



Earth system law: Exploring new frontiers in legal science

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ABSTRACT

The Anthropocene requires of us to rethink global governance challenges and effective responses with a more holistic understanding of the earth system as a single intertwined social-ecological system. Law, in particular, will have to embrace such a holistic earth system perspective in order to deal more effectively with the Anthropocene's predicaments. While a growing number of scholars have tried to reimagine law and legal scholarship in a more holistic way, these attempts remain siloed. What is required is a shared epistemic framework to enable and enhance collaborative intradisciplinary and interdisciplinary research and co-learning that go hand in hand with thorough transdisciplinary stakeholder engagement. We argue that the nascent concept of earth system law offers such an overarching epistemic framework. This article serves as an invitation to fellow explorers from various legal fields, other disciplines, and from a wide range of stakeholders to explore new frontiers in earth system law. Our aim is to further stimulate the study of earth system law, and to encourage collaboration and co-learning in a fertile epistemic space that we share.

1. Introduction

The entire earth system has emerged as a new scale of, and context for, governance in the Anthropocene (Biermann, 2014; Burch et al., 2019). This trend is revealing a range of complex challenges for global governance and opening novel epistemic pathways in global sustainability governance research (Biermann and Lövbrand, 2019). The Anthropocene-centred earth system perspective suggests that our Holocene-premised institutions and modernist episteme are ill-equipped to better understand and address worsening Anthropocene predicaments (Chandler, 2018; Dryzek and Pickering, 2018). The boundaries between humans and non-humans have blurred (Haraway, 2016; Tsing et al., 2020); the world has become increasingly telecoupled through flows of energy, materials, and information (Liu et al., 2007); and planetary risks have become globally networked through, among others, interacting planetary boundaries (Helbing, 2013; Galaz et al.,

2017). This interconnectivity highlights the challenges that global governance interventions face in responding to cascading risks that are deeply embedded in complex multi-scalar and causally linked relationships (Newig et al., 2020; Hey, 2021).

The Anthropocene therefore requires us to rethink global governance challenges and effective responses with a more holistic understanding of the earth system as a single intertwined social-ecological system (Young and Steffen, 2009; Lidskog and Waterton, 2016). One pertinent issue that requires critical reflection is how normative systems, such as those embedded in law, could embrace an earth system perspective (Biermann, 2014; Kotzé, 2020). Several scholars have started engaging with the difficulties of the legal episteme to deal with the Anthropocene's predicaments and with deeply intertwined global governance challenges, and to reimagine law and legal scholarship in a more holistic way that cuts across silos, captures the bigger picture, and opens the closures of law to multiple stakeholders, including the marginalized, the unborn,

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and the non-human (e.g., Kim and Bosselmann, 2013; Scott, 2013; Robinson, 2014; Gonzalez, 2015; Vidas et al., 2015; Kotzé, 2017; Viñuales, 2018; Brunnée, 2019; Lim, 2019; Brown Weiss, 2020; Kim, 2021). This has led to the development of new legal paradigms such as global law (Teubner, 1997; Yang and Percival, 2009; Walker, 2014), transnational law (Koh, 2006; Sand, 2012; Zumbansen, 2020), decolonial, indigenous and métissage law (Black, 2011; Anker, 2017; Nursoo, 2018), Third-World Approaches to (international) Law (Anghie, 2005; Chimni, 2006), and queer law (Otto, 2018), among others.

In the field of environmental law, concepts such as ecological law (Capra and Mattei, 2015; Anker et al., 2020), sustainability law (Boer, 2000; Kim, 2016), Earth-centred law (Bosselmann, 2016), Earth jurisprudence and wild law (Burdon, 2011; Cullinan, 2011), Anthropocene law (Aragão, 2016; Vermeylen, 2017; Kotzé and French, 2018; Grear, 2020), planetary boundaries law (Chapron et al., 2017; Fernandez and Malwé, 2019), and feminist, queer and posthuman ecological law (Grear et al., 2021; Jones, 2021; Norman, 2021; Petersmann, 2021a), have also sought to transcend traditional framings of law and the role of law in mediating human behaviour. However, these emerging efforts remain disjointed and many more interrogations regarding the difficulties posed to law in *thinking with the earth system*, as it were – of which humans and their legal constructs are an inherent part of – remain to be explored.

Such efforts need a shared epistemic framework to enable and enhance collaborative intradisciplinary and interdisciplinary research and co-learning that go hand in hand with transdisciplinary stakeholder engagement to allow for a scholarly understanding of what makes law more sensitive and responsive to earth system governance challenges. The nascent concept of earth system law offers such an overarching epistemic framework. Earth system law has emerged as an alternative innovative legal imaginary that is rooted in the Anthropocene's planetary context and its perceived social-ecological challenges (Kotzé and Kim, 2019, 2021; Du Toit et al., 2021; Gellers, 2021; Kim and Kotzé, 2021; Mai and Boulot, 2021; Kim, 2021; van Asselt, 2021). As a contribution to the further development of the earth system law paradigm, we pose the question in this article: how could the earth system law framework open up new intradisciplinary, interdisciplinary and transdisciplinary epistemic pathways that seek to make law more sensitive to and reflective of the functioning of the earth system as a social-ecological system? We argue that for law to become embedded in and aligned with an earth system perspective, we will need to enable a systems approach to law and its epistemologies through more intensive co-learning and epistemic alliances.

