereafter, and without conceding absolute ecological limits, sustainable development has coincided with (and to a degree supported) the perpetual pursuit of economic growth.

Further criticism is also due, both around the (lack of) substance, and regarding the (quasi) legal status of sustainable development. The Brundtland Report definition contains elements of equitable use, including intergenerational equity, and sustainable use, which, expressed together, integrate economic, social and environmental considerations. These three elements (equity, sustainable use and integration) comprise the concept of sustainable development.

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72 See Agenda 2030 Target 6.6: 'By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes.'

73 Kim and Bosselmann (n 45) 195.

74 Ibid. See also Frank Biermann et al, 'Transforming Governance and Institutions for Global Sustainability: Key Insights from the Earth System Governance Project' (2012) 4(1) Current Opinion in Environmental Sustainability 326.

75 Rakhyun E Kim and Klaus Bosselmann, 'International Environmental Law in the Anthropocene: Towards a Purposive System of Multilateral Environmental Agreements' (2013) 2 Transnational Environmental Law 285.

76 Robert Costanza et al, *Building a Sustainable and Desirable Economy-in-Society-in-Nature* (United Nations Division for Sustainable Development 2012).

77 See Adelman, Chapter 4 in this book.

78 For further critique and reflection on the limitations of the SDGs, including Goal 6, see Owen McIntyre, 'International Water Law and SDG 6: Mutually Reinforcing Paradigms' in French and Kotzé (n 64) 173–200; and Nathan John Cooper and Duncan French, 'SDG 17: Partnerships for the Goals – Cooperation within the Context of a Voluntarist Framework' in French and Kotzé (n 64) 271–303.

79 World Commission on Environment and Development (WCED) *Our Common Future: The Report of the World Commission on Environment and Development* (Oxford University Press 1987) 43.

80 Ibid, Annex at 24.

Applying these to the arena of water security offers the potential to integrate equitable social and economic development in environmentally sensitive and sustainable ways. Triangulating access to water within social, economic and environmental considerations offers a distinctive approach to water governance. But the lack of clarity regarding each of the elements of sustainable development raises the question how such distinctiveness may provide a substantive means by which to progress the developmental agenda to which it has gifted its name.[81] Without such substance, arguably sustainable development has become a hollow concept, co-opted to support the irresponsible economic activities at the heart of the emerging social-ecological crisis. Fitzmaurice has warned that '[t]he continuing reliance on clichéd and worn out definitions [of sustainable development] should be abandoned and the concept (or principle) of sustainable development must acquire a tangible and concrete content'.[82] I would go further, and suggest that the Anthropocene reality to which the planetary boundaries point, and within which achievement of the SDGs must be pursued, requires a more normatively weighty *Grundnorm*.[83]

Yet, as an over-arching goal of the international community and an increasingly recognised (non-binding) principle of international law, sustainable development is likely to continue to feature in the rhetoric around transforming water governance towards greater equity and sustainability. So it is worth considering how sustainable development (with its tangential connection to sustainability) might be rejuvenated to become a more robust beachhead from which to launch the serious and sustained challenge to State-organised, collective and individual human behaviour necessary to secure social-ecological integrity for human–water dynamics and beyond. Without such rejuvenation, sustainable development will remain an 'ideological palliative' helping us 'rationalize our continuing encroachments upon the planet'.[84] Here the conceptual potential of the planetary boundaries can be glimpsed. By stating the limits beyond which Earth's system cannot continue to function in a stable State, they provide a destination towards which the journey of sustainability can aim, and a 'target for reining in human activities, not just a continual process of improvement'.[85] Applied to water governance, the freshwater boundary could, for instance, galvanise us to adopt a principle of social-ecological resilience for all water flows, from which appropriately contextualised and regionally specific targets are set and monitored.

4.1 Planetary Boundaries and the SDGs

The freshwater planetary boundary offers much-needed biophysical context for most of the targets and indicators that comprise SDG 6. Target 6.4 for instance aims, by 2030, to 'substan-

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81 Nathan John Cooper and Duncan French, 'The Right to Water in South Africa: Constitutional Managerialism and a Call for Pluralism' in Elena Blanco and Jona Razzaque (eds), *Natural Resources and the Green Economy: Redefining the Challenges for People, States and Corporations* (Martinus Nijhoff 2012) 111, 118.

82 Malgosia Fitzmaurice, *Contemporary Issues in International Environmental Law* (Edward Elgar 2009) 108.

83 See also Kim and Bosselmann (n 45) 204.

84 Benjamin J Richardson, 'A Damp Squib: Environmental Law from a Human Evolutionary Perspective' (2011) 7 Comparative Research in Law & Political Economy. Research Paper No.8/2011, 31.

85 Maloney (n 7) 201.

tially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity'. Indications of how effectively this target is being achieved come from measuring the 'change in water-use efficiency over time' (6.4.1) and from the 'level of water stress: freshwater withdrawal as a proportion of available freshwater resources' (6.4.2).[86]

The concept of a freshwater planetary boundary, applied at appropriate scale, can guide what constitutes 'sustainable withdrawals'. The freshwater boundary can add global dimensions to measurements of water stress and water scarcity. However, planetary boundaries, including that for freshwater, are not *exactly* determined by biophysical phenomena. Rather, they are human constructs 'and their positions are therefore determined by humans'.[87]

Put simply, planetary boundaries reveal the preconditions for the SDGs, and for any serious efforts towards sustainable development.[88] They hold a mirror up to Anthropocene reality, confronting us with the inconvenient truth[89] that Earth's carrying capacity is limited. In so doing, they lay bare the central assumption of neoclassical economics – that natural resources are infinite – and thereby challenge capitalism's promises of perpetual growth and ever-increasing material prosperity.[90] This 'reveal' has significant potential to shape human developmental ambitions. But it is also profoundly disorientating, described by Klein as a 'psychic attack'[91] against which our socio-physiological configurations and politico-cosmological identities recoil. To help us navigate through this troubling terrain, we will need more than just alternative policies and goals – perhaps more importantly, we will also need an alternative worldview, namely a cosmology to rival the one that propelled us into the Anthropocene.

5. BEYOND *ANTHROPOS*: TOWARDS AN EQUITABLE AND SUSTAINABLE SOCIO-HYDROLOGICAL FUTURE

As this chapter draws to a conclusion it is worth reiterating my recognition that the freshwater planetary boundary itself remains controversial, particularly to the extent that it may purport to directly form the basis of water-related policy and management decisions.[92] As Bogardi helpfully explains: 'Although identifying PBs [planetary boundaries] is essentially a scientific task, their acceptance is fundamentally a societal process reflecting human perspectives. PBs

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86 See Agenda 2030, SDG 6, Target 6.4, Indicators 6.4.1 and 6.4.2. See also McIntyre (n 78) 173.

87 Edgar Fernández Fernández and Claire Malwé, 'The Emergence of the "Planetary Boundaries" Concept in International Environmental Law: A Proposal for a Framework Convention' (2019) 28 1 Review of European, Comparative & International Environmental Law 48, 49.

88 Kim and Bosselmann (n 45) 194.

89 See Al Gore's 2006 documentary 'An Inconvenient Truth'.

90 See Adelman, Chapter 4 in this book.

91 Naomi Klein, 'We Are Seeing the Beginnings of the Era of Climate Barbarism', *The Guardian* (14 September 2019). Available at <www.theguardian.com/books/2019/sep/14/naomi-klein-we-are-seeing-the-beginnings-of-the-era-of-climate-barbarism#maincontent> accessed 8 June 2020.

92 Maik Heistermann, 'HESS Opinions: A Planetary Boundary on Freshwater Use Is Misleading' (2017) 21 Hydrology and Earth System Sciences 3455, 3455.

are inherently value judgments as they are associated with the preservation of a presumably desirable state.'[93]

This state is the relatively stable Holocene period, which has proven favourable in fostering contemporary human societies and is the only state that humans know and that collective human memory can recall.[94] Within this period humanity's growth and successful development has created anthropocentric social institutions, including the legal order.[95] Humanity – and the human subject – is central to the legal order. All laws, legal norms and juridical systems are human creations, and make claims to regulate, prohibit, promote or protect human enterprise and human behaviour. The effect of this 'human centrality' within the legal order has been to embed and perpetuate deeply unequal modes of interaction between human subjects and non-human life on the planet. As a consequence, nature and non-human life – necessarily falling outside of human centrality – have come to be perceived as a collection of objects, variously ripe to co-opt towards human flourishing, or to marginalise or destroy in accordance with human aims. Indeed, the objectification of Earth's non-human lifeworld is established upon the human centrality of the legal order.[96] One consequence of this objectification has been the gradual loss of appreciation for the biophysical fact that we humans are thoroughly imbricated in the Earth system: Earth-bound and entangled in physiological and ecological patterns as much as in socio-economics. Instead, the myth of *Anthropos*, the archetypal dominant human, has been embraced.[97]

Surveying the three water-regulatory domains above, the myth of humanity's unbounded potential can be discerned. The declaration of a human right to water affirms a profound commitment to ensure access to sufficient water for everyone, to support healthy and dignified lives. But without effective enforcement, or adequate scrutiny around equitable distribution, above a minimal social floor, and without sufficient consideration for the limits and fragility of the freshwater cycle, those with the economic means continue to use as much water as they wish, apparently without social or ecological consequences. It is precisely this type of behaviour that is swiftly driving us towards the freshwater planetary boundary, and which poignantly illustrates the issue of global water injustice.[98]

The evolution of IWRM thinking in recent decades has encouraged water governance best practice towards greater realisation of the interconnections between human action and the hydrological cycle, and the need for resilience-based responses to water shocks and stresses. Its place as a technical water governance approach, however, along with its acceptance and tacit support for water commodification, suggest that IWRM is ill-placed to lead the call for

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[93] Bogardi et al (n 11) 581.

[94] Fernández Fernández and Malwé (n 87) 48.

[95] While humanity, as a homogenous species, can be said to have benefited from the stability of the Holocene, it is more accurate to acknowledge that such benefits have fallen unequally, depending on the historical privilege or marginalisation of particular groups of humans. See Louis J Kotzé, 'The Anthropocene, Earth System Vulnerability and Socio-Ecological Injustice in an Age of Human Rights' (2019) 10(1) Journal of Human Rights and the Environment 62, 68.

[96] See generally Anna Grear, 'Deconstructing *Anthropos*: A Critical Reflection on "Anthropocentric" Law and Anthropocene "Humanity"' (2015) 26 Law and Critique 225.

[97] Ibid.

[98] See generally Farhana Sultana and Alex Loftus (eds) *Water Politics: Governance, Justice and the Right to Water* (Routledge 2020).

a more radical social-ecological paradigm of water governance, despite its responsiveness to the freshwater planetary boundary's insights.[99]

Indeed, Rockström and colleagues' 2014 study of emerging water governance modes found 'no evidence … of a more profound movement towards an entirely new paradigm of governance, such as confronting planetary freshwater boundaries'.[100]

The challenges facing implementation of SDG 6 are significant, much as the current state of progress is disappointing. An estimated 70–80 per cent of diseases in sub-Saharan Africa are attributable to poor water quality, and the dearth of water for handwashing facilities risks undermining public health responses to COVID-19 and many other present and future epidemics and pandemics.[101] As discussed above, without legal formality, or strong normative focus, SDG 6 looks hard pressed to achieve sustainable water access for all.

We face on the one hand the inadequacies of three regulatory domains for global water governance, and on the other a disarmingly simple message: global freshwater is limited, the hydrological cycle is fragile and damaged, and continuing in our current human–water dynamics will exceed the planet's freshwater capacity, with profoundly destructive consequences. The planetary boundaries framework sheds bright light on both of these. The freshwater planetary boundary helps to expose some of the key inadequacies in contemporary water governance. But it does not say anything about how we should navigate governance of so precious a resource in the face of swiftly growing demand and finite supply. We must therefore look beyond the planetary boundaries as we wrestle with questions of affluence, human population growth, equitable resource use and the like.[102]

To this end it is imperative that our imaginary enterprises contribute to present a practical vision of the future: holding in tension the need to be realistic while also being visionary. Conventional wisdom might dictate that incremental change is the most that can be hoped for. But perhaps there is opportunity for swifter action than we had previously thought?

The current and emerging COVID-19 pandemic, and the unprecedented steps taken by national governments and the international community to contain, control and slow transmission, provide a vivid example of the scale of change that is quickly achievable once the severity of the threat facing us is accepted. As the ecologist and theologian Thomas Berry reminds us, 'only in the most dire situations do we have the psychic energy needed to examine our way of acting on the scale that is now required'.[103]

Unlike the COVID-19 pandemic, which appears principally to be a threat to humans, the multifarious challenges of the Anthropocene, explicated as they are by the planetary boundaries, threaten the integrity of the entire Earth system. This represents a planetary crisis on

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[99] In light of the profoundly destabilising and disenfranchising effect that commercialisation of water services has had in various domestic locations, it is important to reappraise IWRM's acceptance of commercialisation policies. See eg Nathan John Cooper, 'After Mazibuko: Exploring the Responses of Communities Excluded from South Africa's Water Experiment' (2017) 61(1) Journal of African Law 57; Willem Assies, 'David versus Goliath in Cochabamba: Water Rights, Neoliberalism, and the Revival of Social Protest in Bolivia' (2003) 30(3) Latin American Perspectives 14.

[100] Rockström et al (n 13) 1257.

[101] World Bank blog, 'COVID-19: Solving Africa's Water Crisis Is More Urgent than Ever' (*The World Bank Group*, 30 April 2020) <https://blogs.worldbank.org/nasikiliza/covid-19-solving-africas-water-crisis-more-urgent-ever> accessed 8 June 2020.

[102] Maloney (n 7) 201.

[103] Thomas Berry, *The Great Work: Our Way into the Future* (Three Rivers Press 1999) 100.

a different order of magnitude, requiring us to make practical decisions, based upon ethical judgements, on a scale not previously anticipated, 'because we have never before had the capacity for deleterious action with such consequences'.[104]

What the COVID-19 situation also illustrates is the degree to which the myth of *Anthropos* continues to influence our collective (dominant) response to serious threat, by perpetuating modes of living that variously deny, ignore and obfuscate our innate vulnerability, and our personal imbrication with all of humanity and all other members of the Earth community.[105] The hubris with which notable world leaders have engaged with the COVID-19 pandemic, and the way in which millions of us continued to travel between continents, inadvertently facilitating the virus' global spread, betrays a deep-seated and dangerous set of assumptions: we are immune from the consequences of natural phenomena; our lifestyles are unconstrained by ethical boundaries of mutual responsibility, or by biophysical 'laws' (such as viral transmission processes); our embodied humanity can be transcended and our material world objectified.

Against the backdrop of the Anthropocene, these assumptions look increasingly moribund, and yet, when the COVID-19 pandemic eventually wanes, there is likely to be a swift and energetic return to 'business as usual'. If this happens it will be because we refuse to accept that an (often implicit) ideology of 'unbounded' *Anthropos* cannot productively coexist with the manifold socio-hydrological challenges to water security referred to in this chapter. Moreover, *Anthropos*' myth stands in stark contrast to the explicitly bounded frame of the planetary boundaries. While both frames arguably involve selection, and in so doing represent exercises of choice, power and materialisation (rather than objective, unmediated science), these contradictory framings of Anthropocene reality present a clear, if inconvenient, choice.[106] Either we continue to preserve a cosmological role in the world, as *Anthropos* – positioning ourselves as detached from the world, while bending it to our will – or we (re)turn to a more empirically faithful (if necessarily contested) understanding of ourselves as 'earthlings' – embedded in, integrated with and dependent upon the Earth. Such a collective shift in our self-image might provide the ethical imperative needed to recalibrate the dominant and destructive modes of consumption that govern our relationship with freshwater (epitomised by inequitable access, scarcity and commodification), and that are primarily responsible for the precarious position that the global freshwater system is in.

So, we must bravely confront the fact that the *Anthropos* myth is and always has been a figment of imagination, even while the civilisation built upon this myth is real, and capable of great destruction. In the complex posthuman ecology of the Anthropocene, Scranton posits that the biggest problem we face is to understand that this civilisation is *already dead*: 'The sooner we confront this problem, and the sooner we realize there's nothing we can do to save ourselves, the sooner we can get down to the hard work of adapting, with mortal humility, to our new reality.'[107]

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[104] Ibid 101.

[105] See also Kotzé (n 95) 80.

[106] Anna Grear and Julia Dehm, 'Frames and Contestations: Environment, Climate Change and the Construction of In/justice' (2020) 11(1) Journal of Human Rights and the Environment 1, 1.

[107] Roy Scranton, 'Learning how to Die in the Anthropocene' (*New York Times*, 10 November 2013). <https://opinionator.blogs.nytimes.com/2013/11/10/learning-how-to-die-in-the-anthropocene/> accessed 8 June 2020.

The collective stance we take towards the planetary boundary of freshwater consumption (along with every other area of existential concern), and the decisions flowing from this, will come – at least in part – from the identity we choose to accept and project. Hopefully we are beginning to (re)turn towards a healthier identity as vulnerable, embodied humans in a fragile, finite world. But the fundamental question of our identity in relation to Earth will be answered with or without the bravery and humility demanded by Anthropocene reality: 'As the planetary crisis unfolds … our decisions will reveal who we are.'[108]

[108] Jonathan Safran Foer, *We Are the Weather: Saving the Planet Begins at Breakfast* (Farrar, Straus and Giroux 2019) 27.

