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Reimagining international environmental law for the Anthropocene: An earth system law perspective

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ABSTRACT

Concerns have been raised regarding the ability of international environmental law to respond to potentially irreversible earth system transformations in the Anthropocene. We argue that in order for international environmental law to have the capacity to respond to the socio-ecological challenges of the Anthropocene, it should embrace an earth system perspective. Earth system law, which is grounded in an earth system perspective, has been proposed as a new epistemic framework to facilitate the legal transformations necessary to respond to such socio-ecological challenges. With reference to recent developments in the international environmental law domain, we discuss the ways in which international environmental law currently fails to align with such a perspective and the types of considerations that international environmental law *should* reflect in order to be more responsive to a transforming earth system and, thus, better fit-for-purpose in the Anthropocene.

1. Introduction

In response to concerns that law generally and international environmental law (IEL) in particular have become incapable of responding to complex socio-ecological challenges in the Anthropocene (see, among others, Garver, 2019; Kim and Bosselmann, 2013; Kotzé and Kim, 2019; Kotzé and Kim, 2020), earth system law has recently been proposed as a new epistemic framework to critically rethink the existing Holocene-based collection of legal arrangements related to environmental protection (notably those in the area of IEL (Kotzé and Kim, 2019)). Earth system law is defined as

> an innovative legal imaginary that is rooted in the Anthropocene's planetary context and its perceived socio-ecological challenges. Earth system law is aligned with, and responsive to, the Earth system's functional, spatial, and temporal complexities; and the multiple Earth system science and social science-based governance challenges arising from a no-analogue state in which the Earth system currently operates (Kotzé and Kim, 2020, p. 464; see also Kotzé et al., 2022)

The purpose of earth system law is to align IEL (as an episteme, practice and discipline) with an earth system perspective, or with the understanding of the Earth as a complex system, consisting of interconnected and interacting components, which have the potential to transform in abrupt, nonlinear and irreversible ways (Steffen et al., 2018). In short, IEL must be compatible with an earth system perspective if it is to have the capacity to respond to a continuously transforming earth system (see, e.g., Kotzé, 2020). Earth system law is thus concerned with discarding assumptions of one-dimensional Holocene-nested linearity, predictability, simplicity and harmony on which much of IEL still rests. It instead offers a framework to embrace an alternative understanding of the role and contribution of IEL in governing complex, non-linear, interconnected, multi-scalar and unpredictable earth system governance challenges that arise in the Anthropocene. The epistemic project of earth system law is therefore essentially concerned with crafting "international environmental law 2.0" (Kim, 2021, p. 3) or, in even broader terms, *Lex Anthropocenae* (Kotzé and French, 2018).

While interest in the earth system law research agenda is growing (Ahlström et al., 2021; Cardesa-Salzman and Cocciolo, 2019; Du Toit et al., 2021; Gellers, 2021; Kim et al., 2022; Kotzé et al., 2022; Kumar, 2020; Mai and Boulot, 2021; Petersmann, 2021; Pope et al., 2021; Van Asselt, 2021; Van Dijk, 2021), some questions remain about the earth system law framework, including, for example, the extent to which it offers an alternative to IEL; whether it will be able to garner sufficient support to unite epistemic travellers in the same way that the earth system governance research project has managed to do (Burch et al.,

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2019; Kotzé et al., 2022); and more importantly for present purposes, what added scientific, practical and other value it might offer beyond its nascent conceptual claims, if any at all. In this article, we focus on the last issue and attempt to reveal the practical value of earth system law by using it as a lens through which to reimagine IEL as part of an effort to make IEL more fit-for-purpose in the Anthropocene.

The discussion first explores the notion of earth system law. With reference to Kotzé and Kim (2019), it then discusses perceived deficiencies that currently hinder IEL's ability to meaningfully respond to earth system challenges. In order to address these deficiencies, and as counterpoints, we propose five characteristics that we believe ought to be reflected in IEL if it is to have the capacity to respond to earth system governance challenges. These include that IEL should ideally: be normatively ambitious; embrace polycentrism; be based on alternative onto-epistemologies of care; be sensitive to Anthropocene complexity; and embrace a more holistic earth system focus. With reference to relevant multilateral environmental agreements (MEAs) throughout, we furthermore set out various considerations that could inform their operationalization. Ours is only a first step in pursuit of more elaborate studies concerned with further revealing the practical relevance of earth system law, including by contributing to the strengthening of IEL regimes, which we hope will be embarked on in future.

2. Earth system law

Earth system law seems to mean different things to different scholars. For some it is a new body of law, a new legal typology of sorts (Cadman et al., 2021); while for others earth system law instead offers an epistemic framework or vision/imaginary of what law, in its broadest sense, could become for the purpose of facilitating the legal aspects of earth system governance in the Anthropocene (Kotzé and Kim, 2019, 2020). We align ourselves with the majority view that understands earth system law as a framework to reimagine the law through an earth system lens that also has the potential to explore new legal frontiers in the Anthropocene (see also Biermann, 2021). To this end, earth system law is about exploring the plurality of ways in which the earth system perspective could inspire the transformation of IEL and of social behaviour in the context of the Anthropocene's transformed and transforming earth system. Earth system law therefore offers an analytical framework to better understand and respond to the legal dimensions of earth system governance; the normative foundations to govern the full spectrum of earth system relationships in a way that promotes planetary integrity and justice in their fullest sense; and the legal means to facilitate transformative earth system governance for long-term sustainability (Kotzé and Kim, 2020, p. 464).

The article that first introduced earth system law briefly highlighted five issues that are seen to hamper the ability of IEL to respond to complex earth system governance challenges (Kotzé and Kim, 2019). These were noted as key concerns that the earth system law framework will have to address and include: IEL's lack of normative ambition; its state-centrism; its anthropocentrism; its assumptions of Holocene stability, predictability and simplicity; and, relatedly, its one dimensional focus on the "environment" instead of a more holistic focus on the earth system as its regulatory object. We revisit and discuss each of these below in the light of the ever-maturing discourse on earth system law, and in the light of the most recent developments in the field of IEL.

2.1. *Normatively unambitious*

While normative ambition could relate, *inter alia*, to the legal character of IEL norms (their bindingness), the geographical reach of IEL, or the parties to which IEL applies (Kotzé, 2019), the focus here is on the substance of IEL norms. We support the emerging concern that, with few exceptions, the substantive norms of IEL, including those that shape its objectives, are not sufficiently ambitious to limit human behaviour in a way that could safeguard planetary integrity (French and Kotzé, 2019). Admittedly, much of IEL's failures also have to do with lack of implementation, lack of political will, and structurally vested neoliberal pro-growth corporate interests. After all, possibly because law is also a result of political processes, IEL is often a set of political compromises to ensure, as far as possible, that multiple political, societal, economic and environmental interests are accommodated. IEL therefore inevitably seems to chase the lowest common denominator that is shaped by political and economic interest (Tarlock, 1992). That being said, and while some correctly point to the "increasing maturity in the content of IEL, both customary and treaty law" (Rajamani and Peel, 2021, p. 14), it is hard to ignore the fact that IEL remains unable to achieve deep structural reforms because it lacks normative ambition at a time when precisely as high as possible a level of such ambition is urgently required.

For example, scientists have revealed that we have crossed four out of nine planetary boundaries (Rockström et al., 2009a; Rockström et al., 2009b), including climate change, which has been identified as one of two "core" planetary boundaries, "based on [its] fundamental importance for the [earth system]" (Steffen et al., 2015, p. 736). The relevance of the planetary boundary approach for law is that

> effective environmental legislation must at a minimum act as legal boundaries that prevent human activities from reaching and breaching planetary boundaries, defined as the safe space for mankind to operate within … In other words, legal boundaries must translate the physical reality of a finite world into law and thereby delimit acceptable levels of human activity (Chapron et al., 2017, p. 1).

Although international climate law is only one part of the larger global climate governance regime, its unambitious temperature targets are not commensurate with the severity of the deepening climate crisis. The lacklustre commitments of states under the Paris Agreement are projected to be wholly insufficient to hold the global average temperature increase to well below 2 °C (IPCC, 2021; SEI et al., 2021), let alone to limit the global temperature increase to just 1.5 °C above pre-industrial levels (IPCC, 2018, p. SPM-18). Recent research suggests that there is a 40 per cent chance that the global average temperature will be 1.5 °C above pre-industrial levels in at least one of the next five years, "and the chance is increasing with time" (WMO, 2021, p. 2). In other words, the current legal boundaries of the international climate law regime are not commensurate with the challenge of ensuring that the climate change planetary boundary is not transgressed, and the current targets necessary to give effect to ambitious climate laws will not set us on a path to protecting the integrity of the climate system.