This will have to happen in the context of, and as a response to, three important challenges that arise when critically reflecting on law's engagement with an earth system perspective. First, legal scholars often confine their research within their specific areas of legal specialisation, such as environmental law, criminal law, property law, and tort law. Intradisciplinary research collaborations are few and often result from haphazard interactions (Pedersen, 2018). Second, we question whether law is apt to engage with other disciplines situated in the humanities, social sciences and natural sciences, since a thorough interdisciplinary dialogue still seems to be in its infancy when it comes to understanding earth system governance challenges and legal ways to respond to these challenges (Kotzé, 2018; Stephens, 2018). Third, legal scholarship does not yet fully engage with a wide range of stakeholders in a way that could initiate and sustain positive changes to realities of these stakeholders in the context of a rapidly changing earth system (Holley et al., 2018). In sum, there needs to be greater connections within approaches to law as well as with other disciplines, and a radical reimagining of the subjects of law and those who co-produce it.

In the light of these challenges, this article serves as an invitation to fellow explorers from various legal fields, other disciplines, and from a range of stakeholders, to explore new frontiers in earth system law. Our aim is to further stimulate the development of the nascent idea of earth system law, and to encourage collaboration and co-learning in the fertile epistemic space that we share. We first elaborate the importance of

embracing systems thinking for the purpose of reimagining law's relationship with the earth system. This is followed by three sections that explore responses to the three challenges that we outlined above, and as they exist (1) with respect to silos within law as a system; (2) between law and other disciplines; and (3) in a transdisciplinary sense, between legal and other scholars and multiple stakeholders in a broad sense, including the marginalized, the unborn, and the non-human. The discussion in each of these three sections ultimately seeks to reveal the liberating prospects of thorough collaboration and co-learning that would be necessary to advance earth system law and its research agenda as a new legal episteme for the Anthropocene, and to further the potential transformations earth system law could initiate for the collective benefit of multiple stakeholders.

2. Law and earth system thinking

Systems thinking lies at the heart of recent paradigms such as those evident in earth system science (Schellnhuber et al., 2004) and earth system governance (Biermann, 2007), and by extension, earth system law (Kotzé and Kim, 2019). These paradigms attempt to understand the functioning of planet Earth and the entire community of life it hosts. This includes specifically the interactions between living (human and non-human) and non-living earth system constituents and processes, the multiple intertwined and complex governance challenges arising from such interactions, and particularly the deepening interconnected social-ecological disruptions through a complex web of feedback loops. The earth system, understood as a complex adaptive system, is inherently unpredictable and uncontrollable, and the challenge is how to respond to surprises and uncertainties in a holistic way through legal and other regulatory interventions. Embracing an earth system perspective, we argue, is a key prerequisite for any effort that seeks to reimagine the role and potential of law as a social regulatory institution to tackle earth system governance challenges.

Systems thinking is, first and foremost, premised on the notion of a system, which is "an entity that maintains its existence and functions as a whole through the interaction of its parts" (Assaraf and Orion, 2005, p. 519). Systems thinking is based on the belief that any system, whether "natural" or "social", is best understood by a non-reductionist approach that focuses on the interactions between its constituent parts and its relation to other systems. Systems thinking has been applied in a wide range of disciplines, such as cybernetics (Beer, 1972), biology (Maturana and Varela, 1975), or sociology (Morin, 2001). In the 1980s, systems thinking started being applied to the Earth as a planetary whole. Thinking about the Earth in terms of a system allows a pertinent shift of focus to the planetary scale and offers pathways of entry into new areas seeking to understand complex and dynamic human and non-human relationships, complex self-organising systems, irreversible impacts of interacting stresses, multiple scales of organisation, and the various actors and their agendas that influence or are affected by earth system change (Kotzé, 2020).

The idea of systematicity also lies at the heart of law and legal science, whereby law is viewed as a coherent, ordered system of norms (Kelsen, 1967; González Hauck, 2020). One of the most paradigmatic examples of a systems approach to law can be found in Luhmann's theory of autopoietic law (Luhmann, 1986, 2004; Teubner, 1993). Autopoietic law has already been applied to environmental law and ecological issues (Teubner, 1994), and subsequently criticized (Philipopoulos-Mihalopoulos, 2007, 2014; Petersmann, 2021b). Some scholars have developed a "complex adaptive systems" approach to law (Ruhl, 1997), arguing that "international environmental law, as a control system, may benefit from the insights gained and from being modelled in ways more appropriately aligned with the functioning of the Earth System itself" (Kim and Mackey, 2014, p. 5). Yet others have suggested a new legal system altogether, an "ecological law" based on systemic ecological principles created by widespread community networking and resistance against external forces that threaten the life

of the ecological community writ large (Capra and Mattei, 2015).