19. Land system change

Karen Morrow

1. INTRODUCTION

The land system change planetary boundary as defined by the Stockholm Resilience Centre (SRC) is concerned with the conversion of land for human purposes, and it has implications not only in its own right, but also for many of the other planetary boundaries. While local in origin, the aggregate impacts of land system change extend to the global scale. This planetary boundary encompasses human activities featuring quantitative, qualitative, functional and spatial dimensions.[1]

From a scientific point of view, finding a measurable indicator for each planetary boundary is crucial in order to identify where we currently stand in regard to the safe operating space for humanity that they seek to delineate – and it may, if well selected, also serve to wake a supine international polis to the need for urgent and decisive action in a given area. This chapter will consider the challenges inherent in indicator selection in general, and the particular difficulties that arise with regard to the land use change boundary. The preferred indicator for land system change selected by the SRC (2015) (replacing its initial choice of cropland) is now global forest area. Despite lengthy and ongoing debate, at a global level, forests continue to be subject to rather limited international governance and to only non-binding agreements (notably General Assembly (GA) Resolution 62/98, non-legally binding instrument on all types of forests, 2007; renamed in 2015 under GA Resolution 70/199 as the United Nations (UN) forest instrument (UNFI) in its own right). The focus of the UNFI activity is strongly clustered around timber and provisioning issues, although with forest cover and sustainability concerns coming increasingly to the fore, general activity falls under the auspices of the United Nations Forum on Forests (UNFF).

This chapter considers the problematic nature of international forest governance arrangements and their ramifications for the selected indicator for the land use change boundary, which are further complicated by the fact that forests also receive instrumental coverage under various otherwise-oriented hard law regimes. Global climate change and biodiversity provision, for example – which encapsulate two significant planetary boundaries – also interface with forest issues.[2]

One of the key challenges that applies to all planetary boundaries, but perhaps more directly to land system change than most, is the crucial need to find ways to translate the scientifically compelling approach that they offer into societally applicable action, through the adoption of

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[1] Stockholm Resilience Centre, 'The Nine Planetary Boundaries' <www.stockholmresilience.org/research/planetary-boundaries/planetary-boundaries/about-the-research/the-nine-planetary-boundaries.html> accessed 11 February 2020.

[2] See, respectively, Verschuuren, Chapter 13; and Somsen and Trouwborst, Chapter 12, in this book.

persuasive and viable policy and law.[3] This process requires that judicious choices are made in order to ensure that well-intentioned science-grounded initiatives are not stymied by political and legal constraints, and requires a fuller and more effective integration of the combined expertise of hard sciences, social sciences and law than has hitherto been the case.[4] Where land system change in particular is concerned, at a global level there is a fundamental need to find a creative and effective accommodation between the *realpolitik* and law of State sovereignty and the planetary boundary. This is a challenging task at best, and made more so by the choice of afforestation as a metric, which has long been established as problematic in both political and legal terms. As this chapter will show through its examination of possible routes to progress in this regard, the challenges are undoubtedly substantial, but not insurmountable.

2. THE MULTIPLE DIMENSIONS OF PLANETARY BOUNDARIES AND LAND USE CHANGE

In theory, the potential of the planetary boundaries approach to Earth system science, and its key underpinning conception of identifying a 'safe operating space for humanity' in the face of systemic threats to the viability of Earth's life support systems, is revolutionary. However, while the work that has been and is being done under its auspices to fill in the enormous gaps in scientific knowledge about the operation of the Earth system is highly impressive, the necessary integration of this work with human systems, while implicit in planetary boundaries thinking as originally conceived, was not actively pursued at an early stage.[5] This is perhaps symptomatic of an approach that emerged from predominantly hard science roots (albeit drawing from an ambitious range therein), with only economics explicitly representing human systems at the outset.[6] The need to address this linkage has, however, increasingly been coming to the fore in the ongoing development of planetary boundaries thinking,[7] and slowly gaining momentum[8] – though achieving practical progress is proving monumentally challenging. While some commentators question the utility of a boundaries approach, pointing to its supposed arbitrariness in seeking to 'depoliticise' the difficult choices that need to be made with respect to those boundaries (including land use) that are not subject to hard thresholds,[9] this interpretation arguably skews the approach adopted by the SRC. In fact, the

3 See Kim and Kotzé, Chapter 3; and Bleby, Holley and Milligan, Chapter 2, in this book.

4 See Collins, Chapter 5, in this book.

5 See Johan Rockström et al, 'Planetary Boundaries: Exploring the Safe Operating Space for Humanity' (2009) 14 Ecology and Society 32.

6 Johan Rockström et al, 'A Safe Operating Space for Humanity' (2009) 461 Nature 472, 474.

7 Will Steffen et al, 'Planetary Boundaries: Guiding Human Development on a Changing Planet' (2015) 347 Science 1259855.

8 See, for example, Kate Raworth, *Doughnut Economics: Seven Ways to Think Like a 21st-Century Economist* (Random House 2017). In the field of behavioural economics this is an early example of thoroughgoing social science engagement with planetary boundaries thinking. See also the physical and social science essay collection Future Earth, *Our Future on Earth 2020* (hereafter Future Earth) <www.futureearth.org/publications/our-future-on-earth> accessed 13 February 2020.

9 See, for example, the technological optimism-based critique provided by Ted Nordhaus, Michael Shellenberger and Linus Blomqvist, *The Planetary Boundaries Hypothesis: A Review of the Evidence* (Breakthrough Institute 2012) <https://s3.us-east-2.amazonaws.com/uploads.thebreakthrough.org/legacy/blog/Planetary%20Boundaries%20web.pdf> accessed 11 February 2020.

need to integrate science and other societal systems has been recognised, if not perhaps fully appreciated, from the outset of the planetary boundaries project and the core concept of identifying a safe operating space for humanity needs to be attended to, as it is geared precisely to provide a viable (though bounded in both scientific and legal terms)[10] realm within which trade-offs between competing priorities may be negotiated. These endeavours will ultimately – and inevitably – be science-based, as boundaries are transgressed because of human actions, but they will also necessarily be highly politicised, as our responses to them will be shaped by human institutions.

Narratives of the Anthropocene identify the fusing of natural and human systems into 'novel anthrome [anthropogenic biome] geographies in an increasingly artificial biosphere'.[11] This neologism is particularly revealing for present purposes as it comprehends 'the reassembling of living and artificial components … making the future Anthropocene one shaped by political decisions'.[12]

The seismic schism between our ability to initiate Earth system shifting change on the one hand, and the increasingly apparent inadequacy of our institutional efforts to address its adverse impacts on the other, has been succinctly described by Galaz as the 'Anthropocene gap'.[13] The inherently political shortcomings of global governance are a central element of this gap. While Galaz's appreciation of the scale and complexity of this Anthropocene gap may be novel, in governance terms the challenges posed by planetary boundaries thinking replicate other long established manifestations of the often problematic interface between hard science with human (particularly political and legal) systems in areas that are of shared but also divisive concern.[14] Examples of this rupture abound in most areas of ecological concern, not least as expressed in environmental law and policy, where, despite policy being presented or perceived as exhibiting 'science-driven' responses to environmental degradation, the reality is often one of profound disciplinary dissonance and fundamental communication failure.[15] This is particularly apparent in international law in respect of other planetary boundaries, notably climate change and biodiversity, where escalating calls for urgent action founded on the work of global scientific communities such as the Intergovernmental Panel on Climate Change

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[10] See Karen Morrow, 'Human Rights and the Environment: Substantive Rights' in Malgosia Fitzmaurice, Marcel Brus and Panos Merkouris (eds), *Research Handbook on International Environmental Law* (2nd edn, Edward Elgar forthcoming) for a discussion of the role that human rights could play in choice architecture within the safe operating spaces that boundaries could provide.

[11] Simon Dalby, 'Anthropogenic Discourse: Geopolitics after Environment' (Not Drowning but Fighting: Decolonizing the Anthropocene Institute of British Geographers Conference, Exeter, September 2015) <https://www.researchgate.net/publication/282355094_Anthropocene_Discourse?channel=doi&linkId=560dc29c08ae2aa0be4a58b6&showFulltext=true> accessed 18 March 2020, 1.

[12] Ibid.

[13] Victor Galaz, *Global Environmental Governance, Technology and Politics: The Anthropocene Gap* (Edward Elgar 2014).

[14] See, for example, David Leary and Balakrishna Pisupati, 'Introduction'; Ann Powers, 'Climate Change and Pollution: Addressing Intersecting Threats to Oceans, Coasts and Small Island Developing States'; and Susan Shearling, 'Biodiversity' in David Leary and Balakrishna Pisupati (eds), *The Future of International Environmental Law* (United Nations University Press 2010).

[15] Jonathan W Moore et al, 'Towards Linking Environmental Law and Science' (2018) 3 Facets 375–39.

(IPCC)[16] and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES),[17] respectively, have yet to motivate sufficiently efficacious engagement by States (and other actors) to meaningfully address the pressing and escalating problems that we face. Clear science notwithstanding, we continue to make political decisions that at best are ineffectual in addressing adverse impacts and at worst actively facilitate continued destructive practices. Progress on other planetary boundaries, land use among them, that are absent this level of scientific clarity is not likely to fare better. As considered below, climate change and biodiversity concerns are strongly related to the more novel questions posed by the land system change planetary boundary. This is apparent in the characterisation of the latter as one of the 'biophysical features of Earth that contribute to the underlying resilience of its self-regulatory capacity',[18] and is explored later in this chapter. Its significance in this regard is underlined by the fact that both the IPCC and IPBES have produced recent reports focused on manifest land degradation as it pertains to their own remits. In this context it is no surprise that the SRC has concluded that the safe operating space for land use change is now 'in the zone of uncertainty/at risk'.[19]

While it is abundantly clear that '[h]umans are now the main driver behind planetary change, and human systems must be targeted if we are to do something about it',[20] there are important distinctions to be considered when addressing the nature of the various human activities that are driving Earth system change. Land use change, for example, represents a planetary boundary that is expressly and directly driven by human behaviour, and its reach is already truly pervasive.[21] Land use change is also immensely complex as it encapsulates human conversion of natural land such as forests, grasslands and wetlands to a wide variety of uses, where this can be done, across the globe. The drivers and manifestations of land use change are composite and range from basic survival-oriented activities through a whole spectrum of attempts to secure various degrees of human betterment.[22] In general terms, however, land use change brings fairly apparent and immediate benefits to some (usually powerful and privileged) people, and also often to corporations and States; at the same time, it imposes indeterminate, longer term, more widely distributed environmental and oftentimes human costs (the later mostly experienced by the underprivileged and powerless) on individuals and communities. Where planetary boundaries are concerned, the costs of land use change are ultimately made manifest across a range of Earth system aspects, for example, in contributing

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16 For example, Valérie Masson-Delmotte et al (eds), 'Global Warming of 1.5°C: An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty' (IPCC 2018) <www.ipcc.ch/site/assets/uploads/sites/2/2019/06/SR15_Full_Report_Low_Res.pdf> accessed 11 February 2019.

17 For example, IPBES, 'The Global Assessment Report on Biodiversity and Ecosystem Services' (IPBES, 2019) <https://ipbes.net/global-assessment-report-biodiversity-ecosystem-services> accessed 11 February 2020.

18 Rockström et al (n 5).

19 Steffen et al (n 7) 7.

20 Gaia Vance, 'Charting the Future' in Future Earth (n 8) 8.

21 See, for example, IPBES (n 17), which examines the main classes of land use change by region and the trends therein.

22 Eric F Lambin et al, 'The Causes of Land-use and Land-cover Change: Moving beyond the Myths' (2001) 11 Global Environmental Change 261.

to climate change and biodiversity depletion and interfering with the hydrological, nitrogen and phosphorus cycles.[23]

While each localised occurrence of land use change in the first instance has relatively confined impacts, when these are aggregated they can be seen as a hallmark of the Anthropocene, as characterised by the ability of human activities to have consequences that ultimately extend their reach to key aspects of the Earth system on a global scale.[24] In addition to exhibiting such significant and accumulative quantitative dimensions, the land use boundary is further complicated by its inherent qualitative dimensions – altering land use changes the ecological characteristics in play,[25] usually impoverishing biomes as they are transformed into anthromes. In this, land use change stands in partial but significant contrast to many of the other boundaries, not least climate change and biodiversity loss, where adverse Earth system impacts are the indirect and usually undesired by-products of human endeavour. While unanticipated impacts may also be in play in land use change contexts, their setting is therefore somewhat different. In some ways this is a potential boon in that, in principle, it is easier to address intentional than inadvertent impacts and to act to design out adverse impacts of intended actions. In practice, however, as discussed below, the complex interlinked social, political and economic drivers that operate in this context, hinged around development as they are – coupled with the expression and exercise of State sovereignty over territory and natural resources that are inherent in land use – serve to make this planetary boundary particularly problematic. Thus the land use change planetary boundary provides a particularly thorny example of the conundrum of finding a workable marriage between the imperatives communicated by complex, fast-moving and cross-cutting science and the human institutions that need to respond to it and develop and implement informed and efficacious law and policy. The land use change planetary boundary, in order to be effectual, needs to operate with considerable sophistication, reflecting not only quantitative elements of land use (encapsulating the area of land converted) but also qualitative concerns (going to the nature of change, and its impacts on land and its systemic functions, particularly as related to ecosystems) and its wide-ranging implications for human beings, most directly manifest in ecosystem services.

3. BOUNDARIES: THE CHALLENGES OF INTEGRATING SCIENCE AND POLITICS

The inherently politically contentious application of planetary boundaries thinking is apparent in the fact that, while it engaged academia in relatively short order,[26] it has yet to be fully embraced by the international polis. Hesitancy in the latter context is revealed by the fact

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23 See, on the latter issues, Cooper, Chapter 18; Diz, Chapter 17, in this book.

24 Chris Otter (moderator), with Alison Bashford, John L Brooke, Fredrik Albritton Jonsson and Jason M Kelly, 'Roundtable: The Anthropocene in British History' (2018) 57 Journal of British Studies 568, 582.

25 See, for example, the models used by Gregory S Cooper, Simon Willcock and John A Dearing, 'Regime Shifts Occur Disproportionately Faster in Larger Ecosystems' (2020) 11 Nature Communications 1, 7.

26 See, for example, the regular and latterly increasing coverage that it attracts from authors across a broad range of disciplines in The Conversation, 'Articles on Planetary Boundaries' (*The Conversation*, 2020) <https://theconversation.com/uk/topics/planetary-boundaries-3316> accessed 20 February 2020.

that, though enthusiastically endorsed by the then UN Secretary General Ban Ki Moon[27] in the run-up to the UN Conference on Sustainable Development (UNCSD-Rio+20), and even appearing in the zero-draft of the Conference outcome document,[28] planetary boundaries did not appear in the conference's agreed outcome document, *The Future We Want*.[29] One could argue with some force that that the inclusion at that time of the planetary boundaries concept, which in 2012 was still very much in its infancy, would have been somewhat premature.[30] Nonetheless, it is significant for present purposes that the approach was regarded with particular suspicion by States as representing a possible brake on development, and this remains a concern.[31] Tellingly, critics at the time pointed to the frankly underdeveloped coverage that planetary boundaries offered the social/human systems aspects of sustainable development.[32] As examination of the land use boundary reveals, while the salience of boundaries thinking is now broadly acknowledged in principle,[33] practical progress remains more elusive. That said, planetary boundaries thinking has subsequently found other more conducive settings in which to mature, notably with regard to the Sustainable Development Goals (SDGs) and their implementation.[34] Boundaries offer a potentially important counterpoint to viewing the SDGs as merely aspirational, bringing to the fore their role as drivers of transformation[35] but grounding this in environmental realities, which remains a matter of particular import for the land use boundary.

3.1 Boundaries and Indicators

In order to realise the planetary boundaries approach, the SRC has identified an indicator to act as a measure, or in some cases – land use change included, where there is no straightforward gauge that can be applied – a surrogate measure, for each boundary. While not unproblematic,[36] the use of indicators has a number of merits, not least the fact that such an approach is familiar in international governance contexts, for example playing a key role in underpinning

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27 Speech to the Leaders in United Nations, 'Ban Urges Leaders to Show Greater Commitment to Agreement on Climate Change' (UN, 20 September 2011) <https://news.un.org/en/story/2011/09/387382> accessed 20 February 2020.

28 Yojana Sharma, 'Rio+20 Zero Draft Accepts "Planetary Boundaries"' (SciDevNet, 28 March 2012) <www.scidev.net/global/innovation/news/rio-20-zero-draft-accepts-planetary-boundaries-.html> accessed 20 February 2020.

29 UNGA Res 66/288 (11 September 2012) UN Doc A/RES/66/288.

30 See Victor Galaz et al, '"Planetary Boundaries" and Global Environmental Governance' (2012) 81 Ecological Economics *passim* for broad discussion of the governance challenges in respect of planetary boundaries.

31 Sharma (n 28).

32 Ibid. See also Kim and Kotzé, Chapter 3 in this book.

33 See, for example, European Commission, European Political Strategy Centre, *Sustainability Now! A European Vision for Sustainability* EPSC Strategic Notes, Issue 18, 20 July 2016 (EPSC) online <https://ec.europa.eu/epsc/sites/epsc/files/strategic_note_issue_18.pdf> accessed 20 February 2020.