Worryingly, the official non-binding and watered-down outcome of the United Nations Climate Change Conference held in Glasgow (COP26) – including a last minute decision to call for the "phase down" rather than "phase out" of unabated coal power in the Glasgow Climate Pact (UNFCCC, 2021; see also Masood and Tollefson, 2021) – suggests that many states still do not seem to appreciate the need for adopting ambitious climate laws that are in fact sufficient to effectively respond to the deepening climate crisis. In addition, while parties presented scaled-up targets at COP26, on the basis of targets for 2030 as well as current policies, global temperature increases of well in excess of 2 °C are nevertheless projected (Climate Action Tracker, 2021). Courts around the world have recently been stepping forward in an effort to, among others, expose this lack of normative ambition, significantly increase the level of ambition required, and force governments and corporations to take more urgent and drastic action to address the climate crisis (BVerfG, Beschluss des Ersten Senats vom 24 März 2021; De Staat der Nederlanden tegen Stichting Urgenda; Vereniging Milieudefensie et al. tegen Royal Dutch Shell Plc; see also Kotzé, forthcoming).

While this is an important step in the right direction, more comprehensive structural reforms of IEL across the board that are deliberately driven by states will also be necessary. Regrettably, recent initiatives to reform IEL remain disappointingly unambitious and merely

reinforce the status quo ante of IEL's path-dependent norms. For example, the proposed Global Pact for the Environment, on which considerable hopes have been pinned, has been criticized on several fronts for its lack of normative ambition and its inability to radically transform the predatory neoliberal world order in which unrestrained socio-economic development continues without limits, regardless of planetary limits and widespread injustices (Biniaz, 2019; Kotzé and French, 2018).

2.2. State-centrism

IEL is still considered to be predominantly state-centric, especially insofar as it mostly revolves, like the broader corpus of international law from which it derives, on the state as the prevailing "pre-eminent international legal person" (Sands and Peel, 2018, p. 53), and state apparatus and inter-governmental processes for its creation, legitimacy, amendment and enforcement (Tarlock, 1992). In other words, states still remain, formally at least, the principal architects, agents and actors of IEL. IEL has admittedly over the years managed to gradually open up to other understandings of legal subjectivity, authority, legitimacy, participation and even law-making and enforcement, which means that states' role in IEL is increasingly seen as steering instead of rowing (Rajamani and Peel, 2021). Yet, any suggestion that the state is losing its central authoritative position in IEL should not be overdrawn: "the increasing autonomy offered to States in more recent multilateral environmental instruments also supports the argument that the State is as powerful and central as before, albeit in a changed context, and with more sophisticated demands placed on it" (Rajamani and Peel, 2021, pp. 26–27).

Its state-centrism means that IEL has, among others, not yet managed to fully embrace the "complex architectures of Earth system governance" (Biermann and Kim, 2020), or "earth system governmentality" (Lövbrand et al., 2009), in a way that would sufficiently enable it to respond to complex, integrated, multi-scalar earth system governance challenges. Earth system governance is "the sum of the formal and informal rule systems and actor-networks at all levels of human society that are set up in order to influence the coevolution of human and natural systems in a way that secures the sustainable development of human society" (Biermann, 2017, p. 329). As a paradigm that recognizes the need for a diverse and plural set of social actors in pursuit of global sustainability, earth system governance is an approach that accommodates ways to govern complex earth system challenges at the earth system or planetary scale of governance. Based as it predominantly is on the state and international legal personhood of the state, IEL has not yet fully embraced such an understanding of diffused agency and dynamic interactions between state and non-state actors in terms of its formal processes.

While there are several practical reasons for the centrality of the state, especially from an international relations and politics point of view (Beyerlin and Marauhn, 2011), such a strong focus on the state could shut out meaningful opportunities for broad-based participation, in processes related to the development and enforcement of IEL, of a much larger range of change agents and other stakeholders, including those most impacted by earth system transformations and associated policy responses (Schroeder, 2010; Dillard et al., 2008). This, in turn, raises concerns revolving on global democracy, representation and legitimacy, with the possibility that the potential for deliberative earth system governance is minimized. This could happen where: non-state actors are not fully able to benefit from and contribute to a free and broadly defined public space where a diversity of viewpoints and discourses can interact; an empowered space does not exist where authoritative collective decisions are produced and where the public space influences the empowered space through cultural exchanges; measures are absent to hold the empowered space accountable; meta-deliberation is made impossible; and democratic deliberation is not consequential, authentic and inclusive (Dryzek and Stevenson, 2011).

One example is the lost opportunity for more meaningful civil society participation during COP26 in Glasgow. Despite well-meaning intentions that COP26 would "be the most inclusive COP ever" (Sharma, 2021), civil society representatives and those directly impacted by climate change were allowed extremely limited access to decision-making spaces (CIEL, 2021; Masood and Tollefson, 2021), which was in sharp contrast to the access gained by lobbyists for the fossil fuel industry (Hughes et al., 2021). The inevitable result is the disappointingly unambitious future trajectory of global climate law and governance that states have agreed on in Glasgow, which stands in direct contrast to the much more ambitious action demanded by civil society stakeholders before, during and after COP26 (Hales and Mackey, 2021).

2.3. Anthropocentric epistemologies of mastery and exploitation

IEL is seen to be predominantly aimed at promoting human interests, health and well-being, and is therefore criticized for being too anthropocentric, which effectively shuts out alternative ways of seeing, knowing, being and caring for the entire vulnerable living order (Adelman, 2015). One reason for its structurally entrenched anthropocentrism is that IEL fully embraces, as its foundational directing and ethical fulcrum, the principle of sustainable development which, in its prevailing neoliberal guise, has now been exposed for the predatory, socio-ecologically destructive principle that it is (e.g., Kotzé, 2019). IEL's tendency to privilege (some) humans through its privileging structures of oppression to the detriment of a non-human world, a world that ironically it was designed to protect in the first place, is a significant concern and focus of intense debate among critical legal scholars (e.g., Grear, 2014). For example, instead of incorporating ecological norms that protect human and non-human interests and well-being in the face of the deepening climate crisis, states and some social actors seem more interested in pursuing technological solutions, such as solar geoengineering, which further exposes "the belief in humankind's right to exercise total mastery over nature" (Hamilton, 2014, p. 24). There have been strong calls against the "normalization" of research into solar geoengineering technologies (Biermann et al., forthcoming), not least due to concerns over justice (Hamilton, 2014).

Equally worrying, not even the recent proposal to include "ecocide" as a crime in the Rome Statute of the International Criminal Court (ICC) has managed to break free from IEL's debilitating shackles of anthropocentrism. In draft form, "ecocide" is defined by a panel of experts as "unlawful or wanton acts committed with knowledge that there is a substantial likelihood of severe and either widespread or long-term damage to the environment being caused by those acts" (Stop Ecocide Foundation, 2021). "Wanton" is defined as "reckless disregard for damage which would be clearly excessive in relation to the *social and economic benefits anticipated*"; while "severe" includes "damage which involves very serious adverse changes, disruption or harm to any element of the environment, including grave impacts on *human life or natural, cultural or economic resources*" (Stop Ecocide Foundation, 2021; own emphasis). There are high hopes that this new definition of ecocide will be accepted by the ICC and included in its Rome Statute, which would enable the prosecution of ecocide in the ICC, alongside genocide, war crimes, crimes against humanity, and the crime of aggression. However, some commentators are sceptical (e.g., Ambos, 2021), not least because of the definition's continued reliance on some of IEL's sacred anthropocentric terms that regard the environment as a "resource" and promote socio-economic development, while doing little to safeguard planetary integrity. If ever there was an opportunity for international legal norms to explicitly embrace ecocentrism, then this is it; however, there is a very real chance that this opportunity will be lost, unless the ongoing efforts to adopt ecocide pursue a radically different direction. Moreover, while the recent recognition by the UN Human Rights Council of the "human right to a safe, clean and sustainable environment" (United Nations General Assembly, 2021) is significant

and could have important benefits for people and nature (Savaresi, 2021), it also remains human-centred, with no attempt by states to recognize, for example, rights of nature in IEL or, at least, the explicit need to safeguard ecological foundations as a prerequisite for the enjoyment of all other human rights.

2.4. Holocene stability, predictability and harmony

A major concern about IEL is that it is seen to rest on assumptions of Holocene stability, predictability and harmony (Garmestani et al., 2019). Evidence, however, now suggests that we have entered the post-Holocene epoch of the Anthropocene, which is anything but stable, harmonious and predictable (Crutzen, 2002; Crutzen and Stoermer, 2000; Steffen et al., 2007, 2018). The Anthropocene trope illuminates the severe instability and unpredictability or, in short, the complexity, that must increasingly be recognized and embraced by regulatory institutions, including law, to steer human behaviour in such a way as to ensure the continuation of life on Earth. This "planetary regime shift" implies that IEL's prevailing Holocene assumptions are unsuitable to confront Anthropocene realities; any "starting point for reimagining international environmental law [must be] that the Anthropocene signifies the start of an entirely new, no-analogue state of the Earth System, one that is fundamentally different from the Holocene" (Kim, 2021, p. 4; see also Fox, 2007; Ruhl, 2011). IEL cannot therefore continue to try to allow humans to "live in harmony with nature" (UNEP, 2019), or "maintain global environmental change within the Holocene envelope of natural variability" (Kim, 2021, p. 5), simply because such a pristine, harmonious nature does not exist anymore.

