

Towards planetary nexus governance in the Anthropocene: An earth system law perspective

Louis J. Kotzé^{1,2,3} | Rakhyun E. Kim⁴

¹Faculty of Law, North-West University, Potchefstroom, South Africa

²Lincoln Law School, University of Lincoln, Lincoln, UK

³Institute for Advanced Sustainability Studies, Potsdam, Germany

⁴Copernicus Institute of Sustainable Development, Utrecht University, Utrecht, The Netherlands

Correspondence

Louis J. Kotzé, North-West University, 11 Hoffmann Street, Potchefstroom 2531, South Africa.

Email: louis.kotze@nwu.ac.za

Funding information

European Research Council, Grant/Award Number: 949252; Institute for Advanced Sustainability Studies

Abstract

Nexus governance recognises that sustainability concerns such as water, energy, and food security are interlinked and provides an alternative to fragmented governance. Although it has been applied mostly in the domestic context, the need for nexus governance is also apparent at a planetary scale, as highlighted by interacting planetary boundaries, global telecoupling, and global tipping cascades. However, international environmental law is unable to facilitate what we call ‘planetary nexus governance’. This is mainly because international environmental law lacks an ecological *Grundnorm* and because its primary rules of conduct remain fragmented in the absence of effective secondary rules on how primary rules should relate to each other. Recognising this challenge, scholars have recently proposed earth system law as a new framework to rethink, in an integrated way, law in an Anthropocene context. Building on this framework, we suggest that international environmental law should adopt a unifying *Grundnorm* such as planetary integrity. We also suggest that international institutional law, as a body of secondary rules, has an important role to play in facilitating planetary nexus governance by bringing together fragmented bodies of international law. We briefly discuss ways in which international environmental law could reorientate itself to better facilitate planetary nexus governance.

1 | INTRODUCTION

Despite a deepening critical awareness of the impact of human activities on planetary integrity, the existing suite of global governance institutions struggle to effectively respond to interconnected multiscale ‘super wicked’ earth system governance challenges such as climate change (Levin et al., 2012). Commentators argue that a key reason for this is the assumption on which existing institutions are built: the stability of Holocene conditions (Dryzek & Pickering, 2019; Galaz, 2014). The assumed premise of these Holocene conditions results in a linear, one-dimensional, and segmented approach

to understanding and responding to what is perceived to be discrete, unrelated, and localised ‘environmental’ problems that occur only in specific geographical locations (Dryzek, 2016). The Anthropocene, however (both as an epoch and episteme), foregrounds a critical awareness of the existence of a complex earth system and the multifarious governance challenges arising from this system (Young, 2021a). These challenges, in turn, interact with each other as highlighted through frameworks such as planetary boundaries (Lade et al., 2020), global telecoupling (Hull & Liu, 2018; Newig et al., 2020), and global tipping cascades (Brovkin et al., 2021; Pereira & Viola, 2018). In short,

This is an open access article under the terms of the [Creative Commons Attribution](https://creativecommons.org/licenses/by/4.0/) License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.

© 2022 The Authors. *Global Policy* published by Durham University and John Wiley & Sons Ltd.

our regulatory institutions designed in the context of the Holocene are no longer fit for governing a complex earth system in the Anthropocene in a way that is sensitive to the interconnected nature of the earth system (Biermann, 2014).

International environmental law, the focus of our present inquiry, is an example of a regulatory institution that remains detached from the new realities of the Anthropocene and the complex governance challenges of this epoch (Stephens, 2017). Commentators argue that the architects of international environmental law, notably states and international organisations, remain unwilling to embrace an earth system approach, which renders international environmental law less able to address complex and interactive global change phenomena in holistic ways (Viñuales, 2018). For example, the interdependencies between environmental problems are not adequately recognised and reflected in the architecture of international environmental law. The reductionist approach to environmental problem solving has reinforced silos between hundreds of international environmental regimes and created conditions that only exacerbate environmental problem-shifting (Kim & Bosselmann, 2013; Kim & van Asselt, 2016). International environmental law must adapt rapidly to the dynamic nature of the earth system, but its path-dependency has locked the governance system into its current one-dimensional state (Kotzé, 2019b). International environmental law will ultimately need to be able to more effectively coordinate dynamics and interacting planetary boundaries and the multitude overlapping earth system governance challenges these create (Kim & Kotzé, 2021).

The need for integrated governance that is commensurate with an integrated earth system is evident in the notion of nexus governance, which offers a useful frame to think about strategies to break down the silos between issue-specific regimes. Although it is principally concerned with sectoral fragmentation, nexus governance is premised on a systems approach and occurs at multiple levels, from the local to the global, and it is associated with the process of globalisation (Franz et al., 2018). A common institutional problem that nexus governance seeks to address is fragmented water, energy, and food regulatory regimes, which often lead to unintended consequences; although its principal objective, both as a framework for integrated governance and as a practical guide for implementation, is to achieve 'policy coherence by identifying synergies and trade-offs, optimizing policy options, and adapting governance arrangements' (Weitz et al., 2017, p. 166).

Although nexus governance is studied mostly in local, domestic, and regional contexts, we believe it is also relevant to planetary-scale earth system governance. Nexus governance, if operationalised at a planetary scale, would also depart from a systems perspective and seek to understand and respond to the complex interactions between Earth's subsystems and

Policy Implications

- Nexus governance, which is premised on an earth system perspective, must be better facilitated, not only at the domestic level, but also increasingly, at the planetary scale.
- While law plays a key role in facilitating nexus governance, international environmental law is fragmented and unable to facilitate planetary nexus governance of the water-energy-food triad because it does not follow an earth system perspective. International environmental law must therefore be reformed alongside an earth system perspective if it were to respond more effectively to nexused earth system governance challenges at the planetary scale.
- Earth system law provides a theoretical framework to re-imagine international environmental law in such a way so that it is better able to facilitate planetary nexus governance.
- Two options to practically reform international environmental law within the framework of earth system law are through the adoption of a Grundnorm such as planetary integrity, and/or by using the secondary rules of international law, also known as international institutional law.

processes and the many human activities that affect the integrity of the earth system as a whole. For example, the water–energy–food nexus that exists at the local level through biofuel crop plantations may scale up all the way to the level of planetary boundaries interaction between, among others, freshwater use (water), climate change (energy), and biogeochemical flows (food) (Lade et al., 2020; see also Biermann & Kim, 2020).

The challenge, however, is that international environmental law would have to embrace a perspective that is commensurate with the nexus governance demands of an interconnected earth system, which it still fails to do (Kotzé, 2020). As a response to international environmental law's perceived inability to align with and embrace an earth system perspective, earth system law has recently been proposed as an alternative vision for law in the Anthropocene (Kim & Kotzé, 2021; Kotzé, 2019a; Kotzé & Kim, 2019). Earth system law is intended to serve as a framework that can guide interrogations regarding the difficulties posed to international environmental law in *thinking with the earth system*, as it were and, ultimately, as a roadmap for international environmental law to become more sensitive to and reflective of the functioning of the earth system and the multiple complex governance implications of the earth system. The epistemic

project of earth system law is therefore essentially concerned with crafting 'international environmental law 2.0 for a profoundly changed, complex world of the Anthropocene' (Kim, 2021, p. 3) or, in short, *Lex Anthropocenae* (Kotzé & French, 2018).