34 Ibid, *passim*.

35 Future Earth (n 8) 5.

36 Discussed in Karen Morrow, 'Gender and the Sustainable Development Goals' in Duncan French and Louis J Kotzé (eds), *Sustainable Development Goals: Law, Theory and Implementation* (Edward Elgar 2018) 149.

first the Millennium Development Goals,[37] and then their successors the SDGs.[38] In this context, indicators have a proven track record in facilitating the tracking of progress (or the lack thereof) towards complex overarching ends, which in principle suits the similar needs of planetary boundaries. The selection of indicators is, however, crucial in a number of ways – an ill-chosen indicator being, among other things, vulnerable to being gamed, and/or resulting in unintended consequences or even proving counterproductive.[39] Key characteristics of an effective indicator include: apposite identification – founded on suitability and salience; a sound data foundation – encompassing availability, consistency, and quality;[40] and aptness for clear and simple communication to multiple audiences.

At the present time the selection of planetary boundaries indicators is rooted in quantitative measures. The appeal of this approach is obvious, but it can, for some boundaries, go to suitability, as it renders their reach partial. As Running puts it, such metrics are 'compelling conceptually but many phenomena are not easily measured globally'.[41] Land use change falls into this problematic category. Nonetheless, the original indicator chosen to act as a surrogate for land use change was entirely quantitative, setting a notional limit at <15 per cent of the ice-free land surface under cropland.[42] This measure – set for a specific aspect of the Earth system that, unlike some of the others, is not subject to a fixed threshold – sought to operate as a species of surrogate for the broader concept of land use change, but it is arguable that its limited reach, which was recognised from the outset, constrained its utility.[43] The indicator for land use change was subsequently changed to forest cover.[44] The scientific rationale for this choice is difficult to fault, the SRC stating that 'the three major forest biomes – tropical, temperate and boreal – play a stronger role in land surface–climate coupling than other biomes. In particular, we focus on those land-system changes that can influence the climate in regions beyond the region where the land-system change occurred.'[45]

However, this indicator does not heed the manifold roles which forests play in natural and human systems, which in many ways reflect the complexity and multiplicity of guises invoked by broader land use issues.

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[37] United Nations Millennium Development Goals indicators, 'Official list of MDG Indicators' (UN, 15 January 2008) <http://mdgs.un.org/unsd/mdg/Host.aspx?Content=Indicators/OfficialList.htm> accessed 17 March 2020.

[38] 2030 Agenda for Sustainable Development, 'Report of the Inter-Agency and Expert Group on Sustainable Development Goal Indicators' (15 December 2016) E/CN.3/2017/2, Annex III <https://unstats.un.org/unsd/statcom/48th-session/documents/2017-2-IAEG-SDGs-E.pdf> accessed 09 March 2020.

[39] See Veena S Raleigh and Catherine Foot, *Getting the Measure of Quality: Opportunities and Challenges* (The King's Fund, 2010), 15 et seq.

[40] See Anne Thurston, 'Can We Access and Trust Digital Records to Support Development Goals?' in Friends of Sustainable Governance (eds), *Governance for Sustainable Development: Ideas for the Post 2015 Agenda* (New World Frontiers 2015).

[41] Steven W Running, 'A Measurable Planetary Boundary for the Biosphere' (2012) 337 Science 1458, 1458.

[42] Rockström et al (n 5).

[43] Ibid.

[44] Steffen et al (n 7) 7.

[45] Ibid.

3.2 International Law and Governance and the Land System Change Planetary Boundary

3.2.1 The implications of choosing forests as the land use change indicator

In the most basic terms, forests, as terrestrial entities, fall within the territories and therefore under the *sovereign* control of States, who remain the prime actors in the realm of international law. Regardless of the multiple guises under which forests may be presented, ranging from sources of timber and other economically valuable goods, through ecosystems, to culturally/spiritually significant places and simultaneously homes to forest dwelling peoples,[46] States – often acting through State-run enterprises – still tend to view them primarily as resources. This tendency is reinforced by the fact that 70 per cent of forest land globally is State-owned.[47] On the face of things this seems to indicate that forests offer a suitable proxy for the land use planetary boundary, not least in the potential for efficacious State action to steward them to best effect.[48] In reality, though, when viewed primarily as resources, forests fall squarely under Principle 2 of the 1992 Rio Declaration on Environment and Development and its application of State sovereignty:

> States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental and developmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction.[49]

Principle 2 largely restates the approach articulated in Principle 21 of the Stockholm Declaration,[50] which in turn drew on by then well-established customary international law.[51] Significantly, though, Principle 2 explicitly adds 'developmental' to the 'environmental policies' referred to in Principle 21. This juxtaposition of sovereign rights – to exploit resources, on the one hand; against the prohibition of transboundary harm, on the other – lies at the core of modern international environmental law. Principle 2 effectively seeks to mediate the foundational conflict of international environmental law that pits individual State sovereignty

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46 Rudolph de Groot, 'Function-Analysis and Valuation as a Tool to Assess Land Use Conflicts in Planning for Sustainable, Multi-functional Landscapes' (2006) 75 Landscape and Urban Planning 175.

47 High-Level Political Forum Review of SDGs implementation: SDG 15 – Protect, restore and promote us of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss (hereafter HPLF), 3 <https://sustainabledevelopment.un.org/content/documents/196552018backgroundnotesSDG15.pdf> accessed 8 January 2019.

48 Similar observations apply in regard to other state-owned resource contexts: see Louis J Kotzé, 'International Environmental Law and the Anthropocene's Energy Dilemma' (2019) 36 Environmental and Planning Law Journal 437.

49 UNGA Report of the United Nations Conference on Environment and Development A/CONF.151/26 (Vol. I) Annex I (12 August 1992) <www.un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A_CONF.151_26_Vol.I_Declaration.pdf> accessed 24 March 2020.

50 UNGA Res/2994 Declaration of the United Nations Conference on the Human Environment (15 December 1972) UN Doc A/RES/2994.

51 Foo Kim Boon, 'The Rio Declaration and Its Influence on International Environmental Law' (1992) Singapore Journal of Legal Studies 347, 351–53.

against the collective interests of humanity.[52] This was evident at the Rio Earth Summit itself, where forests were a topic of particularly intractable conflict, rooted within what has become known colloquially as the North–South divide.[53] Broadly speaking, the States of the developed world, having benefited for centuries from destructive patterns of development, now advocated environmental protection for the common good. The States of the developing world, however, sought protection for their path to development on their own terms, not least pointing to the injustice of now being subject to constraints in this regard that the developed nations had not been subject to in the past.[54] In many ways this justice issue, fixed around questions of past responsibility and future constraint, and the attempt to address it without really engaging with the hard truths that it raises, remains the obdurate issue at the heart of environmental and sustainability law and practice. For present purposes Principle 2 represents the most relevant incarnation of the uneasy – and, as we are becoming increasingly aware, probably *unworkable* – compromise between the diametrically opposed positions of the North and South.

3.2.2 Forest-specific governance

Given the larger conflicts, of which forests provided one manifestation, it was perhaps unsurprising that efforts to negotiate a legally binding forests convention at the 1992 UNCED proved abortive.[55] The situation was exacerbated by the fact that the putative agreement was strongly focused on tropical forests, which only served to magnify the significance of the North–South conflict in this regard.[56] In the end, a non-legally binding authoritative statement of principles for a global consensus on the management, conservation and sustainable development of all types of forest[57] (the Forest Principles), representing 'the first global consensus on forests',[58] was agreed. The failure to arrive at a legally binding agreement was not necessarily crucial: 'While many of the agreements did not rise to the level of binding international legal obligations, it is conceivable that the consensus reached will form the basis for new norms to emerge that will be followed in the future.'[59]

In other areas, much has ultimately been built on the foundations laid at the Rio Conference, but unfortunately the issue of global forest governance has, as we shall see below, remained fraught with difficulty. Nonetheless, the Forest Principles did serve a useful function in recognising the multifaceted nature of forests, acknowledging that their functions and significance straddle multiple social, environmental and economic dimensions and that there are significant interconnections between them. This at least served to begin to shift the assumption that resource-dominated approaches represented the optimal model for forest governance. In

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52 See Adelman, Chapter 4 in this book.

53 Michael Grubb et al, *The Earth Summit Agreements: A Guide and Assessment – an Analysis of the Rio '92 UN Conference on Environment and Development* (Earthscan and Royal Institute of International Affairs 1993)

54 Boon (n 51) *passim*.

55 This was however only one of the many disappointments of the Rio Summit: see Geoffrey Palmer, 'The Earth Summit: What Went Wrong at Rio?' (1992) 70 Washington University Law Quarterly 1005.

56 Ibid 1020.

57 Non-legally binding authoritative statement of principles for a global consensus on the management, conservation and sustainable development of all types of forests (1992) (hereafter Forest Principles) available at 28 Australian Zoologist 103 <https://publications.rzsnsw.org.au/doi/pdf/10.7882/AZ.1992.019> accessed 8 November 2019.

58 Forest Principles ibid., Preamble, (d).

59 Palmer (n 55) 1008.

this regard, while Principle 2 clearly foregrounds State sovereignty over natural resources, 'States have the sovereign and inalienable right to utilize, manage and develop their forests in accordance with their development needs and levels of socio-economic development and on the basis of national policies consistent with sustainable development and legislation'.[60] It also explicitly points to the multifunctionality of forests as key governance considerations: 'Forest resources and forest lands should be sustainably managed to meet the social, economic, ecological, cultural and spiritual human needs of present and future generations.'[61]

However, it is also the case that it is in this very multifunctionality of forests that one of the most intractable governance issues lies – there are so many different institutions with responsibility for aspects of forests, and even more stakeholder perspectives on them, that developing a coherent approach is extremely difficult. In terms of institutional actors, even if we focus just on key players in the UN system, the range of engagement with the UN Forum on Forests (UNFF) is hugely revealing. The UNFF is the current UN umbrella organisation with regard to forests,[62] and was set up as a subsidiary body of the Economic and Social Council (ECOSOC) in 2000.[63] The UNFF is a member of, and supported by, the Collaborative Partnership on Forests (CPF), which comprises no fewer than 15 institutional actors[64] with 'substantial programmes on forests'.[65] Its membership includes: UN agencies, for example, the Food and Agriculture Organisation, United Nations Environment Programme (UNEP), United Nations Development Programme (UNDP); multilateral environmental agreement (MEA) secretariats, including those of the Convention on Biodiversity (CBD),[66] the UN Convention to Combat Desertification (UNCCD)[67] and the UN Framework Convention on Climate Change (UNFCCC);[68] and the World Bank. Accredited major groups (as identified under Agenda 21)[69] also engage with the UNFF. Add to this States, regional groups and registered international governance organisations (IGOs)[70] and we have a snapshot of just one dimension of the immense range of conflicting and overlapping interests gathered around the table in

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60 Forest Principles (n 57) para 2(a).

61 Ibid para 2(b).

62 Its predecessors were the Ad-hoc Intergovernmental Panel on Forests (IPF) established by ECOSOC decision 1995/226 (1 June 1995) and the Intergovernmental Forum on Forests (IFF) established by E/RES/1997/65 (25 July 1997).

63 Under the UNCHR 'Commission on Human Rights resolution 2000/35 Draft optional protocol to the Convention against Torture and Other Cruel, Inhuman or Degrading Treatment or Punishment' E/CN.4/RES/2000/35 (20 April 2000) UN Doc E/CN.4/RES/2000/35.

64 Collaborative Partnership on Forests, 'Members' <www.cpfweb.org/73039/en/> accessed 25 March 2020.

65 United Nations, 'Collaborative Partnership on Forests' <https://www.un.org/esa/forests/collaborative-partnership-on-forests/index.html> accessed 25 March 2020.

66 Convention on Biological Diversity (adopted 5 June 1992, entered into force 29 December 1993) 1760 UNTS 79.

67 United Nations Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa (adopted 14 October 1994, entered into force 26 December 1996) 1954 UNTS 3.

68 United Nations Framework Convention on Climate Change (adopted 9 May 1992, entered into force 21 March 1994) 1771 UNTS 107.

69 United Nations Conference on Environment and Development, 'Agenda 21, Rio Declaration, Forest Principles' (UNCED, Rio de Janerio, Brazil, 3–14 June 1992).

70 United Nations, 'UNFF Participant Registration' <www.un.org/esa/forests/forum/unff-participant-registration/index.html> accessed 25 March 2020.

multi-stakeholder dialogue, which at once also serves as an indication of the institutional complexity involved.[71]

On reflection, the Rio Summit served to put forestry more firmly on the international agenda than was hitherto the case and spawned an almost bewildering plethora of developments in international forestry governance,[72] both in its own right and in tandem with other concerns, including many coordinated by forest-rich States.[73] While it is not possible to provide exhaustive coverage of the many initiatives that have been undertaken, focusing on key developments offers a flavour of the deep fragmentation that continues to characterise international forestry governance.[74]

Other key early events in developing international forestry governance included the 1995 Food and Agricultural Organization (FAO) Rome Statement on Forestry, which sought to garner political support for and further develop the 'Rio consensus'.[75] As a document it is perhaps more revealing with regard to the considerable distance that the international community still had to travel in realising the latter than anything else, laying bare the jockeying for position among UN actors seeking to grasp control of the process and the multiple conflicting stakeholder interests involved, and garnering strong, but inevitably often conflicting, interest from the global north and south.[76] Progress was, as might have been expected, slow, but the Rome Statement evidenced forests as an established concern on the international agenda and demonstrated traction in seeking to develop international forest governance. Momentum gradually grew – particularly following the ECOSOC resolution 2006/49 of 28 July 2006 – in support of strengthening the international arrangement on forests.[77] In more symbolic but still significant popularising developments, the UNGA designated 2011 the International Year of Forests,[78] requesting that the UNFF serve as the focal point for this in collaboration with governments, the CPF, major groups and other relevant organisations. This was followed up in 2012 by the declaration that from 2013 onwards 21 March would be the International Day of Forests,[79] with all States invited to undertake activities related to all types of forests, including tree-planting and other community-focused events.

This wide-ranging activity notwithstanding, a binding international agreement on forestry remains elusive. The most significant coverage to date remains soft law in nature, namely

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71 See, for example, Rakhyun E Kim and Brendan Mackey, 'International Environmental Law as a Complex Adaptive System' (2014) 14 International Environmental Agreements: Politics, Law and Economics 5.

72 This section is written with thanks to Joan Ilobi, who undertook research mapping global provision for forestry during a Hillary Rodham Clinton School of Law internship in 2019.

73 UN Secretary-General, '3rd Session of the Commission on Sustainable Development' (11–28 April 1995) (E/CN.17/1995/32) (E/CN.17/1995/36) No.12 (CSD 3). <www.un.org/ga/search/view_doc.asp?symbol=E/CN.17/1995/36&Lang=E> accessed 8 November 2019, para 201.

74 Ibid.

75 Food and Agriculture Organization, 'Rome Statement on Forestry' (FAO, Rome 16–17 March 1995) <www.fao.org/3/v6585e/V6585e17.htm#rome Statement on Forestry> accessed 8 November 2019, para 1.

76 Ibid, *passim*.

77 ECOSOC, 'Outcome of the Sixth Session of the United Nations Forum on Forests' Res 2006/49 (28 July 2006) <www.un.org/en/ecosoc/docs/2006/resolution%202006-49.pdf> accessed 30 March 2020.

78 UNGA Res 61/193 (6 February 2007) UN Doc A/RES/61/193.

79 UNGA Res 67/200 (14 February 2013) UN Doc A/RES/67/200.

UNGA Resolution 62/98, which in 2007 was adopted as the non-legally binding instrument on all types of forests.[80] This was renamed in 2015 under UNGA 70/199 as the UN Forest Instrument (UNFI).[81] The UNFI represents significant progress in not just recognising, but also attempting to address, the multiple roles played by forests and the complex institutional framework this invokes. While the instrument points to its various and varied antecedents across a range of international contexts,[82] it also breaks new ground in laying out four designated 'Global Objectives' for forests. These relate to: reversing deforestation, developing sustainable forest management, increasing forest protection, and addressing funding.[83] The document includes lengthy coverage, running to some 19 sub-paragraphs, on strengthening all aspects of international forest governance.[84] These provisions range across a number of key areas, including political[85] and financial[86] commitments, trade and trafficking in forest products,[87] technology transfer[88] and scientific and research cooperation.[89]

The Rio+20 process provided renewed impetus to the development of international forest governance, prompting the UNFF's adoption of the 2015 Durban Declaration.[90] This clarified the agreed international focus on forests in a number of ways: deforestation was joined by forest degradation as a key area of concern;[91] the UNFI was endorsed;[92] and the institutional roles of the UNFF[93] and the CFP[94] were explicitly supported. Akin to the UNFI, there is also evidence in the Durban Declaration of a maturing, more coherent approach to the complexities of international forest governance, made manifest in its explicit references to the 1992 Rio Conference treaties, the global sustainability regime and international development and environmental finance structures,[95] and their importance in forest governance.