Much of the motivation behind these attempts to (re)orientate law with a systems perspective arises from the belief that the architecture of law, including its assumptions, orientation, operation and objectives, cannot be brought in line with the regulatory challenges of a complex earth system (Cardesa-Salzmänn and Cocciolo, 2019; Kotzé, 2020). Formally introduced in 2019, the most recent attempt to rethink law alongside a systems perspective is earth system law, which aims to “align” law with the earth system (Kotzé and Kim, 2019). Because it is an evolving notion, there are different views on what earth system law is (e.g., Gellers, 2021; Mai and Boulot, 2021; Petersmann, 2021b; van Asselt, 2021). There seems to be some agreement though that earth system law is not a new body of law that regulates a specific issue (such as environmental law that deals with environmental protection, or contract law that focuses on contracts); although it could become in time. It is rather a new way of thinking about the role, purpose, objectives and design of law in the Anthropocene that specifically draws on the earth system context (Kim and Kotzé, 2021).

The development of earth system law is a response to law’s continued inability to fully align itself, and to embrace, earth system complexity. Premised as it is on assumptions of Holocene stability, law, like other political and economic institutions, “could often take for granted the presence of the non-human world and the ecological systems in which human societies are embedded [and] institutional success came most straightforwardly in the form of rules or informal arrangements to control access, rather than in adaptation to ecological dynamism of the sort that could be expected were stable Holocene conditions to change” (Dryzek, 2016, p. 938). Such a reductionist approach that is based on Holocene stability has now become problematic: “[A]lthough humanity has been capable of transforming the Earth through a deluge of entangled but uncoordinated actions, it was evidently intellectually unprepared to do so or to cope with the consequences at the level of whole-systems wisdom. Nobody had a grand plan for planetary refurbishment” (Clark et al., 2004, p. 8).

Earth system law instead explicitly revolves on an earth system perspective and fully embraces the regulatory concerns of the earth system governance framework. To this end, earth system law discards the notion of Holocene stability and purports to rethink law’s systems approach in the light of the functioning of the earth system itself, and the multiple governance challenges that arise (Kim, 2021). Earth system law therefore fully embraces the earth system’s key characteristics such as interconnectedness, unpredictability, instability, and complexity. This systems approach is emerging in dialogue with earth system science and earth system governance (Biermann and Löwbrand, 2019), and it is informed by insights from the literature critiquing the ontology and epistemology of modernist law in the context of the Anthropocene (Kotzé, 2017; Birrell and Matthews, 2020; Birrell and Dehm, 2021).

The earth system law framework advances here a novel systems approach to law; an approach that merges the systemic and complex nature of the earth system and of the legal system into a single operative framework. In doing so, the framework allows the epistemic traveller to explore responses to earth system-related regulatory implications of the Anthropocene such as complexity, inclusivity, interdependencies, and the need for radical transformations in the face of unprecedented social-ecological injustices at a planetary scale (Kotzé, 2019a). Such an exploration is guided by the evolving research agenda for earth system law (Kotzé and Kim, 2019) that links up with the recently proposed new research framework of the Earth System Governance Project (Burch et al., 2019). This agenda highlights the contribution that earth system law research could make to the four contextual conditions (transformations, inequality, Anthropocene, diversity) and five research lenses (architecture and agency, democracy and power, justice and allocation, anticipation and imagination, adaptiveness and reflexivity) of the earth system governance research framework (Mai and Boulot, 2021).

For law to meaningfully embrace an earth system perspective, and to

investigate how law could better respond to complex earth system governance challenges, will require lawyers in specific branches of law to continue reaching out to other legal branches, and to further deepen existing collaborations. Lawyers will also have to reach out to other disciplines, and conversely, non-lawyers from other disciplines will need to collaborate with lawyers in an interdisciplinary effort. Collectively, all this could contribute to a better transdisciplinary understanding of a more innovative contribution of law to urgent transformations for the benefit of all. To this end, we explore below how increased intra-disciplinary and interdisciplinary collaboration, and transdisciplinary multistakeholder engagement, could contribute to reimagining law in the light of the earth system perspective.

3. Reaching out to other branches of law

The study and practice of law is marked by ever-growing specialisation, with a wide range of increasingly narrowly defined branches of law, such as business law, criminal law, human rights law, or environmental law. These specialisations of law have in themselves become even further specialised over time. Environmental law, for instance, is sub-divided into different issue areas such as climate law and biodiversity law. Each of these issue areas has developed its own internal logic and set of institutions, evolving into autonomous subdisciplines rather than being a branch of a larger legal system (e.g., Bodansky, 2006). One example is the complex body of climate law at the international, regional, domestic, and subnational levels; with a range of norms from hard to soft law that are crafted and implemented by multiple actors including legislatures, courts, corporations, and civil society (van Asselt et al. forthcoming).