In this article, we seek to contribute to the emerging earth system law debate by reflecting on the potential of the earth system law framework to rethink the way in which international environmental law could facilitate nexus governance at a planetary scale in the Anthropocene. The planetary scale is increasingly emerging as a new framework to scale up, reframe, and reinvigorate existing debates about (planetary) health (Myers, 2017) and (planetary) justice (Biermann & Kalfagianni, 2020), among others. As the debate on nexus governance is located primarily in local, national, and regional contexts (primarily with a focus on urban and domestic law), we also aim to contribute by broadening the debate on nexus governance to the planetary scale, including with a focus on international environmental law, which we situate in the overarching context of the Anthropocene and the earth system perspective. Our focus is not on nexus governance per se, or the burgeoning field of nexus governance scholarship, but rather on the regulatory challenges that an integrated earth system poses to fragmented international environmental law, which are clearly visible in the context of the water–energy–food nexus. We therefore employ nexus governance as a useful way to think about the system-oriented challenges facing international environmental law, and we reference the water–energy–food nexus throughout the discussion to concretise our argument.

First, in Part 2, we discuss what the nexus governance approach means from an earth system perspective, and what its regulatory implications and demands could entail. In Part 3, we illustrate why international environmental law does not effectively facilitate planetary nexus governance. In Part 4, we introduce the idea of earth system law as a theoretical premise and framework to reimagine a type of international environmental law that can facilitate planetary nexus governance. Moving from theory to practice, we illustrate in Part 5 how an earth system law approach to some of the international legal norms governing water, energy, and food could operationalise nexus governance at a planetary scale. Although recognising there might be others, we focus for present purposes on two options: adopting a common shared *Grundnorm* (a fundamental norm underlying all other norms), such as planetary integrity in international environmental law that embodies its ultimate objective, and advancing the secondary rules of international law, also referred to as international institutional law, to better define how primary rules of conduct relate to each other, especially when they are in normative conflict. We conclude the discussion in Part 6.

2 | PLANETARY NEXUS GOVERNANCE IN AN EARTH SYSTEM CONTEXT

The Earth, as a complex system, is understood as the collection of all interacting physical, chemical, and biological global-scale cycles and energy fluxes which collectively provide the conditions necessary to enable and sustain life (Lenton, 2016). It is a materially closed system consisting of interlinked physical, chemical, and biological processes that cycle materials and energy in nonlinear, complex, and dynamic ways within the system, where all living organisms are active participants in (not simply passive respondents to) this system and vis-à-vis the range of other nonliving earth system components and processes (Steffen et al., 2004). As a 'science of integration' with a specific focus on the dynamics of the planetary life-support system as a whole, earth system science attempts to understand the earth system as a complex intertwined system, and it contributes to offering a more sophisticated and nuanced understanding of global sustainability challenges by *thinking with the earth system* (Kotzé, 2020).

Although earth system science is largely a natural science discipline, its insights have gradually been infiltrating the social science domain (Lövbrand et al., 2009). One consequence is that the earth system is emerging as a new planetary scale of governance in the Anthropocene, and this has numerous epistemic, normative, and ethical consequences (Schmidt, 2019). Social science research frameworks such as earth system governance are now exploring complex earth-system-related challenges for global governance, while at once opening novel epistemic pathways in global sustainability governance research (Biermann, 2014; Biermann & Lövbrand, 2019).

The novelty inherent in earth system thinking makes it possible to appreciate more fully the complexity of planetary earth system transformations and the multiple multiscale challenges these create. Climate change, for example, is one of nine interacting planetary boundaries (Rockström et al., 2009; Verschuuren, 2021) and is caused by activities ranging from fossil fuel combustion (energy) through land use change and biodiversity loss (food) to changes in hydrological cycles (water). The impacts of climate change are not only localised but are seen everywhere, also at a planetary scale. The cost of these impacts cannot only be measured in monetary or ecological terms; they also have profound impacts on the equity and justice concerns of vulnerable humans and nonhumans. States are not the only or primary stakeholders in governing climate change but, increasingly, also corporations and civil society actors, and their efforts to solve one aspect of the climate change challenge often create pervasive challenges elsewhere, as the deepening biofuels conundrum suggests (Gonzalez, 2016).

An earth system perspective reveals that climate change, with its embedded cause and effect relationships, is a planetary governance challenge that involves a complex set of interconnected concerns, actors, and impacts that must, as a consequence, be governed with a critical awareness of the implications of a deeply interconnected earth system that also recognises the many nexuses among earth system governance challenges (Steffen, 2011). The focus of an earth system governance approach will be, among others, on multiple intertwined human and nonhuman relationships, complex self-organising systems, irreversible impacts of interacting stresses, multiple interacting scales of organisation, the various state and nonstate actors and their overlapping agendas that influence and depend on earth system change, and the multiple norms operating at all levels to change behaviour (Ehlers & Krafft, 2006).

Nexus governance has emerged within the foregoing context of interdisciplinary transplantations from the natural to the social science domain, and the transition from an 'environmental management' paradigm to an earth system, governance-focused framework (Boas et al., 2016). The literature on nexus governance is burgeoning (Keairns et al., 2016), and it is now applied in many contexts, with the Sustainable Development Goals being one prominent example (Bleischwitz et al., 2018; Howe, 2019; Liu et al., 2018). The concept arose initially as a response to the specific challenge of governing interconnected aspects related to three particular problem domains, namely water, energy, and food, which is a classic example of an intertwined governance challenge that requires a systems approach. The challenge lies therein that water, for example, is required to produce food and energy; energy is required to produce and transport food and to purify and deliver water; and food virtually transports water, which is also an energy intensive process (Biggs et al., 2015; Endo et al., 2017; Leck et al., 2015; Weitz et al., 2017; Zhang et al., 2018). At a planetary scale, these nexus challenges are evident in the climate change context to the extent that water, energy, and food are all key climate change concerns, as we noted earlier. It is therefore not surprising that 'nexus literature often relates climate change as an element of the nexus as important as water, energy and food' (Urbinatti et al., 2020, p. 36).

The word 'nexus' clearly implies systematicity insofar as the nexus of water, energy, and food is considered as an interconnected system, and systems thinking fully underlies and frames several foundational concepts in nexus analysis, including, for example, the water–energy–food system (Urbinatti et al., 2020). As Covarrubias, Spaargaren, and Boas (2019, p. 1) put it, in essence:

Nexus thinking is about breaking down silos; it emerges as a way of thinking to identify and understand the interconnectedness of multiple resource flows within a particular

spatial and temporal context—for instance, the flows of water, energy, and food in a city. The nexus approach then is a form of systems thinking which focusses on the inter-linkages between natural resources and the ways in which the linkages are or could be managed and steered into more sustainable and integrated configurations.