3.2.3 Sustainability governance and forests

The governance picture for land use and forests within it is further complicated by the fact that, in addition to forestry-specific changes such as those sketched above, emerging sustainable development praxis has also had enormous significance in this regard. Though land use change was addressed in Chapter 10 of Agenda 21, it was covered in fairly rudimentary form, focusing on the need to develop an 'integrated approach to the planning and management of land resources' as a corrective to: '[e]xpanding human requirements and economic activities

80 UNGA Res 62/98 (31 January 2008) UN Doc A/RES/62/98.
81 UNGA Res 70/199 (16 February 2016) A/RES/70/199.
82 Ibid para 1.
83 Ibid para 5.
84 Ibid para 7.
85 Ibid para 7(a).
86 Ibid paras 7(b),(c),(d) and (e).
87 Ibid para 7(g) and paras 7(h) and (i) respectively.
88 Ibid paras 7(k) and (l).
89 Ibid paras 7(n), (o) and (p).
90 United Nations Forum on Forests, 'International Arrangement on "The Forests We Want: Beyond 2015"' (13 May 2015) E/CN.18/2015/L.1/Rev.1 <www.un.org/ga/search/view_doc.asp?symbol=E/CN.18/2015/L.1/Rev.1&Lang=E> accessed 8 November 2019.
91 Ibid para 5.
92 Ibid para 14(a).
93 Ibid paras 9–10.
94 Ibid para 14(d).
95 Ibid para 15.

… placing ever increasing pressures on land resources, creating competition and conflicts and resulting in suboptimal use of both land and land resources'.[96]

Given the acknowledged cross-sectoral nature of land use, the coverage offered was largely conceptual, with operational concerns left to other sectors[97] – but its inclusion was nonetheless meaningful, not least in acknowledging the interconnected and often competing nature of land use considerations and the relative data poverty that existed concerning it.[98] Forests – and, more specifically given the preoccupations that shaped the Summit, *deforestation* – received more in-depth treatment in Chapter 11. Significantly, given the problems that blighted a forests treaty at the Rio Conference, the coverage adopted here explicitly related to all types of forest. It began by acknowledging 'major weaknesses in the policies, methods and mechanisms adopted to support and develop the multiple ecological, economic, social and cultural roles of trees, forests and forest lands'.[99]

The chapter set out priorities for change, notably regarding forest governance; namely, forest management,[100] data[101] and international and regional cooperation and coordination.[102]

In a noteworthy demonstration of the importance of forests to sustainable development and vice versa, they featured early in the work of the Commission for Sustainable Development (CSD) in support of Agenda 21. In 1995, this prompted the establishment of the predecessor of the UNFF, the open-ended ad hoc intergovernmental panel on forests.[103] This panel was envisaged as a consensus-building exercise, seeking to provide momentum for further action consistent with the Forest Principles. Identified priority areas for the ad hoc panel to consider included 'International organizations and multilateral institutions and instruments including appropriate legal mechanisms'.[104] The ad hoc panel was further charged with connecting to the already voluminous legal and institutional landscape which impinged on forestry issues.[105] The process has been a long and involved one and continues under the auspices of the UNFF.

More substantive systemic engagement of sustainability governance with land use and forests has however taken longer to emerge and mature. Land use change was not mentioned in the MDGs and forests featured only as a bare quantitative indicator under Goal 7, Ensure Environmental Sustainability.[106] It has however become increasingly accepted that land use change, particularly where it depletes biodiversity, is strongly implicated, both directly and indirectly, in sustainability, and it therefore plays a much more significant role in the pursuit of the SDGs. The Rio +20 Summit's outcome document, *The Future We Want*, sets the scene for subsequent developments, including the SDGs. While it only touched on land use change in passing, it considered all types of forest at some length, foregrounding their governance, their

[96] UNCED (n 69) 10.1.
[97] Ibid 10.2.
[98] Ibid 10.11–12.
[99] Ibid 11.1.
[100] Ibid 11.3.
[101] Ibid 11.4.
[102] Ibid 11.5.
[103] CSD 3 (n 73) para 204 and Annex I.
[104] Ibid Annex 1 para II.1(e).
[105] Ibid Annex I para IV.
[106] Forest area appeared in bare terms as an indicator under Goal 7, in the United Nations Millennium Development Goals indicators (n 37).

multifunctionality and their economic, social and environmental significance.[107] The document also endorsed the Forests Instrument,[108] and the respective roles of the UNFF and CFP.[109]

Given the relative prominence of forests in the Rio +20 outcome document, it is no surprise that the subsequent SDGs place land use and forests centre stage – notably in SDG 15, Life on Land, which aims to 'protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss'.[110] The significance of land use and forests to the SDGs however reaches much further than a single goal. The IPBES report, for example, indicates that '[c]urrent negative trends in biodiversity and ecosystems will undermine progress towards 80% (35 out of 44) of the assessed targets of the Sustainable Development Goals, related to poverty, hunger, health, water, cities, climate, oceans and land (SDGs 1, 2, 3, 6, 11, 13, 14 and 15)'.[111]

It is also the case that land use change can have adverse impact implications for other less obviously implicated SDGs, not least gender (SDG 5) and reduced inequalities (SDG 10), where, as is often the case, it affects access, particularly by indigenous peoples, to common resources.[112]

3.2.4 MEAs and forests

Forests, given their multifunctionality, are inevitably intimately connected to a number of MEAs – notably, for present purposes, the UNFCCC and CBD regimes. As climate change and biodiversity are themselves planetary boundaries, dealt with in detail elsewhere in this book,[113] the discussion here will be brief and focused on key areas of overlap with land use and forests.

The IPCC has long recognised that '[g]lobal and regional land-use and ecosystems transitions and associated changes in behaviour that would be required to limit warming to 1.5°C can enhance future adaptation and land-based agricultural and forestry mitigation potential'.[114] In doing so, the IPCC recognises afforestation and reforestation as having the potential to make a significant contribution to carbon management strategies. The IPCC, however, acknowledges that land use and public acceptability constraints will apply and that, even if fully exploited, the carbon capture potential of forestry-based approaches would diminish with time as saturation is reached.[115] The more modestly scaled and comparatively

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107 UNGA Res 66/288 (n 29) para 193.

108 Ibid para 194.

109 Ibid para 195.

110 United Nations, 'Sustainable Development Goals' <https://sustainabledevelopment.un.org/?menu=1300> accessed 26 March 2020.

111 United Nations, 'UN Report: Nature's Dangerous Decline "Unprecedented"; Species Extinction Rates "Accelerating"' (UN, 6 May 2019) <www.un.org/sustainabledevelopment/blog/2019/05/nature-decline-unprecedented-report/> accessed 19 March 2020.

112 See, for example, UN REDD Programme, 'Guidance Note on Gender Sensitive REDD+' (UN, 2013) <www.undp.org/content/dam/undp/library/gender/Gender%20and%20Environment/Guidance%20Note%20Gender%20Sensitive%20REDD%20English_FINAL.pdf> accessed 19 March 2020; Permanent Forum on Indigenous Issues, 'Indigenous People's Rights and Safeguards in Projects related to Reducing Emissions from Deforestation and Forest Degradation' (5 February 2013) E/C.19/2013/7.

113 See Verschuuren, Chapter 13; and Somsen and Trouwborst, Chapter 12, respectively.

114 Heleen de Coninck et al, 'Strengthening and Implementing the Global Response' in Masson-Delmotte et al (n 16) 315, <www.ipcc.ch/sr15/> accessed 13 February 2020.

115 Ibid 316.

under-utilised approach to land use, forestry and emissions offered by agroforestry – which, when well practised, offers a modulated, cross-cutting response to the overlapping issues that characterise land use – is also identified as a potentially mutually beneficial focus area.[116] The IPCC clearly recognises the limitations in current approaches to forestry in the context of the UNFCCC regime, which sees efforts largely focused on tropical forests and the developing world, not least through the high-profile North/South emissions offset mechanism Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (REDD+).[117] While REDD+ tends to be regarded favourably by UN institutions, many States and commercial forestry actors, and continues to be vigorously pursued by them,[118] it has long been subject to trenchant criticism by other key actors, notably non-governmental organisations (NGOs)[119] and indigenous peoples,[120] for its environmental and social shortcomings.[121]

The CBD too, given its subject nature, inevitably impinges on land use and forest issues and the regime regards forest biodiversity as an important – indeed, increasingly so – subcategory within its remit, to the extent that forest biodiversity features as a discrete work programme within the regime.[122] The constituent elements of the CBD's expanded work programme, encapsulated in the Annex to Decision VI/22, are revealing both as to how forests are viewed under the CBD and on regime priorities. The first goal of the first programme element is to apply an ecosystem approach to all types of forest; the second goal of this programme element includes addressing land use change, and seeks to prevent and mitigate losses due to fragmentation and conversion to other land uses (specifically under objective 6). The second programme element looks to institutional provisions.[123] For present purposes, it seems likely that treatment of forests will benefit from a regime shift under the Convention more generally, moving away from a prevailing atomistic, species-specific-based focus[124] to a more holistic, ecosystems-framed approach.[125] This approach is founded upon the basic understanding that any ecosystem is more than the sum of its parts – an observation that is particularly pertinent with regard to forests. Ecosystems-based thinking in the context of the CBD is also influential in that, as considered below, it is increasingly engaged with explicitly addressing the link

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116 Ibid 328.

117 Ibid 329.

118 REDD+ not only takes a prominent position in the UNFCCC, not least under the 2013 Warsaw Framework for REDD: see UNFCC, 'Warsaw Framework for REDD+' <https://redd.unfccc.int/fact-sheets/warsaw-framework-for-redd.html> accessed 13 November 2020; it is also strongly highlighted in the SDG regime: see <http://sdg.iisd.org/issues/forests-redd/redd-plus/> accessed 13 February 2020.

119 See for example Client Earth, *How can REDD+ promote & support social safeguards in national laws? A comparative look at the integration of social safeguards into the laws of Ghana, Liberia & the Republic of Congo* (ClientEarth, October 2019) <www.documents.clientearth.org/wp-content/uploads/library/2019-10-01-how-can-redd-promote-amp-support-social-safeguards-in-national-laws-ce-en.pdf> accessed 13 February 2020.

120 See, for example, Permanent Forum on Indigenous Issues (n 112).

121 See, for example, Kate Wilkinson, 'Payment for Ecosystem Services and the Green Economy: Green Washing or Something New?' (2014) 5(2) Journal of Human Rights and the Environment 168.

122 COP 6 Decision (Decision VI/22 Forest Biological Diversity) 'Sixth Ordinary Meeting of the Conference of the Parties to the Convention on Biological Diversity' (7–19 April 2002, The Hague, Netherlands) para 10 and Annex.

123 Ibid Annex.

124 See, for example, the CBD 'Aichi Biodiversity Targets' <www.cbd.int/sp/targets> accessed 2 February 2020.

125 James EM Watson et al, 'Set a Global Target for Ecosystems' (2020) 578 Nature.

between natural and human systems in a drive to improve efficacy.[126] However, while a range of MEAs have important implications for both land use and forests, it is crucial to acknowledge that, as illustrated by the situation prevailing under the UNFCCC and the CBD, their actions and activities in regard to these issues serve other institutional priorities, perspectives and ends, and may ultimately conflict with one another and with a coherent view of land use overall.

3.3 Gaps and Challenges

3.3.1 Regime asymmetry

As outlined above, land use (and forests, as an indicator thereof) suffers from fragmented coverage in terms of both the institutions and the instruments applicable to it relative to some other planetary boundaries, notably climate change and biodiversity. Thus, the land use planetary boundary reveals one example of what may be termed 'regime asymmetry' in current institutional, legal and policy coverage for key aspects of the Earth system. Planetary boundaries with better defined institutional and instrumental arrangements in place operate at a relative advantage to those that are less choate, not least in benefiting from a supporting constituency with the potential to address them and established (albeit imperfect) regimes through which action can be channelled to do so. Extant regimes, such as those pertaining to climate change and biodiversity, will, without careful coordination, also inevitably be at odds with each other over forests,[127] creating an additional layer of complexity in engaging with the land use boundary with which they may also conflict.

Regime asymmetry is of course attributable in part to the siloed approach which is in many ways a hallmark of modern international environmental law,[128] and an inevitable by-product of the happenstance of its, often crisis-driven, development.[129] Nonetheless, as our understanding of the Earth system grows, it becomes ever less justifiable to fail to adopt a more mimetic, joined-up approach to the cross-cutting issues of the sustainability crisis that better reflects the real-world conditions that we are seeking to address. While progress towards a more coordinated approach to forestry has undoubtedly been made, it remains slow, and as IGOs jockey for position in driving progress, institutional power struggles remain an inhibiting factor in developing efficacious forest governance. These problems are, in part, attributable to the multifunctional nature of forests, with different bodies' remits foregrounding particular aspects of this, but at the same time they are profoundly rooted in the unresolved tensions of the north–south divide that are perhaps the hallmark of current international environmental governance, and for which there are no easy solutions in terms of addressing deep-seated environmental justice concerns.[130] There is a conceptual argument for developing a more coherent

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[126] Sandra Diaz et al, 'The IPBES Conceptual Framework – Connecting Nature and People' (2015) 14 Current Opinion in Environmental Sustainability 1.

[127] Harro van Asselt, 'Managing the Fragmentation of International Environmental Law: Forests at the Intersection of the Climate and Biodiversity Regimes' (2012) 44 International Law and Politics 1205.

[128] Karen N Scott, 'International Environmental Governance: Managing Fragmentation through Institutional Connection' (2011) 12 Melbourne Journal of International Law 1.

[129] Daniel Bodansky, *The Art and Craft of International Environmental Law* (Harvard University Press 2010), 30–35; Kim and Mackey (n 77).

[130] Carmen G Gonzalez, 'Bridging the North–South Divide: International Environmental Law in the Anthropocene' (2015) 32 Pace Environmental Law Review 407.

approach to addressing land use issues – including forests – in international governance, but the reality is that, tied as these issues are to State sovereignty, this remains at best unlikely. This does not, however, necessarily preclude effective steps to achieve greater coordination between regimes that do address these issues, as the emerging role of the UNFF demonstrates. That said, developments have as yet not gone nearly far enough, and it is not clear that sufficient political will exists to press forward at a rate that would be effective to address even the forestry aspect of cumulative global land use change or its contributions to climate change and biodiversity depletion.

3.3.2 The crucial role of indicator choice

If discrete, swift and substantial institutional progress is unrealistic, can the use of indicators play a role in focusing attention on land use change in other planetary boundary contexts? Perhaps. Given that the planetary boundaries are obviously interconnected, a cross-cutting indicator for land use, like forests, is on one level a desirable corrective to the dominant siloed approach that is applied to the study of and engagement with Earth system issues.[131] In the current context it is clear that forests play a particularly important role in linking the dynamics of land use, biodiversity and climate change in particular, and with that in mind, on the scientific front, the choice of forest cover as the focus of the current boundary for land system change has considerable appeal.[132] However, the quantitative approach that has been adopted as to the forests indicator thus far is subject to the same flaws as its predecessor (see the discussion above). Lessons about indicator choice with regard to forests are however already being learned in other global political contexts. The issue of appropriate indicator selection and how this goes to substantive progress has arisen in explicit terms in regard to SDG 15, which, among other things, addresses aspects of land use change. The SDG regime's High-Level Political Forum (HLPF) carried out an evaluation of this goal in 2018 and pointed to limitations in current quantitative indicator-based approaches in regard to biodiversity targets. The review revealed that positive progress on quantitative indicators, here on the rate of deforestation, did not ensure improvement in qualitative terms, and that forest degradation continues to be hugely problematic.[133] As the HLPF stated: 'The monitoring framework of SDG 15 does not capture essential elements related to quality that are crucial for more meaningful results, pointing to the need for additional indicators in areas such as forest intactness.'[134]

In short, a quantitative indicator offers only the illusion of progress – it can be satisfied on paper without offering a solution to the core problem to be addressed in practice. It is, however, possible to add a qualitative dimension to forest indicators, and while this would doubtless raise challenges, it is by no means impossible to secure improved coverage in this regard. The HLPF looks to future developments that seek to achieve this, positing a range of potential additional qualitative indicators that could encompass forest intactness, efficacy in managing protected areas and integrating biodiversity protection concerns.[135] The HLPF

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[131] Maria Ivanova et al, 'Global Risks: A Survey of Scientists' Perceptions', in Future Earth (n 8) 14 *passim*.

[132] Stockholm Resilience Centre, 'The Nine Planetary Boundaries' <www.stockholmresilience.org/research/planetary-boundaries/planetary-boundaries/about-the-research/the-nine-planetary-boundaries.html> accessed 8 November 2019.

[133] HLPF (n 47) 2.

[134] Ibid 5.