The growing number of subdisciplines may, on the one hand, be considered a reflection of increasing social complexity, where diverse challenges require distinct regulatory responses. The specialisation of law also “enable[s] consistency by designating categories of similar situations to which a common set of principles applies” (Aagard, 2010, p. 224), and subsequently improves our understanding of the function of law. On the other hand, the divvying up of the law in ever-smaller pieces has downsides. First, through specialisation, lawyers may lose sight of the broader landscape of legal norms (Easterbrook, 1996) and the complex relationships between subdisciplines. As a consequence, scholars may come to “resemble something akin to a group of international diplomats without a translation service” (Fisher et al., 2009, p. 231). Second, the technical turn inherent in specialisation often creates a mindset of “expert rule and managerialism” (Koskenniemi, 2007, p. 29; Petersmann, 2021c), in which each legal field sees its priorities according to its own rules. These shortcomings make law more reductionist, increase the risk of creating contradictions within law, and undermine law’s overall effectiveness in addressing earth system transformations.

Law’s silos are most problematic in the context of interconnected planetary social-ecological governance challenges (Galaz et al., 2017). For example, one can study the regulatory design of market-based climate policies such as renewable energy subsidies or carbon pricing. But without an analysis of how larger bodies of diverse legal norms, including investment law and corporate law, support the fossil fuel-based economy (Affolder, 2021), our understanding of the cumulative and collective role of law in achieving climate goals remains limited. A siloed approach may further overlook the role of law in preventing, and more worryingly, causing, environmental problem shifting, or situations where one aspect of the environment is protected by damaging another (Kim and Bosselmann, 2013). For instance, while replacing gasoline with biofuels may cut greenhouse gas emissions, it may also exacerbate other environmental problems such as eutrophication and lead to water scarcity (Yang et al., 2012). It has become an enormous challenge for lawyers to address problem shifting against the backdrop of the fragmentation of environmental law (Kim and van Asselt, 2016).

Increased specialisation in legal subdisciplines is natural and a necessary process in the evolution of law in a modern society. But the deeply complex and often existential questions of multifaceted social-ecological problems must now be addressed more than ever before in a coherent, collective and holistic way by the entire legal system and all legal subdisciplines that are relevant. Moreover, answers to these questions must go beyond usual critiques of law's epistemology and actively dismantle law's outdated Holocene-based frame of operations (Kim, 2021), to materially enact a legal onto-epistemology that is sensitive and responsive to the functioning of the earth system.

4. Reaching out to other disciplines

The legal discipline is not only internally fragmented; it also suffers from interdisciplinary fragmentation. The siloed nature of academic disciplines prevents us from adopting novel systems-oriented onto-epistemologies and regulatory approaches that are needed to respond to the social-ecological predicaments of the Anthropocene. Interdisciplinarity has found increasing patronage through training, growing diverse methodological literacy of lawyers, and institutional shifts in organisational arrangements and funding (Hutchinson, 2015); but the extent to which this is done remains insufficient to craft the type of reform directions necessary for systematic, sufficient and effective collaboration across academic disciplines to confront the Anthropocene's social-ecological disruptions.

We are concerned here with interdisciplinary interactions that seek to integrate "techniques, perspectives, concepts and/or theories from more than one discipline to develop knowledge in a way that is beyond the capacity of one discipline" (Little, 2016, p. 61). This is more than lawyers joining with scientists, engineers or historians to pursue the same social or ecological goals in an interactive but independent manner, and it goes beyond the long history of traditional legal research relying on other disciplines (from history to psychology) to interpret law (Ulen, 2004; Taekema and van der Burg, 2015). Such "shallow" interdisciplinary endeavours have been observed in the past. Law and geography (Bartel et al., 2013) and law and science and technology studies (Rohracher, 2015) are only two examples that have emerged as spaces for destabilising disciplinary demarcations (Pieraccini, 2018). The same can be said of the environmental law subdiscipline. While debates continue as to the maturity of environmental law as a subdiscipline (Fisher et al., 2009; Pieraccini, 2018), a common thread of environmental law research has been its interconnectedness with other disciplines. This is because the nature of its object of interest – namely "the environment" – depends on understanding disciplines such as environmental science, politics, and economics. Environmental problems have also interacted with regulatory tools, like permit trading systems and information and education programmes, which require environmental lawyers to develop an understanding of economics, behavioural sciences, and other related disciplines (Fisher et al., 2009; Holley, 2017).

