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 consensus⁶ that the current trajectory of human development is ultimately unsustainable:

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

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.

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

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

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

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.

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 BOUNDARIES³⁹

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 compli-

ance, 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 (CO₂) 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 CO₂ 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 pursue⁴¹ 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

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.