Although the complex interconnected relationships between water, energy, and food are most apparent in the local context and, whereas the nexus governance discourse focusses predominately on the local level and domestic laws, its relevance is also becoming increasingly apparent for the planetary context. This is evident through the lens of the planetary boundaries framework. The nine planetary boundaries interact with each other, and the overall size of the safe operating space for humanity is determined by the dynamics of their complex interactions (Lade et al., 2020; Steffen et al., 2015). Therefore, the ultimate objective of staying within the safe operating space defined by the planetary boundaries raises difficult questions. How can the nexus of planetary boundaries on 'freshwater use', 'climate change', and 'biogeochemical flows', which correspond roughly to water, energy, and food, be governed? More specifically for the purpose of the present analysis, how can international environmental law facilitate planetary nexus governance that is fit for purpose in the Anthropocene?

3 | INTERNATIONAL ENVIRONMENTAL LAW DOES NOT EFFECTIVELY FACILITATE PLANETARY NEXUS GOVERNANCE

In answering these questions, we proceed from the premise that, as a human social system, law is an essential element of governance. It serves as a 'purposeful vehicle for shaping behavior to achieve desired ends' (Hadfield & Weingast, 2012, p. 473). International environmental law, in particular, will play a critically important role in a nexused form of earth system governance insofar as it helps to shape and constrain (or *govern*) how humans interact with other earth system constituents, elements, and processes (Du Toit & Kotzé, 2022).

International environmental law has admittedly made important contributions to advance environmental protection globally (Rajamani & Peel, 2021). Yet, it is also recognised in the same breath that 'there are clear constraints on what [international environmental law] can do, and can be expected to do, as it develops further' (Rajamani & Peel, 2021, p. 31). What is of particular interest for present purposes is the limits of international environmental law in governing the interaction between planetary boundaries and the concomitant need to reconceptualise how international environmental law

could facilitate nexus governance at a planetary scale. Recent reviews of the relevant literature highlight that international environmental law struggles to grapple with the coordination of planetary boundaries, which is a key challenge of planetary nexus governance (Biermann & Kim, 2020; French & Kotzé, 2021; Kim & Kotzé, 2021). We elaborate on this below by focusing on the issue of fragmentation and normative conflicts arising between treaty regimes governing the planetary water–energy–food security nexus and the inability of international environmental law to mediate these conflicts.

Because ‘the environment’ (or the ‘earth system’ in modern parlance) is an integrated phenomenon, one might logically assume that international environmental law will regulate global environmental issues in an integrated way. But this is not always the case. International environmental law, and its subdisciplines, such as international climate law (van Asselt, 2011, 2014), is characterised as a fragmented regime complex with conflicting provisions that often overlap and contradict, and it contains numerous regulatory gaps while lacking comprehensive and consolidated enforcement measures that could address environmental degradation in a holistic way (Wolfrum & Matz, 2003). Scholars acknowledge that fragmentation may ‘promote diversity in approaches, experimentation, and flexibility’, but it also gives rise to ‘uncertainty, confusion, and the entrenchment of power imbalances’ (Young, 2021b, p. 91).

International law makes provision to address such conflicts, and these also apply in the environmental context—the most prominent being the Vienna Convention on the Law of Treaties, which stipulates conflict resolution principles such as *lex specialis*, *lex posterior*, and *lex superior* (Sadat-Akhavi, 2003) that states can invoke. Over time, additional principles have emerged and evolved for similar purposes, including the principle of mutual supportiveness, which plays an important role in governing the trade–environment nexus (Kulovesi, 2014). Other examples are the principles of sustainable development and integration (Kim, 2016). There are, however, at least two concerns that arise in relation to this arrangement that seeks to resolve normative conflicts, concerns that might also significantly diminish the potential of international environmental law to address intertwined conflicts arising from the inherently competing water–energy–food triad at the planetary level.

First, the current set of principles seems to be ill-equipped to address normative conflicts in international *environmental* law, especially those arising between norms of equal priority (van Asselt, 2014; Wolfrum & Matz, 2003). Despite the International Law Commission (2006, p. 25) stating that ‘there is a strong presumption against normative conflict’ in international law, several norms continue to collide, especially in

the field of global sustainability. This fragmentation, and the conflicts that inevitably arise as a result, have legal and political dimensions and implications. As Young (2021a, 2021b, p. 21) notes, for example, an ‘intuition to interpret treaties so as to reduce the appearance of conflict usually modulates the weaker regime’.

One example of how this plays out in practice is the conflict between norms related, on one hand, to the governance of energy (renewable and nonrenewable; e.g., Redgwell, 2021), and on the other hand, those relating to the conservation of biodiversity (van Asselt, 2011). When conflict arises between these two sets of norms in relation to the development of hydropower or production of biofuels, for example, international environmental law provides little guidance on which of the norms should take priority (Kim, 2016; Pittock, 2010).

These concerns are addressed only to a limited extent through conflict clauses found in multilateral environmental agreements that specify which treaty (either the treaty that includes the conflict clause or others that it refers to) should prevail in case of conflict (van Asselt, 2011). Article 22 of the Convention on Biological Diversity, for example, states that ‘[t]he provisions of this Convention shall not affect the rights and obligations of any Contracting Party deriving from any existing international agreement, *except where the exercise of those rights and obligations would cause a serious damage or threat to biological diversity*’ (own emphasis). But these provisions are still not effectively operationalised, while they remain rather limited in their capacity to address environmental problem-shifting (Kim & van Asselt, 2016). What exactly is meant by ‘a serious damage or threat to biological diversity’ remains unclear, and the Conference of the Parties (COP) has yet to elaborate on the content of Article 22 to properly clarify and give effect to it. One could ask, for example, how much loss of what type of biodiversity is allowed under the Convention on Biological Diversity when its parties are implementing biofuel projects under the United Nations Framework Convention on Climate Change (Tilman et al., 2009)? Answering this question will arguably have a significant impact on how states decide to proceed in their efforts to clear rainforests (affecting biodiversity protection and food security) to increase agricultural capacity to plant crops for biofuels (to promote energy security); which in turn, affects both water security and climate change, and which will inevitably also have major justice implications globally (Gonzalez, 2016). The current constellation of international environmental law does not offer a satisfactory answer that might guide the formulation of a balanced or integrated solution to such conflicts where the aim should be to recognise nexuses, promote energy, water, and food security, and protect biodiversity, water resources, and the climate all at once.