[135] Ibid.

approach chimes with emerging scholarship which suggests that composite metrics are required to engage with complex, multi-dimensional issues.[136]

As far as planetary boundaries are concerned, there is another, arguably more problematic, dimension inherent in the choice of forests as the indicator for land use change, which complicates the issue further in particularly problematic ways insofar as the human/societal dimensions of the land use boundary are concerned. This is implicit in the SRC's articulation of the indicator:

> The biome-level boundary for … [boreal and tropical] forest[s] ha[s] been set at 85% … and the boundary for temperate forests has been proposed at 50% of potential forest cover, because changes to temperate forests are estimated to have weaker influences on the climate system at the global level than changes to the other two major forest biomes.[137]

On one level, the location and the distribution of forests falling into the categories defined as relevant for the purposes of the indicator are simply matters of geography, and the operation of the indicator merely a matter of measurement and calculation. This aside, the application of the boundary simultaneously raises other real-world issues, not least some extraordinarily complex and obdurate political and legal questions. This is because of where the various classes of forest are found: boreal forests, broadly speaking, are located in the developed world; tropical forests are for the most part located in the developing world; and temperate forests tend to be located in the developed world.[138] Insofar as the first two types of forest are concerned, further complexity arises as, where they are populated, they tend to be inhabited by indigenous peoples. Boreal and tropical forests, though not untouched, are often comparatively little altered by human endeavour and the SRC observes that, in consequence, they offer richer boundary potential than relatively impoverished (both in scale and biodiversity) temperate forests. By virtue of this, forests are one of the most contentious issues between the developed and the developing world, which has – as discussed above – had significant ramifications for their governance, and which goes to their efficacy as an indicator for the land use planetary boundary if there is a will to exploit them and/or reluctance to report accurately on their state and governance. The significance of forests as politically contentious sovereign resources is currently particularly visible in the prominent, but far from unique, case of Brazil, where, after a decade of significant progress, a rollback of forest protection actually began prior to the entry into power of the current Bolsonaro administration[139] – though the latter has ramped up both the rhetoric and the pace of change.[140]

In any case, it is very apparent that the full legal and political ramifications of indicator choice were not appreciated by the SRC, and this chapter now turns to consider some of the inherent problems that it raises and how they might be addressed. Even if they choose to take a less extreme position than that evident in Brazil, if States are either unwilling or unable to

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136 Jessica Rowland et al, 'Ecosystem Indices to Support Global Biodiversity Conservation' (2019) 13 Conservation Letters.

137 Steffen et al (n 7) 7.

138 Global Forest Atlas, 'Ecoregions' (Yale School of Forestry and Environmental Studies, 2020) <https://globalforestatlas.yale.edu/ecoregions> accessed 30 June 2019.

139 Roberto Novaes and Renan França de Souza, 'Legalizing Environmental Exploitation in Brazil: The Retreat of Public Policies for Biodiversity Protection' (2013) 6 Tropical Conservation Science 477.

140 Ignacio Amigo, 'When Will the Amazon Hit a Tipping Point?' (2020) 578 Nature 505.

report accurately (or at all) on forest cover, we have now arrived at a point where technology increasingly renders this obstacle surmountable – and indeed where it can be used to check both the accuracy and veracity of figures reported. Satellite-based mapping is now sufficiently global and granular in reach to map forest[141] and even plant coverage,[142] and already supports the quantitative forests indicator, rendering at least this basic element of the metric a question of fact. Such technology may well also evolve sufficient granularity to allow it at least a partial role in assessing forest quality; however, at present (and perhaps unavoidably) this also requires on-the-ground surveys and thus depends at the very least on State cooperation.

While physical measurability presents significant challenges with regard to forests, these may increasingly be surmounted by technology; its qualitative and human dimensions, however, remain more problematic and, if left unaddressed, can go to the salience of the indicator.

4. MOVING FORWARD

The land use change planetary boundary does not map well on to existing international law and policy regime architecture, suffering the downside of regime asymmetry. Counterintuitively, this could however prove useful, as where land use change is concerned, this serves to highlight the failure of existing institutional provision, law and policy to achieve anything close to the cross-cutting approach required to address issues that are intimately interwoven. In this regard, forests, in their very complexity, may actually be viewed as representing a highly apposite indicator for the larger intricacies of land use change if we can reframe our approach to them in ways that take due account of this and their multi-dimensional significance. A useful first step would be to view forests in the first instance as ecosystems, with all that that entails in both natural and human contexts, and not primarily as resources or assets to be exploited for 'development'. Diaz and colleagues, in their modelling of a conceptual framework that explicitly seeks to connect nature and humanity for IPBES, provide an example of the type of approach this would require.[143] The methodology they adopt, in developing co-constructed knowledge in a complex sphere, encapsulates a number of key values – notably, transparency and participation – and extends its reach to 'explicit consideration of diverse scientific disciplines, stakeholders, and knowledge systems, including indigenous and local knowledge'.[144]

Such an expansive scope would be well suited to addressing forest issues which invoke similar parameters. Adopting a conceptual framework approach towards forests potentially has much to offer in embracing complexity and multi-dimensionality, as '[i]ntegrative conceptual frameworks are particularly useful tools in fields requiring interdisciplinary collaboration where they are used to make sense of complexity by clarifying and focusing thinking about relationships, supporting communication across disciplines and knowledge systems and between knowledge and policy'.[145]

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[141] This is already in place for some types of forest: see Matthew Hansen et al, 'High-Resolution Global Maps of 21st-Century Forest Cover Change' (2013) 342 Science 850.
[142] Running (n 41).
[143] Diaz et al (n 126).
[144] Ibid 1.
[145] Ibid 3.

Crucially, the IPBES conceptual framework is also strongly focused on the central role played by 'institutions, governance and decision-making'[146] and the links between them, viewing them as integral elements rather than an optional, later bolt-on to the science. In the latter approach in particular, developing a similarly nuanced conceptual framework for forests would go a long way towards addressing the continuing failure to grasp that effective communication is a two-way street and that science and societal approaches require careful coordination that takes into account the complex reality in which each operates and thoughtfully engages with the ways in which they combine. This again is where indicator choices come to the fore. It is imperative that boundary indicators take social/political realities as well as the scientific context fully on board. To influence governance, the choices made in communicating the message are centrally important – and the issues are already more than sufficiently complex in their own right, without adding an extra layer of problems to deal with in choosing scientifically compelling but socially ill-informed indicators to carry the meaning. Poor choices will simply provide further opportunities and excuses to evade the issues.

5. CONCLUSION

We need to make the most of the planetary boundaries approach: if fully developed and more effectively marrying its scientific and human dimensions, it offers the promise of enabling us to rise to the challenge of making the hard choices that environmental breakdown necessitates. As Hetan Shah[147] puts it:

> Environmental issues are not just technical challenges that can be solved with a new invention … Scientific and technological innovations are necessary, but enabling them to make an impact requires an understanding of how people adapt and change their behaviour. That will probably require new narratives – the purview of rhetoric, literature, philosophy and even theology.[148]

While this type of approach, which invites a synthesis of science and the humanities, is welcome, *law* as an engine of social and behavioural change seems an odd omission from the list. It must also be said that the disciplinary rollcall here, while illustrative, does not extend its reach far enough: other social sciences, not least psychology, human geography and sociology, have a crucial role to play in this context. The scope of the challenge we face will require all of the talent and ingenuity that we have to address it, and we must use all the tools at our disposal.

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[146] Ibid.

[147] Former director of the Royal Statistical Society, now chief executive of the British Academy.

[148] Hetan Shah, 'Global Problems Need Social Science' (2020) 577(295) Nature 295 – noting that the subjects referred to in the quotation are in the humanities rather than the social sciences, which is perhaps indicative of the complexities that ensue when stepping outside disciplinary siloes.

20. Chemical pollution (and the release of novel entities)[1]

Tiina Paloniitty, Chukwukpee Nzegwu and Duncan French

1. INTRODUCTION TO THE PLANETARY BOUNDARY OF CHEMICAL POLLUTION

The role of chemicals in perpetuating and advancing modern life is seemingly all-pervasive. Despite the central role chemicals have played in the development of the global economy, particularly since 1945 – it would, for instance, be almost inconceivable to think of human advancement without the industrial intensification of chemical use[2] – the negative externalities associated with the unsafe use of chemicals have been known (at least in part) at least since the nineteenth century. Of course, the benefits and costs of the development of the chemical industry have never been evenly spread, either across society or around the globe. The human health costs were most famously reported in the matchgirls' strike of 1888.[3] In the twentieth century, the developed North relied intensely on mass chemical use, often at the expense of factory workers in the global South,[4] or using the global South as a final resting site for its waste.

As our scientific knowledge has improved, of course, we now better understand the complex interaction between our dependency on chemicals and their often toxic, persistent and irreversible impacts on the environment and on many living organisms (including humans), and in particular the extent to which chemicals can cause infertility, genetic malformations and premature death.[5] Understanding the extent of chemical pollution has rightly led many to question society's dependence on a wide variety of chemicals, including 'radioactive compounds, heavy metals, and a wide range of organic compounds of human origin'.[6]

Nevertheless, recognising such damage merely highlights the size of the challenge facing humanity when it comes to our chemical dependence: the lack of alternatives; a global economy that seems unwilling – or unable – to disentangle itself from chemicals; a pervasive use of chemicals in almost all sectors; and a myriad of vested interests in protecting a hugely

[1] The full title of the planetary boundary is 'Chemical Pollution and the Release of Novel Entities'. For reasons explained later in this chapter, we focus primarily on the former, and thus have placed the latter in parentheses. See nn 9 and 10 and accompanying text below.

[2] See eg David D Vail, *Chemical Lands: Pesticides, Aerial Spraying, and Health in North America's Grasslands since 1945* (University of Alabama Press 2018).

[3] John Emsley, *The Shocking History of Phosphorus: A Biography of the Devil's Element* (Macmillan 2000).

[4] Ved P Nanda, 'Global Environmental Governance and the South' in Shawkat Alam et al (eds), *International Environmental Law and the Global South* (Cambridge University Press 2015) 149.

[5] See, for instance, World Health Organization (WHO) *Global Assessment of the state-of-the-science of Endocrine Disruptors* (WHO/PCS/EDC/02.2, WHO, 2002).

[6] Johan Rockström et al, 'Planetary Boundaries: Exploring the Safe Operating Planetary Boundaries: Exploring the Safe Operating Space for Humanity Space for Humanity' (2009) 14 Ecology and Society 32.

powerful industrial base. These and other considerations highlight chemicals regulation as a very rich example of a complex problem.[7] Indeed, the categorisation of chemical pollution as an environmental (and human health) issue has itself historically been a contentious issue. The fact that the law that has only recently become noticeably more prohibitive in nature – replacing an earlier general permissiveness – is reflective of a larger unwillingness to see the *use* of chemicals (except perhaps *in extremis*) as an issue that must be dealt with. In fact, time and again in the matter of chemicals, one is confronted with an important – and first-order – question: are we concerned with only the truly noticeable ill-effects of chemicals, or with the overuse of them, or with both?

Thus it remains the case that the international legal, policy and institutional framework on chemical pollution, while having evolved noticeably over time, has remained piecemeal, and arguably is still reflective of a lack of political will to truly tackle the seriousness of the problem.[8] The linkages between the development, production, use and disposal of chemicals in the global economy have restricted regulatory policy. Attempts to regulate chemical pollution were initially reactive, limited to sectoral initiatives, often driven by factors other than environmental concerns and dominated by industrial, corporate and policy networks disconnected from those agendas more specifically concerned with ecological challenges. To that extent, it would not be inappropriate to see much of the law – domestic, regional and international – as pertaining more to chemical governance than to tackling chemical pollution *per se*, reflecting the often conflicting considerations at work. It is important to acknowledge that the planetary boundary on chemical pollution (more on which below) is combined with the release of novel entities, the current regulation of which remains somewhat distinct from chemical pollution.[9] For this reason, as well as for reasons of space, this chapter focuses primarily on chemical pollution. This is not to underplay the significance of the release of novel entities to planetary harm, both now and, particularly, in the future.[10] We have also excluded radioactive material from our discussion, again not because of any assessment of its relative harm – indeed, from an intergenerational perspective, radioactive waste is a principal concern – but for no other reason than the somewhat privileged regime given over to it, which itself is worthy of separate comment.[11]

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[7] Ibid.

[8] As examined in eg Louis J Kotzé, 'International Environmental Law and the Anthropocene's Energy Dilemma' (2019) 36 Environmental and Planning Law Journal 437.

[9] Their characteristics ecologically are not dissimilar, however. See the developments on thinking in relation to novel entities in Will Steffen et al, 'Planetary Boundaries: Guiding Human Development on a Changing Planet' (2015) 347 Science 1259855, 1259855-7: 'We define novel entities as new substances, new forms of existing substances, and modified life forms that have the potential for unwanted geophysical and/or biological effects. Anthropogenic introduction of novel entities to the environment is of concern at the global level when these entities exhibit (i) persistence, (ii) mobility across scales with consequent widespread distributions, and (iii) potential impacts on vital Earth-system processes or subsystems.'

[10] On novel entities see eg Rosina Bierbaum et al, 'Novel Entities and Technologies: Environmental Benefits and Risks' (2020) 105 Environmental Science & Policy 134.

[11] The international legal management of radioactive materials, and especially radioactive waste, has attracted significant scholarly attention (see eg Ellen Hey, 'Hard Law, Soft Law, Emerging International Environmental Law and the Ocean Disposal Options for Radioactive Waste' (1993) 40 Netherlands International Law Review 405). On waste generally, see Olivier Barsalou and Michael Hennessy

Including chemical pollution as one of the nine planetary boundaries very notably draws greater attention to the global harm associated with chemicals, and consequently challenges the dominant paradigm – seen up to now – of the social necessity of accepting the negative externalities of the pollution caused. Incorporating it as a planetary threat recognises chemical use (and pollution) as going to the heart of the long-term sustainability of the industrial basis of modern society. Just as the threat of climate change is requiring society to face the challenge of economic growth without a dependency on fossil fuels, chemical pollution poses a very similar question: can we perceive of – and achieve – a future that does not require jeopardising both our ecological and genetic integrity? Still, much remains unknown. As the planetary boundary framework acknowledges:

> There are many examples of additive and synergic effects from these compounds, but these are still poorly understood scientifically. At present, we are unable to quantify a single chemical pollution boundary, although the risk of crossing Earth system thresholds is considered sufficiently well-defined for it to be included in the list as a priority for precautionary action and for further research.[12]

Though the existence of a definite boundary remains to be agreed,[13] there is no doubt as to the scale of the issue. As Steffen and colleagues note:

> Despite this progress in developing an Earth-system–oriented approach, there is not yet an aggregate, global-level analysis of chemical pollution on which to base a control variable or a boundary value. It may also serve little purpose to define boundary values and control variables for a planetary boundary of this complexity. Nevertheless, there is a potential threat from novel entities to disrupt the functioning of the Earth-system and society needs to learn how to mitigate these unknown risks and manage chemicals under uncertainty.[14]

Despite present scientific uncertainty, this particular planetary boundary is by no means the least regulated of the nine planetary boundaries. In fact, there is a lot of direct and tangential law in the area, offering us insights on how to develop the governance of a chemical pollution planetary boundary. And though, as this chapter highlights, there are a number of key fault-lines in the current law, resulting in gaps in both knowledge and regulation, there is also evidence of progressive first steps in a more comprehensive approach to the issue. In this chapter we outline the present state of international law and policy on chemical compounds and chemical pollution, as well as making specific mention of a key transnational legal instrument on the issue, namely the European Union (EU) Registration, Evaluation, Authorisation

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Picard, 'International Environmental Law in an Era of Globalised Waste' (2018) 17 Chinese Journal of International Law 887. See also Picard and Barsalou, Chapter 11 in this book.

[12] See Stockholm Resilience Centre, 'The Nine Planetary Boundaries' <www.stockholmresilience.org/research/planetary-boundaries/planetary-boundaries/about-the-research/the-nine-planetary-boundaries.html> accessed 20 May 2020. See, however, Miriam L Diamond et al, 'Exploring the Planetary Boundary for Chemical Pollution' (2015) 78 Environment International 8.

[13] Steffen et al (n 9) 7–8 seem to identify the following as potentially very useful criteria, however: 'there are three conditions that need to be fulfilled for a chemical to pose a threat to the Earth system: (i) the chemical has an unknown disruptive effect on a vital Earth-system process; (ii) the disruptive effect is not discovered until it is a problem at the global scale; and (iii) the effect is not readily reversible' (relying on Linn M Persson et al, 'Confronting Unknown Planetary Boundary Threats from Chemical Pollution' (2013) 47 Environmental Science & Technology 12619.

[14] Steffen et al (n 9) 8.

and Restriction of Chemicals (REACH) Regulation.[15] We argue that insights from both these inter- and transnational legal regimes will be necessary to provide the building blocks of governance needed to tackle chemical pollution, and to put in place further measures to prevent threshold breach of this particular planetary boundary.

Over time, a global approach to chemical pollution – be that via an international or a transnational legal regime – will have to confront three systemic challenges in the current law.[16] First, whether such law is adequately capturing the broader – and more cumulative – impact of unsustainable chemical bioaccumulation, damage to ecological systems and other related threats. The possibility of toxicological build-up over time and the geographical ease with which chemicals spread exacerbate this global challenge. Second, though precaution is present within the present law, how far is it only applied and implemented at the level of individual compounds and not at the meta- or global level, which would then allow regulators to take into account the cumulative impact on the environment? Moreover, as risk itself is subjective, there is a genuine concern whether differing variations on risk assessment prevent a truly global perception of risk from materialising. And third, what should law and policy in this area ultimately focus on: tackling only the *effects* of chemical pollution – both the immediate and the longer-term (both temporally and geographically) – or seeking also to curb unsustainable production and consumption – something that, since the 1992 Rio Declaration on Environment and Development (Rio Declaration),[17] law has had little normatively to say on? If nothing else, the planetary boundaries framework at least requires us to ask such complex questions with a view to illuminating both best practice, and alternatively gaps in the laws governing chemicals around the globe.

The chapter contains four main sections. We begin by building the context, with a focus on risk, precaution and scientific uncertainties related to chemical regulation (Section 2). We then describe the existing international legal regimes on chemical pollution (Section 3). We continue to consider chemical governance by examining the relatively successful chemical regulation in the EU (Section 4). We then conclude with the consequences for the chemical pollution planetary boundary (Section 5).