2.5. Reductionist "environmental" focus

Related to the foregoing concern, IEL has been described as being reductionist; a description which critically reflects on its tendency to focus on a one-dimensional "environment" that consists of separate, unconnected parts in distinct geographical locations as its regulatory object, instead of more fully embracing the earth system as its regulatory object (Kotzé, 2020). The problem is, as Ruhl (1997, p. 940) says, that "we have not designed our environmental law system with this underlying [complex adaptive system] property in mind. Rather, [IEL] is mired in a reductionist, linear, predictivist mentality ignorant of underlying complex system behaviors." In other words, IEL does not yet embrace a planetary systems perspective despite clear and obvious reasons emanating from, for example, earth system science and frameworks such as the planetary boundaries that it should do so sooner rather than later (French and Kotzé, 2021). New sustainability governance paradigms such as the planetary boundaries framework are grounded in a planetary perspective and are provoking a major shift in how we perceive and understand human impacts on planet Earth. This shift has scaled up and redirected our attention away from a localized "environmental" context to a planetary context, as it were. As Biermann (2020, p. 64) says,

> … more recent [system] perspectives emphasize instead the complete integration of human and non-human agency in complex socio-ecological systems, from local scales – such as forests or water bodies – up to regional scales, such as the Alpine region, and the entire earth system. A socio-ecological system perspective breaks down conceptual barriers between humans and their "surroundings" and integrates them in a complex understanding where agency is diffuse, interactions are dynamic, and boundaries become blurred.

Some of the results of IEL's reductionist focus include that it emphasizes the untenable separation of humans and "nature"; a concern that is also related to the issue of anthropocentrism raised above. Recent research revealing the evolution of "tuskless" elephants in response to heavy poaching (Campbell-Staton et al., 2021) emphasizes the extent of humanity's impacts on the non-human world and the interrelatedness of human and non-human components but also, more importantly, how non-human beings are evolving to adapt to human domination in order to survive. Our laws in general, and IEL specifically, have not been able to protect elephants, with evolution now running its natural course to allow these non-human animals a chance of survival. In short, IEL's reductionist focus fails to deal with novel challenges of the Anthropocene; and it may risk political marginalization of central concerns of human and non-human survival (Biermann, 2021).

IEL's reductionist focus is also seen quite clearly in the focus of IEL "on environmental issues within defined spatial boundaries … or relating to specific environmental subjects" (Stephens, 2018, p. 124). Indeed, different environmental concerns are dealt with in separate MEAs, with one database noting that more than 1300 such agreements exist (University of Oregon, n.d.). Kim and Bosselmann (2013, p. 286) argue that the result of having so many agreements and accompanying governance institutions "is that international legal responses are fragmented and issue-based according to the objective of individual treaty systems, resulting in differing or even contradictory positions adopted across or within various treaty bodies". Although this enables the development of nuanced and problem-specific responses to diverse environmental challenges (Biniaz, 2017, p. 2), the lack of an integrated approach in IEL between different MEAs, as well as the lack of an overarching unifying goal (or *grundnorm*), has resulted in "problem shifting rather than problem solving" (Kim and Van Asselt, 2016, p. 495). Such an approach represents anything but a holistic earth system-oriented legal response to governing deeply intertwined earth system processes. The earth system perspective instead demands that "the Earth must be viewed as a single dynamic system with multiple intersecting environmental subsystems" (Stephens, 2018, p. 124).

3. An earth system law perspective

The earth system law paradigm encourages and enables a reimagination of IEL in line with a planetary systems perspective, *inter alia*, through "offer[ing] a framework alongside which it should be possible to critique the current deficiencies of environmental law in the Anthropocene … [and] … more clearly reveal, in a systemised way, the regulatory implications of the Earth system metaphor for law generally and for environmental law specifically" (Kotzé, 2020, p. 78).

If the foregoing represent some of the key concerns associated with IEL, we propose that, as counterpoints to these concerns, a reimagined IEL will at least have to embrace five characteristics which lie at the heart of earth system law and its research agenda. Thus, a reimagined IEL will have to: i) provide for the type of ambitious norms that are commensurate with, and that are likely able to address, the severity of the Anthropocene's socio-ecological challenges; ii) fully embrace a polycentric architecture by drawing on multiple soft and hard norms that are made, revised and enforced by a wide range of state and non-state actors ranging from the city governance level, through to the national, regional and international governance levels; iii) be grounded in alternative onto-epistemologies of care that embrace not only human concerns, but also those of the entire living order, including non-human beings; iv) be premised on, as its central point of departure, the idea of Anthropocene complexity; and v) fully embrace a holistic earth system

Table 1
Reimagining IEL through the lens of earth system law.

International environmental law	Earth system law
Normatively unambitious	Normatively ambitious
State-centric	Polycentric
Anthropocentric epistemologies of mastery and exploitation	All-embracing onto-epistemologies of care
Holocene stability, predictability and harmony	Anthropocene complexity
Reductionist "environmental" focus	Holistic earth system focus

as its regulatory object. We summarize these in Table 1.

In this section, and without being prescriptive, we begin to explore the characteristics identified above and think tentatively about what these characteristics might look like in practice through the lens of earth system law. These characteristics, as we shall see, are not necessarily mutually exclusive and they may even overlap. Moreover, these characteristics are possibly also not fully representative, and we acknowledge that there may be others. For example, it is questionable whether IEL sufficiently reflects the latest developments in earth system science (see, e.g., Fernández Fernández and Malwé, 2019) and whether IEL is sufficiently anticipatory (see, e.g., Kim, 2021). In line with the emerging nature of earth system law, the discussion here is therefore exploratory and will benefit from further insights and critique.

3.1. Normatively ambitious

As discussed above, and previously (see, amongst others, Kim, 2021; Kotzé and Kim, 2019), the necessity and urgency of responding to the socio-ecological crisis is not currently reflected in IEL. Indeed, the *Harmony with Nature* report of the United Nations Secretary-General notes that

> [i]t has been recognized that environmental policy no longer addresses the full range of challenges that we face in terms of sustainability, and the same holds true of environmental legislation. Since the 1960s, when the promulgation of environmental legislation began in earnest, and now five decades later, environmental legislation has failed to protect the basic structure and integrity of the Earth's ecosystems (United Nations General Assembly, 2014, para. 57).

As noted above, IEL often results from political compromises. In the climate change context, it has been argued that "consensus means that any agreement here can only aspire to the lowest common denominator amongst us. From our perspective … making decisions based only on the lowest common denominator is beyond irresponsible, it's gravely negligent" (Conrad, 2009, cited in Dryzek and Stevenson, 2011, p.1872). Considering the severity of the socio-ecological crisis, vividly evident through the intensifying global climate crisis and its profoundly uneven world order that is characterized by continuing "forms of eco-violence, economic predation and the unparalleled imposition of precarity on humans and non-humans alike" (Grear, 2020, p. 355), it is rather the case that the highest possible level of normative ambition ought to be reflected in the substance of the norms of IEL.

While some recent IEL developments suggest there is at least an increased recognition by states of the need to strengthen IEL's norms, it is not yet clear whether this is sufficient. Although climate change is an extremely complex challenge, the climate regime has not provided for the elimination of substances that contribute to greenhouse gas emissions (to which increasing scholarly attention is being paid: Burke and Fishel, 2020; Newell and Simms, 2020; Van Asselt, 2021). This is in contrast to the ozone regime which has the (ambitious) "ultimate objective of [the] elimination [of ozone-depleting substances]" (Montreal Protocol, 1987, Preamble). Thus, the specific reference to the "phasedown of unabated coal power" in the 2021 Glasgow Climate Pact (UNFCCC, 2021, para. 36) is significant, and potentially points to increasing ambition in the climate change regime – although it is regrettable that stronger language, such as a call for the "phase out" of unabated coal power, was not included (see 2.1 above). Furthermore, the Glasgow Climate Pact specifically requests Parties to "revisit and strengthen the 2030 targets in their nationally determined contributions as necessary to align with the Paris Agreement temperature goal by the end of 2022" (UNFCCC, 2021, para. 29). This provision is also noteworthy and represents an increase in ambition from the Paris Agreement's comparatively weak and imprecise requirement that Parties' successive nationally determined contributions (NDCs) "represent a progression over time" (art. 3; see also Anonymous, 2021). Whether states will abide by this comparatively stronger, but arguably still insufficient, undertaking remains to be seen.

More broadly, Kim (2016, pp. 405–406) states that "[t]he ultimate purpose of international environmental law should clearly be maintaining and restoring the integrity of Earth's life-support system as a precondition for sustainable development". There have also been calls for the entrenchment of rights for nature (Kotzé and Villavicencio Calzadilla, 2017; Villavicencio Calzadilla and Kotzé, 2018); and the pursuit of "ecological law" (Anker et al., 2021). Particular attention has been paid to the concept of ecological integrity, or "the integrity of Earth's life-support systems", and its establishment as a *grundnorm* of IEL (Kim and Bosselmann, 2015, p. 194). Bridgewater et al. (2015, p. 73) even propose that global ecological integrity should be measured with reference to the planetary boundaries framework. These are examples of the types of norms (or normative approaches at least) that could be included in IEL, with the proviso that neither humanity nor nature should be the "central reference point" (Kotzé and Kim, 2020, p. 465; see also Garver, 2019), and that the focus should be on the entire earth system, and all its living and non-living beings. Such normative ambition has the potential to contribute to developing IEL that is more fit-for-purpose in the Anthropocene (French and Kotzé, 2019; Kotzé, 2019).