Second, international environmental law’s prevailing reductionist approach to addressing the type of

trade-offs that are evident in the foregoing example is unsuitable for governing complex interconnectivity. This is because this approach to resolve normative conflicts focusses mostly on a dyadic interaction rather than triadic interactions in a system-nexus context. Dyadically, the underlying assumption seems to be that if we address trade-offs in water–energy, water–food, and food–energy interactions, the outcome will be net positive. But this is not necessarily the case. For example, if energy security is prioritised over water security, and food security prioritised over water security, we end up with little water security regardless of how the trade-off between energy and food security is addressed. Furthermore, scholars from across multiple disciplines have long observed that qualitative change occurs (or complexity emerges) when we move from two to three distinct entities (Orsini et al., 2013). Moreover, if water security is prioritised over energy security, energy security prioritised over food security, and food security prioritised over water security, we will possibly observe a negative downward spiral (where everyone loses), rather than a positive upward spiral (where everyone wins). With only a few exceptions suggesting otherwise (such as the joint COPs of the Basel, Rotterdam, and Stockholm Conventions; the Joint Liaison Group of the three Rio Conventions; and the Common Market for Eastern and Southern Africa-East Africa Community-Southern African Development Community [COMESA-EAC-SADC] Tripartite Institutional Framework), the practice seems to remain on addressing dyadic conflicts. Yet, what matters in a nexus (or a regime complex) is not just the dyadic interaction between two institutions, but also triadic dependencies that may ensue through how a focal institution affects relationships between other institutions.

This example suggests that nexus governance, where three priorities of equal importance compete against each other, must be more than the sum of the three separate processes that govern three interactions in isolation from each other. In other words, collectively addressing the trilemma of nexus governance is not the same as addressing three dilemmas separately. Whereas international environmental law seems to accomplish the latter, it is failing at the former, and it does not seem to be fully equipped yet to facilitate planetary nexus governance in both theory and practice. In that regard, international environmental law must advance, and for that purpose, we need a new conceptual framework to imagine what an international environmental law 2.0 could look like. We argue below that, with a systems-oriented ontology at its core, the earth system law framework is a promising potential candidate to reorientate international environmental law in such a way that it is better geared to facilitating nexus governance at a planetary scale.

4 | EARTH SYSTEM LAW: A CONCEPTUAL FRAMEWORK FOR LAW IN THE ANTHROPOCENE

Scholars are increasingly exploring alternative visions for international environmental law in the Anthropocene, alternatives that they hope will be more fully able to respond legally to the prevailing Anthropocene reality that is filled with nexuses, as it were (Kotzé, 2017; Webster & Mai, 2021). One candidate is earth system law, an innovative legal imaginary that is rooted in the Anthropocene's planetary context and its perceived socioecological crisis (Kotzé & Kim, 2019; see also Ahlström et al., 2021; Cardesa-Salzman & Cocciolo, 2019; Du Toit et al., 2021; Gellers, 2021; Du Toit & Kotzé, 2022; Kim et al., 2022; Kotzé, Kim, Blanchard, et al., 2022a; Mai & Boulot, 2021; Petersmann, 2021; Pope et al., 2021; van Asselt, 2021; van Dijk, 2021).

By definition, 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. It is an alternative theoretical framing for law which is geared towards facilitating the type of transformation of law that is in step with a continuously transforming earth system. The purpose of earth system law is to align law (as an episteme, practice, and discipline) with an earth system perspective. It does so by prompting lawyers and policymakers to discard assumptions of one-dimensional Holocene-nested linearity, predictability, simplicity, and harmony on which much of law still rests; and instead to embrace an alternative understanding of the role and contribution of law in governing complex, nonlinear, interconnected, multiscalar, and unpredictable earth system governance challenges that arise in the Anthropocene.

In the foregoing conceptualisation, earth system law is not so much a new body of law as it is a vision or imaginary of what law, in its broadest sense, could be or become for the purpose of, among others, facilitating the legal aspects of planetary nexus governance. Earth system law is therefore a way of seeing the law through an earth system lens; it is about exploring the plurality of ways, in intra-, inter-, and transdisciplinary settings, about how an earth system perspective could inspire innovative legal responses to and reforms of social behaviour (and certainly reforms of the law itself) to confront the complex challenges posed by interconnected earth system transformations (Kotzé, Kim, Blanchard, et al., 2022a). In this sense, our vision of earth system law closely resembles other emerging reconceptualisations of 'interconnected' law, such as transnational environmental law, that have been proposed as alternative integrated epistemic frameworks to think about, and advance, law in a globalised, highly interconnected, world (Heyvaert & Ety, 2012). But earth system

law is particularly novel in the sense that it explicitly embraces earth system complexity, and everything that goes with that impulse, as its central orientation that must guide the development of law and determine how law could more effectively tackle intertwined earth system governance challenges (Kotzé & Kim, 2019).

The earth system law perspective offers an opportunity to engage critically with how international environmental law relating to the governance of water, energy, and food security could cater for the high levels of complexity and interconnectivity required to govern this triad at a planetary scale. The mismatch between the ways in which international environmental treaty regimes governing issues related to water, energy, and food interact with each other on one hand, and how the water–energy–food nexus ought to be governed on the other hand, neatly illustrates the conundrum (Ebbesson, 2014). It is time to explore new legal imaginaries that are more fit for purpose in a new geological epoch. To this end, the concept of earth system law offers an opportunity to innovatively reimagine a form of international environmental law that is better able to govern interdependent earth system concerns such as water, energy, and food at a planetary scale.

5 | FROM THEORY TO PRACTICE: OPERATIONALISING PLANETARY NEXUS GOVERNANCE

The earth system law framework must not only acknowledge the need to take a planetary nexus approach and overcome fragmentation, but it must go well beyond conventional approaches of normative conflict resolution discussed above. For example, because it has the benefit of drawing on a systems ontology and because it focusses on an integrated earth system as its principal regulatory object (informed as such a focus is by earth system science; Kotzé, Kim, Blanchard, et al., 2022a), the question that earth system law could help address is not simply *whether* to take interlinkages seriously and break down silos, but *how* to strike a balance between competing interests, as well as suggesting *where* that balance might be in complex governance situations.

The earth system law framework is concerned with the *net* effectiveness of planetary nexus governance or the extent to which its nexus-level goal is achieved. Although the nexus-level goal is often not explicitly defined by the actors or institutions involved in a particular instance and although it is necessarily context-dependent, in principle, the goal of any nexus governance approach would be to achieve an *optimal* outcome for all. Seen from such a perspective, the process of planetary nexus governance could then be described as akin to solving the problem of multi-objective optimisation in complex systems. Here the optimal solution could be, for example, a situation where no individual preference (such as water, energy,

or food security) can be made better off without making at least one individual preference worse off (Kennedy et al., 2008). The earth system law framework could facilitate this optimisation process in planetary nexus governance by offering a perspective on what is desirable for the earth system as a whole.

But although the idea of earth system law offers in theory a solution for international environmental law to pursue planetary nexus governance, the more pertinent question remains: *how to achieve this in practice?* How could one make fragmented international environmental law work better as a whole in a nexused way at the planetary level? In the remainder of this part, we briefly explore two options.