2. RISK, PRECAUTION AND UNCERTAINTY IN CHEMICAL REGULATION

A key issue in toxic chemical regulation is establishing an appropriate balance between the lack of *complete* scientific understanding of the regulated phenomenon, and the application of environmental principles – notably the precautionary principle – to determine the basis

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[15] Regulation concerning Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC [2006] OJ L 396/1 (REACH).

[16] We have excluded analysis of national chemical laws from the scope of our study. One national context is, however, referred to, when the EU's REACH developments are mirrored against the less ambitious United States regime in Section 4.2.

[17] The Rio Declaration on Environment and Development, UN Conference on Environment and Development (12 August 1992) UN Doc. A/CONF. 151/5/Rev. 1, 31 I.L.M.

for, and in defining the scope of, necessary regulatory action.[18] Chemical regulation is a field where questions of evidence, burden of proof, the precautionary principle and other factors justifying regulatory action are both pivotal and emergent.[19] Moreover, regulating chemical pollution exemplifies the increasingly contested question of *whose* science, scientific evaluation, risk assessment or values ought to be adhered to when regulating matters dealing with human health and the environment.[20]

It has long been noted that international chemical law struggles to tackle the fundamental challenges which chemicals, as an object of regulation, present.[21] Such regulation has historically failed to recognise the accumulation of persistent pollutants, pollution's global and cumulative nature, toxicological complexity, the lack of adequate data (resulting in rarely fulfilling the traditional burden of proof) and the complexity of chemical mixtures, as well as failing to identify necessary technical measures to successfully prevent such pollution.[22] International chemical regulation has also been plagued by 'problem shifting', a tendency of altering the focus of regulatory action from one recipient to another, or from one group of victims to another.[23] Changing the regulatory target from air to water, or (in terms of principal victim) from the population in general to workers in particular, exemplifies this phenomenon.[24] These challenges, combined with the notable lack of scientific knowledge on, especially, the cumulative impacts of chemicals, have resulted in chemical pollution being especially difficult to regulate.[25] As a consequence, a lack of accountability and transparency in regulation has led many to suspect the chemical industry of prioritising management of regulatory compli-

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18 The common misunderstanding of the application of precautionary principle, and its relations with scientific uncertainties, are analysed in Brian J Preston, 'The Judicial Development of the Precautionary Principle' (2018) 35 Environmental and Planning Law Journal 123. Also found within REACH is another principle, namely the substitution principle, becomes essential in chemical regulation. Including the two principles in the same regulation earned REACH the status of a paradigm shift in chemical governance: Ragnar Lofstedt, 'The Substitution Principle in Chemical Regulation: A Constructive Critique' (2014) 17(5) Journal of Risk Research 543, 544. See also Collins, Chapter 5 in this book.

19 On the inadequacy of the concept of 'burden of proof' in environmental regulation, Elizabeth Fisher, *Risk Regulation and Administrative Constitutionalism* (Hart Publishing 2007) 290, 247–48, 252.

20 See also Kim and Kotzé, Chapter 3 in this book.

21 Joe Thornton, 'Beyond Risk: An Ecological Paradigm to Prevent Global Chemical Pollution' (2000) 6(3) International Journal of Occupational and Environmental Health 318, 319–23, summarising work in Joe Thornton and Campbell Donald, *Pandora's Poison: Chlorine, Health and a New Environmental Strategy* (British Medical Journal Publishing Group 2001) 596.

22 Thornton (n 21) 319–23; Mikael Karlsson, 'The Precautionary Principle in EU and US Chemicals Policy: A Comparison of Industrial Chemicals Legislation' in Johan Eriksson, Michael Gilek and Christina Rudén (eds), *Regulating Chemical Risks* (Springer 2010) 239, 257–58.

23 See also Piselli and Van Asselt, Chapter 7 in this book.

24 Megan R Schwarzman and Michael P Wilson, 'Science and Regulation. New Science for Chemicals Policy' (2009) 326(5956) Science 1065, 1066. Problem shifting is nothing new for environmental governance and there have been calls for a more integrated approach: Rakhyun E Kim and Harro van Asselt, 'Global Governance: Problem Shifting in the Anthropocene and the Limits of International Law' in Elisa Morgera and Kati Kulovesi (eds), *Research Handbook on International Law and Natural Resources* (Edward Elgar 2016) 473, 473–95.

25 Elizabeth Fisher, 'The "Perfect Storm" of REACH: Charting Regulatory Controversy in the Age of Information, Sustainable Development, and Globalization' (2008) 11(4) Journal of Risk Research 541, 542–45.

ance over embedding longer-term chemical safety within its operational philosophy.[26] As we will show, the EU has found an effective remedy for the difficulty of chemical regulation in REACH, where industry is made to bear greater responsibilities; and shifting the burden of proof has been elementary in this progressive approach.[27] Nevertheless, chemical regulation is 'inherently controversial', leading to innate fragmentation and divergent choices in different jurisdictions and at different layers of governance.[28] When placed within the context of discussing the planetary boundaries, one needs to recognise that the boundary refers to a specific point related to a global-scale environmental process, beyond which humanity should not go.[29] However, as detailed above, determining the boundary is a normative judgement because the determination is 'largely based on human perceptions of risk'.[30] Therefore, when responding to the chemical pollution planetary boundary, while objective in many respects, innate variations in risk assessment will have to be borne in mind, as well as the relative involvement of expertise, expert power and democracy.[31] Thus, the innate contingency of chemical risk regulation, and the challenges of chemical pollution as an object of scientific enquiry,[32] must never be simplified at the altar of desiring readily explainable, and consequently unduly simplistic, thresholds and boundaries. Both legal and social science analysis posits the importance of a polycentric governance approach for the chemical planetary boundary (as elaborated in Section 5). Before getting to that, however, we discuss the existing international law on chemical pollution in order to analyse its significance and lessons learnt for future chemical governance.

3. THE INTERNATIONAL LAW AND POLICY ON CHEMICAL POLLUTION

Almost since its creation, international environmental law has recognised the specific risks involved in industrial activity. However, these risks were rarely phrased in terms of chemical pollution, but instead were framed within a broader discourse around the regulation of dangerous or toxic substances and activities. The 1972 United Nations Declaration on the Human Environment (Stockholm Declaration), for instance, noted in Principle 6 that:

> the discharge of toxic substances or of other substances and the release of heat, in such quantities or concentrations as to exceed the capacity of the environment to render them harmless, must be halted

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[26] Schwarzman and Wilson (n 24) 1065, who use the US regulation as their example of a system leading the market undervaluing chemicals' safety.

[27] See Fisher (n 25); Fisher (n 19) 247–48.

[28] Fisher (n 25) 542.

[29] Rockström et al (n 6).

[30] Rockström et al (n 6); see also Will Steffen et al, 'How Defining Planetary Boundaries Can Transform Our Approach to Growth' (2011) 2(3) The Solutions Journal 59–65.

[31] Maria Weimer and Anniek de Ruijter, *Regulating Risks in the European Union: The Co-production of Expert and Executive Power* (Hart Publishing 2017).

[32] Jessica Coria, 'Policy Monitor – The Economics of Toxic Substance Control and the REACH Directive' (2018) 12(2) Review of Environmental Economics and Policy 342, 343ff; Elizabeth Fisher, 'Drowning by Numbers: Standard Setting in Risk Regulation and the Pursuit of Accountable Public Administration' (2000) 20(1) Oxford Journal of Legal Studies 109, 110.

> in order to ensure that serious or irreversible damage is not inflicted upon ecosystems. The just struggle of the peoples of all countries against pollution should be supported.[33]

Over the years such language has become more precise, though still limited in its direct reference to chemicals. For instance, the 1982 World Charter for Nature expressed the hope that States should take ‘special precautions … to prevent discharge of radioactive or toxic wastes’.[34] The Rio Declaration offered only vague provisions on providing citizens access to information on ‘hazardous material and activities’ (Principle 10), the need for developing national liability laws for ‘pollution and other environmental damage’ (Principle 13) and the exhortation against relocation of harm ‘to other States of any activities and substances that cause severe environmental degradation or are found to be harmful to human health’.[35] Of greater significance was Agenda 21, adopted at the same conference, which contained numerous references to chemicals, chemical management and the need for better regulation.[36] Notably, chapter 19 covered ‘environmentally sound management of toxic chemicals, including prevention of illegal international traffic in toxic and dangerous products’.[37] Agenda 21 recognises that global chemical governance remains a work in progress. It summarises by stating that ‘a significant strengthening of both national and international efforts is needed’ to better ecologically manage toxic chemicals and the ‘long-range effects’ caused by chemical pollution.[38]

The increased interest in and attention to institutional and diplomatic efforts on chemical regulation since 1992 was most comprehensively reflected in the development of the Strategic Approach to International Chemical Management (SAICM).[39] SAICM is an overarching policy approach, agreed in 2006 following an initiative at the 2002 World Summit on Sustainable Development.[40] It is accurate to say that most *legislative* effort remains at the national level, with international regulation providing a supplementary role, focused on issues of international cooperation and mutual interest.[41] As the Overarching Policy Strategy on SAICM notes, a key purpose is to ‘strengthen enforcement and encourage the implementation

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33 Stockholm Declaration on the Human Environment (5–16 June 1972) UN Doc. A/CONF.48/14 and Corr. 1, reprinted in 11 ILM 1416.

34 United Nations World Charter for Nature, GA Res. 37/7 (28 October 1982) UN Doc. A/RES/37/7, reprinted in 22 ILM 455 [1983].

35 Rio Declaration on Environment and Development (14 June 1992) UN Doc. A/CONF. 151/5, 31 ILM 874.

36 ‘Adoption of Agreements on Environment and Development’, UN Conference on Economic (Rio de Janeiro, 3–14 June 1992), 47th Sess., Agenda Item 21, UN Doc. A/CONF.151/4.

37 Ibid.

38 Ibid.

39 See the Strategic Approach to International Chemicals Management (SAICM, 2020) <www.saicm.org/> accessed 20 May 2020.

40 Ibid.

41 OECD, ‘International Regulatory Co-operation: Adapting Rulemaking for an Interconnected World’ (Policy Brief, OECD Regulatory Policy Division, October 2018) <http://oecd.org/gov/regulatory-policy/international-regulatory-cooperation-policy-brief-2018.pdf> accessed 20 May 2020; see generally John Munthe et al, ‘Increase Coherence, Cooperation and Cross-Compliance of Regulations on Chemicals and Water Quality’ (2019) 31 Environmental Sciences Europe 64.

of national laws and regulations regarding chemical management, including those that serve to implement international agreements'.[42]

International law in this area has historically focused on matters of international transit and transboundary movements, the dumping of waste particularly in common areas (such as the high seas), sharing information, and promoting a general level of cooperation. In a few high-profile instances, international law has also sought to regulate – occasionally even successfully – production and use of a chemical as part of a broader international effort, especially where there are certain inherent risks, such as in matters involving nuclear safety,[43] chlorofluorocarbons (CFCs)[44] and mercury.[45] But these high-profile instances remain the exception when looking at the scale of the challenge within the chemical pollution and novel entities planetary boundary.

3.1 Global Chemical Governance: Piecemeal and Sectoral

International law in this area is not unified, but has developed over time, in a piecemeal and sectoral manner. To the extent that one can talk of international chemicals law at all, one is referring to a complex fabric of specific regimes, general rules, soft law and policy processes, and interweaving national legislative frameworks that exist. It is impossible within the scope of this chapter to outline the many international rules that relate, directly or indirectly, to the life of a chemical and the ensuing pollution that occurs. Fragmentation of legal rules is thus both a side-effect of how the law has developed over time, and a characteristic of how it operates. Of course, normative fragmentation is not inherently problematic when justified – and explicable – by the science and/or sound policy choices. However, one must be wary of the unseen drivers of fragmentation and what it tells us about the more overt political and legal choices made. Moreover, identifying the omissions – what is not regulated – is as important as considering the divergences in what (and how it) is regulated.

As the current law has developed somewhat haphazardly over time, it is a truism to note that a unified and comprehensive legal regime for chemicals is lacking. When compared to other fields with comprehensive frameworks, such as the 1982 United Nations Convention on the Law of the Sea (UNCLOS), the governance of chemical use and pollution is notably less coherent.[46] Whether a global regime is necessary to tackle the myriad of chemical issues is, of course, debatable. Sector-specific regimes, national and transnational arrangements (such as the EU's REACH legislation) should not *a priori* be discarded as inferior simply because

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[42] UNEP, 'Strategic Approach to International Chemicals Management: SAICM Texts and Resolutions of the International Conference on Chemicals Management' (International Conference of Chemicals Management, Dubai, UAE, 4–6 February 2006) 16–17. By 2020, SAICM desired '[t]hat chemicals or chemical uses that pose an unreasonable and otherwise unmanageable risk to human health or the environment based on science-based risk assessment and taking into account the costs and benefits as well as the availability of safer substances and their efficacy, are no longer produced or used for such uses' (ibid at 15).

[43] Convention on Nuclear Safety (adopted on 29 September 1994, entered into force 24 October 1996) IAEA (Legal Series No. 16, 1994).

[44] See Piselli and Van Asselt, Chapter 7 in this book.

[45] Minamata Convention on Mercury (adopted on 10 October 2013, entered into force 16 August 2017) Reference C.N.560.2014.TREATIES-XXVII.17 (hereinafter, 'Minimata Convention').

[46] See also Diz, Chapter 17 in this book.

they are not universal in scope or comprehensive in coverage. Though there is some value in a single, unified regime, as can be demonstrated by the role UNCLOS has played in broader maritime governance, environmental law is arguably better assessed by its effectiveness than by the ease by which it can be codified.

Regarding specific international rules that regulate chemicals, there are a number of conventions which are now incrementally providing the legal building blocks for global action. But even the most optimistic of observers would struggle to argue that this actually provides a comprehensive chemical law and governance regime. The key conventions are the 1989 Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal,[47] the 1998 Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade,[48] the 2001 Stockholm Convention on Persistent Organic Pollutants (POPs Convention)[49] and the 2013 Minamata Convention on Mercury.[50] As it is beyond this chapter's scope to explain the complexity of these conventions, key elements are captured in Table 20.1 and several key features are described in Section 3.2 below. Outside of these major conventions there are countless other international, transnational and regional conventions, though as with any treaty regime, membership and compliance varies.

Global chemical governance is a combination of soft law,[51] an increasing number of conventions, a broad range of domestic law and private/voluntary codes of practice, all with varying levels of State, regulator and industrial capacity to follow through, and consequent effectiveness. As the Overarching Policy Strategy on SAICM rather optimistically perhaps notes, its purpose is to 'achieve the sound management of chemicals throughout their life cycle by means of appropriate national, regional and international mechanisms, as needed, that are multi-sectoral, comprehensive, effective, efficient, transparent, coherent and inclusive'.[52] As Piselli and Van Asselt point out in this book, identifying apposite and multi-contextual forms of global governance will be foundational to respond to planetary boundary challenges.[53] This is equally, if not more, true of chemical regulation, which is why we explore transnational

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47 The Basel Convention became enforced in 1989 as a response to toxic trading patterns that emerged in the 1970s whereby developed countries were found to be exporting hazardous wastes to developing countries. The Basel Convention restricts the trade of 'hazardous waste' under the treaty itself or under Basel parties' national legal definitions for hazardous waste. Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (adopted on 22 March 1989, entered into force 5 May 1992) 1673 UNTS 126, UN Doc. UNEP/WG. 190/4.

48 The Rotterdam Convention entered into force in 2004 as a response to the increased global trade in hazardous chemicals. It includes a legally binding prior informed consent (PIC) procedure that allows states to deny imports of a volatile list of hazardous substances that are banned by the Rotterdam Convention or banned by the individual states. Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (adopted on 10 September 1998, entered into force 24 February 2004) 2244 UNTS 337, 38 ILM 1 (hereinafter, 'Rotterdam Convention').

49 Stockholm Convention on Persistent Organic Pollutants (adopted on 22 May 2001, entered into force 17 May 2004) 2256 UNTS 119, 40 ILM 532 (hereinafter, 'Stockholm Convention').

50 The Minamata Convention seeks to defeat the serious global environmental and public health threat caused by mercury pollution; it entered into force in August 2017 with its 50th ratification.

51 For instance, the Food and Agriculture Organization (FAO) 'International Code of Conduct on the Distribution and Use of Pesticides' (FAO 2002).