Furthermore, the elaborate set of IEL's agreements should substantively give effect to such norms. For instance, while the Paris Agreement recognizes "the importance of ensuring the integrity of all ecosystems" in its Preamble, this concern is not practically given effect to or spelt out in detail in later provisions of the Agreement. Its focus on sustainable development (see, e.g., art. 2 and art. 4) – a principle which has been described as an epistemology of mastery that successfully manages to further entrench the predatory neoliberal world order (Adelman, 2015, p. 22) – is arguably not consistent with ensuring the integrity of all ecosystems. We support the sceptic view that "sustainable development is an ecopolitical project which might be neither sustainable nor developmental … [I]t is a palatable approach to 'green-wrap' the economic and political project of 'sustainable degradation' already now fully in play" (Luke, 2008, p. 1813). Significant progress will therefore be made in pursuit of designing more ambitious norms once IEL rejects the principle of sustainable development as its point of departure and instead embraces alternative onto-epistemologies and more radical forms of ecological law (Kotzé et al., forthcoming).

3.2. Polycentrism

In order to be more responsive to complex earth system governance challenges, IEL must recognize the need for linked, multi-level governance responses to socio-ecological challenges (Ahlström and Cornell, 2018; Krause, 2014; Nilsson and Persson, 2012), possibly so within the context of polycentric governance (Ostrom, 2009). Advocates of polycentric governance underline the benefits of a holistic, participative, multi-level, multi-actor, normatively plural, non-hierarchical approach to governing all aspects of the earth system in an integrated manner; also in a legal context (Cardesa-Salzman and Cocciolo, 2019; Viñuales, 2018).

The move towards increased polycentrism in IEL could significantly increase its potential to drive more deliberative forms of earth system governance. For example, in regard to participation, Folke et al. (2011, p. 729) emphasize that "transparent[] and inclusive decision-making processes that are viewed as legitimate by stakeholders, are a precondition for effective adaptive governance systems to emerge and be sustained over time despite social and ecological uncertainty and surprise". Dryzek and Stevenson (2011, p. 1870) state in the context of the climate regime, that authoritative decisions on climate change "may be considered legitimate to the extent they reflect inclusive and authentic dialogue responsive to the needs of all affected parties". They furthermore highlight that in order to enhance the deliberative democracy

capacity of global climate governance, "special attention will need to be directed to institutionalising opportunities for deliberative accountability" (Dryzek and Stevenson, 2011, p. 1872). This suggests that attention should be paid to enhancing the participation of affected parties in decision-making processes and, more importantly, moving the primary focus of IEL away from the state to also include a much more diverse set of actors responsible for continuously shaping, applying and enforcing IEL.

While this is only a start and much more needs to be done, we already see a gradual move towards polycentrism and decentralisation in IEL, evidenced, for example, by the emergence of bottom-up forms of environmental governance. These trends are occurring as a response to the "gaps exposed in traditional environmental law, together with difficulties in shifting the entrenched positions of sovereign States"; and have "shrunk the space for international enforcement and expanded the scope for domestic law, litigation and courts" (Rajamani and Peel, 2021, p. 27).

3.3. All-embracing onto-epistemologies of care

The gradual emergence of alternative onto-epistemologies of care, humility and vulnerability that are already evident in, for example, the rights of nature paradigm (e.g., O'Donnell, 2021), signals the urgent need for a shift of ontological and epistemological premises to realize IEL's long overdue reimagination in the context of the Anthropocene. In terms of ontological assumptions, IEL's traditional subjects can thus be expanded to a greater range of societal actors to better reflect the entangled being of vulnerable (human and non-human) living and non-living entities present in the earth system (Kotzé et al., 2022).

Gellers (2021, p. 4) argues that the emergence of rights of nature, contained in various national laws, "actively combats inter and intra-generational and inter-species injustices". This, in turn, has significant potential to shape the emerging discourse (and practice) of planetary justice. Planetary justice is concerned with justice at the planetary scale and arises from the need for planetary society-nature integration and the need for non-binary system thinking. It reflects "the intertwined nature of the earth system in the Anthropocene where social and ecological systems have become inseparable and where obligations are owed to nonhuman entities as well" (Biermann and Kalfagianni, 2020, p. 2; see also Baxi, 2016; Kim, 2021). Such an "expanded" view of justice allows one to identify earth system risks that impact equity and justice considerations, such as climate change, that affect all present and future human and non-human beings everywhere, and to consolidate and move towards a deeper understanding of intergenerational justice, intra-generational justice for particularly vulnerable segments of society such as young and poor people, justice in adaptation and mitigation strategies, and interspecies justice (Biermann, 2021).

In practice, "[e]nvironmental claims are invariably made through the lens of the human person" (Sands, 2012, p. 3), and Gellers identifies, based on an analysis of the adjudication of rights of nature cases, that the rights of non-humans are only "activated" if humans decide to take action to enforce such rights. A first important step in taking action will therefore be to change the content of IEL to "activate" and broaden IEL's protective scope so that it also embraces non-human beings while at once allowing humans to act on behalf of nature. This means that IEL will have to include the type of provisions that fully embrace onto-epistemologies of care, such as rights of nature.

There is already a useful example in the domain of IEL, namely the World Charter for Nature, that was adopted with a majority vote by the United Nations General Assembly in 1982. Although it is an example of the softest of soft law instruments that IEL has to offer (Kotzé, 2014), the Charter significantly recognizes that "[hu]mankind is a part of nature and life depends on the uninterrupted functioning of natural systems", and that "[e]very form of life is unique, warranting respect regardless of its worth to [humans]". The World Charter for Nature has been described as an "avowedly ecological instrument, which emphasizes the protection of nature as an end in itself" (Sands and Peel, 2018, p. 37). Such formulations that recognize the value of nature as an end in itself, irrespective of its value to humans, are the type of legal language that could reflect all-embracing onto-epistemologies of care in MEAs, but which still remain absent, and they starkly differ from what IEL currently has to offer. For example, while the Convention on Biological Diversity (Convention on Biological Diversity, 1992), in its Preamble, recognizes "the intrinsic value of biological diversity", the goal of conserving biodiversity is arguably linked to its value to humans. Indeed, the CBD's "ecosystems services" approach is focused on the "usefulness" of biodiversity to humans (Secretariat of the Convention on Biological Diversity, n.d.), rather than the inherent value of biodiversity "regardless of whether of [it] serve[s] human needs and aspirations" (Taylor et al., 2020, p. 1089).

3.4. Anthropocene complexity

In order to avoid the risk of becoming irrelevant (Stephens, 2018), IEL must take Anthropocene complexity as its starting point. In this regard, Fernández Fernández and Malwé (2019) argue for the integration of the planetary boundaries framework into IEL, including to address the concern that earth system processes are treated on a sectoral basis in IEL despite their interdependencies. Furthermore, IEL must have the capacity to respond or adapt to this complexity (Ruhl, 2011). As Garver (2019, p. 168) notes: "[t]o regulate coherently human impacts on ecosystems on which humanity depends, legal systems must become more flexible and adaptive while remaining firmly grounded in a commitment to a mutually enhancing human-Earth relationship" (see also Garmestani et al., 2019). This is also consistent with the recommendation that IEL must move away from a "front-end focus", which relies on "assumptions of stationarity and predictability", to mechanisms that enable ongoing adjustments to be made in order to integrate new information (Ruhl, 2011, p. 1394).

Of course, many MEAs were agreed to prior to the recognition of the failure of "classical analytical science" to embrace a systems perspective, and amid calls for a "systems-level approach [to understanding Earth System functioning that] … encompass[es] complex interactions, synergies between system components, non-linear responses and multiple feedbacks" (Steffen et al., 2004, p. 2). Thus, MEAs are unlikely to explicitly acknowledge such Anthropocene complexity. However, at the least, MEAs should have the capacity to adapt to challenges presented by an unpredictable and transforming earth system.

In this regard, and as an example of what might be possible, although the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer precedes the emergence of earth system science and the concept of the Anthropocene, and thus is not explicitly premised on Anthropocene complexity, the Montreal Protocol has been described as "the most successful example of adaptive governance" at the global level (Dryzek, 2016, p. 943), and arguably provides an example of how adaptiveness can be reflected in an MEA. In particular, 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 (art. 2(9)(*c*)). This is especially beneficial because, as highlighted by Biermann et al. (2012, p. 1307) majority-based decision-making can "speed up international norm-setting".