First, we suggest that how exactly a trilemma between water, energy, and food should be addressed would likely depend on whether or not a solution aligns with, and contributes to, advancing an ultimate sustainability *Grundnorm* (a norm that underlies all other norms), such as safeguarding the integrity of Earth's life-support system, or planetary integrity (Kim et al., 2020; Kotzé, Kim, Burdon, et al., 2022b). What this essentially entails is 'the return of Kantian ethics via a *grundnorm* that uses planetary boundaries for the Earth system to ground international law' (Schmidt, 2019, p. 726). The overarching goal of the water–energy–food nexus, or any other planetary-scale nexus for that matter, would then be to balance competing interests in a way that contributes to overall planetary integrity. If all norms must eventually work towards the collective achievement of the planetary integrity *Grundnorm*, any one specific norm that might conflict with others and impede the pursuit of planetary integrity will have to stand down in favour of the norms that do contribute to achieving the *Grundnorm*. A nexus-level goal accordingly defined would in turn serve as an 'arbiter' for normative conflict resolution to ensure an optimal outcome at the nexus level. To promote the prospect of potentially competing norms as being part of any shared purpose, such as the pursuit of planetary integrity, an earth system law perspective must also allow for legal interpretation that builds systemic relationships. To this end, ambitious, out-of-the-box legal innovations are necessary and could, for example, include formally adopting a legally binding *Grundnorm* in international environmental law in a new global framework environmental agreement or as a foundational principle that is incorporated in all issue-specific existing and new multilateral environmental agreements dealing with biodiversity, climate change, and so on (Kim & Bosselmann, 2013, 2015).

Second, another opportunity lies in so-called 'secondary rules' of international law that are concerned with international institutional governance. As Bodansky (2006, p. 304) writes:

what is thought to tie international law together—what makes it a 'system' rather than simply an amalgamation of rules—is

not its primary rules of conduct, but rather its secondary rules: its rules about how the international legal process works—how international law is created, interpreted, applied, and enforced—as well as about the fundamental structural elements of the international system—the concepts of sovereign equality, state responsibility, international legal personality, and so forth.

We have witnessed an explosion of multilateral environmental agreements over the past three decades (Mitchell et al., 2020); there is certainly no shortage of primary rules of conduct for states. So far, states and other lawmakers have focused on expanding the corpus of international environmental law by agreeing on an increasing number of primary rules for different issue areas. These primary rules include, for example for international water law, the principle of equitable and reasonable use and the obligation not to cause significant harm. However, less attention has been paid to secondary institutional type rules that could help align international environmental law with the earth system's functional, spatial, and temporal complexities and enable planetary nexus governance.

Many of these secondary rules can be found in a separate branch of international law—international institutional law (or global administrative law; Kingsbury & Casini, 2009). This is the body of rules and practices concerning the legal status, membership, decision-making, financing, supervision, and external relations of international organisations and other governance institutions (Schermers & Blokker, 2011). As the law governing the relationship between international institutions, international institutional law could bring together fragmentary international (environmental) law alongside an earth system perspective by aligning secondary/administrative rules and procedures (Figure 1).

One example of a promising secondary rule in this regard is Article 31(3)(c) of the Vienna Convention on the Law of Treaties, which is referred to as the principle of systemic integration (McLachlan, 2005). Pursuant to this principle, various international legal norms at work in planetary nexus governance could be interpreted and applied with reference to 'any relevant rules of international law applicable in the relations between the parties'. Article 31(3)(c) could help fulfil the critical role of institutionalising flexibility when, for example, resolving a conflict that arises between primary rules related to water–energy–food. These could include overarching

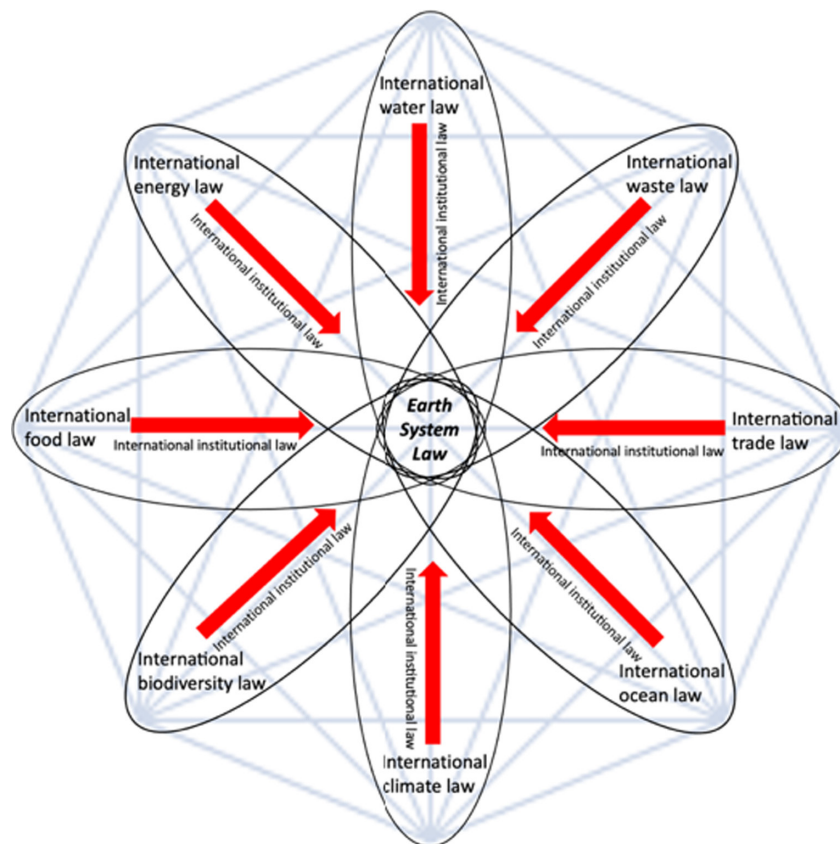


FIGURE 1 Earth system law in its integrated form is required to operationalise nexus governance at a planetary scale. Advancing the fragmented system of international (environmental) law to earth system law, in turn, requires further development of international institutional law.

rules that are essential to enabling polycentric governance initiatives to work (Jordan et al., 2018).

Yet, the formulation of Article 31(3)(c) has been criticised as being unclear both in its substantive and temporal scope and its normative force (French, 2006; McLachlan, 2005; Merkouris, 2015), and it will therefore be necessary to also drive further development of the law of treaties specifically, and international institutional law more generally, to fully advance an earth system-oriented legal approach.

Another area for development would include the liability regime for international organisations, including, specifically COPs. COPs are autonomous institutional arrangements with a considerable degree of agency (Churchill & Ulfstein, 2000) and law-making power (Wiersema, 2009), which should in principle be accompanied by a corresponding level of responsibility to make the type of laws that actually give full effect to the overall objectives of treaty regimes. However, the seldom questioned assumption that decisions of environment-related COPs are inherently 'green' seems to have discouraged a discussion of the responsibility of these treaty bodies. The 2011 Draft Articles on the Responsibility of International Organizations of the International Law Commission remains in draft form, and currently little is being done in practice to hold international organisations accountable when they engage in an internationally wrongful act, also if that wrongful act leads to environmental harm. More difficult even is the case of COPs making decisions that could result in severe and chronic environmental harm, for example, through environmental problem-shifting (Kim & van Asselt, 2016), including within the water–energy–food nexus.