52 UNEP (n 42) at 16–17.

53 See Piselli and Van Asselt, Chapter 7 in this book.

Table 20.1 Summary of key chemical regulation conventions

	Objective	Num. Parties (as of May 2020)	Overarching Operational Principles	Simplified Amendment Procedure for Technical Annexes?
1989 Basel Convention	'management of hazardous wastes and other wastes including their transboundary movement and disposal is consistent with the protection of human health and the environment whatever the place of disposal' (preamble)	187	Prior informed consent of State of import (article 4.1(c); article 6.3) Duty to re-import (article 8) Illegal traffic of hazardous waste (article 9) Effort to minimise generation of hazardous waste (article 4.2(a)) and the transportation thereof (article 4.2(d))	Yes; (see articles 18.2 and 18.3)
1998 Rotterdam Convention	'to promote shared responsibility and cooperative efforts among Parties in the international trade of certain hazardous chemicals in order to protect human health and the environment from potential harm and to contribute to their environmentally sound use, by facilitating information exchange about their characteristics, by providing for a national decision-making process on their import and export and by disseminating these decisions to Parties' (article 1)	161	Listing of chemicals (article 7) Prior informed consent (articles 10 and 11) Information exchange (article 14)	Yes; (see articles 22.3, article 22.4 and as regards Annex III ('PIC Annex') article 22.5)

	Objective	Num. Parties (as of May 2020)	Overarching Operational Principles	Simplified Amendment Procedure for Technical Annexes?
2001 Stockholm Convention	'to protect human health and the environment from persistent organic pollutants' (article 1)	184	Eliminate / restrict production and use of intentionally created POPs (article 3) Reduce or eliminate releases of unintentional POPs (article 5) Environmentally sound management of stockpiles of POPs (article 6)	Yes; (articles 22.3 and 22.4 (as regards Annexes A-C) and article 22.5 (as regards Annexes D-F))
2013 Minamata Convention	'to protect the human health and the environment from anthropogenic emissions and releases of mercury and mercury compounds' (article 1)	120	Controlling mercury supply sources and trade (article 3) Phase-out and phase-down of mercury use in products and processes (articles 4, 5 and 6) Controlling artisanal and small scale gold mining where mercury is used (article 7) Controlling emissions and releases (articles 8 and 9) Storage, waste and contaminated sites (articles 10, 11 and 12)	Yes; (articles 27.3 and 27.4)

Source: Prepared by authors.

regulation and governance in more detail in the following section. At the global level, governance is largely achieved through high-level institutional oversight (such as the United Nations Environment Assembly (UNEA)[54]), policy integration (such as SAICM) and convention coordination (such as the BRS Secretariat,[55] which jointly services the Basel, Rotterdam and Stockholm Conventions and seeks to ensure synergies between them).

This brief overview of existing international chemical regulation has revealed its sectoral nature (more critical voices would suggest – despite the synergies identified above – its continuing fragmented quality). However, though fragmentation is often portrayed as negative – understandably so when coherence, consistency and certainty are intrinsic to law – this is not necessarily always the case.[56] Fragmentation may, in turn, prove of assistance when working towards the governance of something as complex as the chemical pollution planetary

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54 UNEA Res 8 'Environmentally Sound Management of Chemicals' (15 March 2019) UN Doc UNEP/EA.4/Res.8.

55 The Secretariat of the *B*asel, *R*otterdam and *S*tockholm Conventions is jointly administered by UNEP and FAO.

56 Fariborz Zelli and Harro van Asselt, 'The Institutional Fragmentation of Global Environmental Governance: Causes, Consequences, and Responses' (2013) 13(3) Global Environmental Politics 1, 3.

boundary. Fragmentation might then be accepted as the 'inherent structural characteristic' of such law.[57] Now with the planetary boundaries framework demarcating a safe – in other words, singular – operating space for humanity (admittedly not yet achieved for chemical pollution), there are valid reasons to strive towards stronger normativity and interaction at multiple levels of governance. In Section 5 we will continue discussing the interlinkages necessary in achieving an appropriate governance model for a chemical pollution planetary boundary. However, to focus on fragmentation ignores some of the significant normative similarities that exist in international chemical law, and which are characteristic of the present law – something which is equally worthy of note.

3.2 The Four Common Key Features of Global Chemical Governance

Despite the plurality of global conventions concerning chemicals, there are certain key features. First, as with much of modern international environmental law, such conventions are generally flexible in responding to changing scientific understanding, though such scientific developments will not per se prompt direct convention change without being filtered by States, usually through some form of scientific-cum-bureaucratic procedure. Take, for instance, the Stockholm Convention's rather complex but seemingly effective POPs listing procedure.[58] Article 8 provides a carefully balanced division of labour between the Conference of the Parties (CoP), the POPs Review Committee and the Secretariat, where scientific evidence is elevated in significance but socio-economic and political aspects are given secondary weight, and both are held in creative tension. The flexibility of the ozone regime exemplifies a similar arrangement, as Du Toit further describes in this book.[59] Such flexibility is then operationalised through simplified amendment processes for technical annexes, as outlined in Table 20.1 above.

Second, such processes relating to individual listing decisions should be contrasted with provisions reviewing the effectiveness of a convention as a whole. Article 22 of the Minamata Convention, for instance, institutes a periodic evaluation process whereby the CoP must establish 'arrangements for providing itself with comparable monitoring data on the presence and movement of mercury and mercury compounds in the environment as well as trends in levels of mercury and mercury compounds observed in biotic media and vulnerable populations'.[60] The impact of such an evaluation remains, however, distinctly political, thus relying on the collective weight of the global consensus to push forward change. In some ways it is not dissimilar to the Paris Climate Change Agreement's much more high-level global stock-taking exercise,[61] recognising that governance is an adaptable and dynamic process, which requires

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57 Ibid 3–4; though it is important to note that the authors do not specifically use international chemicals law as an example.

58 The Stockholm Convention eliminates or reduces the release into the environment of persistent organic pollutants. POPs are chemicals that: exist in the environment for extended periods of time; accumulate in the fatty tissue of humans and wildlife; multiply from one host to the next; and cause cancers, birth defects and other health problems in a variety of species.

59 See Du Toit, Chapter 14 in this book.

60 Minamata Convention (n 45).

61 UNFCCC, 'Adoption of the Paris Agreement' COP 21th session (12 December 2015) UN Doc FCCC/CP/2015/L.9/Rev.1, art 14.

review of both individual substances and the broader challenge. We continue discussing the role of adaptive and dynamic governance in Section 5.

Third, such conventions are only as effective as the ability of states parties to monitor their implementation. The conventions contain, within either their texts or decisions of their CoP, procedures by which national implementation is monitored and, when necessary, compliance reviewed. International environmental law has moved towards a greater focus on implementation over the decades, departing from a passive reporting requirement to a much more collective compliance process. These conventions are no different in this regard.[62]

Fourth, technological transfer, technical advice and financial assistance – particularly for developing country parties – are key features of such regimes, whether as provisions of the treaty or as side promises. However, an often heard complaint is that such commitments invariably fail to live up to their idealistic goals. Nevertheless, the very existence of such commitments hints at an important reality: no treaty exists within a normative bubble of compliance; many non-legal factors come into play in determining its success, both at the convention level and in respect of compliance by individual States. To understand the role that international law plays here, one needs to recognise the broader context of, and the wider effect of, such a regime including domestic legal implementation, as well as other initiatives – be that financial, social and political; private, non-governmental and inter-governmental (including through such organisations as the World Bank) – which can prompt action or otherwise induce a response, hopefully positive. These broader aspects – as intrinsic elements of a broader governance solution for the chemical pollution planetary boundary – are returned to in Section 5.[63]

Chemical pollution differs from many other planetary boundaries in its complexity, its cumulative nature and our significant and persistent lack of knowledge, reflecting Earth's finite assimilative capacity, as well as posing serious institutional challenges as to how to effectively regulate this particular boundary.[64] Nevertheless, as our understanding improves and the political will to tackle the issue incrementally increases, this in turn paves the way for closer collaborations.[65]

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62 It remains the case that the COP to the Stockholm Convention has yet, as of the time of writing in 2020, to finalise agreement on its compliance process, whereas the COP to the Rotterdam Convention has agreed to the establishment of a Compliance Committee, which was established in 2019. Undoubtedly learning the lesson of leaving negotiation of such a structure to after the finalisation of the Convention text itself, the Minamata Convention itself established an Implementation and Compliance Committee under article 15.

63 Broadening the horizon of and enhancing democracy within the governance of planetary boundaries is discussed in eg Kim and Kotzé, Chapter 3 in this book, and Will Steffen and Mark Stafford Smith, 'Planetary Boundaries, Equity and Global Sustainability: Why Wealthy Countries Could Benefit from More Equity' (2013) 5 Current Opinion in Environmental Sustainability 1.

64 Miriam L Diamond et al, 'Exploring the Planetary Boundary for Chemical Pollution' (2015) 78 Environment International 8.

65 Jonas Ebbesson, 'Planetary Boundaries and the Matching of International Treaty Regimes' (2014) 59 Scandinavian Studies in Law 259.

4. PEELING AWAY THE LAYERS OF GLOBAL CHEMICAL GOVERNANCE: LESSONS FROM THE EU'S REACH

The EU's precautionary approach to toxic chemical regulation under its REACH legislation is perceived by many as the present gold standard of chemical regulation.[66] This is not to suggest that REACH is not without its imperfections. While one of the most impactful pieces of EU environmental law, REACH has room for improvement. Notably, REACH has been cited as one of the most controversial pieces of EU regulation,[67] with its paradigmatic 'substitution principle', which is said to be both blunt and imprecise.[68] Both the privatisation of risk management functions and centralisation of administration shift significant power away from Member States,[69] and there are shortcomings in REACH's ability to manage chemicals due to both data sharing agreement challenges and European cultural differences with global counterparts, such as countries in Asia.[70] But undoubtedly, the EU has adopted one of the most aggressive approaches to chemical regulation in the world, applying the precautionary principle and putting the onus on industry to prove its chemicals do not pose an 'unreasonable risk' to human health or the environment.[71] Below, we analyse reasons behind the EU's success with REACH, its impact on current global chemical governance and its putative consequences for the governance of the chemical pollution planetary boundary.

4.1 Proactive Regulation Embracing the Precautionary Principle

Before 2007, the EU chemical regulation landscape was similar to many others: reactive and fragmented.[72] In 2007 REACH came into force, with the dual goal of advancing industry competitiveness and improving chemical-related health and environmental quality.[73] REACH applies to all chemical substances, from the industrial process to everyday household items; therefore, every company that operates in the EU is impacted by the regulation.[74] REACH is based on the principle of 'no data, no market',[75] and in this way requires the bringing of private

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66 Veerle Heyvaert, 'Regulating Chemical Risk: REACH in a Global Governance Perspective' in Johan Eriksson, Michael Gilek and Christina Rudén (eds), *Regulating Chemical Risks: European and Global Challenges* (Springer 2010) 217.

67 Again confirming that in Brussels, corporate interests are better represented than eg environmental non-governmental organisations, Thomas Persson, 'Democratising European Chemicals Policy: Do Consultations Favour Civil Society Participation?' (2007) 3(3) Journal of Civil Society 223, 234–36.

68 Substitution principle refers to the obligation in REACH art 6(2) to examine the alternatives before applying for authorisation: Lofstedt (n 18) 544, 555.

69 Heyvaert (n 66) 222ff, Fisher (n 25) 545.

70 Maren Rectanus and Doris Peters, 'Global Data Sharing: Requirements from Chemical Regulation' (2019) 2 International Chemical Regulatory and Law Review 61.

71 REACH art 1(3); Persson (n 67) 223; Dieter Pesendorfer, 'EU Environmental Policy under Pressure: Chemicals Policy Change between Antagonistic Goals' (2006) 15 Environmental Politics 95.

72 Steven Vaughan, *EU Chemicals Regulation: New Governance, Hybridity and REACH* (Edward Elgar 2015), 237; Heyvaert (n 66) 219ff.

73 Coming into force in 2007 was only the first step; it was followed by processes of registration expanding over 11 years: Fisher (n 25) 543–44.

74 Ibid.

75 REACH art 5; Ellen K Silbergeld, Daniele Mandrioli and Carl F Cranor, 'Regulating Chemicals: Law, Science, and the Unbearable Burdens of Regulation' (2015) 36 Annual Review of Public Health 175.

data into the public domain and reconfiguration of the roles of private actors in regulatory action:[76]

> REACH places the burden of proof on companies. To comply with the regulation, companies must identify and manage the risks linked to the substances they manufacture and market in the EU. They have to demonstrate to ECHA [European Chemicals Agency] how the substance can be safely used, and they must communicate the risk management measures to the consumers. If the risks cannot be managed, authorities can restrict the use of substances in different ways. In the long run, the most hazardous substances should be substituted with less dangerous ones.[77]

It is clear that REACH's precautionary approach and risk-averse burden of proof has slowed down the production of hazardous materials in the EU. According to a European Environment Agency (EEA) report, since 2008 there has been an overall decline in the EU's production and consumption of harmful chemicals.[78] REACH has allowed the ECHA to ban and/or severely restrict 70 chemicals within the EU.[79]

REACH promotes the belief that a substance is unsafe unless proven otherwise by the producers of the chemical.[80] Though ECHA's role is primarily managerial, it also has regulatory power: it can, for instance, make decisions binding on third parties, or if it suspects a dangerous release, it can on its own initiative require producers to submit to registration.[81] A significant strength of REACH is that it impacts the entire chemical substance's history –from the manufacturer and importer to the downstream users and companies established outside the EU. It also outlines the responsibilities and steps required by each related party.[82] As Vaughan has observed, the REACH system is at the same time hierarchical and heterarchical – the latter referring to the panoply of private and public actors moulding the operationalisation of REACH.[83] In essence, REACH has two sides: one of traditional authorisations and one of innovative market-based approaches.[84] Both potentially offer insights into the governance of the chemical pollution planetary boundary, as discussed below.

Earlier we discussed the role of risk in chemical governance and noted the increased demands for precautionary action in the chemical pollution regime. REACH embraces the

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76 Fisher (n 25) 542.

77 Ibid. On the significance of question of burden of proof, see Fisher (n 19).

78 Eurostat, 'Chemicals Production and Consumption Statistics' (Eurostat, December 2019) <https://ec.europa.eu/eurostat/statistics-explained/index.php/Chemicals_production_and_consumption_statistics#Production_of_chemicals_hazardous_to_health> accessed 25 June 2020.

79 European Environment Agency, 'Consumption of Hazardous Chemicals' (EEA 2017) <www.eea.europa.eu/airs/2017/environment-and-health/production-of-hazardous-chemicals> accessed 20 May 2020; European Chemicals Agency, 'Substances Restricted under REACH' (ECHA 2019) <https://echa.europa.eu/substances-restricted-under-reach> accessed 20 May 2020.

80 REACH art 5; Sheldon Krimsky, 'The Unsteady State and Inertia of Chemical Regulation under the US Toxic Substances Control Act' (2017) 15 PLOS Biology.

81 Lucas Bergkamp and DaeYoung Park, 'The Organizational and Administrative Structure' in Lucas Bergkamp (ed), *The European Union REACH Regulation for Chemicals: Law and Practice* (Oxford University Press 2013) 23, 25–27.

82 REACH is meticulous on this: Fisher (n 25) 544–45.

83 The former referring to the ECHA acting within its mandate: Vaughan (n 72) 243. The ECHA works within its (administrative and managerial) mandate, rarely overstepping its realm or expanding into regulatory action by filling the gaps left in REACH: ibid.

84 Vaughan (n 72) 243–44; Fisher (n 25) 545.

precautionary principle, implementing it in earnest.[85] One downside of the generally perceived successful regulation is the issue of incompatibility with other EU legislation. For example, the administrative burden on operators to register chemicals can cause difficulties with proximate regulatory regimes adopting different strategies for reaching their aims. An example is the relationship of REACH and EU waste regulation. 'Waste', as defined in the Waste Framework Directive,[86] has been deliberately left out of REACH's scope. The concept of waste has been the object of intense legal debate, and the conceptual and legal challenges are reflected in the REACH regime: whether an object is defined as waste or not is decisive on whether the registration obligation exists.[87] Another concern in the original REACH was its approach to nanomaterials, which are increasing in usage, but which REACH was not equipped to address as rigorously as one might have anticipated. The root cause was that REACH did not define nanomaterials as materials in their own right. Due to their innate features, the nanomaterials did not fall into the scope of registered materials, leaving their chemical safety unassessed.[88] The deficiency was corrected only recently, when nano-specific provisions were added to the annexes.[89] Another frailty in REACH is that it is only one tool in regulating complex chemical mixtures, targeting only intentional mixtures (such as products that are produced for markets). Even more challenging regulatory targets are unintentional mixtures (such as those formed unintentionally during the production process), which are regulated mainly by environmental legislation that chiefly focuses on broader considerations, resulting in scattered and uneven regulation.[90]

Furthermore, a major downside in REACH is that the precautionary principle does not apply throughout all the phases. After the registration and evaluation phase, it is still possible for a harmful substance to enter the market.[91] In the *authorisation* phase, REACH begins to mirror the US chemical regulatory system (returned to immediately next). Authorisation can be granted for a chemical if the applicant demonstrates adequate control of risks; however,

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[85] The praise for REACH has been balanced by analyses explaining how not all characteristics of precaution are equally present in the instrument – alternatives assessment is lacking, for example: Steffen Foss Hansen et al, 'Chemicals Regulation and Precaution: Does REACH Really Incorporate the Precautionary Principle?' (2007) 10(5) Environmental Science & Policy 395, 399–401.

[86] Directive 2008/98/EC of 19 November 2008 on Waste and Repealing Certain Directives, [2008] OJ L312/3 (WFD).

[87] Joonas Alaranta and Topi Turunen, 'Drawing a Line between European Waste and Chemicals Regulation' (2017) 26(2) Review of European, Comparative and International Environmental Law 163, 164, 171–72.

[88] Christian Calliess and Heidi Stockhaus, 'Precautionary Principle and Nanomaterials: REACH Revisited' (2012) 9(2) Journal for European Environmental and Planning Law 113, 133–34.

[89] At the time of writing, the amendment was due to come into force in 2020: European Commission, Commission Regulation (EU) 2018/1881 of 3 December 2018 amending Regulation (EC) No 1907/2006 of the European Parliament and of the Council on the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) as regards Annexes I, III, VI, VII, VIII, IX, X, XI and XII to address nanoforms of substances. L308, 1–20 (Official Journal of the EU, 2018). The legal reality around nanomaterials is diverse, to say the least; the challenges of the European regulative process are analysed in Martin Miernicki et al, 'Legal and Practical Challenges in Classifying Nanomaterials according to Regulatory Definitions' (2019) 14(3) Nature Nanotechnology 208.