While the wording would differ depending on the MEA, an MEA would ideally have the ability "to alter its requirements, standards, and goals—large and small—in response to changed conditions" (Garmestani et al., 2019, p. 19901). Furthermore, consideration should be given to providing for majority voting to ensure that IEL regimes are able to evolve swiftly in response to such changed conditions. In contrast, and in relation to the challenge of biodiversity loss, the Aichi Biodiversity Targets, which were established under the CBD for the period 2011–2020, have arguably not enabled swift responses to changed conditions. Of further concern, none of the targets was fully met

(Secretariat of the Convention on Biological Diversity, 2020). Furthermore, while the Paris Agreement allows for the submission of new NDCs every five years, in light of the climate crisis and the rapidly changing climate system, it is questionable whether this is sufficiently adaptive. More promisingly, the Glasgow Climate Pact "*requests* Parties to revisit and strengthen the 2030 targets in their nationally determined contributions as necessary to align with the Paris Agreement temperature goal by the end of 2022" (UNFCCC, 2021, para. 29; emphasis in original). It is arguable that the provision for more regular revisions will enhance the capacity of the climate regime to respond to constantly changing conditions.

3.5. Holistic earth system focus

As highlighted above, the reductionist focus of IEL has given rise to problem shifting (Kim and Van Asselt, 2016). For example, earlier actions taken under the Montreal Protocol (namely, the replacement of chlorofluorocarbons (CFCs) by hydrochlorofluorocarbons (HCFCs), which were, in turn, replaced by hydrofluorocarbons (HFCs)), led to an increase in greenhouse gas emissions (see, e.g., Piselli and Van Asselt, 2021). But there are already some developments that suggest a more holistic systems approach is possible in IEL. For example, although the (primarily) narrow concern of the ozone regime is with stratospheric ozone depletion, it is noteworthy that in response to the problem of rising greenhouse gas emissions, the Parties to the Montreal Protocol agreed to the insertion of section 2J (in terms of the Kigali Amendment), which provides for the phase-down of HFCs beginning in 2019 (UNEP, 2016). A link between the ozone and climate regimes has thereby been created, and 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" (Newman, 2018, p. 442; see also Velders et al., 2007). Links have also been created between institutions under the climate and ozone regimes, and the Intergovernmental Panel on Climate Change and the Technological and Economic Assessment Panel (TEAP) under the Montreal Protocol together prepared a Special Report regarding the impacts of ozone-depleting substance (ODS) substitutes on the global climate system (Metz et al., 2005). Furthermore, the TEAP's Energy Efficiency Task Force (EETF) is exploring the potential coordination of measures to phase down HFCs and enhance energy efficiency, which would also have climate co-benefits (IISD, 2021).

While the creation of such links has contributed to some extent to addressing problem shifting, it is arguable that this linking or integration in a piecemeal manner is insufficient in the face of the overall fragmentation of IEL (see, e.g., Kim and Bosselmann, 2013). In this regard, more deliberate linking of regimes is required. Kim (2013, p. 981) argues that cross-references in an MEA to other MEAs can serve as "proxies for relationships among multilateral environmental agreements" and can contribute to enhancing the complexity of IEL. Thus, including cross-references in an MEA to other MEAs where links exist between the earth system processes regulated by the respective MEAs, could contribute to enhancing the capacity of IEL to embrace earth system interconnectedness.

It has recently been suggested that CFC substitutes are contributing to the accumulation of persistent organic pollutants in the environment (Pickard et al., 2020). However, no references to the 2001 Stockholm Convention on Persistent Organic Pollutants (Stockholm Convention on Persistent Organic Pollutants, 2001) are contained in the Montreal Protocol. Recent research also shows that increasing GHG concentrations have caused the stratosphere to contract, with stratospheric contraction of 1.3 km projected by 2080 (Pisoft et al., 2021). Yet, the climate regime does not explicitly acknowledge the impacts of climate change on ozone. Furthermore, and despite the interactions between climate change and biodiversity, there has been no deliberate linking of these regimes. The UNFCCC (United Nations, 1992) and Kyoto Protocol (1998) do not refer to biodiversity at all, while the Paris Agreement and Glasgow Climate Pact refer to the protection of biodiversity once and twice respectively. There have thus been calls for the explicit consideration of the interactions between climate change and biodiversity in the post-2020 CBD framework as well as "[e]nhancing the dialogue between important conventions, such as the … UNFCCC … and … [the] CBD" (Arneth et al., 2020, p. 30889). The foregoing highlights the ongoing need for laws that embrace an earth system perspective, possibly through the creation of explicit links between separate legal regimes.

4. Conclusion

The 2019 article that formally introduced the concept of earth system law (Kotzé and Kim) and much of the ensuing scholarship on earth system law have thus far been focused on identifying principal concerns that are seen to hinder the ability of IEL to respond to complex earth system changes in the Anthropocene. Building on this, and by situating the debate within the most recent developments in the IEL domain, we have started to think about the characteristics that should ideally be reflected in IEL and its MEAs in order to respond to the gaps or deficiencies of IEL. Such (micro) steps could contribute to the transformation of IEL at the macro level into "international environmental law 2.0" (Kim, 2021, p. 3). While further wide-scale transformations are required to halt earth system degradation, including a move away from consumerism (Lister, 2015) and the current "growth-insistent narrative" (Garver, 2019), IEL will continue to play a crucial regulatory role in the Anthropocene. But it can only do so if it more fully takes into account the types of characteristics that we have outlined above within the framework of earth system law.

CRediT authorship contribution statement

Louise du Toit: Conceptualization, Writing – original draft, Writing – review & editing. **Louis J. Kotzé:** Conceptualization, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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References

Adelman, S., 2015. Epistemologies of mastery. In: Grear, A., Kotzé, L.J. (Eds.), Research Handbook on Human Rights and the Environment, Research Handbook in Human Rights Series. Edward Elgar, Cheltenham and Northampton, pp. 9–27.

Ahlström, H., Cornell, S.E., 2018. Governance, polycentricity and the global nitrogen and phosphorus cycles. Environ. Sci. Pol. 79, 54–65. https://doi.org/10.1016/j.envsci.2017.10.005.

Ahlström, H., Hileman, J., Wang-Erlandsson, L., Mancilla García, M., Moore, M.-L., Jonas, K., Pranindita, A., Kuiper, J.J., Fetzer, I., Jaramillo, F., Svedin, U., 2021. An earth system law perspective on governing social-hydrological systems in the Anthropocene. Earth Syst. Gov. 10, 100120. https://doi.org/10.1016/j.esg.2021.100120.

Ambos, K., 2021. Protecting the Environment through International Criminal Law? EJIL: Talk! 29 June. https://www.ejiltalk.org/protecting-the-environment-through-international-criminal-law/.

Anker, K., Burdon, P.D., Garver, G., Maloney, M., Sbert, C. (Eds.), 2021. From Environmental Law to Ecological Law. Routledge, Abingdon and New York.

Anonymous, 2021. What difference will it make? New Sci. 252 (3361), 9. https://doi.org/10.1016/S0262-4079(21)02047-9.

Arneth, A., Shin, Y.-J., Leadley, P., Rondinini, C., Bukvareva, E., Kolb, M., Midgley, G.F., Oberdorff, T., Palomo, I., Saito, O., 2020. Post-2020 biodiversity targets need to embrace climate change. Proc. Natl. Acad. Sci. U.S.A. 117 (49), 30882–30891. https://doi.org/10.1073/pnas.2009584117.