Although it is a work-in-progress, international institutional law does offer the potential to link disparate environmental and other regimes that are all relevant to governing the planetary water–energy–food nexus through secondary institutional rules. As we illustrate in Figure 1, these could include international energy law, waste law, water law, food law, biodiversity law, climate law, ocean law, and trade law through secondary institutional laws. In line with Bodansky's (2006) suggestion above, we argue that the further development of international institutional law should become a priority in future, as it can better link up and integrate disparate environment-related international legal regimes through secondary rules.

6 | CONCLUSION

As sustainability challenges become increasingly interconnected, the need to break down silos between governance institutions is becoming increasingly important, also at the planetary level. As a key regulatory institution, international environmental law has an important role to play in addressing deeply complex earth system governance challenges. However, it remains unable to do so, mainly

because it is blind to the need for facilitating a planetary nexus governance approach. We have argued that earth system law offers an epistemic framework to reimagine law more generally, and international environmental law specifically, alongside an earth system perspective that could better govern nexuses at the planetary level.

Earth system law is a vision of what law in the Anthropocene should become. It is a legal imaginary that is being shaped by the idea of the earth system, on which it draws, to inform its own innovative reconstruction of legal responses to complex and interconnected earth system governance challenges. Earth system law as a systems-oriented 'continuum of laws' is not territorially bound; it is not local, national, regional, or international law; it is nonterritorial and nonsectoral, or more generally put, noncentric. The earth system law framework's embrace of an earth system perspective renders it more attentive to the concerns of complexity and interconnectivity that characterise the earth system.

This, in turn, implies that the earth system law framework might offer alternatives that could be more effective at governing complex interconnectivity (Young, 2017). This would include addressing trilemmas such as those evident in the water–energy–food nexus more effectively, also at a planetary level. Earth system law, as we envision it, could therefore be a useful approach to determine the legal aspects related to cross-scaling of governance solutions to and from multiple nexuses that occur and interact across levels.

Practically, earth system law for planetary nexus governance could be nurtured by adopting a common global *Grundnorm* such as the need to safeguard planetary integrity, and/or through advancing secondary rules of international law that would effectively determine how primary rules of conduct would relate to each other. Taken to its extreme, our vision of earth system law, both in theory and in practice, could extend to the nexus of nexuses, as it were, or the entire network of international institutions (Kim, 2020) that we need in order to address globally networked socioecological risks (Galaz et al., 2017), as we continue to plunge deeper into the unknown abyss of the Anthropocene.

ACKNOWLEDGEMENTS

Our sincere thanks to Amanda Kennedy, Tim Stephens, Duncan French, the special issue editors, and the anonymous reviewers, for their helpful views on an earlier draft. Research was supported by Institute for Advanced Sustainability Studies, Potsdam under its Klaus Töpfer Sustainability Fellowship Scheme. Responsibility for its contents lies with the authors. Research was also supported by the European Research Council under grant agreement number 949252.

DATA AVAILABILITY STATEMENT

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

REFERENCES

- Ahlström, H., Hileman, J., Wang-Erlandsson, L., García, M.M., Moore, M.L., Jonas, K. et al. (2021) An earth system law perspective on governing social-hydrological systems in the Anthropocene. *Earth System Governance*, 10, 100120.
- Biermann, F. (2014) *Earth system governance: world politics in the Anthropocene*. Cambridge, MA: MIT Press.
- Biermann, F. & Kalfagianni, A. (2020) Planetary justice: a research framework. *Earth System Governance*, 6, 100049.
- Biermann, F. & Kim, R.E. (2020) The boundaries of the planetary boundary framework: a critical appraisal of approaches to define a “safe operating space” for humanity. *Annual Review of Environment and Resources*, 45, 497–521.
- Biermann, F. & Lövbrand, E. (2019) *Anthropocene encounters: new directions in green political thinking*. Cambridge: Cambridge University Press.
- Biggs, E.M., Bruce, E., Boruff, B., Duncan, J.M.A., Horsley, J., Pauli, N. et al. (2015) Sustainable development and the water–energy–food nexus: a perspective on livelihoods. *Environmental Science and Policy*, 54, 389–397.
- Bleischwitz, R., Spataru, C., VanDeveer, S.D., Obersteiner, M., van der Voet, E., Johnson, C. et al. (2018) Resource nexus perspectives towards the United Nations sustainable development goals. *Nature Sustainability*, 1, 737–743.
- Boas, I., Biermann, F. & Kanie, N. (2016) Cross-sectoral strategies in global sustainability governance: towards a nexus approach. *International Environmental Agreements: Politics, Law and Economics*, 16, 449–464.
- Bodansky, D. (2006) Does one need to be an international lawyer to be an international environmental lawyer? *American Society of International Law Proceedings*, 100, 303–307.
- Brovkin, V., Brook, E., Williams, J.W., Bathiany, S., Lenton, T.M., Barton, M. et al. (2021) Past abrupt changes, tipping points and cascading impacts in the earth system. *Nature Geoscience*, 14(8), 550–558.