[90] Aude Kienzler et al, 'Assessment of Mixtures – Review of Regulatory Requirements and Guidance' (Joint Research Centre Science and Policy Report, Publications Office of the European Union) 123, 143.

[91] REACH arts 60(2)–60(4).

if such control does not exist, authorisation can nonetheless be granted if a substitute for the chemical does not exist and the benefits of using the chemical outweigh the risks.[92] Even REACH is susceptible to market forces and vested interests when it comes to weighing environmental costs against economic benefits.[93] Moreover, there is still a long way to go, as the chemicals registration phase only ended in 2018 and there are countless chemicals to evaluate and perhaps authorise.[94] But even with its weaknesses, REACH has already had significant impact on chemical governance around the globe.

4.2 REACH's Inter-jurisdictional Impacts

Importantly, the gains of REACH do not stop at the border of the EU. REACH was anticipated to have, and has had, inter-jurisdictional impacts across the globe.[95] Even though REACH is still less than 20 years old, it has influenced not only the US, but also countries such as China, Turkey, Japan, Taiwan, New Zealand and South Korea.[96] We make an example of one of these, and look at REACH's influence on the developments of another major chemical producer's regulatory system, in the US Toxic Substances Control Act of 1976 (TSCA).[97] The differences between the US and the EU regulatory systems are stark: the TSCA does not oblige the industry to be aware of its data and risks, being significantly less ambitious than REACH. After prolonged debate, in 2016, bipartisan legislation – albeit not progressive enough for many environmental groups – was finally passed to revise the original act.[98] The revision empowers the Environmental Protection Agency (EPA) to review existing toxic chemicals in the inventory, to evaluate the substances for risk within three-and-a-half years, to obtain testing data from manufacturers more easily and to charge companies for testing they request the EPA to conduct.[99] However, the burden still remains with the EPA to prove the toxic chemical poses an 'unreasonable risk' to human health or the environment.[100]

Though respective legal cultures play a significant role in shaping the regulation of risk,[101] at the regulatory level REACH and TSCA also share a number of common features. In Applegate's analysis, the similarities are listed as: both having goals in environmental and

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92 Fisher (n 25) 544–45.

93 Gerwin Schaafsma et al, 'REACH, Non-testing Approaches and the Urgent Need for a Change in Mind Set' (2009) 53(1) Regulatory Toxicology and Pharmacology 70; Persson (n 67) 223–38.

94 Coria (n 32) 342.

95 Fisher (n 25) 541.

96 Silbergeld et al (n 75); Heyvaert (n 66) 229; Lucas Bergkamp and Mike Pennan, 'Introduction' in Lucas Bergkamp (ed), *The European Union REACH Regulation for Chemicals: Law and Practice* (Oxford University Press 2013) 1, 11; see also Daniel Uyesato et al, 'REACH's Impact in the Rest of the World', at 335–73 in the same volume.

97 John S Applegate, 'Synthesizing TSCA and REACH: Practical Principles for Chemical Regulation Reform' (2008) 35 Ecology Law Quarterly 721, 746.

98 Namely, the Frank R Lautenberg Chemical Safety for the 21st Century Act: Valerie J Watnick, 'The Lautenberg Chemical Safety Act of 2016: Cancer, Industry Pressure, and a Proactive Approach' (2019) 43 Harvard Environmental Law Review 373.

99 The Frank R Lautenberg Chemical Safety for the 21st Century Act, EPA (codified at 15 USC §§2601–2629 (2017)) [hereinafter, 'FLCS'] at at 15 USCA §§2604(a)(3)(A), 2604(e)–(f).

100 Ibid at 15 USCA §§2604(a)(3), (c).

101 Fisher (n 25) 542; Fisher (n 19) 290, 39, 44, 46. Ultimately adopting this stance of contingency leads to an anti-foundationalist approach: Eloise Scotford, *Environmental Principles and the Evolution of Environmental Law* (Hart Publishing 2017) 272, 273.

economic health; both focusing on regulating the chemicals themselves (instead of their presence in the environment); and both drawing on prevention, though in REACH it is in a more protective and anticipatory form.[102] Also, both are concerned with the scientific uncertainties prevalent in chemicals, resulting in emphasising probabilistic risk and the inevitable judgment calls based on such determinations.[103] Though REACH is still more rigorous in many ways at a regulatory level, it is ironic – or perhaps not – that in the US common law approach to compensation for industry's errors are more punitive than in the EU system: a system invariably premised upon harm done rather than on stopping perceived harm before it occurs.[104] Vogel once compared the earlier start of toxic chemical regulation in the US to a hare, as compared with the slower tortoise of EU policy; however, as with the hare in the allegory, the initial fast start of TSCA has proven to have little global influence.[105] REACH's inter-jurisdictional impact has, however, been significant. We continue to draw conclusions from it for governing the global chemical pollution planetary boundary in what immediately follows.

5. TOWARDS A GLOBAL CHEMICAL POLLUTION PLANETARY BOUNDARY

One of the principal purposes of the planetary boundaries framework is to guide humanity away from the destruction of the Earth system. Scholars have theorised as to the increased difficulty in sustaining life on Earth should humanity ignore the planetary boundaries and dangerously exceed liveable limits. Global chemical regulation plays a significant role in every single sphere of the planetary boundaries: freshwater use, biochemical flows, ocean acidification, atmospheric aerosol loading, stratospheric ozone depletion, novel entities, climate change, biosphere integrity, and land-system change. Nevertheless, the current preference for consumption to prompt further economic growth, for regulation to be insufficiently prescriptive (or proscriptive), and for regulators to struggle to hold corporations fully accountable has grossly undermined the overall efficiency of most regulatory schemes.[106] At a transnational level of regulation, only REACH has shown the potential for breaking this pattern, though even here there are limitations in what has been achieved. International chemicals law has potential, but its success remains aspirational rather than proved.

As Kim and Kotzé rightfully point out elsewhere in this book, 'the planetary boundaries framework describes the problem, but it offers little as far as solutions are concerned'.[107] When combined with Schwarzman and Wilson's notion that 'the lack of well-functioning chemicals

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[102] Applegate (n 97) at 753–56.

[103] Ibid 756–59. The common ground establishes the suggested way forward for the TSCA: ibid 761–7.

[104] Ágnes Botos, John D Graham and Zoltán Illés, 'Industrial Chemical Regulation in the European Union and the United States: A Comparison of REACH and the Amended TSCA' (2019) 22(10) Journal of Risk Research 1187, 1187.

[105] David Vogel, 'The Hare and the Tortoise Revisited: The New Politics of Consumer and Environmental Regulation in Europe' (2003) 33(4) British Journal of Political Science 557.

[106] Anna Grear, 'Towards "Climate Justice"? A Critical Reflection on Legal Subjectivity and Climate Injustice: Warning Signals, Patterned Hierarchies, Directions for Future Law and Policy' (2014) 5 Journal of Human Rights and the Environment 103, 119ff.

[107] See Kim and Kotzé, Chapter 3 in this book.

policies worldwide has contributed to extensive ecosystem contamination by anthropogenic chemicals',[108] the present point of departure for the governance of the chemical pollution planetary boundary is not auspicious. In particular, we take from this bleak, yet still pertinent, second quote that the policy – and, we would add, legal – framework around chemicals remains both normatively inadequate (in its poor 'functioning') and ineffective (it results in continued 'contamination'). Thus, the need for a more robust global law and governance system to ensure a safe operating space, so as not to breach the chemical pollution planetary boundary, is undeniably pressing. What can we learn from international and transnational chemical governance as we seek this goal?

We begin from what is already functioning (reasonably) well. Due to the so-called 'Brussels Effect', REACH's success in addressing chemical pollution might have more to say at the global level than one might first assume.[109] The Brussels Effect is a legal construct developed by Anu Bradford, and it details that the EU's market capacity and regulatory authority are sufficient to economically incentivise non-EU entities to adhere to the stricter EU regulation.[110] Without the need for any form of additional international regulation or institutions, the stricter European standards become the global norm because in this way, a company need only adhere to one set of standards rather than each standard for each different market in which that company operates. The chemical exporters, finding it too costly to alter their product for each different market, view it as economically wiser to follow the stricter standard in all their activities and all exports. Moving all production to 'REACH-compatible' mode is a form of non-divisibility of standards, allowing businesses to maintain economies of scale in their production.[111] The economics of scale pertinent in global chemical production make it more susceptible to the Brussels Effect. In the case of global chemical regulation, the impact would seem to be not a race to the bottom, but perhaps more positively a global following of the stricter existing regulatory framework, as REACH influences behaviour outside of the EU's territorial borders.[112]

The success the EU fashioned in REACH turns our thoughts more closely to the role of corporations in the governance of this planetary boundary. As Sjåfell and others have long pointed out, redefining the role of corporations is essential for effective and just sustainability efforts.[113] And REACH demonstrates that such a stance is even more apparent in the chemical pollution boundary. By imposing the burden of proof (of safety) on private corporations,

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[108] Schwarzman and Wilson (n 24) 1065.

[109] Anu Bradford, 'Exporting Standards: The Externalization of the EU's Regulatory Power via Markets' (2015) 42 International Review of Law and Economics 158, 163–65; Anu Bradford, 'The Brussels Effect' (2012) 107 Northwestern University Law Review 1; Anu Bradford, *The Brussels Effect: How the European Union Rules the World* (Oxford University Press 2020) 403, 1–2.

[110] Bradford, *The Brussels Effect: How the European Union Rules the World* (n 109) 1–2.

[111] Bradford, 'Exporting Standards' (n 109) 163.

[112] Ibid 163; David Vogel, *The Politics of Precaution: Regulating Health, Safety, and Environmental Risks in Europe and the United States* (Princeton University Press 2012) 217.

[113] Beate Sjåfjell, 'Redefining the Corporation for a Sustainable New Economy' (2018) 45 Journal of Law and Society 29; Beate Sjåfjell and Christopher M Burner, 'Corporations and Sustainability' in Beate Sjåfjell and Christopher M Bruner (eds) *The Cambridge Handbook of Corporate Law, Corporate Governance and Sustainability* (Cambridge University Press 2019) 3–12; Gail Whiteman, Brian Walker and Paolo Perego, 'Planetary Boundaries: Ecological Foundations for Corporate Sustainability' (2013) 50 Journal of Management Studies 307; Carl Folke et al, 'Transnational Corporations and the Challenge of Biosphere Stewardship' (2019) 3 Nature Ecology and Evolution 1396.

these corporations are incentivised with a strong economic and normative burden to comply. The logical next question would be how to gain the same results in regions without a strong transnational entity such as the EU. REACH has not only inter-jurisdictional influence – as we saw in the case of the US legislative developments – but also positive impact on the behaviour of private corporations, regardless of their location. Concerning the globalisation of REACH itself, we concur with Heyvaert, who has argued against any attempts to transpose REACH to the international level. REACH relies on strong management and administration – incorporating it into an international setting could severely hamper its success.[114]

Since REACH's influence has been gained without establishing any new international institutions or conventions, it might be thought that it will be unnecessary to strengthen its role by adding an international layer. REACH has made transnational governance pivotal, and as such offers interesting views on the general discussion regarding devolving the governance of planetary boundaries: REACH is a 'living and breathing' example of achieving global results through non-global means. Nonetheless, we find REACH to be only a partial solution to the question of chemical pollution boundary governance.[115] As we noted above, plurality and fragmentation are inherent to international chemical law and policy, and that being so is not necessarily a weakness.[116] We find it inadvisable to strive for a stronger, centralised international institution governing the boundary,[117] but are instead inclined to promulgate the ideas of polycentric governance[118] and enhanced international collaboration. In our understanding, polycentric governance can also help develop the general notion of an ecological *Grundnorm*:[119] various actors at multiple levels can trace their authorities directly back to it, keeping both the dynamically shifting relations and normative validity.[120]

We do so primarily because one cannot over-emphasise the biophysical complexity of chemical pollution. We note once again the reality that scientific colleagues still have not

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114 Heyvaert (n 66) 233ff.

115 Md Sarwar Hossain and Chinwe Ifejika Speranza, 'Challenges and Opportunities for Operationalizing the Safe and Just Operating Space Concept at Regional Scale' (2020) 27 International Journal of Sustainable Development and World Ecology 40; Gregory S Cooper and John A Dearing, 'Modelling Future Safe and Just Operating Spaces in Regional Social-Ecological Systems' (2019) 651 Science of the Total Environment 2105.

116 Zelli and Van Asselt (n 56) 3–4.

117 For a summary of the discourses to this end, see Kim and Kotzé, Chapter 3 in this book.

118 Elinor Ostrom, 'Polycentric Systems for Coping with Collective Action and Global Environmental Change' (2010) 20 Global Environmental Change 550; Victor Galaz et al, 'Polycentric Systems and Interacting Planetary Boundaries: Emerging Governance of Climate Change – Ocean Acidification – Marine Biodiversity' (2012) 81 Ecological Economics 21; also Louis J Kotzé and Duncan French, 'A Critique of the Global Pact for the Environment: A Stillborn Initiative or the Foundation for Lex Anthropocenae?' (2018) 18 International Environmental Agreements: Politics, Law and Economics 811.

119 Rakhyun E Kim and Klaus Bosselmann, 'Operationalizing Sustainable Development: Ecological Integrity as a Grundnorm of International Law' (2015) 24 Review of European, Comparative and International Environmental Law 194. See also Piselli and Van Asselt, Chapter 7 in this book, on the issue of regime interaction that will inevitably arise in this context.

120 As Widłak argues, 'the Kelsenian toolkit is not destined to build any figuratively 'pyramidal' or predetermined hierarchical legal system. On the contrary, it enables comprehending a polycentric system as it stands – diverse and specialised, but connected, and therefore, responsive rather than systematically 'stratified' or otherwise stalled' in Tomasz Widłak, 'Polycentric vs. Fragmented: A Neo-Kelsenian Order of Global Law' (2019) 10(2) Transnational Legal Theory 229, 250.

been able to establish a single planetary boundary for chemical pollution and novel entities.[121] The fragmented and piecemeal existing nature of international law also reflects this scientific reality, as do the insights sourced from regulating the chemical risk in general: chemicals are a notoriously controversial field to regulate, which both explains and justifies the contingency of existing regulatory approaches.[122] In the case of regulating chemicals as a planetary boundary, fragmentation might not only have to be accepted, but it might have to be cultivated over time to ensure the achievement of a positive, yet realistic, approach to regulation. With closer collaboration, the 'safe policy space' can eventually be established[123] – most likely not at once but in an iterative fashion – both embracing the responsivity and flexibility of polycentric governance and reflecting the realities of gradually increasing knowledge on chemical pollution.[124] Coordinating the existing regimes is one way forward but in the case of chemicals, one must bear in mind that which we do not know, as well as what we do. Information sharing – usually part of collaborative action – does not help if information does not exist.[125]

A strong role for REACH in governing the present chemical regulation regime, however, invariably brings us to a discussion of the ethics and equity of the planetary boundaries.[126] Northern bias is an established reality of the planetary boundaries and offering a EU-originated approach as a prime solution only re-establishes and strengthens this bias; it is hardly a globally democratic solution.[127] Moreover, when setting up REACH, the EU Member States limited their decision-making powers in favour of European-level and private data gathering and assessment.[128] We acknowledge this, but would like to add a nuance of responsibility to our findings and suggestions: the global north is responsible for the Earth's current situation with chemical pollution. In REACH we have an example of not just precautionary action, but also taking responsibility as one of the major contributors to the chemical pollution problem. What might make REACH more palatable is the establishment of a significantly endowed solidarity fund for the industries of the global south to support compliance. This may still not appear to be a long-term solution, and we would wish to avoid European hegemony; but with the urgency of the planetary boundaries, we either start from where we are, or we look elsewhere in a utopian fashion. Nevertheless, such regimes must recognise the innate inequity in the present global economic and political structure, and address the current lack of substantive solidarity towards, especially, the global south. It may not be REACH; it may be something else. But from a normative perspective – and this is what this chapter has sought to highlight – even when confronted with a *global* challenge, this should not immediately prompt a singular *global* scheme. What chemical pollution suggests is the possibility – nay, the desirability – of

[121] See n 13.
[122] Fisher (n 25).
[123] Lauriane Mouysset et al, 'Operationalizing Sustainability as a Safe Policy Space' (2018) 10 Sustainability 3682; Paulo Magalhães et al (eds), *The Safe Operating Space Treaty: A New Approach to Managing Our Use of the Earth System* (Cambridge Scholars 2016).
[124] Widłak (n 120) 249.
[125] Ebbesson (n 65); Zelli and Van Asselt (n 56); Galaz et al (n 118).
[126] See also Adelman, Chapter 4 in this book.
[127] Kim and Kotzé, Chapter 3 in this book; Tiina Häyhä et al, 'From Planetary Boundaries to National Fair Shares of the Global Safe Operating Space: How Can the Scales be Bridged?' (2016) 40 Global Environmental Change 60.
[128] Heyvaert (n 66) 226.

a more intelligent design combining multiple actors, especially private ones, and various layers of governance.

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Note: Throughout the index, the abbreviation IEL is used to refer to international environmental law.