Baxi, U., 2016. Towards a climate change justice theory? J. Hum. Rights Environ. 7 (1), 7–31. https://doi.org/10.4337/jhre.2016.01.01.
Beyerlin, U., Marauhn, T., 2011. International Environmental Law. Hart, London.
Biermann, F., 2017. "Earth system governance" as a crosscutting theme of global change research. Global Environ. Change 17, 326–337. https://doi.org/10.1016/j.gloenvcha.2006.11.010.
Biermann, F., 2021. The future of "environmental" policy in the Anthropocene: time for a paradigm shift. Environ. Polit. 30 (1/2), 61–80. https://doi.org/10.1080/09644016.2020.1846958.
Biermann, F., Abbott, K., Andresen, S., Bäckstrand, K., Bernstein, S., Betsill, M.M., Bulkeley, H., Cashore, B., Clapp, J., Folke, C., Gupta, G., Gupta, J., Haas, P.M., Jordan, A., Kanie, N., Kluvánková-Oravská, T., Lebel, L., Liverman, D., Meadowcroft, J., Mitchell, R.B., Newell, P., Oberthür, S., Olsson, L., Pattberg, P., Sánchez-Rodríguez, R., Schroeder, H., Underdal, A., Camargo Vieira, S., Vogel, C., Young, O.R., Brock, A., Zondervan, R., 2012. Navigating the Anthropocene: improving earth system governance. Science 335, 1306–1307. https://doi.org/10.1126/science.1217255.
Biermann, F., Kalfagianni, A., 2020. Planetary justice: a research framework. Earth Syst. Gov 6, 100049. https://doi.org/10.1016/j.esg.2020.100049.
Biermann, F., Oomen, J., Gupta, A., Ali, S.H., Conca, K., Hajer, M., Hulme, M., Kashwan, P., Kotzé, L.J., Leach, M., Messner, D., Okereke, C., Persson, Å., Potočnik, J., Schlosberg, D., Scobie, M., VanDeveer, S.D., forthcoming. Solar geoengineering: the case for an international non-use agreement. WIREs Clim. Change.
Biermann, F., Kim, R., 2020. Architectures of earth system governance: setting the stage. In: Biermann, F., Kim, R. (Eds.), Architectures of Earth System Governance: Institutional Complexity and Structural Transformation. Cambridge University Press, Cambridge, pp. 1–34.
Biniaz, S., 2017. 10 Questions to Ask about the Proposed "Global Pact for the Environment". Columbia Law School. http://columbiaclimatelaw.com/files/2017/08/Biniaz-2017-08-Global-Pact-for-the-Environment.pdf.
Biniaz, S., 2019. The UNGA Resolution on a 'Global Pact for the Environment': a chance to put the horse before the cart. Rev. Eur. Community Int. Environ. Law 28, 33–39. https://doi.org/10.1111/reel.12281.
Bridgewater, P., Kim, R.E., Bosselmann, K., 2015. Ecological integrity: a relevant concept for international environmental law in the Anthropocene? Yearb. Int. Environ. Law 25 (1), 61–78. https://doi.org/10.1093/yiel/yvv059.
Burch, S., Gupta, A., Inoue, C.Y.A., Kalfagianni, A., Persson, A., Gerlak, A.K., Ishii, A., Patterson, J., Pickering, J., Scobie, M., Van der Heijden, J., Vervoort, J., Adler, C., Bloomfield, M., Djalante, R., Dryzek, J., Galaz, V., Gordon, C., Harmon, R., Jinnah, S., Kim, R.E., Olsson, L., Van Leeuwen, J., Ramasar, V., Wapner, P., Zondervan, R., 2019. New directions in earth system governance research. Earth Syst. Gov. 1, 100006. https://doi.org/10.1016/j.esg.2019.100006.
Burke, A., Fishel, S., 2020. A coal elimination treaty 2030: fast tracking climate change mitigation, global health and security. Earth Syst. Gov. 3, 100046. https://doi.org/10.1016/j.esg.2020.100046.
BVerfG, Beschluss des Ersten Senats vom 24 März 2021. ECLI:DE:BVerfG:2021:PS20210324.1bvr265618.
Cadman, T., Hurlbert, S., Simonelli, A. (Eds.), 2021. Earth System Law: Standing on the Precipice of the Anthropocene. Routledge, Abingdon-on-Thames.
Campbell-Staton, S.C., Arnold, B.J., Gonçalves, D., Granli, P., Poole, J., Long, R.A., Pringle, R.M., 2021. Ivory poaching and the rapid evolution of tusklessness in African elephants. Science 374 (6566), 483–487. https://doi.org/10.1126/science.abe7389.
Cardesa-Salzman, A., Cocciolo, E., 2019. Global governance, sustainability and the earth system: critical reflections on the role of global law. Transnatl Environ. Law 8 (3), 437–461. https://doi.org/10.1017/S2047102519000098.
Centre for International Environmental Law, 2021. Public Participation and COP26: A Report from Glasgow. CIEL. https://www.ciel.org/public-participation-and-cop26-a-report-from-glasgow/, 2021.
Chapron, G., Epstein, Y., Trouwborst, A., López-Bao, J.V., 2017. Bolster legal boundaries to stay within planetary boundaries. Nat. Ecol. Evol. 1, 0086 https://doi.org/10.1038/s41559-017-0086.
Climate Action Tracker, 2021. Warming Projects Global Update. https://climateactiontracker.org/documents/997/CAT_2021-11-09_Briefing_Global-Update_Glasgow2030CredibilityGap.pdf.
Conrad, K., 2009. Statement to the 1st meeting of the fifteenth conference of the parties, cited in: Dryzek, J.S., Stevenson, H., Global democracy and earth system governance. Ecol. Econ. 70 (11), 1865–1874. https://doi.org/10.1016/j.ecolecon.2011.01.021.
Convention on Biological Diversity 31 I.L.M. 818, 1992.
Crutzen, P.J., 2002. Geology of mankind. Nature 415, 23. https://doi.org/10.1038/415023a.
Crutzen, P.J., Stoermer, E.F., 2000. The "Anthropocene". IGBP Newsl 41, 17–18.
De Staat der Nederlanden tegen Stichting Urgenda. ECLI:NL:HR:2019:2006.
Dillard, J., Dujon, V., Kin, M.C. (Eds.), 2008. Understanding the Social Dimension of Sustainability. Routledge, New York.
Dryzek, J.S., 2016. Institutions for the Anthropocene: governance in a changing earth system. Br. J. Polit. Sci. 4, 937–956. https://doi.org/10.1017/S0007123414000453.
Dryzek, J.S., Stevenson, H., 2011. Global democracy and earth system governance. Ecol. Econ. 70, 1865–1874. https://doi.org/10.1016/j.ecolecon.2011.01.021.
Du Toit, L., Lopez Porras, G., Kotzé, L.J., 2021. Guiding environmental law's transformation into earth system law through the telecoupling framework. Eur. Environ. Law Rev. 30 (3), 104–113.
Fernández Fernández, E., Malwé, C., 2019. The emergence of the "planetary boundaries" concept in international environmental law: a proposal for a framework convention. Rev. Eur. Community Int. Environ. Law 28, 48–56. https://doi.org/10.1111/reel.12256.
Folke, C., Jansson, Å., Rockström, J., Olsson, P., Carpenter, S.R., Chapin III, F.S., Crépin, A.-S., Daily, G., Danell, K., Ebbesson, J., Elmqvist, T., Galaz, V., Moberg, F., Nilsson, M., Österblom, H., Ostrom, E., Persson, Å., Peterson, G., Polasky, S., Steffen, W., Walker, B., Westley, F., 2011. Reconnecting to the biosphere. Ambio 40, 719–738. https://doi.org/10.1007/s13280-011-0184-y.
Fox, D., 2007. Back to the no-analog future? Science 316, 823–825. https://doi.org/10.1126/science.316.5826.823.
French, D., Kotzé, L.J., 2019. Towards a Global Pact for the Environment? International environmental law's factual, technical and (unmentionable) normative gaps. Rev. Eur. Community Int. Environ. Law 28, 25–32. https://doi.org/10.1111/reel.12278.
French, D., Kotzé, L.J. (Eds.), 2021. Research Handbook on Law, Governance and Planetary Boundaries. Edward Elgar, Cheltenham and Northampton.
Garmestani, A., Ruhl, J.B., Chaffin, B.C., Craig, R.K., Van Rijswick, H.F.M.W., Angeler, D.G., Folke, C., Gunderson, L., Twidwell, D., Allen, C.R., 2019. Untapped capacity for resilience in environmental law. Proc. Natl. Acad. Sci. U.S.A. 116 (40) https://doi.org/10.1073/pnas.1906247116, 19899–19904.
Garver, G., 2019. A systems-based tool for transitioning to law for a mutually enhancing human-earth relationship. Ecol. Econ. 157, 165–174. https://doi.org/10.1016/j.ecolecon.2018.09.022.
Gellers, J.C., 2021. Earth system law and the legal status of non-humans in the Anthropocene. Earth Syst. Gov. 7, 100083. https://doi.org/10.1016/j.esg.2020.100083.
Grear, A., 2014. Towards "climate justice"? A critical reflection on legal subjectivity and climate *in*justice: warning signals, patterned hierarchies, directions for future law and policy. J. Hum. Rights Environ. 5, 103–133. https://doi.org/10.4337/jhre.2014.02.08.
Grear, A., 2020. Legal imaginaries and the Anthropocene: 'of' and 'for. Law Critiq. 31, 351–366. https://doi.org/10.1007/s10978-020-09275-7.
Hales, R., Mackey, B., 2021. The ultimate guide to why the COP26 summit ended in failure and disappointment (despite a few bright spots). The Conversation 14 November. https://theconversation.com/the-ultimate-guide-to-why-the-cop26-summit-ended-in-failure-and-disappointment-despite-a-few-bright-spots-171723.
Hamilton, C., 2014. Geoengineering and the politics of science. Bull. At. Sci. 70 (3), 17–26. https://doi.org/10.1177/0096340214531173.
Hughes, N., Ekins, P., Drummond, P., 2021. COP26 – what happened, and where next? The Bartlett 29 November. https://www.ucl.ac.uk/bartlett/news/2021/nov/cop26-what-happened-and-where-next.
Intergovernmental Panel on Climate Change, 2018. Summary for policymakers. In: Masson-Delmotte, V., Zhai, P., Pörtner, H.-O., Roberts, D., Skea, J., Shukla, P.R., Pirani, A., Moufouma-Okia, W., Péan, C., Pidcock, R., Connors, S., Matthews, J.B.R., Chen, Y., Zhou, X., Gomis, M.I., Lonnoy, E., Maycock, T., Tignor, M., Waterfield, T. (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. https://www.ipcc.ch/site/assets/uploads/sites/2/2019/05/SR15_SPM_version_report_LR.pdf (IPCC, 2018).
Intergovernmental Panel on Climate Change, 2021. Summary for policymakers. In: Masson-Delmotte, V., Zhai, P., Pirani, A., Connors, S.L., Péan, C., Berger, S., Caud, N., Chen, Y., Goldfarb, L., Gomis, M.I., Huang, M., Leitzell, K., Lonnoy, E., Matthews, J.B.R., Maycock, T.K., Waterfield, T., Yelekçi, O., Yu, R., Zhou, B. (Eds.), Climate Change 2021: the Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. IPCC. https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM.pdf, 2021.
International Institute for Sustainable Development, 2021. In: Summary of the Second Part of the 43rd Meeting of the Open-Ended Working Group of the Parties to the Montreal Protocol: 14–17 July 2021 19(156). https://enb.iisd.org/sites/default/files/2021-07/enb19156e.pdf (IISD, 2021).
Kim, R.E., 2013. The emergent network structure of the multilateral environmental agreement system. Global Environ. Change 23, 980–991. https://doi.org/10.1016/j.gloenvcha.2013.07.006.
Kim, R.E., 2016. Transnational sustainability law – whither international environmental law? Environ. Pol. Law 46 (6), 405–408.
Kim, R.E., 2021. Taming gaia 2.0: earth system law in the ruptured Anthropocene. Anthropocene Rev 1–14. https://doi.org/10.1177/20530196211026721, 0(0).
Kim, R.E., Blanchard, C., Kotzé, L.J., 2022. Law, systems, and planet earth: editorial. Earth Syst. Gov. 11, 100127. https://doi.org/10.1016/j.esg.2021.100127.
Kim, R.E., Bosselmann, K., 2013. International environmental law in the Anthropocene: towards a purposive system of multilateral environmental agreements. Transnatl Environ. Law 2 (2), 285–309. https://doi.org/10.1017/S2047102513000149.
Kim, R.E., Bosselmann, K., 2015. Operationalising sustainable development: ecological integrity as a *grundnorm* of international law. Rev. Eur. Community Int. Environ. Law 24 (2), 194–208. https://doi.org/10.1111/reel.12109.
Kim, R.E., Van Asselt, H., 2016. Global governance: problem shifting in the Anthropocene and the limits of international law. In: Morgera, E., Kulovesi, K. (Eds.), Research Handbook on International Law and Natural Resources. Edward Elgar, Cheltenham and Northampton, pp. 473–495.
Kotzé, L.J., 2014. The Anthropocene's global environmental constitutional moment. Yearb. Int. Environ. Law 25, 24–60. https://doi.org/10.1093/yiel/yvv065.
Kotzé, L.J., 2019. International environmental law's lack of normative ambition: an opportunity for the Global Pact for the Environment? J. Eur. Environ. Plann. Law 16, 213–238. https://doi.org/10.1163/18760104-01603002.
Kotzé, L.J., 2020. Earth system law for the Anthropocene: rethinking environmental law alongside the earth system metaphor. Transnatl Leg. Theory 11 (1/2), 75–104. https://doi.org/10.1080/20414005.2020.1776556.