- Cardesa-Salzman, A. & Cocciolo, E. (2019) Global governance, sustainability and the earth system: critical reflections on the role of global law. *Transnational Environmental Law*, 9(3), 437–461.
- Churchill, R.R. & Ulfstein, G. (2000) Autonomous institutional arrangements in multilateral environmental agreements: a little-noticed phenomenon in international law. *American Journal of International Law*, 94, 623–659.
- Covarrubias, M., Spaargaren, G. & Boas, I. (2019) Network governance and the urban nexus of water, energy, and food: lessons from Amsterdam. *Energy, Sustainability and Society*, 9, 1–11.
- Dryzek, J. (2016) Institutions for the Anthropocene: governance in a changing earth system. *British Journal of Political Science*, 46(4), 937–956.
- Dryzek, J. & Pickering, J. (2019) *The politics of the Anthropocene*. Oxford: Oxford University Press.
- Du Toit, L. & Kotzé, L.J. (2022) Reimagining international environmental law for the Anthropocene: an earth system law perspective. *Earth System Governance*, 11, 100132.
- Du Toit, L., Lopez Porras, G. & Kotzé, L.J. (2021) Guiding environmental law's transformation into earth system law through the telecoupling framework. *European Energy and Environmental Law Review*, 30(3), 104–113.
- Ebbesson, J. (2014) Planetary boundaries and the matching of international treaty regimes. *Scandinavian Studies in Law*, 59, 259–284.
- Ehlers, E. & Krafft, T. (Eds.) (2006) *Earth system science in the Anthropocene: emerging issues and problems*. Berlin: Springer.
- Endo, A., Tsurita, I., Burnett, K. & Orencio, P.M. (2017) A review of the current state of research on the water, energy, and food Nexus. *Journal of Hydrology: Regional Studies*, 11, 20–30.
- Franz, M., Schlitz, N. & Schumacher, K.P. (2018) Globalization and the water-energy-food nexus: using the global production networks approach to analyze society-environment relations. *Environmental Science and Policy*, 90, 201–212.
- French, D. (2006) Treaty interpretation and the incorporation of extraneous legal rules. *International and Comparative Law Quarterly*, 55(2), 281–314.
- French, D. & Kotzé, L.J. (Eds.) (2021) *Research handbook on law, governance and planetary boundaries*. Cheltenham: Edward Elgar.
- Galaz, V. (2014) *Global environmental governance, technology and politics: the Anthropocene gap*. Cheltenham: Edward Elgar.
- Galaz, V., Tallberg, J., Boin, A., Ituarte-Lima, C., Hey, E., Olsson, P. et al. (2017) Global governance dimensions of globally networked risks: the state of the art in social science research. *Risk, Hazards and Crisis in Public Policy*, 8(1), 4–27.
- Gellers, J.C. (2021) Earth system law and the legal status of non-humans in the Anthropocene. *Earth System Governance*, 7, 100083.
- Gonzalez, C. (2016) The environmental justice implications of bio-fuels. *UCLA Journal of International Law and Foreign Affairs*, 20, 229–274.
- Hadfield, G. & Weingast, B. (2012) What is law? A coordination model of the characteristics of a legal order. *Journal of Legal Analysis*, 4(2), 471–514.
- Heyvaert, V. & Etty, R. (2012) Introducing transnational environmental law. *Transnational Environmental Law*, 1(1), 1–11.
- Howe, P. (2019) The triple nexus: a potential approach to supporting the achievement of the sustainable development goals? *World Development*, 124, 104629.
- Hull, V. & Liu, J. (2018) Telecoupling: a new frontier for global sustainability. *Ecology and Society*, 23(4), 41.
- International Law Commission. (2006) *Fragmentation of international law: difficulties arising from the diversification and expansion of international law*. Geneva: United Nations.
- Jordan, H., Huitema, D., Schoenefeld, J., van Asselt, H. & Forster, J. (2018) Governing climate change Polycentrically: setting the scene. In: Jordan, A., Huitema, D., van Asselt, H. & Forster, J. (Eds.) *Governing climate change: Polycentricity in action?* Cambridge: Cambridge University Press, pp. 3–26.
- Keairns, D., Darton, D. & Irabien, A. (2016) The energy-water-food nexus. *Annual Review of Chemical and Biomolecular Engineering*, 7, 239–262.
- Kennedy, M.C., Ford, E.D., Singleton, P., Finney, M. & Agee, J.K. (2008) Informed multi-objective decision-making in environmental management using Pareto optimality. *Journal of Applied Ecology*, 45(1), 181–192.
- Kim, R.E. (2016) The nexus between international law and the sustainable development goals. *Review of European, Comparative and International Environmental Law*, 25(1), 15–26.
- Kim, R.E. (2020) Is global governance fragmented, polycentric, or complex? The state of the art of the network approach. *International Studies Review*, 22(4), 903–931.
- Kim, R.E. (2021) Taming Gaia 2.0: earth system law in the ruptured Anthropocene. *The Anthropocene Review*, 1–14.
- Kim, R.E. & Bosselmann, K. (2013) International environmental law in the Anthropocene: towards a purposive system of multilateral environmental agreements. *Transnational Environmental Law*, 2(2), 285–309.
- Kim, R.E. & Bosselmann, K. (2015) Operationalizing sustainable development: ecological integrity as a *Grundnorm* of international law. *Review of European, Comparative and International Environmental Law*, 24(2), 194–208.
- Kim, R.E. & Kotzé, L.J. (2021) Planetary boundaries at the intersection of earth system law, science and governance: a state of the art review. *Review of European, Comparative and International Environmental Law*, 30(1), 3–15.
- 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*. Cheltenham: Edward Elgar, pp. 473–495.
- Kim, R.E., van Asselt, H., Kotzé, L.J., Vijge, M.J. & Biermann, F. (2020) Hierarchization. In: Biermann, F. & Kim, R.E. (Eds.) *Architectures of earth system governance: institutional complexity and*