Despite these developments, however, most have been narrowly defined around self-contained scholarship/projects, often involving other disciplines, but remaining safely within disciplinary bounds (Fisher et al., 2009; Pieraccini, 2018). Instead, our ideal involves a much deeper integration of disciplinary perspectives to mutually develop a far more comprehensive and networked systems-oriented understanding of a problem and possible ways to address it (Burris et al., 2016; Boone et al., 2020). We argue that lawyers and non-lawyers will need to transcend disciplinary boundaries and rethink the production of knowledge across fields in order to attempt solving deeply intertwined earth system governance challenges by drawing on a rich variety of knowledges.

There are at least three reasons why interdisciplinarity has become necessary for responding to complex problems such as those evident in terms of the earth system. First, where different disciplinary knowledge is combined, new knowledge and discoveries can be created beyond the scope of a single discipline (Owen and Noblet, 2014). The added value of

such interactive efforts is particularly evident in the context of complex or wicked problems (e.g., Institute of Medicine US Committee on Building Bridges in the Brain, Behavioral, and Clinical Sciences, 2000). Second, as disciplines challenge each other's orthodoxy, blind spots within otherwise separate disciplines can be addressed and corrected, for example, where behavioural economics (psychology and economics) challenge traditional rational-actor assumptions (Thaler and Sunstein, 2008). The third benefit of interdisciplinarity is that sharing diverse data and knowledge enables individual disciplines to be informed by and bolster their own research agendas, for example, using history to contextualise statutory or constitutional provisions (Owen and Noblet, 2014).

In moving towards greater interdisciplinarity, a first step is to acknowledge that it is the legal discipline's defining conventions themselves that tend to create conceptual and methodological barriers to interdisciplinarity. For example, legal scholars do not tend to interrogate the doctrinal and normative approaches of other disciplines. Yet, through the lenses of the natural and social sciences, a legal scholar might legitimately be asked questions about assumptions, hypotheses, methods, and data (Taekema and van der Burg, 2015). A lack of shared vocabulary and thought processes, or difficulty in finding common ground with other disciplines (such as shared expectations, research objectives, or desired results) make interdisciplinary communication among researchers especially difficult and time consuming (Fisher et al., 2009; Tobias et al., 2019). Lawyers will also need to get acquainted with the methods used in other disciplines, especially in earth system science, the findings of which heavily rely on modelling (Steffen et al., 2020). Fundamental, here, will be the ability to detect biased assumptions that modellers (consciously or unconsciously) might bring into their models (Kerkhoff et al., 2014) – biases that are not less present in the juridical tools and semantics used and deployed by lawyers themselves. At the institutional level, we need to acknowledge that opportunities for collaboration are often stymied by siloed university structures with hard boundaries between a law faculty and, for example, a science faculty (Owen and Noblet, 2014).

The existing interdisciplinary efforts have been epistemologically less challenging than the interdisciplinary systems-based approach we propose. While our reflection on these trends reveals awareness and attempts to break down disciplinary silos, further work is needed to overcome ongoing barriers and develop clear pathways toward interdisciplinary solutions for the purpose of confronting earth system governance challenges (Bammer et al., 2020).

5. Broadening law's subjects and reaching out to diverse stakeholders

In addition to intradisciplinary and interdisciplinary considerations, law will have to open up to a wider range of social actors to retain legitimacy as a social regulatory institution, to increase this legitimacy, and ultimately, to enhance its effectiveness to respond to earth system governance challenges. Earth system law, more specifically, requires a shift of ontological and epistemological premises to realise law's long overdue reimagination in the context of the Anthropocene. In terms of ontological assumptions, subjects of earth system law should 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. Crucially, to embrace such an ontology, we must ask ourselves questions such as "Who belongs to communities of justice in the Anthropocene?" (Gellers, 2021); and "How can law address the entire living order's shared but differentially distributed vulnerability in the face of accelerating Earth System decay and diminishing planetary integrity?" (Kotzé, 2019b). Answering such questions involves acknowledging law's necessary extension to those beings situated in the physical, biological, social and mental worlds comprising the earth system. It also requires a very deliberate rejection of law's prevailing dualist Cartesian ontology of disembodiment where

invulnerable, invincible humans who are emboldened by their hubris, master nature, control natural disasters and (ironically) dictate the fate of humanity itself (Assiter, 2013). Recognizing the fundamental inseparability from the earth system in which they are embedded, entangled human and non-human beings and entities find themselves occupying a plane of shared vulnerability, one in which “human vulnerability is ontologically intertwined with non-human vulnerability” (Kotzé, 2020, p. 27).

Practically speaking, this shift in legal thinking would allow the introduction of certain legal subjects who have thus far enjoyed limited or nascent recognition in constitutions and courts around the world (such as non-humans and future generations). More controversially, some argue that engaging non-humans implies more than recognising their legal status (Stone, 1972), but taking their interests just as seriously as those of their human counterparts and even elevating them above human preferences when conflicts arise (Emmenegger and Tschentscher, 1994). No longer can the imperative of economic development reign supreme, as dictated by Western law’s unsustainable insistence on protecting human property rights, for example. Instead, a law informed by an earth system perspective would be oriented towards the more egalitarian goal of achieving social-ecological justice, notably at a planetary scale (Biermann and Kalfagianni, 2020), by fully embracing all present and future earth system constituents including especially marginalized and unborn humans and the non-human world (Kotzé and Kim, 2019).