Kotzé, L.J., forthcoming. *Neubauer et al versus Germany*: planetary climate litigation for the Anthropocene? Ger. Law J.
Kotzé, L.J., Adelman, S., Dube, F., forthcoming. The problem with sustainable development in the Anthropocene epoch: reimagining international environmental law's mantra principle through Ubuntu. In: Burdon, P., Martel, J. (Eds.), Ecological Law for the Anthropocene. Routledge.
Kotzé, L.J., French, D., 2018. A critique of the Global Pact for the environment: a stillborn initiative or the foundation for *Lex Anthropocenae*? Int. Environ. Agreements Polit. Law Econ. 18, 811–838. https://doi.org/10.1007/s10784-018-9417-x.
Kotzé, L.J., Kim, R.E., 2019. Earth system law: the juridical dimensions of earth system governance. Earth Syst. Gov. 1, 100003. https://doi.org/10.1016/j.esg.2019.100003.
Kotzé, L.J., Kim, R.E., 2020. Exploring the analytical, normative and transformative dimensions of earth system law. Environ. Pol. Law 50, 457–470. https://doi.org/10.3233/EPL-201055.
Kotzé, L.J., Kim, R.E., Blanchard, C., Gellers, J., Holley, C., Petersmann, M., Van Asselt, H., Biermann, F., Hurlbert, M., 2022. Earth system law: exploring new frontiers in legal science. Earth Syst. Gov. 11, 100126. https://doi.org/10.1016/j.esg.2021.100126.
Kotzé, L.J., Villavicencio Calzadilla, P., 2017. Somewhere between rhetoric and reality: environmental constitutionalism and the rights of nature in Ecuador. Transnatl Environ. Law 6 (3), 401–433. https://doi.org/10.1017/S2047102517000061.
Krause, G., 2014. The scientific challenge of bridging the gap from the local to the earth system level: lessons from the study of mangroves and people in North Brazil. Reg. Environ. Change 14, 2089–2103. https://doi.org/10.1007/s10113-014-0636-6.
Kumar, D., 2020. An analysis of earth system approach to the Global Pact for the Environment. In: Honkonen, T., Romppanen, S. (Eds.), International Environmental Law-Making and Diplomacy Review 2019. University of Eastern Finland, Joensuu, Finland.
Lister, J., 2015. Consumerism. In: Pattberg, P., Zelli, F. (Eds.), Encyclopedia of Global Environmental Politics and Governance. Edward Elgar, Cheltenham and Northampton, pp. 9–15.
Lövbrand, E., Stripple, J., Wiman, B., 2009. Earth system governmentality: reflections on science in the Anthropocene. Global Environ. Change 19, 7–13. https://doi:10.1016/j.gloenvcha.2008.10.002.
Luke, W., 2008. The politics of true convenience or inconvenient truth: struggles over how to sustain capitalism, democracy, and ecology in the 21st century. Environ. Plann.: Econ. Space 40, 1811–1824. https://doi.org/10.1068/a40158.
Mai, L., Boulot, E., 2021. Harnessing the transformative potential of earth system law: from theory to practice. Earth Syst. Gov. 7, 100103. https://doi.org/10.1016/j.esg.2021.100103.
Masood, E., Tollefson, J., 2021. "COP26 hasn't solved the problem": scientists react to UN climate deal. Nature 599, 355–356. https://doi.org/10.1038/d41586-021-03431-4.
Metz, B., Kuijpers, L., Solomon, S., Andersen, S.O., Davidson, O., Pons, J., De Jager, D., Kestin, T., Manning, M., Meyer, E. (Eds.), 2005. Safeguarding the Ozone Layer and the Global Climate System: Issues Related to Hydrofluorocarbons and Perfluorocarbons. Cambridge University Press, Cambridge.
Montreal Protocol on Substances that Deplete the Ozone Layer 26 I.L.M. 1541 (1987).
Newell, P., Simms, A., 2020. Towards a fossil fuel non-proliferation treaty. Clim. Pol. 20 (8), 1043–1054. https://doi.org/10.1080/14693062.2019.1636759.
Newman, P.A., 2018. The way forward for Montreal Protocol science. Compt. Rendus Geosci. 350, 442–447. https://doi.org/10.1016/j.crte.2018.09.001.
Nilsson, M., Persson, A., 2012. Can earth system interactions be governed? Governance functions for linking climate change mitigation with land use, freshwater and biodiversity protection. Ecol. Econ. 75, 61–71. https://doi.org/10.1016/j.ecolecon.2011.12.015.
O'Donnell, E., 2021. Rivers as living beings: rights in law, but no rights to water? Griffith Law Rev. 1–26. https://doi.org/10.1080/10383441.2020.1881304.
Ostrom, E., 2009. A Policy Approach for Coping with Climate Change. Background Paper to the 2010 World Development Report (Policy Research Working Paper 5095). The World Bank.
Petersmann, M.-C., 2021. Sympoietic thinking and earth system law: the Earth, its subjects and the law. Earth Syst. Gov. 9, 100114. https://doi.org/10.1016/j.esg.2021.100114.
Pickard, H.M., Criscitiello, A.S., Persaud, D., Spencer, C., Muir, D.C.G., Lehnherr, I., Sharp, M.J., De Silva, A.O., Young, C.J., 2020. Ice core record of persistent short-chain fluorinated alkyl acids: evidence of the impact from global environmental regulations. Geophys. Res. Lett. 47 (10), e2020GL087535 https://doi.org/10.1029/2020GL087535.
Piselli, D., Van Asselt, H., 2021. Planetary boundaries and regime interaction in international law. In: French, D., Kotzé, L.J. (Eds.), Research Handbook on Law, Governance and Planetary Boundaries, Research Handbook in Environmental Law Series. Edward Elgar, Cheltenham and Northampton, pp. 125–146.
Pisoft, P., Sacha, P., Polvani, L.M., Añel, J.A., De la Torre, L., Eichinger, R., Foelsche, U., Huszar, P., Jacobi, C., Karlicky, J., Kuchar, A., Miksovsky, J., Zak, M., Rieder, H.E., 2021. Stratospheric contraction caused by increasing greenhouse gases. Environ. Res. Lett. 16, 064038 https://doi.org/10.1088/1748-9326/abfe2b.
Pope, K., Bonatti, M., Sieber, S., 2021. The what, who and how of socio-ecological justice: tailoring a new justice model for earth system law. Earth Syst. Gov. 10, 100124. https://doi.org/10.1016/j.esg.2021.100124.
Rajamani, L., Peel, J., 2021. Reflections on a decade of change in international environmental law. Camb. Int. Law J. 10, 6–31. https://doi.org/10.4337/cilj.2021.01.01.
Rockström, J., Steffen, W., Noone, K., Persson, A., Stuart Chapin III, F., Lambin, E., Lenton, T.M., Scheffer, M., Folke, C., Schellnhuber, H.J., Nykvist, B., De Wit, C.A., Hughes, T., Van der Leeuw, S., Rodhe, H., Sörlin, S., Snyder, P.K., Constanza, R., Svedin, U., Falkenmark, M., Karlberg, L., Corell, R.W., Fabry, V.J., Hansen, J., Walker, B., Liverman, D., Richardson, K., Crutzen, P., Foley, J., 2009a. A safe operating space for humanity. Nature 461 (24), 472–475, 10.1038/461472a. (Rockström et al.2009aa.
Rockström, J., Steffen, W., Noone, K., Persson, A., Stuart Chapin III, F., Lambin, E.F., Lenton, T.M., Scheffer, M., Folke, C., Schellnhuber, H.J., Nykvist, B., De Wit, C.A., Hughes, T., Van der Leeuw, S., Rodhe, H., Sörlin, S., Snyder, P.K., Constanza, R., Svedin, U., Falkenmark, M., Karlberg, L., Corell, R.W., Fabry, V.J., Hansen, J., Walker, B., Liverman, D., Richardson, K., Crutzen, P., Foley, J.A., 2009b. Planetary boundaries: exploring the safe operating space for humanity. Ecol. Soc. 14 (2), 32, 10.5751/ES-03180-140232. (Rockström et al.2009bb.
Ruhl, J.B., 1997. Thinking of environmental law as a complex adaptive system: how to clean up the environment by making a mess of environmental law. Houst. Law Rev. 34 (4), 933–1002.
Ruhl, J.B., 2011. General design principles for resilience and adaptive capacity in legal systems: applications to climate change adaptation law. N. C. Law Rev. 89, 1373–1401.
Sands, P., 2012. On being 40: a celebration of "should trees have standing? J. Hum. Rights Environ. 3, 2–3. https://doi.org/10.4337/jhre.2012.02.01.
Sands, P., Peel, J., 2018. Principles of International Environmental Law, fourth ed. Cambridge University Press, Cambridge.
Savaresi, A., 2021. The UN HRC recognizes the right to a healthy environment and appoints a new Special Rapporteur on Human Rights and Climate Change. What does it all mean? EJIL:Talk!. https://www.ejiltalk.org/the-un-hrc-recognizes-the-right-to-a-healthy-environment-and-appoints-a-new-special-rapporteur-on-human-rights-and-climate-change-what-does-it-all-mean/.
Secretariat of the Convention on Biological Diversity, 2020. Global Biodiversity Outlook 5 – Summary for Policy Makers. Montréal.
Secretariat of the Convention on Biological Diversity, n.d. Ecosystem services. <https://www.cbd.int/undb/media/factsheets/undb-factsheet-ecoserv-en.pdf>.
Sharma, A., 2021. Questions to the president of COP26. https://www.aloksharma.co.uk/parliament/questions-president-cop26-1.
Steffen, W., Crutzen, P.J., McNeill, J.R., 2007. The Anthropocene: are humans now overwhelming the great forces of nature? Ambio 36 (8), 614–621. https://doi.org/10.1579/0044-7447(2007)36[614:TAAHNO]2.0.CO;2.
Steffen, W., Richardson, K., Rockström, J., Cornell, S.E., Fetzer, I., Bennett, E.M., Biggs, R., Carpenter, S.R., De Vries, W., De Wit, C.A., Folke, C., Gerten, D., Heinke, J., Mace, G.M., Persson, L.M., Ramanathan, V., Reyers, B., Sörlin, S., 2015. Planetary boundaries: guiding human development on a changing planet. Science 347 (6223), 1259855. https://doi.org/10.1126/science.1259855.
Steffen, W., Rockström, J., Richardson, K., Lenton, T.M., Folke, C., Liverman, D., Summerhayes, C.P., Barnosky, A.D., Cornell, S.E., Crucifix, M., Donges, J.F., Fetzer, I., Lade, S.J., Scheffer, M., Winkelmann, R., Schellnhuber, H.J., 2018. Trajectories of the earth system in the Anthropocene. Proc. Natl. Acad. Sci. U.S.A. 115 (33), 8252–8259. https://doi.org/10.1073/pnas.1810141115.
Steffen, W., Sanderson, A., Tyson, P.D., Jäger, J., Matson, P.A., Moore III, B., Oldfield, F., Richardson, K., Schellnhuber, H.J., Turner II, B.L., Wasson, R.J., 2004. Global Change and the Earth System: A Planet under Pressure. Global Change – the IGBP Series. Springer.
Stephens, T., 2018. What is the point of international environmental law scholarship in the Anthropocene? In: Pedersen, O. (Ed.), Perspectives on Environmental Law Scholarship: Essays on Purpose, Shape and Direction. Cambridge University Press, Cambridge, pp. 121–139.
Stockholm Convention on Persistent Organic Pollutants 2256 U.N.T.S. 119; 40 I.L.M. 532, 2001.
Stockholm Environment Institute, International Institute for Sustainable Development, ODI, E3G, United Nations Environment Programme, 2021. The Production Gap Report 2021. https://productiongap.org/wp-content/uploads/2021/10/PGR2021_web_rev.pdf. SEI et al., 2021.
Stop Ecocide Foundation, 2021. Independent expert panel for the legal definition of ecocide: commentary and core text. https://static1.squarespace.com/static/5ca2608ab914493c64ef1f6d/t/60d7479cf8e7e5461534dd07/1624721314430/SE+Foundation+Commentary+and+core+text+revised+%281%29.pdf.
Tarlock, A., 1992. The role of non-governmental organizations in the development of international environmental law. Chic. Kent. Law Rev. 68 (1), 61–76.
Taylor, B., Chapron, G., Kopnina, H., Orlikowska, E., Gray, J., Piccolo, J.J., 2020. The need for ecocentrism in biodiversity conservation. Conserv. Biol. 34 (5), 1089–1096. https://doi.org/10.1111/cobi.13541.
United Nations Environment Programme, 2016. 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, 15 november 2016) (UNEP/OzL.Pro.28/12). https://ozone.unep.org/system/files/documents/MOP-28-12E.pdf (UNEP, 2016).
United Nations Environment Programme, 2019. Towards the vision 2050 on biodiversity: living in harmony with nature. https://www.unep.org/news-and-stories/story/towards-vision-2050-biodiversity-living-harmony-nature (UNEP, 2019).
United Nations Framework Convention on Climate Change 1771 U.N.T.S. 107, 165; 31 I.L.M. 849 (1992) (UNFCCC).
United Nations Framework Convention on Climate Change, 2021. Glasgow Climate Pact (decision -/CMA.3). https://unfccc.int/sites/default/files/resource/cma3_auv_2_cover%20decision.pdf (UNFCCC, 2021).
United Nations General Assembly, 2014. Harmony with nature (18 august) (A/69/322). https://undocs.org/en/A/69/322 (UN General Assembly, 2014).