- structural transformation*. Cambridge: Cambridge University Press, pp. 275–296.
- Kim, R.E., Blanchard, C. & Kotzé, L.J. (2022) Law, systems, and planet earth: editorial. *Earth System Governance*, 11, 100127.
- Kingsbury, B. & Casini, L. (2009) Global administrative law dimensions of international organizations law. *International Organizations Law Review*, 6, 319–358.
- Kotzé, L.J. (Ed.). (2017) *Environmental law and governance for the Anthropocene*. Oxford: Hart.
- Kotzé, L.J. (2019a) Earth system law for the Anthropocene. *Sustainability*, 11, 1–13.
- Kotzé, L.J. (2019b) International environmental Law's lack of normative ambition: an opportunity for the global pact for the environment? *Journal for European Environmental and Planning Law*, 16, 213–236.
- Kotzé, L.J. (2020) Earth system law for the Anthropocene: rethinking environmental law alongside the earth system metaphor. *Transnational Legal Theory*, 11(1/2), 75–104.
- Kotzé, L.J. & French, D. (2018) A critique of the global pact for the environment: a stillborn initiative or the foundation for *Lex Anthropocena*? *International Environmental Agreements: Politics, Law and Economics*, 18, 811–838.
- Kotzé, L.J. & Kim, R.E. (2019) Earth system law: the juridical dimensions of earth system governance. *Earth System Governance*, 1, 100003.
- Kotzé, L.J., Kim, R.E., Blanchard, C., Gellers, J., Holley, C., Petersmann, M. et al. (2022a) Earth system law: exploring new frontiers in legal science. *Earth System Governance*, 11, 100126.
- Kotzé, L.J., Kim, R.E., Burdon, P., Du Toit, L., Glass, L.M., Kashwan, P. et al. (2022b) Planetary integrity. In: Biermann, F., Hickmann, T. & Sénit, C.-A. (Eds.) *The political impact of the Sustainable Development Goals: transforming governance through global goals?*. Cambridge: Cambridge University Press, pp. 140–171.
- Kulovesi, K. (2014) International trade disputes on renewable energy: testing ground for the mutual supportiveness of WTO law and climate change law. *Review of European, Comparative and International Environmental Law*, 23(3), 342–353.
- Lade, S.J., Steffen, W., de Vries, W., Carpenter, S.R., Donges, J.F., Gerten, D. et al. (2020) Human impacts on planetary boundaries amplified by earth system interactions. *Nature Sustainability*, 3, 119–128.
- Leck, H., Conway, D., Bradshaw, M. & Rees, J. (2015) Tracing the water–energy–food nexus: description, theory and practice. *Geography Compass*, 9(8), 445–460.
- Lenton, T. (2016) *Earth system science: a very short introduction*. Oxford: Oxford University Press.
- Levin, K., Cashore, B., Bernstein, S. & Auld, G. (2012) Overcoming the tragedy of super wicked problems: constraining our future selves to ameliorate global climate change. *Policy Sciences*, 45(2), 123–152.
- Liu, J., Hull, V., Godfray, H.C.J., Tilman, D., Gleick, P., Hoff, H. et al. (2018) Nexus approaches to global sustainable development. *Nature Sustainability*, 1, 466–476.
- Lövbrand, E., Stripple, J. & Wiman, B. (2009) Earth system governmentality: reflections on science in the Anthropocene. *Global Environmental Change*, 19(1), 7–13.
- Mai, L. & Boulot, E. (2021) Harnessing the transformative potential of earth system law: from theory to practice. *Earth System Governance*, 7, 100103.
- McLachlan, C. (2005) The principle of systemic integration and article 31(3)(c) of the Vienna convention. *International and Comparative Law Quarterly*, 54(2), 279–320.
- Merkouris, P. (2015) *Article 31(3)(c) VCLT and the principle of systemic integration: normative shadows in Plato's cave*. Leiden: Brill.
- Mitchell, R.B., Andonova, L.B., Axelrod, M., Balsiger, J., Bernauer, T., Green, J.F., et al. (2020) What we know (and could know) about International Environmental Agreements. *Global Environmental Politics*, 20(1), 103–121.
- Myers, S. (2017) Planetary health: protecting human health on a rapidly changing planet. *Lancet*, 390, 2860–2868.
- Newig, J., Challies, E., Cotta, B., Lenschow, A. & Schilling-Vacaflor, A. (2020) Governing global telecoupling toward environmental sustainability. *Ecology and Society*, 25(4), 21.
- Orsini, A., Morin, J.-F. & Young, O. (2013) Regime complexes: a buzz, a boom, or a boost for global governance? *Global Governance*, 19, 27–39.
- Pereira, J.C. & Viola, E. (2018) Catastrophic climate change and forest tipping points: blind spots in international politics and policy. *Global Policy*, 9, 513–524.
- Petersmann, M.-C. (2021) Sympoietic thinking and earth system law: the earth, its subjects and the law. *Earth System Governance*, 9, 100114.
- Pittock, J. (2010) A pale reflection of political reality: integration of global climate, wetland, and biodiversity agreements. *Climate Law*, 1(3), 343–373.
- 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 System Governance*, 10, 100124.
- Rajamani, L. & Peel, J. (2021) Reflections on a decade of change in international environmental law. *Cambridge International Law Journal*, 10, 6–31.
- Redgwell, C. (2021) Energy. In: Rajamani, L. & Peel, J. (Eds.) *The Oxford handbook of international environmental law*. Oxford: Oxford University Press, pp. 848–864.
- Rockström, J., Steffen, W., Noone, K., Persson, A., Chapin, F.S., III, Lambin, E. et al. (2009) Planetary boundaries: exploring the safe operating space for humanity. *Ecology and Society*, 14(2), 1–32.
- Sadat-Akhavi, A. (2003) *Methods of resolving conflicts between treaties*. Alphen aan den Rijn: Kluwer Law International.
- Schermer, H.G. & Blokker, N.M. (2011) *International institutional law: Unity in diversity*, 5th edition. Leiden: Martinus Nijhoff.
- Schmidt, J. (2019) The moral geography of the earth system. *Transactions of the Institute of British Geographers*, 44(4), 721–734.
- Steffen, W. (2011) A truly complex and diabolical policy problem. In: Dryzek, J., Norgaard, R. & Schlosberg, D. (Eds.) *The Oxford handbook of climate change and society*. Oxford: Oxford University Press, pp. 21–37.
- Steffen, W., Sanderson, R.A., Tyson, P.D., Jäger, J., Matson, P.A., Moore, B., III et al. (2004) *Global change and the earth system: a planet under pressure*. Berlin: Springer.
- Steffen, W., Richardson, K., Rockström, J., Cornell, S.E., Fetzer, I., Bennett, E.M. et al. (2015) Planetary boundaries: guiding human development on a changing planet. *Science*, 347, 1259855.
- Stephens, T. (2017) Reimagining international environmental law in the Anthropocene. In: Kotzé, L.J. (Ed.) *Environmental law and governance for the Anthropocene*. Oxford: Hart, pp. 31–54.
- Tilman, D., Socolow, R., Foley, J.A., Hill, J., Larson, E., Lynd, L. et al. (2009) Beneficial biofuels - the food, energy, and environment trilemma. *Science*, 325(5938), 270–271.
- Urbanatti, A.M., Benites-Lazaro, L.L., Monteiro de Carvalho, C. & Giatti, L.L. (2020) The conceptual basis of water-energy-food nexus governance: systematic literature review using network and discourse analysis. *Journal of Integrative Environmental Sciences*, 17(2), 21–43.
- van Asselt, H. (2011) Managing the fragmentation of international environmental law: forests at the intersection of the climate and biodiversity regimes. *New York University of International Law and Politics*, 44(4), 1205–1278.
- van Asselt, H. (2014) *The fragmentation of global climate governance: consequences and management of regime interactions*. Cheltenham: Edward Elgar.
- 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 System Governance*, 9, 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 System Governance*, 10, 100123.
- Verschuuren, J. (2021) Climate change. In: French, D. & Kotzé, L.J. (Eds.) *Research handbook on law, governance and planetary boundaries*. Cheltenham: Edward Elgar, pp. 245–259.
- Viñuales, J. (2018) The organisation of the Anthropocene in our hands? *International Legal Theory and Practice*, 1(1), 1–81.
- Webster, E. & Mai, L. (Eds.) (2021) *Transnational environmental law in the Anthropocene: reflections on the role of law in times of planetary change*. London: Routledge.
- Weitz, N., Strambo, C., Kemp-Benedict, E. & Nilsson, M. (2017) Closing the governance gaps in the water-energy-food nexus: insights from integrative governance. *Global Environmental Change*, 45, 165–173.
- Wiersema, A. (2009) The new international law-makers? Conferences of the parties to multilateral environmental agreements. *Michigan Journal of International Law*, 31, 231–287.
- Wolftrum, R. & Matz, N. (2003) *Conflicts in international environmental law*. Berlin: Springer.
- Young, O.R. (2017) *Governing complex systems: social capital for the Anthropocene*. Cambridge, MA: MIT Press.
- Young, O.R. (2021a) *Grand challenges of planetary governance: global order in turbulent times*. Cheltenham: Edward Elgar.
- Young, M. (2021b) Fragmentation. In: Rajamani, L. & Peel, J. (Eds.) *The Oxford handbook of international environmental law*. Oxford: Oxford University Press, pp. 85–101.
- Zhang, C., Chen, X., Li, Y., Ding, W. & Fu, G. (2018) Water-energy-food nexus: concepts, questions and methodologies. *Journal of Cleaner Production*, 195, 625–639.

AUTHOR BIOGRAPHIES

Louis J. Kotzé is a Research Professor at the North-West University in South Africa. He is also Senior Professorial Fellow in Earth System Law at the University of Lincoln, UK, and the 2022 Klaus Töpfer Sustainability Fellow at the Institute for Advanced Sustainability Studies (IASS) in Potsdam, Germany.

Rakhyun E. Kim is an assistant professor at the Copernicus Institute of Sustainable Development at Utrecht University in the Netherlands. He directs a research programme on the complex dynamics of problem-shifting in global environmental governance with a Starting Grant from the European Research Council.

How to cite this article: Kotzé, L.J. & Kim, R.E. (2022) Towards planetary nexus governance in the Anthropocene: An earth system law perspective. *Global Policy*, 13(Suppl. 3), 86–97. Available from: <https://doi.org/10.1111/1758-5899.13149>