This could be accomplished, for example, if law were to finally free itself from longstanding epistemologies of appropriation, extraction and mastery, and instead embrace alternative onto-epistemologies of humility and care (van Dooren, 2014; Puig de la Bellacasa, 2017). Earth system law would therefore actively reject environmental law’s deeply entrenched neoliberal growth-oriented vision of “sustainable development” and replace it with alternative ways of being, knowing, acting and caring (Kotzé et al., forthcoming). Although there are encouraging signs of judicial institutions working more deliberately to protect, for example, future generations against climate change (see e.g. the recent German Constitutional Court ruling in *Neubauer et al. versus Germany* 2021), environmental law’s prevailing ontologies and epistemologies of mastery often work to exacerbate systemic inequalities, and inter- and intra-generation as well as inter-species injustices. In doing so, they repeatedly generate social-ecological harms, and cause destruction of the earth system – a destruction that further intensifies the interconnected vulnerability of the entire living order (Adelman, 2019). Other ecologically sustainable ways of being, knowing, acting and caring must therefore be envisioned to dismantle and replace the hubristic epistemologies of dominance and mastery that one finds in law generally, and in environmental law specifically. Spanning a spectrum of approaches from “epistemologies of the South” and indigenous onto-epistemologies, to new developments in the Western tradition, these epistemologies include, for example, *Buen vivir*, *Ubuntu* and the ideas and practices of degrowth and the dismantling of fossil capitalism (Adelman, 2015; Santos, 2015; Bluwstein, 2021; Chao and Enari, 2021; Moyo, 2021).

In practice, a transition to earth system law would necessitate identifying relevant stakeholders, devising ways to incorporate their knowledge and interests into decision-making processes, and jointly disseminating the results to co-participants and affected communities. These tasks would need to be executed on an iterative basis between different branches of law, different academic disciplines, and a broad range of social actors. Existing methods of stakeholder mapping (e.g., Chevalier and Buckles, 2008; Gilmour et al., 2011) would need to be revised in order to balance and address the interests and agency of humans and non-humans alike (Petersmann, 2021d). For instance, new approaches like Favre’s (2020) ecological understanding of non-human animal rights, or Gellers’ (2020) critical environmental ethic might offer suitable platforms for considering the ambitions of endangered bees alongside (or arguably even above) those of beekeepers and honey

consumers. Equally, such a transition must have a clear focus on particularly vulnerable segments of society, and it must contribute to a recent call by some earth system governance scholars to develop a “clearly articulated pro-poor focus within diverse and often abstract conceptions of planetary justice”; through “better theoretical approaches and differently focused empirical studies that put the needs of the poor first in analyzing and advocating for effective governance responses to planetary ecological crises and earth system transformations” (Kashwan et al., 2020, p. 1).

Law would also have to open itself up to the co-production of knowledge with numerous actors who are not necessarily legal experts, and while doing so, also respect a diversity of epistemologies. Helpful models found in other disciplines, such as citizen science (Irwin 1995), citizen sensing (Petersmann and Berti Suman, 2021), commoning (Capra and Mattei, 2015; Gear and Bollier, 2020), civil disobedience and dissent (Schwartzberg, 2020; Pineda, 2021), community organising (e.g., La Via Campesina, 2021; Progressive International, 2021), fugitive planning (Moten and Harney, 2013), autonomous and insurrectional practices against fossil capitalism (Brock and Dunlap, 2018; Malm, 2021), traditional ecological knowledge (Huntington, 2000), or crowdsourcing (Gellers, 2016), already exist. Earth system law would encourage this brand of inclusion and empowerment by providing a space for collaboration, and permitting non-experts to contribute to legal proceedings through accessible, inclusive and familiar modalities. The goal here is not to devalue or do away with established forms and methods of representative democracy (such as elected parliaments, legislators and independent courts), but rather to add to this by intentionally welcoming a variety of stakeholders (including, for example, vulnerable poor people, the unborn, and non-humans) and to explore possibilities for their strengthened/improved representation into the legal arena. Ultimately, the explicit goal must be one of maximizing civic or citizen participation, where “citizen” is construed as broadly as possible, and “participation” is viewed as essential to legitimising both process and outcome.

Finally, the results of these “radical” participatory efforts need to be communicated to those most likely to be affected by them. The old channels of distribution (all oftentimes elitist and exclusionary) — through academic writings, law reports, gazettes, digital documents, news reports, networks or word of mouth — are alone insufficient for conveying information to all relevant stakeholders that have an interest in preserving planetary integrity and improving the well-being of the entire living order. New forms of outreach – from social media to social robots and beyond – will also be needed to cultivate trustworthy and widespread awareness of the outcomes associated with stakeholder input.