United Nations General Assembly, 2021. The human right to a safe, clean, healthy and sustainable environment (5 October) (A/HRC/48/L.23/Rev.1). https://undocs.org/a/hrc/48/l.23/rev.1 (UN General Assembly, 2021).
University of Oregon, n.d. International environmental agreements (IAE) database project <https://iea.uoregon.edu/>.
Van Asselt, H., 2021. Governing fossil fuel production in the age of climate disruption: towards an international law of "leaving it in the ground". Earth Syst. Gov. 9, 100118. https://doi.org/10.1016/j.esg.2021.100118.
Van Dijk, N., 2021. From exacerbating the Anthropocene's problems to intergenerational justice: an analysis of the communication procedure of the human rights treaty system. Earth Syst. Gov. 10, 100123. https://doi.org/10.1016/j.esg.2021.100123.
Velders, G.J.M., Andersen, S.O., Daniel, J.S., Fahey, D.W., McFarland, M., 2007. The importance of the Montreal Protocol in protecting climate. Proc. Natl. Acad. Sci. U.S. A. 104 (12), 4814–4819. https://doi.org/10.1073/pnas.0610328104.
Vereniging Milieudefensie et al.tegen Royal Dutch Shell Plc, 2021. ECLI:NL:RBDHA, p. 5337.
Kyoto Protocol to the United Nations Framework Convention on Climate Change 2303 U.N.T.S. 148; 37 I.L.M. 22 (1998) (Kyoto Protocol).
Villavicencio Calzadilla, P., Kotzé, L.J., 2018. Living in harmony with nature? A critical appraisal of the rights of Mother Earth in Bolivia. Transnatl Environ. Law 7 (3), 397–424. https://doi.org/10.1017/S2047102518000201.
World Meteorological Organisation, 2021. WMO global annual update to decadal climate update. WMO. https://hadleyserver.metoffice.gov.uk/wmolc/WMO_GADCU_2020.pdf, 2021.