6. A plan of action

Building earth system law as a new frontier in legal science demands us to reimagine law’s relationship with the earth system, which in turn requires more intensive collaboration and co-learning to occur. To that end, a series of steps could be envisioned which corresponds to the challenges of overcoming the intradisciplinary, interdisciplinary, and transdisciplinary silos discussed above.

The first step is to get lawyers to work better together by relying on a shared common language and relatively accepted problem orientations. Lawyers will need to have an open debate about conflicting values and objectives underpinning different fields of law. This may usefully lead to the identification of overarching norms and principles that could guide law-making in different fields (Kim et al., 2020). Such an effort to further systematise legal systems may create a seamless “web of law” (Smith, 2007) that cuts across the boundaries of legal specialisation, which is a prerequisite to effectively address complex and networked risks and challenges. Such intradisciplinary inquiries could also offer deeper insights into how certain legal concepts, such as sovereignty, property rights, the corporate form, and sustainable development,

sustain or even exacerbate interconnected social-ecological impacts. Lawyers could then contribute to the formulation of potential alternatives that might be more fit-for-purpose in the context of the Anthropocene and its social-ecological disruptions. This would require lawyers to collectively imagine a way to broaden law's prevailing focus on governing externalities to also focus on root causes (Viñuales, 2018). For example, law will remain ineffective in addressing climate change by maintaining its current focus on externalities (e.g., carbon emissions) without addressing the many diverse, complex, and interlinked root causes of climate change (e.g., subsidies for fossil fuel extraction) (Skovgaard and van Asselt, 2018). Lawyers will have to draw on a diverse set of legal subdisciplines, such as trade law, investment law, corporate law, transport law, and migration law, to build a more holistic systems approach to governing earth system challenges.

The second step in pursuit of an earth system law approach is to ensure strengthened interaction between lawyers and non-lawyers. In order to learn and interact in new ways, and to frame and conduct research differently, the promotion and development of interdisciplinarity could be explored at both individual and institutional levels. At the level of individual researchers, a first but challenging consideration is for legal scholars to commit time to learn about other disciplines, particularly non-legal research methods and tools, while also explaining the ways in which lawyers conduct their research (Owen and Noblet, 2014). Armed with such knowledge, legal scholars can arguably play a key role in identifying gaps and translating other knowledges through law (Burriss et al., 2016). This could include proactively building interdisciplinary teams and projects by using legal scenarios/problems to facilitate new understandings of the implications of future legal, social and environmental system changes (Little, 2016). For example, lawyers may mobilise scholars around a scenario involving current laws to explore how they might operate in the event of a future environmental situation (Little, 2016). Scenarios may also take as their starting point a future target (e.g., a level of legal compliance) and then work backwards to analyse how that situation came about (Little, 2016; Castilla Rho et al., 2017). These and similar simulations may shed light on the implications of and need for law and governance reform in ways that are relevant to scientific experts and policymakers (Little, 2016). Once such projects are taken on, spending time creating a shared vocabulary, including a glossary developed to provide definitions and descriptions of concepts used in the project will help to break down barriers (Bruzzone et al., 2016). Depending on the nature of the project and its goals, successful interdisciplinary integration will likely require researchers to actively work together; for example, scientists and lawyers jointly reading legislation and designing and conducting collaborative field research (Bruzzone et al., 2016; Schneider et al., 2020).

At the institutional level, increasing interdisciplinary practices will require further structural changes in institutions, funding streams, and performance measures (Burriss et al., 2016). This will need to involve universities encouraging collaboration between expertise areas by, among others, putting more scholars in joint disciplinary appointments; actively funding and celebrating interdisciplinary and collaborative successes, and developing new metrics and criteria for activities outside the scope of traditional legal disciplinary research and journals (Owen and Noblet, 2014; Gordon et al., 2019; Bammer et al., 2020). Creating connected physical and digital spaces for different disciplines to come together will also be vitally important. Such co-location can help build social capital, spark ideas and facilitate problem ownership for interdisciplinary work. At least in the medium term, such spaces and the collaborations that occur around them are likely to be based on soft money and to be problem oriented (Gordon et al., 2019; Tobias et al., 2019). Deeper interdisciplinary training will also be needed, including further integration of dual degree models, and introducing research methods training for all levels of legal academics (Owen and Noblet, 2014; Pieraccini, 2018; Gordon et al., 2019). Strengthening interactions between lawyers and non-lawyers can further be accomplished through interdisciplinary epistemic alliances such as the Earth System

Governance Network (Earth System Governance), and more specifically, its Task Force on Earth System Law (Earth System Governance Task Force on Earth System Law), where scholars, students and practitioners from various social science disciplines are already convening around the shared theme of law's role in mediating earth system governance challenges.

The third step speaks to reaching out to multiple stakeholders in a transdisciplinary setting, and it requires that earth system law must define relevant actors broadly to include both present and future human and non-human beings and entities. This step is couched as a more fundamental change in what law is and used for across the globe – from government, neoliberal and expert dominant, to co-produced, participatory and ecologically focused forms of law that are specifically geared towards protecting the vulnerable. As this would require deeper changes in normative orders, different considerations can be envisaged and relied upon. For example, in an increasingly digitized world, new opportunities arise for soliciting participation and providing meaningful and timely updates about the outcomes of adjudicatory and decision-making processes. But these modes of communication must complement, not replace, low-cost means of participation available to those for whom time and technology remain luxuries. To fully benefit from digitalization, it would be imperative to provide and improve access to information technology. Sincere efforts must be made to invite affected communities into spaces where their perspectives will not only be heard, but also acted upon. Importantly, this means throwing law's rigid gates open to accepting forms of knowledge previously deemed unable to meet conventional or doctrinal standards of scientific validity, including specifically indigenous knowledge. It will also mean breaking down law's real and perceived narrow scope of protection to enable a more all-encompassing protective embrace of the concerns of an *entire* vulnerable living order, including (present and future) humans and non-humans. Finally, while social media, and information technology generally, offer innovative ways of targeting information to stakeholders, the reality of an ongoing digital divide within and across countries dictates that outreach strategies need to be sensitive to the particularities of a given context, especially where resources (e.g., bandwidth) are scarce.

While the abovementioned changes are important for laying the conditions of more widespread collaboration across intra-, inter-, and transdisciplinary boundaries, it is ultimately in the combination and complementarity of all three steps that earth system law will find its ultimate strength and trigger the necessary shifts. These shifts, however, will likely occur in phases rather than a great leap. Notably, all of the above suggestions will be time consuming for individuals and institutions and will require research organisations and leaders to be intra-, inter- and transdisciplinary advocates (Owen and Noblet, 2014). Through such steps, new paradigms may gradually emerge to transcend traditional boundaries and develop new languages and thought processes for earth system law research and practice. Of course, independent disciplines still have benefits in their own right, and they remain inherently a precondition to interdisciplinary and transdisciplinary research. Even so, it is clear that there are many earth system governance challenges in the Anthropocene that have remained as unanswered as they are troubling (such as biodiversity loss and changes in the climate). It is these types of challenges for which intra-, inter- and transdisciplinary research are well suited in the context of an earth system law framework because they call "upon all disciplines, the entire body of human knowledge about the world, to analyse what is happening and how to face it" (Viñuales, 2016, p. 4).

7. Conclusion

The Anthropocene creates a new sense of urgency, a new unease about humanity and its impacts, thereby demanding an ethic that cultivates new imaginaries of community, inclusivity, recognition, representation, and answerability (Biermann and Löwbrand, 2019), as well as requiring new ways of knowing, being, caring, and acting for an entire

vulnerable living order. Collectively, this calls for a reimagination of law, as the set of rules, norms, and principles that regulate behaviour within the context of the earth system. To be meaningful, embracing a systems perspective must also be accompanied by transformational solutions (Fedele et al., 2019) that invoke a paradigm shift (Daigneault, 2014; Nustar et al., 2018). Paradigm shifts involve questioning assumptions and mental models underpinning strategies and action; they involve changes in the sphere of ideas, beliefs, values and worldviews (Few et al., 2017). Paradigm shifts also foreground real change in law, policy, behaviour, and practice that could lead to emancipatory goals (Scoones et al., 2020).

Such changes will ask not only for a more deliberate receptivity towards systems thinking, alignment of different branches of law, and a new methodology that operates across disciplines. The development of earth system law will also require reaching out beyond the (legal) academe to involve all social actors, including especially the global poor, as well as the unborn and the non-human in a transdisciplinary setting. In this article we explored some possible directions and actions that could facilitate such a collaborative intradisciplinary, interdisciplinary, and transdisciplinary reimagination of law within the earth system context. We hope that fellow epistemic travellers will join us in the effort to further explore new frontiers in earth system law.

CRedit authorship contribution statement

Louis J. Kotzé: Lead author, Supervision, Project administration, Conceptualization, Writing – original draft, Writing – review & editing. **Rakhyun E. Kim:** Lead author, Supervision, Project administration, Conceptualization, Writing – original draft, Writing – review & editing. **Catherine Blanchard:** Lead author, Supervision, Project administration, Conceptualization, Writing – original draft, Writing – review & editing. **Joshua C. Gellers:** Conceptualization, Writing – original draft, Writing – review & editing. **Cameron Holley:** Conceptualization, Writing – original draft, Writing – review & editing. **Marie Petersmann:** Conceptualization, Writing – original draft, Writing – review & editing. **Harro van Asselt:** Conceptualization, Writing – original draft, Writing – review & editing. **Frank Biermann:** Conceptualization, Writing – original draft, Writing – review & editing. **Margot Hurlbert:** 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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